TECHNOLOGY ACCEPTANCE MODEL: PREDICTING NURSES' ACCEPTANCE OF TELEMEDICE TECHNOLOGY (eICU®)

by

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DEDICATION

This dissertation is dedicated to Mr. Kamol Kowitlawakul and Mr. Udom Kongphonpan who gave me the opportunity to come to America. Even though they are no longer with their family in this world, their will always inspires me to advance my education. In addition, this dissertation is dedicated to my mother, my grandparent, and my sisters who are in Thailand.

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1. TAM: Technology Acceptance Model
2. TRA: Theory of Reasoned Actions
3. TTAM: Telemedicine Technology Acceptance Model
4. ICTAM: Information Communication Technology Acceptance Model
5. ICU: Intensive Care Unit
6. eICU: electronic ICU or remote ICU

ABSTRACT

TECHNOLOGY ACCEPTANCE MODEL: PREDICTING NURSES' ACCEPTANCE OF TELEMEDECINE TECHNOLOGY (eICU®)

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The Technology Acceptance Model (TAM) is one of the promising models that represent an important theoretical framework to explain and predict an individual's technology acceptance. TAM has been used extensively in the business, education, and information technology settings, but rarely in a health care setting. Rapid growth of investment worldwide in information technology by health care organizations has dramatically raised the importance of technology acceptance as an issue. Technology systems can not enhance the performance of health care providers or improve patient outcomes if the technology systems are not accepted by the end users. In the health care industry, nurses are often identified as end users. Therefore, more investigation for better understanding of why nurses accept or reject new technology is needed. This research study attempted to examine the applicability of the TAM in explaining nurses' acceptance of telemedicine technology (eICU®) in a health care setting, and also determined factors and predictors that influenced the probability of the nurses' acceptance of this technology. The

psychometric evidence (validity and reliability) of the measurement scales used in the study was discussed.

CHAPTER I

Research Objectives

Introduction

The concept of *technology acceptance* for this study is derived from the Technology Acceptance Model (TAM), which was developed by David in 1986. TAM was first developed in the discipline of social psychology and specifically was meant to provide an explanation, prediction, and identification of the determinants of computer acceptance or explanation of why a particular system was unacceptable (Davis, Bagozzi, & Warshaw, 1989). It provides theoretical linkages among users' internal beliefs, attitudes, intention, and usage behavior, to determine how individuals accept or reject a new technology (Davis, 1989).

TAM has been used extensively as a theoretical framework in the areas of information technology, education, and business (Szajna, 1996; Cheung & Huang, 2005; Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Drennan, Kennedy & Pisarki, 2005; Harrison & Rainer, 1992; Straub, Limayem & Karahanna-Evaristo, 1995; Lu, Yu, Liu & Yao, 2003 ; Venkatesh, 2000; Venkatesh & Davis, 2000). There have been few studies in health care settings (Chang et al, 2004; Handy, Hunter, & Whiddett, 2001; Hu, Chau, & Tam, 1999), and even fewer with regard to nursing practice (Ammenwerth, Mansmann, Iller, & Eichstadter, 2003; Tung, Chang, & Chou, 2007).

Over the years, information technology has been used in healthcare delivery systems to improve patient care outcomes worldwide (Barnard, 2002; Beach, 2002; DeLuca & Cagan, 1996). In the United States, since IOM (Institute of Medicine) released "To Err is Human" in 1998, there has been a remarkable effort to use information technology to improve patient safety throughout healthcare delivery systems. For example, the Leapfrog Group, the National Patient Safety Foundation, the Institute for Healthcare Improvement, and the Joint Commission, all encourage information technology implementation to prevent human error (Davis & Duchene, 2006).

According to many studies (Bracco et al, 2001; Celi et al, 2001; Cullen et al, 1997; Donchin et al, 1995; Rothschild et al, 2005), a high incidence of adverse events and medical errors has been found in critical care settings (intensive care units or ICUs). One of the recommendations from the Leapfrog Group, the National Quality Forum, and the Agency for Health Care Research and Quality is to staff ICUs with board-certified critical care physicians to provide care exclusively and immediately within five minutes to prevent medical errors and adverse events, and to reduce hospital mortality rates (Breslow et al, 2004; Spiegler, 2004).

Nevertheless, a shortage of critical care physicians and nurses makes it difficult to be compliant with the recommendation. During overnight and weekend hours, it is more difficult to have critical care physicians (intensivists) covering for the ICU patients (Spiegler, 2004). Therefore, telemedicine technology, eICU® (remote ICU or electronic ICU), has been proposed as a possible alternative solution to allow critical care nurses and intensivist expertise to monitor ICU patients from off-site locations. Patients can

then be monitored at all times to detect adverse events and improve patient outcomes. This health telemedicine technology, eICU®, is beginning to be implemented in many hospitals nationwide now.

The eICU® technology system is possible and may well be advantage to a health care system (Celi et al, 2001). According to Breslow et al (2004) study, after the implementation of an eICU® technology system in a large tertiary care hospital between 1999 – 2001, the results shown that the hospital mortality for ICU patients was lower to 9.4 % (from 12.9%), ICU length of stay was shorter (from 4.35 days to 3.63 days), and costs per case of patient was lower. Similar to Webber's study (2007), after one year of using the eICU® technology system, the hospital (167 bed facility) has seen patient mortality drop by 24 percent, length of stay has been shortened by 6 percent, and overall hospital length of stay for ICU patients has decreased 14 percent from 2005. Those studies suggested that the eICU® technology system may provide a great resource for hospitals to achieve quality of care using fewer intensivists (critical care physicians).

The eICU® unit is a secure telemedicine center where a team of critical care physicians and nurses provide oversight surveillance for the patients in off-site intensive care units. This monitoring utilizes various technology such as a video assessment directly into the patient room, speakers in the patient room, telephone, hospital information systems, and the VISICU's eCareManagement® (a computer software program). The data of vital signs from bedside monitors and medical data, such as temperature, intake/output, blood sugar, labs results, and medication, are interfaced with the computer data base system. However, bedside nurses have to monitor the patient

closely and cooperate with the eICU® team for the accuracy of the medical data. Then the eICU® team can review all of the medical data through the computer system and have immediate communication with and access to the on-site nurses and physicians.

Nurses are generally identified as computer end users in health care settings and they are often apprehensive to use available computer systems in their nursing practice (Stronge & Brodt, 1985). New technology in the nursing environment often leads to curiosity, frustration, and anxiety of the staff nurses. However, they try to adapt themselves to the new technology, while providing nursing care to their patients. Fear also appears when nurses confront technical difficulties, while using the computers and that can lead to anger and dislike of the new equipment (Kearns, 2000). Consequently, nurses will tend to refuse using the computers.

Based on this researcher's critical care experiences in one setting, many nurses complained when they received a phone call from the eICU® nurses. On-site nurses felt as though someone was watching over their shoulder. They complained about having to do extra work, losing autonomy, contradicting orders from two different doctors (from on-site and off-site), and duplicating documentation. On the other hand, some nurses had positive attitudes toward eICU®, but struggled when they had to deal with technical problems with the computer program. They were under stress when they could not import the data or could not enter the data in the way in which they wanted. As a result, some nurses were not willing to communicate with the eICU® nurses, and refused to take any advice from the eICU® team. Each of these situations caused conflict among health care providers, management issues, and negative patient outcomes.

The computer equipment or technological advances cannot improve organizational performance if they are not accepted and used by the end users (Davis, Bagozzi, & Warshaw, 1989). Farlee (1972) discovered that users' acceptance of an information system was a key factor in the success of that system. The resistance from the computer end users has a large impact on patient safety and patient outcomes. Also, it can cause increasing cost of care, increasing complexity of clinical care, and an increase in medical errors. Ideally, administrators should be able to predict whether a computer system will be accepted by users, in order to enhance the business regarding the large investment of time and money (Davis, Bagozzi, & Warshaw, 1989). Therefore, understanding why people accept or reject new technology has become a very significant issue (Legris, Ingham, & Collerette, 2003).

Successful investment of new technology can lead to improved productivity, while failure of the system implementation can lead to financial losses and dissatisfaction among employees (Hu, Chau, Liu Sheng, & Tam, 1999; Venkatesh, 2000). In many cases, people may use the technology system because it is mandated from the organizational administration, rather than using the system due to their own intentions. If individuals were to perceive pressure from the administration, then the outcomes of the system implementation might be poor performance (Davis, Bagozzi, & Warshaw, 1989).

In healthcare delivery systems, if the bedside nurse as the end user does not accept and use the eICU® computer system, the health care organization might fail to produce optimal outcomes and gain revenue. To prevent such consequences, identification factors influencing technology acceptance by nurses are needed.

The intent of this study was to determine significant factors and predictors of nurses' acceptance of telemedicine technology (eICU®), and to provide psychometric evidence (content validity and reliability) of measurement scales used in the study. The original Technology Acceptance Model (Davis, 1986) was used as a conceptual framework, and TAM with additional external variables (age, years working in the hospital, years of nursing experience, years of experience with computers, support from administrators, and support from physicians) was developed and tested.

Conceptual Framework

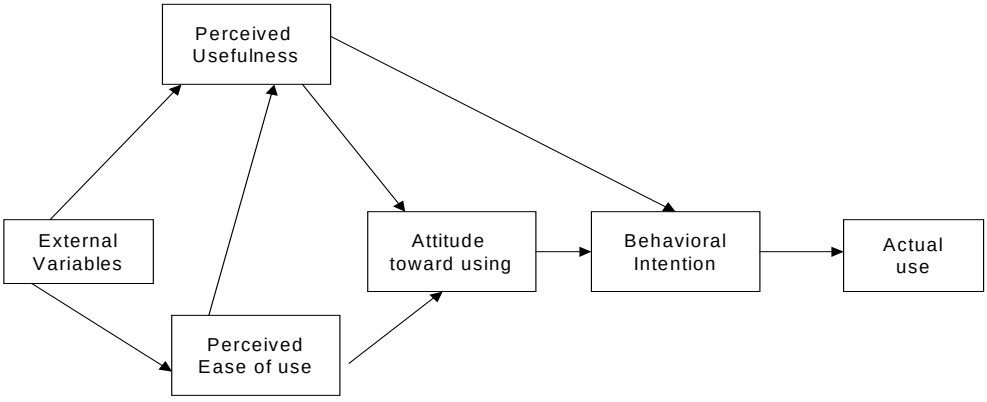


Figure 1.1. TAM: Technology Acceptance Model (Davis, Bagozzi, & Warshaw, 1989).

The Technology Acceptance Model (TAM) was initially developed by Davis in 1986. The goal of TAM is to provide an explanation of the determinants of computer acceptance that has a capability in explaining user behavior with a variety of end-user, technology, and user populations (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). Ideally, TAM provides a theoretical framework to explain, predict, and identify factors on internal beliefs, attitudes, and intentions of technology end-user.

Davis (1986) adapted the theory of reasoned actions (TRA) of Fishbein and Ajzen (1975) to construct the model of technology acceptance. The TRA is the theory that is concerned with the determinants of consciously intended behaviors (Fishbein & Ajzen, 1975), and was designed to explain human behavior across a wide variety of areas (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989).

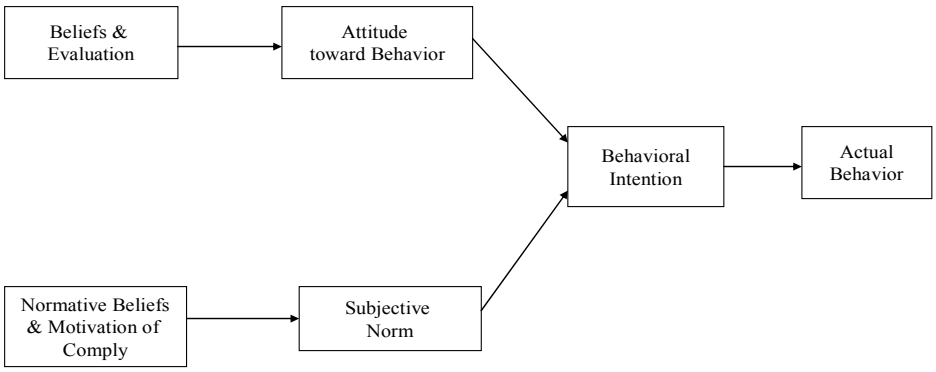


Figure 1.2. TRA: Theory of Reasoned Actions (Fishbein & Ajzen, 1975).

Both TAM and TRA proposed that intention is the major determinant of usage behavior, and usage behavior should be predicted by intention and any factors that influence intention directly and indirectly (Davis, Bagozzi, & Warshaw, 1989; Mathieson, 1991). According to the TAM, the primary key determinants to predict the actual usage are perceived usefulness and perceived ease of use, and they are influenced by external variables (Davis, Bagozzi, & Warshaw, 1989). Also, attitudes are the bridge between both key determinants and intentions before the actual behavior is generated (Fishbein & Ajzen, 1975).

However, TAM and TRA have some differences. First, TAM does not include *subject norm* (the influence of social pressures and beliefs) nor does it include any social variables in the model because it is one of the least understood aspects of TRA and it has uncertain theoretical and psychometric status (Davis, Bagozzi, & Warshaw, 1989). Second, TAM proposed that *perceived usefulness and perceived ease of use* are the primary key determinants for computer acceptance behaviors. Third, the intention to use the technology system in TAM is determined by the attitude toward using the system and perceived usefulness, but in TRA the intention to use is determined by the attitude toward behavior and subjective norm. In conclusion, TAM is easier to apply, and it supplies very general information on users' opinions about the system (Mathieson, 1991).

TAM is specifically meant to explain computer usage behaviors. The goal of TAM is to explain, predict, and identify the key determinants of computer acceptance or why a particular system is unacceptable (Davis, Bagozzi, & Warshaw, 1989). TAM provides the theoretical connection between two key determinants of beliefs (perceived

usefulness and perceived ease of use), and both determinants influence attitude, which in turn leads to intention to use. Then the intention generates the actual behavior (Davis, 1986). TAM is general enough to enable use with various types of populations and computer systems (Davis, Bagozzi, & Warshaw, 1989 & Mathieson, 1991).

With the original TAM (Davis, 1986), there are five constructs, which are *perceived usefulness, perceived ease of use, attitude toward using, behavioral intention to use, and actual system use.* The key determinants of computer acceptance in TAM are the belief that the computer system will help to improve his/her job performance (perceived usefulness), and the belief that using the computer system is free from mental effort (perceived ease of use) or that it is easy to use (Davis, Bagozzi, & Warshaw, 1989). Those two determinants are considered as the basis for attitudes toward using particular computer systems. Then again, the attitudes toward computers are also used to determine the intention to computer usage. Therefore, the actual behavior should be predictable from measures of behavior intention and any other factors that influence intention directly and indirectly (Mathieson, 1991), such as attitudes, perceived usefulness, perceived ease of use, and external variables.

The original TAM (Davis, 1986) has been modified in the past decade. Many constructs such as playfulness, experience, self-efficacy, management supports, social norm or social influence, individual difference, technology complexity, and others, were added to the original TAM (Lu, Yu, Liu, & Yao, 2003; Malhotra & Galletta, 1999; Taylor & Todd, 1995; Thompson, Higgins, & Howell, 1991; Igbaria, Schiffman, &

Wieckowski 1994; Igbaria, Zinatelli, Cragg & Cavaye, 1997; Venkatesh, 2000; Venkatesh & Morris, 2000; Venkatesh & Davis, 1996).

The original TAM was developed to TAM 2 by adding more constructs especially emphasizing social influences as a factor influencing the key determinants in the original TAM (Venkatesh & Davis, 2000). Then, the TAM 2 was developed to the Communication Technology Acceptance Model (ICTAM) by adding three constructs, which were compatibility, perceived playfulness, and Website loyalty (An, 2005).

Even though TAM has been changed over time with the additional constructs, the two key determinants (perceived usefulness and perceived ease of use) in the original TAM have still been used as predictors of technology acceptance in many studies (Hu, Chau, Liu Sheng, & Tam, 1999; Klopping & McKinney, 2004; Venkatesh, 2000). Szajna (1996) claimed that the original TAM may be more appropriate for predicting intentions to use information system than other revised TAM. Also, the study of Igbaria and his colleagues (1997) that was done in New Zealand with computer users in the business setting has confirmed that perceived ease of use and perceived usefulness were the dominant factors in explaining actual use.

The success of technology innovation relies on the individual end user's decision to adopt it or not (Lee, 2000). Therefore, the original TAM was used to guide the study to understand nurses' acceptance of telemedicine technology (eICU®). The proposed the original TAM (Davis, 1989), literature reviewed, and suggestions from the experts. The suitability of the proposed research model for identifying and predicting technology acceptance in nursing practice was explored by this study.

Proposed Research Model

The proposed research model was modified from the original TAM (Davis, 1986) with an additional six variables identified in the literature review and the suggestion from the experts; age, years working in the hospital, years of nursing experience, years of experience with computers, support from administrators, and support from physicians. Those variables were considered the external variables for TAM.

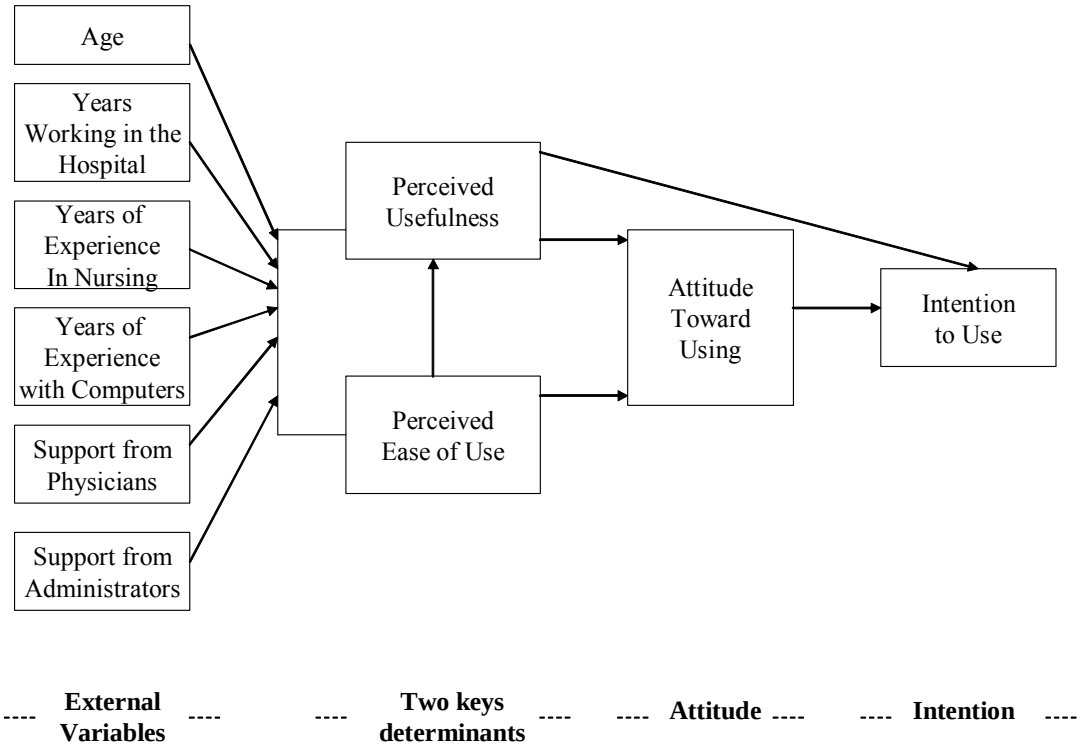


Figure 1.3. Proposed research model for the study

According to the original TAM, the perceived usefulness and the perceived ease of use are influenced by external variables. Perceived usefulness can be influenced by refined system characteristics and sophisticated educational programs designed for users (external variables). Perceived ease of use is influenced by improved system features, extensive user training, well-prepared documentation, and effective user support consultants (Davis, Bagozzi, & Warshaw, 1989). However, TAM's external variables are hypothesized as a priority and are meant to be fairly general determinants of user acceptance. This approach attempts to provide more generalization to different computer systems and user populations (Davis, Bagozzi, & Warshaw, 1989).

Based on many studies in nursing practice (Brumini, Kovic, Zombori, Lulic, & Petrovecki, 2005; McBrige & Nagle,1996; Simpson & Kenrick, 1997; Smith, Smith, Krungman, & Oman, 2005), *age, years of nursing experience, years of experience with computers* are considered the primary factors influencing nurses' attitudes toward using computer systems. *Years working in the hospital, support from administrators, and support from physicians* are considered the primary factors influencing the individuals' belief and attitudes toward using telemedicine technology (eICU®) based on suggestions of bedside nurses who used this technology and the experts. Those factors will be determined as external variables in the proposed research model.

The TAM related constructs are *perceived usefulness, perceived ease of use, attitude toward using, and intention to use*. Perceived usefulness and perceived ease of use are the primary key determinants for computer acceptance behaviors. Both determinants influence attitudes, which in turn lead to intention to use. Based on TAM

(Davis, Bagozzi, & Warshaw, 1989), the intention generates the actual individual usage behavior.

The proposed research model is presented the hypothesized theory based on the original TAM with additional external variables. The hypothesized model generates some expectations about the pattern of the relationship among all variables. Predicting factors influencing computer acceptance of the telemedicine technology (eICU®) are specified in this proposed research model.

Statement of the Purpose

The purposes of this study are: (a) to determine factors and predictors that influence nurses' acceptance of the eICU® (b), to examine the applicability of the TAM (Technology Acceptance Model) in explaining nurses' acceptance of telemedicine technology (eICU®) in health care settings, and (c) to provide psychometric evidence (validity and reliability) of the measurement scales used in the study.

Research questions

1. What are the relationships among the study external variables, the key determinants, the attitude toward using, and the intention to use telemedicine technology (eICU®)?
2. Which variables are most influential in predicting intention to use telemedicine technology (eICU®)?
3. Is the proposed hypothesized model consistent with the empirical data in the study?

Operational Definitions

The definition of each variable from proposed research model was adapted from the literature.

External Variables

External variables for this study are age, years working in the hospital, years of experience in nursing, years of experience with computers, support from physicians, and support from administrators.

Key Determinants

Key determinants for this study are perceived usefulness and perceived ease of use.

Perceived usefulness. Perceived usefulness is defined as the degree to which nurses believe that the eICU® technology system would enhance his or her nursing care performance to improve patient outcomes.

Perceived ease of use. Perceived ease of use is defined as the degree to which nurses expect the use of the eICU® technology system to be free of effort or easy to use.

Attitude

Attitude is a nurses' way of thinking or feeling toward the eICU® technology system use in nursing practice that might be negative or positive.

Intention

Intention is defined as a nurse's plan to use the eICU® computer system.

eICU®

An eICU® is a secured telemedicine center where a team of critical care physicians and nurses, and other staff provide oversight surveillance for the patients in the adult intensive care units. This monitoring is accomplished utilizing various

technology including hospital information systems, VISICU's eCareManager, Smart Alerts and video assessment directly into the patient room.

VISICU

VISICU is a technology company founded in 1998 by two nationally recognized intensivists from Johns Hopkins Hospital to create technology solutions that save lives and improve outcomes.

eCareManager

An eCareManager is the main software application of eVantage System. It includes the patient chart and most of patient care, medical data, and documentation function.

Telemedicine technology

Telemedicine technology is the distant site where the provider/specialist is seeing the patient at a distance or consulting with a patient's provider.

eICU® technology system

An eICU® technology system is the telemedicine technology that includes various technology including hospital information systems, VISICU's eCareManager, Smart Alerts and video assessment directly into the patient room.

Nurses' acceptance of telemedicine technology

Nurses' acceptance of telemedicine technology is defined as the actual behaviour of nurses willingly using the eICU® computer system to help improve their performance and patient outcomes.

CHAPTER II

Review of Literature

Since 1986, TAM has been used worldwide in the business, information technology, and education settings. Many researchers have tested, replicated, and extended TAM with additional constructs (An, 2005; Cheung & Huang, 2005; Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Drennan, Kennedy & Pisarki, 2005; Harrison & Rainer, 1992; Straub, Igbaria, Schiffman, & Wieckowski 1994; Igbaria, Zinatelli, Cragg & Cavaye, 1997; Limayem & Karahanna-Evaristo, 1995; Lu, Yu, Liu, & Yao, 2003; Malhotra & Galletta, 1999; Thompson, Higgins, & Howell, 1991; Taylor & Todd, 1995; Venkatesh, 2000; Venkatesh & Davis, 1996; Venkatesh & Davis, 2000; Venkatesh & Morris, 2000). Therefore, TAM has been developed over time within different populations, and with various technology systems.

In nursing practice, researchers have focused on developing and testing instruments that measure nurses' attitudes toward using new computer technology (Brumini, Kovic, Zombori, Lulic, & Petrovecki, 2005; Jayasuriya & Caputi, 1996; McBride & Nagle, 1996; Levy & Williams 1999; Simpson & Kenrick, 1997; Marasovic, Kenney, Dlliott, & Sindhusake, 1997; Smith, Smith, Krungman, & Oman, 2005; Stronge & Brodt, 1985). However, very few studies (Tung, Chang, & Chou, 2007) have gone further into the concept of technology acceptance in the practice of nursing.

In this chapter, the issues related to theoretical constructs (the key determinants of perceived usefulness and perceived ease of use, attitude toward using, and intention to use) included in the original TAM (Davis, 1986), and additional variables (the external variables of age, years working in the hospital, years of experience in nursing, years of experience with computers, support from physicians, and support from administrators), in TAM are reviewed. In the summary, the context of telemedicine technology (eICU®) acceptance in nursing practice is briefly addressed.

Review of the Technology Acceptance Model (TAM)

In the past 10 years, there have been more than 100 studies that have used TAM as a theoretical framework that addressed technology acceptance issues. 28 of those studies have been reviewed in this literature review. For this literature review, research studies were selected based on two conditions. First, TAM must be used for the research-based study. Second, the research methodology in the study must be thoroughly described.

Of the studies reviewed thus far, most have been done in the United States. There are several studies were done out side the United States. Two studies were done in New Zealand (Handy, Hunter, & Whiddett, 2001; Igbaria, Zinatelli, Gragg, & Cavaye, 1997). One study was done in Hong Kong (Hu, Chau, Liu Sheng, & Tam, 1999), and one was done in Taiwan (Tung, chang, & Chou, 2007).

All of the reviewed studies are quantitative research using a self-report method. The study designs ranged from non-experimental descriptive studies examining the variables influencing computer acceptance, to pre-post computerization studies. The

research designs such as longitudinal study design (i.e., Venkatesh & Morris, 2000), cross-sectional design (i.e., Venkatesh & Davis, 1996), experimental design (Ammenwerth, Mansmann, Iller, & Eichstadter, 2003), and path analysis study testing theory design (i.e., Taylor & Todd, 1995) have often been used with TAM research studies.

According to the reviewed studies, the confirmation of the model's validity has been tested across various technology systems: wireless internet (i.e., Lu, Yu, Liu, & Yao, 2003), voice mail (i.e., Straub, Limayem, & Karhanna, 1995), word processor (i.e., Agarwal & Parsad, 1999), spreadsheets (i.e., Jackson, Chow, & Leitch, 1997), database management systems (i.e., Szajna, 1996), email (i.e., Straub, Keli, & Brenner, 1997), the internet (i.e., Chen, Gillenson, & Sherrell, 2002), telemedicine technology (Hu, Chau, Liu Sheng, & Tam, 1999), computer-based documentation (Ammenwerth, Mansmann, Iller, & Eichstadter, 2003), e-Health (An, 2005), electronic logistics information system (Tung, chang, & Chou, 2007).

The number of participants in each study ranged from 51 (Hendrickson, Massey, & Cronan, 1993) to 471 (Igbaria, Schiffman, & Wieckowski, 1994). All were convenience samples. Participants were undergraduate students using computers (i.e., Hill & Smith, 1987), workers in business firms using information technology (i.e., Thompson, Higgins, & Howell, 1991; Venkatesh & Morris 2000), and online health consumers (An, 2005). Among studies reviewed, only five studies targeted healthcare professionals, physicians (Chang et al, 2004; Handy, Hunter, & Whiddett, 2001; Hu,

Chau, Liu Sheng, & Tam, 1999) and nurses (Ammenwerth, Mansmann, Iller, & Eichstadter, 2003; Tung, chang, & Chou, 2007).

Based on the literature review, the results of the studies are conflicting in term of the key determinants of technology acceptance. In addition, only a few studies have integrated all five constructs from the original TAM (Davis, 1986). Many studies have found that the perceived usefulness and perceived ease of use are important determinants in predicting intentions of actual computer use (Mathieson, 1991; Adams, Nelson & Todd, 1992; Szajna, 1996; Igbaria, Zinatelli, Cragg & Cavaye, 1997; Lu, Yu, Liu & Yao, 2003; Drennan, Kennedy & Pisarki, 2005). All of the studies above have been done in the fields of business or information technology where the system participants were already familiar with the system in use. The purpose for the studies was to determine the individual intention of use, as opposed to use due to organizational mandate. The results of the studies have shown that perceived usefulness and perceived ease of use have a high ability to predict the intention to use computer systems.

For example, the survey conducted in New Zealand (Igbaria, Zinatelli, Cragg, & Cavaye, 1997) supported the original TAM by confirming that both perceived ease of use and perceived usefulness are key determinant factors in explaining actual use. Also, Venketesh (2000) identified perceived ease of use as a key driver of user acceptance of computer technology with additional key determinants of computer self-efficacy, facilitating condition, computer anxiety, and perceived enjoyment. Perceived ease of use was not a key determinant in his study.

Unlike the first set of studies, Szajna's (1996) study showed that the perceived ease of use did not affect graduate business students' intention to use the electronic mail. Instead, the perceived ease of use had an effect directly on perceived usefulness. The study did not mention that the two key determinants influence users' attitudes, making it difficult to compare to all of the above studies.

In healthcare systems, Hu, Chau, Liu Sheng and Tam (1999) examined the physician's acceptance of telemedicine technology in Hong Kong. They found that perceived usefulness was a significant factor that influenced physicians' attitudes and intention to use that technology. Interestingly, perceived ease of use did not have a significant effect on attitude and on perceived usefulness. The explanation for that, is that if learning a new computer system interferes with the work routine practice, the physicians might not want to use it even though it is easy to use (Hu, Chau, Liu Sheng, & Tam, 1999). It might be argued that healthcare environments and business environments are different in terms of the routine and the focus of work. Health care professionals are more focused on patient care rather than computer system features.

In nursing practice, according to Ammenwerth, Mansmann, Iller, & Eichstadter (2003), there was a positive correlation between acceptance of computers and years of experience with computers. The results show that computer knowledge and previous acceptance of nursing documentation procedures were the important factors influencing user's acceptance of the computer-based documentation computer system. However, this study did not perform testing of its instrument, and sample size was very small (N=39). In addition, Tung, chang, and Chou (2007) found that perceived usefulness, perceived

ease of use, and trust all have significant influence on nurses' intention to use the logistics information system in Taiwan. However, the study combined innovation diffusion theory and TAM together.

In conclusion, the review of previous TAM research points out that there is a need to focus on more diverse populations, various technology applications, and various settings regarding new technology acceptance (Davis, Bagozzi, & Warshaw, 1989; Hendrickson, Massey, & Cronan, 1993; Harrison & Rainer, 1992; Straub, Limayem & Karahanna-Evaristo , 1995; Szajna,1996; Venkatesh & Davis, 2000; Cheung & Huang, 2005; Drennan, Kennedy & Pisarki, 2005).

External Variables

The external variables influencing key determinants might be different in the various settings. The healthcare setting might have factors that influence the two key determinants of usage behaviors differently from other settings because of the work environment and organizational context. Unfortunately, there are very few studies that have addressed the external variables in the healthcare setting regarding the concept of technology acceptance. Therefore, the external variables from the proposed study were drawn from the factors that influence attitudes toward computerization in the studies reviewed and experts' suggestion.

According to the proposed research model, the external variables are age, years working in the hospital, years of experience in nursing, years of experience with computer, support from physicians, and support from administrators. There is no literature in nursing practice that mentions the factors influencing the key determinants in

TAM directly. Most studies have linked those variables to nurses' attitudes toward computerization (Stronge & Brodt, 1985; Stockton & Verhey,1995; Jayasuriya & Caputi, 1996; McBride & Nagle, 1996; Simpson & Kenrick, 1997; Liu, Pothiban, Lu, & Khamphonsiri, 2000; Viranyi, Zrinyi, & Barathne, 2001; Moody, Slocumb, Berg, & Jackson, 2004; Brumini, Kovic, Zombori, Lulic, & Petrovecki, 2005; & Smith, Smith, Krungman, & Oman, 2005).

Age. According to the GAO (Government Accounting Office) report in July 2001, forty percent of all RNs will be older than age 50 by the year 2010. In addition, the National Sample Survey of Registered Nurses (U.S. Department of Health & Human Services, March, 2004) reported that the average age of the RN population was estimated to be 46.8 years of age, in 2004, and only 26.6 percent of all RNs were estimated to be under the age of 40.

Several studies suggested that younger nurses had more positive attitudes than older nurses toward computerized technology systems (Simpson & Kenrick, 1997; Brumini, Kovic, Zombori, Lulic, & Petrovecki, 2005). Simpson and Kenrick's study (1997), conducted in a British General Hospital, and Brumini, Kovic, Zombori, Lulic, & Petrovecki's study (2005), conducted in Croatia, both in clinical practice settings, and both using the Nurses' Attitudes Toward Computerization (NATC) tool, found age as the major factor influencing positive computer-related nurse's attitudes.

In contrast, Moody, Slocumb, Berg, and Jackson (2004) found age and attitude has a negative correlation. They found that the older nurses had more positive attitudes toward computer usage than the younger nurses. Similarly, Marasovic, Kenney, Elliott,

and Sindhusake (1997) did a study in Australia and found that age did not have a significant effect on nurses' attitudes toward computers.

The relationship between age and attitude toward computerization is still unclear. The results concerning age as a factor influencing nurse's attitudes toward computer technology systems are conflicting. Therefore additional investigation and research is required.

Years working in the hospital. There is very little literature addressing number of years working in the hospital related to attitudes toward technology or technology acceptance concept. The experts from the experts panel for this study mentioned that nurses who work in the hospital longer seem to have more negative attitudes toward the eICU® technology system than nurses who just started working. There were studies that addressed a relationship between years of working in nursing and nurses' attitudes toward computerization, but not years working in the current hospital. However, the communication among nurses within the hospital often influences each other perceptions. People who have experience with the technology can have a strong effect on intentions of inexperience users (Taylor & Todd, 1995). Nurses who work in their current hospital for long period of time may have a strong influence on intention to use of the technology of new nurses.

Years of experience in nursing. There are several studies that specifically addressed a relationship between experience in nursing and attitudes toward computerization. In a study conducted in Australia, Marasovic, Kenney, Elliott, & Sindhusake (1997) showed that nursing experience in ICU did not have a significant

impact on nurses' attitudes toward computerization. Similar to Moody, Slocumb, Berg, and Jackson's study (2004), they found that there is no significantly relationship between years of experience in nursing and attitudes toward computerization.

In addition, Stricklin, Bierer, and Struk (2003) found that the number of years of experience in nursing has low correlation with attitudes toward computerization. However, nurses who have worked in nursing practice for a long time have confronted change in the technology environment and have adapted themselves many times to those changes. Their perception of a particular computer system might be changed over the period of time regarding their experiences.

Years of experience with computers. Szajna (1996) stated that an additional experience component, added to the original TAM would be a significant enhancement. In addition, Venkatesh and Davis (1996) added the experience with computers to the TAM, and found that it had a positive impact on perceived ease of use.

In nursing practice, McBrige and Nagle (1996) used the Stronge and Brodt (1985) instrument to measure attitudes of nurses and nursing students toward computers, and the results show that both nurses and nursing students have slightly positive attitudes. The interesting result is that even though the nursing students have more experience with the computers, there was no significant difference in mean NATC scores between the two samples. This indicates that the experience with the computers is not the main factor influencing attitudes of nurses and nursing students.

Stricklin, Bierer, and Struk (2003) used the Stronge and Brodt instrument (NATC) to measure home care nurses' attitudes toward computers, and they found years

of experience have low correlation with those attitudes. Consequently, the more knowledge about computers that nurses have, the less apprehensive their attitudes were toward the new technology. Similarly, Simpson and Kenrick's study (1997) showed that previous experience with computers did not necessarily positively increase nurses' attitudes, and nurses who had more than 21 years of experience had the most negative attitudes. Conversely, Brumini, Kovic, Zombori, Lulic, & Petrovecki (2005) found that previous computer experience is one of the factors influencing positive nurses' attitudes toward computers.

Smith, Smith, Krungman, and Oman (2005) did the quasi-experimental design for their study to evaluate the impact of computerized clinical documentation. The results show that nurses had a more negative attitude after one year of implementation of the computerized system. Frequently, when nurses experience a difficult time using the computer or struggle with the new program, it leads to the feeling of dislike and they turn against the implementation of the technology or computer system.

In summary, there are many research studies that mention the years of experience with computers as one of the factors influencing nurses' attitudes toward computerization, however, the results are conflicting.

Support from physicians. Resistance of physicians was an initial obstacle to adoption of the eICU® technology system (Celi et al, 2001). The views and attitudes of physician and nursing staff toward a technology are crucial determinants of the acceptance. According to Weiner et al's study (1997), physicians and nurses had markedly different views about effects of the technology system. Physicians' resistance

to the eICU® technology system may impact nurses' acceptance. According to the researcher observation from one setting, there were some complaints from nurses and administrators that the physicians did not cooperate and nurses had a difficult time working with them.

Moreover, there is evidence that shows contrasting views of physicians and nurses' perceptions about a technology system in Weiner et al's study (1999). Mitsufuji (2002) proposed that after the appearance of an innovation, relevant professionals compete with each other when the various trials and errors of the innovation occur. All health care professionals, especially nurses and physicians who work closely with each other, often confront conflict among themselves regarding new technology, and that impacts their perception of that technology.

Support from administrators. Nurse managers of ICUs are accountable for clinical outcomes as much or more as nursing staff (McCauley & Irwin, 2006). They play a significant role in preparing and supporting staff for the implementation of the new technology. Nurse managers are often selected to served in the super user role, to provide ample resources to explain the benefits of the eICU® technology system and answer questions one-on-one to get bedside nurses engaged (Kirkley & Stein, 2004). Communication and collaboration during preparing to implement a new technology in ICU unit bring bedside nurse and nurse manger together and make them closer to each other. Therefore, nurse managers' perception of a particular technology using in ICUs would have a great impact on nursing staff's perspective of the technology.

Perceived Usefulness and Perceived Ease of Use

According to Davis (1986, 1989), TAM has two significant dimensions of cognitive response that emerged from external variables. Many studies stated that perceived usefulness and perceived ease of use are two crucial beliefs for computer acceptance behaviors in TAM (Davis, 1989; Davis, Baggozi, & Warshaw, 1989). Legris and colleagues (2003) also stated that perceived usefulness and perceived ease of use have been considered important to understand the individual's acceptance and use of technology.

Attitudes

Fishbein and Ajzen (1975, see also Fishbein, 1967) believes that attitudes are learned predispositions to respond to an object in a favorable or unfavorable way. They pointed out that attitudes can be determined by beliefs, and that attitudes are the bridge between the belief and an intention, before the actual behaviour is generated. Logically, if attitudes can be determined by beliefs, then the beliefs can be determined by external variables.

Research studies of nurses' attitudes toward computerization have been conducted since the late 1960's. In 1985, Stronge and Brodt developed the Nurses' Attitudes toward Computerization (NATC) tool. Multiple research studies have investigated nurses' attitudes toward computer and information technology in many regions and with a variety of technology computer systems (Brumini, Kovic, Zombori, Lulic, & Petrovecki, 2005; Liu, Pothiban, Lu, & Khamphonsiri, 2000; McBride & Nagle, 1996; Moody, Slocumb, Berg, & Jackson, 2004; Simpson & Kenrick, 1997; Smith, Smith, Krungman, & Oman,

2005; Stronge & Brodt, 1985; Stockton & Verhey, 1995; Jayasuriya & Caputi, 1996; Viranyi, Zrinyi, & Barathne, 2001). The study designs ranged from pre-post computerization studies to non-experiment descriptive studies that examined the variables influencing computer acceptance. The descriptive studies tried to correlate nurse attitudes with variables such as age, years of experience, computer experience, and level of education. The results in some studies support each other. Interestingly though, other studies show conflicting results even though researchers used the same instrument with the same population.

The reviewed literature of many studies spanning almost ten years has shown that there are no consistent demographic variables or factors influencing positive attitudes of nurses toward computerization. Those studies may not appear to be relevant in the twenty first century, even though almost every study shows a high reliability of the instrument (McBrige & Nagle, 1996). In addition, no conclusive evidence, either from past or recent literature, has been found to provide a rationale for nurses' attitude changes.

Intention

Fishbein and Ajzen (1975) have defined intention as "a person's location on a subjective probability dimension involving a relation between himself and some action". Therefore, it refers to a person who has a probability to perform some action. The relationship and the difference between attitude and intention were well described in the Theory of Reason Action (Fishbein & Ajzen, 1975). They made the assumption that the

more favorable a person's attitude toward some object, the more she/he will intend to perform positive behavior.

Many research studied have used intention as a dependent variable (Hu, Chau, Liu Sheng, & Tam, 1999; Mathieson, 1991). If an individual has an intention to use the technology, she/he will actually use that technology. However, the organization has a great impact on the actual usage behavior. If it is mandated, whether or not the employees have intention to use the innovation, they must use it. The difference is that when the innovation is used with willingness, the outcomes will be more positive than when it is used with unwillingness. Therefore, this study will try to focus on individual's intention rather than organizational intention.

Research Gaps in the Technology Acceptance Model

Based on this literature review, the original TAM is a useful theoretical model in explaining, identifying, and predicting an individual's acceptance of new information technology. It has been used extensively in the areas of technology information systems, education, and business (Cheung & Huang, 2005; Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Drennan, Kennedy & Pisarki, 2005; Harrison & Rainer, 1992; Lu, Yu, Liu & Yao, 2003; Straub, Limayem & Karahanna-Evaristo, 1995; Szajna, 1996; Venkatesh, 1999; Venkatesh, 2000; Venkatesh & Davis, 2000), but with few studies in health care settings (Chang et al, 2004; Handy, Hunter, & Whiddett, 2001; Hu, Chau, Liu Sheng, & Tam, 1999) and very few, especially in nursing practice (Ammenwerth, Mansmann, Iller, & Eichstadter, 2003; Tung, Chang, & Chou, 2007).

The previous TAM research studies suggested that further testing of the suitability of the model in different settings and populations was needed (Davis, Bagozzi, & Warshaw, 1989). It is necessary to focus on more diverse populations, various technological applications, and various settings regarding new technology acceptance in TAM research (An, 2005).

Nurses' attitudes toward computer use have been investigated over a period of time. However, as mentioned earlier, there are very few studies that examine computer acceptance in nursing practice, using the two key determinants from the TAM model. The TAM model has been used extensively in others areas, but not in the nursing practice. Therefore, this study will examine the TAM model with nursing populations and the telemedicine technology system (eICU®) to increase exploration and suitability of the model.

Summary

The variables in the proposed research model (age, years working in the hospital, years of experience in nursing, years of experience with computers, support from physicians, and support from administrators) have never been used with the original TAM. There are many studies that have tried to identify factors such as age, experience with computers, and years of nursing experience, that influence nurses' attitudes toward computer use. The results from those studies were unclear and conflicting. There are very few of those studies trying to go further with the technology acceptance concept and investigate the factors and predictors that influence nurses' acceptance on the new

technology computer system. Therefore, the investigation for factors and predictors of nurses' acceptance of technology is needed.

As stated earlier, the purpose of the study is to examine the applicability of the TAM (Technology Acceptance Model) in explaining nurses' acceptance of telemedicine technology (eICU®) in health care settings, and also to determine factors and predictors that influence nurses' acceptance of the eICU® and to provide psychometric evidence (validity and reliability) of measurement scales used in the study.

CHAPTER III

Research Design and Method

Research Design

The research design was a non-experimental, descriptive design. Use of this design allowed examination of the relationship among the variables and facilitated testing of the TAM model with a nursing population. In addition, this design assisted in identifying predictors that influence nurses' acceptance of telemedicine technology (eICU®).

Population and Sample

The sample was a convenience sample. The data were collected from the critical care units of two healthcare systems in Virginia. The inclusion criteria for the sample were registered nurses who worked in critical care units that have not yet implemented eICU® technology at this time. The nurses working in these units had a nurse to patient ratio of 1:2, and may or may not have had experiences with eICU® technology. In general, the nurses in this study were taking care of the patients who were in critical conditions that might require life support, such as a ventilator or vasopressive medications. The exclusion criteria for the sample were registered nurses who worked as the managers or the directors of the critical care units.

Power analysis was used to determine sample size for multiple regression analysis and path analysis (see Appendix N). The target number of 114 was calculated using Cohen's formula (Munro, 2001; see also Cohen, 1987), for a moderate effect size (0.13) with $\alpha = 0.05$ and power level = 0.80 with a maximum of nine independent variables from the original proposed research model

For the SEM (Structural Equation Modeling) analysis method, as cited in Tabachnick and Fidell (2001, see also Comrey & Lee,1992) classified sample sizes of 50 as very poor, 100 as poor, 200 as fair, 300 as good, and 500 as very good. Other authors suggested latent variables model "require at least a sample size of 100 observations, although parameter estimates may be inaccurate in samples of less than 200" (Kelloway, 1998, p. 20; see also Marsh et al, 1988). Therefore, it was decided that the sample size for this study would be 100 to 200.

The eICU® Acceptance Surveys (EAS) were distributed to 139 potential participants in two healthcare systems, and 131 responses were obtained (a 94 % return rate). Out of 131 responses, 3 (2.16%) were excluded due to inappropriate responses (have all the same uncertain answers), and 11 (7.19%) did not meet the criteria (2 participants were managers and 9 participants were not in the critical care units). The final sample size of 117 was obtained for this study.

The sample size of 117 for SEM methods was slightly less than fair, according to Comrey and Lee (1992) as cited in Tabachnick and Fidell (2001) , but it was considered adequate based on Marsh et al (1988) as cited in Kelloway (1998), Bollen (1989), and Harris and Schaubroek (1990).

Instrument and Pilot Study

At the beginning of the study, a new instrument was developed, revisions were made to existing instruments, content validity was explored, and a pilot study was conducted. Approval was received from both the Institutional Research Board (IRB) in the two healthcare systems and the Human Subject Review Board (HSRB) at George Mason University. The purpose of the pilot study was to test the reliability of the instruments. A questionnaire was provided directly to 40 nurses working in the critical care unit within a health system. Of the 40 questionnaires distributed, 31 responses were obtained, a 78% return rate (see Appendix C).

Nurses' acceptance of the telemedicine technology was determined by measuring all of the constructs: external variables, key determinants (perceived usefulness and perceived ease of use) and attitudes that have an effect on intention to use the telemedicine technology (eICU®).

External Variables

Demographic form. This 16-item demographic data form was designed by the researcher for use in this study to measure age (in years), years working in the current hospital, years of experience in nursing, years of experience with computers, support from administrators, and support from physicians. Level of education is measured as a nominal scale from 1 to 7. Support from administrators and support from physicians are measured by Likert scale from 1 to 10 (1 is no support and 10 is the most support, see Appendix M, p. 102).

In the pilot study, all subjects completed this questionnaire within 5-8 minutes. Items number seven, eight, and nine were added to the survey after the pilot study to measure the source of information about the eICU®. These items were added since most nurses had not been trained to use the eICU® or only had a brief summary provided by either their administrators or nurses from other units. For the added items, item seven measured in number of the period of time that heard about the eICU® on a ratio scale, item eight measured a source of the information on a nominal scale ranging from 1 to 8, item number nine measured in number of times attending conferences on a ratio scale.

Key Determinants

In this section, information is presented about original instrument development, instrument changes resulting from the pilot study, and instrument reliability in this study.

Perceived Usefulness (PU) scale. The perceived usefulness (PU) scale was designed by Davis (1989) to measure the belief that the technology enhances an individual's performance. The original perceived usefulness scale (Davis, 1989) consisted of 6 items in a seven-point Likert scale ranging from 1-7 (1 = extremely unlikely and 7 = extremely likely). The original reliability of the scale was 0.98. In subsequent studies (Adams, Nelson, & Todd, 1992; Segars & Grover, 1993; Chin & Todd, 1993; Hendrickson, Massey, & Cronan, 1993; & Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Szajna, 2004), the reliability of this instrument ranged from 0.82 to 0.96 in the various technology systems, such as electronic mail, voice mail, and microcomputer technology.

For this study, based on the recommendations from five experts (see Appendix B), the PU scale was adapted for use with nursing populations to adequately measure the belief that the eICU® computer system enhances individual's performance. The following changes were made for this study:

- The term "CHART-MASTER" was replaced with "eICU®".
- Item number seven, regarding improving communication, was added to the original PU scale.
- A five-point Likert scale where 1 = strongly disagree and 5 = strongly agree, replaced the seven-point Likert scale.

In the pilot study of the revised instrument, the reliability (coefficient alpha) was 0.94. The corrected item-total correlation ranged from 0.60 to 0.91. The new question (item 7) that was added in to the PU scale had the corrected item-total correlation = 0.76, which means this question had a high correlation with the rest of the items.

Based on 117 responses in this study, the PU scale (7 items) had a coefficient alpha of 0.96 with mean score of 2.8. The corrected item-total correlation ranged from 0.84 to 0.90.

Perceived Ease of Use (PEOU) scale. The perceived ease of use (PEOU) scale was developed by Davis (1989), and was designed to measure the belief that the technology is easy to use and free from mental effort. The original PEOU scale (Davis, 1989) consisted of 6 items in a seven-point Likert scale ranging from 1-7 (1 = extremely unlikely and 7 = extremely likely). The reliability of the original instrument was 0.94. In subsequent studies (Adams, Nelson, & Todd, 1992; Segars & Grover, 1993; Chin &

Todd, 1993; Hendrickson, Massey, & Cronan, 1993; & Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Szajna, 2004), the reliability of this instrument ranged from 0.79 to 0.94 in the various technology systems such as electronic mail, voice mail, and microcomputer technology.

In this study, according to the recommendations from five experts, the PEOU scale was adapted for use with nursing populations to adequately measure the belief that the technology is easy to use. The following changes were made for this study:

- The term "CHART-MASTER" was replaced with "eICU®".
- The five-point Likert scale where 1 = strongly disagree and 5 = strongly agree, replaced the seven-point Likert scale.

In the pilot study, the PEOU scale had a coefficient alpha of 0.93. The corrected item-total correlation ranged from 0.69 to 0.91, meaning all of the items correlated to each other.

Based on 117 responses in this study, the PEUO scale (6 items) had a coefficient alpha of 0.94 with mean score of 3.4. The corrected item-total correlation ranged from 0.73 to 0.88.

Attitudes

Nurses' Attitudes Toward eICU®(NATE) scale. The NATE scale was designed to measure nurses' attitudes toward the eICU® computer system. It was modified from the Nurses' Computer Attitudes Inventory (NCAIT) scale developed by Jayasuriy and Caputi (1996). The instrument consisted of 22 items in a five-point Likert scale ranging from 1

to 5 (1= strongly disagree and 5 = strongly agree). The original reliability of this instrument was 0.95.

For this study, based on the recommendations from the content experts, the NATE scale was adapted for a nursing population to adequately measure nurses' attitudes toward the eICU® technology system. The following changes were made:

- Items were rearranged; item number 5 is now 22, 22 is now 5, item number 12 is now 21 and 21 is now 12.
- The term "computer system" is replaced with "eICU®" computer system.
- The wording in item number 17 was changed (the word aggressive and hostile were replaced with threatened).
- Item number three was deleted (as explained below), resulting in a final NATE scale consisting of 21 items.

The results from the pilot study showed that the NATE scale had a coefficient alpha of 0.86. The corrected item-total correlation ranged from 0.28 to 0.73 for all but one item. Item number three on the scale had the corrected item-total correlation of negative 0.64. This item was deleted because it negatively correlated with the rest of the items.

Based on 117 responses in this study, the NATE scale (21 items) had a coefficient alpha of 0.91 with mean score of 3.3. The corrected item-total correlation ranged from 0.38 to 0.71.

Intention to Use

Intention to Use (ITU) scale. The intention to use (ITU) scale was designed to measure the individuals' decision to implement the eICU® computer system. It was modified from Hu, Chau, Liu Sheng, and Tam's study (1999).

Hu, Chau, Liu Sheng, and Tam (1999) tested and extended the Technology Acceptance Model (TAM) by using the questionnaire that was obtained from the prior studies (Davis, 1989; Davis, Bagozzi & Warshaw, 1989 and Mathieson, 1991). The original ITU scale (Hu, Chau, Liu Sheng, & Tam, 1999) consisted of 6 items in a seven-point Likert scale ranging from 1 to 7 (1 = extremely unlikely and 7 = extremely likely). The original reliability of the scale was 0.86, and the construct validity was adequate and satisfied.

In this study, based on the recommendations from content experts (see Appendix B), the ITU scale was adapted for a nursing population to adequately measure nurses' intention to implement the eICU® technology system. The following changes were made for this study:

- The term "eICU®"computer system replaced "telemedicine technology".
- The five-point Likert scale where 1 = strongly disagree and 5 = strongly agree, replaced the seven-point Likert scale.

According to the pilot study results (see Appendix C), the reliability (coefficient alpha) of the ITU scale was 0.88. The corrected item-correlation ranged from 0.52 to 0.83. Therefore each item correlated well with other items.

Based on 117 responses in this study, the PEUO scale (6 items) had a coefficient alpha of 0.95 with mean score of 3.2. The corrected item-total correlation ranged from 0.75 to 0.90.

Table 1 presents the reliability value for each construct in this study. The coefficient alpha of each construct range from 0.91 (nurse attitude toward eICU® construct) to 0.96 (perceived usefulness construct). The total number of items was 40, and overall item mean score was 3.2.

Table 3.1. Reliability in this study

Constructs	Number of Items	Item Mean	Coefficient Alpha
Perceived Usefulness (PU)	7	2.8	0.96
Perceived Ease of Use (PEOU)	6	3.4	0.94
Nurse Attitudes toward eICU® (NATE)	21	3.3	0.91
Intention to Use (ITU)	6	3.2	0.95
Total	40	3.2	0.96

Knowledge and Awareness

Knowledge. This questionnaire section was designed to have more information of nurses' knowledge on eICU® technology, and to assess how much knowledge they have at the present time. This section consisted of five true-false questions.

Awareness. This questionnaire section was designed to assess critical care nurses' recognition and preference of eICU® technology. This section consisted of 4 multiple choice questions.

Ethical Consideration

The data collection was begun after George Mason University's Human Subjects Review Broad (HRSB) and the two research facilities Institutional Review Board (IRB) approved the study. Three ethical principles, human dignity, beneficence, and justice were included in the informed consent.

Participation in this study was voluntary and a consent form was obtained from each participant. Information obtained from the participants was confidential. There was no foreseeable risk of potential physical, psychological, social, or legal outcomes arising from the study. The participants were provided full disclosure of the study proposal and their rights as human subjects.

Data collection

After receiving HSRB and IRB approval, the researcher provided cover letters, informed consents, and questionnaires (see Appendix D, E, F, G, H, I, J, K, L, and M) to potential participants in person. The purpose of the study, the information about informed consent, and the questionnaire were explained to the participants by the researcher directly on site.

The researcher obtained the informed consent from each participant before the participant filled out the questionnaire. The researcher was available at all time for answering any questions. The questionnaire with answers was given back to the

researcher right after the participant finished. The researcher then put the answered questionnaire in a sealed envelope and the signed informed consent into a different sealed envelope. No one saw the questionnaires except the researcher. All of the questionnaires and informed consents were kept separately in a locked drawer.

Data analysis

Each research question was answered by the statistical approaches in the Table 2 below:

Table3.2. Data analysis for research questions

Research questions	Variables	Measurement Approaches	Data Analysis
1. What are the relationships among the study external variables, the key determinants, the attitude toward using, and the intention to use telemedicine technology (eICU®)?	1) External variables (age, years working in hospital, years of nursing experience, years of experience with computers, support from physicians, and support from administrators) 2) Key determinants (perceived usefulness and perceived ease of use) 3) Attitude toward using 4) Intention to use	- Find the nature of the population; mean, percentage, standard deviation, missing data, outliers, normality, and linearity - Find the relationship among the variables	- Descriptive frequencies procedure - Pearson Correlation statistics
2. Which study variables are most influential in predicting intention to use telemedicine technology (eICU®)?	1) External variables (years working in hospital, support from physicians, and support from administrators) 2) Key determinants (perceived usefulness and perceived ease of use) 3) Attitude toward using 4) Intention to use	-Find the regression equation to predict the intention to use - Find the significant path coefficients (β) among the variables as specified in the model for the most influential variable in predicting intention to use	- Multiple Regression - Path Analysis
3. Is the proposed hypothesized model consistent with the empirical data in the study?	Using all variables and constructs from the proposed research model: 1. Years working in the hospital 2. Supports from physicians 3. Supports from administrators. 4. Perceived usefulness 5. Perceived ease of use 6. Attitude toward using 7. Intention to use	Find fit indices: - Chi-square/degree of freedom - GFI - AGFI - NFI - NNFI - CFI - RMR - RMSEA	-SEM (Structural Equation Modeling) using LISREL

The SPSS (Statistical Package for the Social Sciences) software program (version 15.0) was used to analyze the data for descriptive statistics, frequencies statistics, regression, and multiple regressions (for path analysis). Structural equation modeling (SEM) methods were conducted by using LISREL 8.8 (student version) to test the model fit with the proposed model. Statistical significance for all of the analyses was defined as $p \leq 0.05$.

Data Screening

Missing data. The frequency procedure was used to screen the data for missing values. The mean score is the best estimate value for missing data when no other information is available to the researcher (Mertler & Vannata, 2002). For this study, the researcher replaced missing data with a mean score.

Outliers. The Mahalanobis distance can be used to identify outliers of any type and can be used with all of the items within a construct (Mertler & Vannatta, 2002, also see Stevens, 1996). The further investigation was made to determine whether the outliers were due to an error data entry or due to an error of an instrument. The decision to keep the outliers in the sample was based on their values on the variables.

Assumptions of Multivariate Analysis

The assumptions of multiple regression analysis and structural equation model (SEM) methods were considered; a) normality, b) linearity, c) homoscedasticity, and d) multicollinearity (Mertler & Vannatta, 2002; Tabachnick & Fidell, 2001).

Normality and linearity. The multivariate normality and linearity for the study

were assessed from normal p-p plots and scatterplots of regression standardized residual. The normal plot for all values should show the straight line for normality, and scatterplots should show a rectangle shape with scores in the center and clustering around zero line.

Homoscedasticity. The multivariate homoscedasticity for this study was assessed by using Box's M test for equality of variance-covariance matrices. If the significance level of Box's M test is small ($p < 0.05$), then the null hypothesis should be rejected so that the covariance matrices are equal (Mertler & Vannatta, 2002).

Multicolinearity. The multicolinearity is a problem created when independent variables are very highly correlated with each other. The multicolinearity was assessed from tolerance statistics and the variance inflation factor (VIF) from multiple regression analysis. The tolerance measures collinearity among independent variables (values range from 0-1), and the tolerance value that approached zero indicates multicolinearity (Mertler & Vannatta, 2002). The VIF defines a linear strength between given predictors and all remaining predictors. The values of VIF those are greater than 10 indicate cause of concern (Mertler & Vannatta, 2002; see also Stevens, 1992).

Descriptive and Frequency Statistics

Descriptive statistics were run on the demographic data to describe the nature of the population, such as mean or mode, percentage and standard deviation for all of the continuous variables in the proposed research model. Non-parametric statistics were run on nominal data such as level of education, sex, and shift of working.

Measurement Assessment

Reliability. The coefficient alpha or Cronbach's alpha method was used to evaluate internal consistency of the instruments. All instruments were expected to have higher reliabilities than 0.70. Coefficient alpha of 0.70 are usually adequate, although coefficients of 0.80 or greater are highly desirable (Polit & Beck, 2004).

Content validity. Content validity is determined by the degree to which an instrument has an appropriate item sample for the construct being measured (Polit & Beck, 2004). The preliminary test was conducted to evaluate the instrument's content validity. In this study, five experts were invited to review and assess the content, wording, layout, and the appropriateness for the nursing population. All of the constructs and items in the instrument originally were derived from the previous studies and they were modified by the researcher.

The questionnaire for the experts consisted of 10 questions. The experts were asked about the content of each construct for clarity, appropriateness, the relationship of overall items, and if those items measured the constructs. The experts were given one week for filling out the questionnaire and then the researcher discussed the results with each expert.

The results from five experts (see Appendix B) showed that they all agreed and strongly agreed on each item. No one strongly disagreed, disagreed, or was uncertain on each item. The results of an evaluation of the instrument from the experts for the appropriateness, wording, layouts, and content to measure each construct have shown

satisfactory results. Therefore, overall results of content validity for this study were satisfied as stated previously in this chapter.

Analyzing and Testing Model

Correlation and multiple regression analysis. After screening the data, confirming assumptions, and running descriptive and frequency analysis, the bivariate correlation among continuous variables was performed. The correlation results are presented as a correlation matrix (see Appendix I). The significance level for this study was $p \leq 0.05$. The continuous variables that were not significantly correlated with the constructs were deleted from the originally proposed research model before multiple regression analysis and the LISREL program as a syntax file were performed to examine if the proposed models fit the data.

The final proposed research model was reduced to three external variables (years working in hospital, support from physicians, and support from administrators), and kept the four constructs drawn from the original TAM (perceived usefulness, perceived ease of use, attitudes toward using, and intention to use). The final proposed research model is called Telemedicine Technology Acceptance Model (TTAM) (see Appendix A).

The multiple regression analysis was performed to explain causal relationships among variables. The multiple regression analysis was conducted using enter method on the final proposed research model on four paths based on the assumption of causal closure in the model. Exogenous variables are considered as the starting points and endogenous variables are considered and the ending points. The endogenous variables

can be predicted by the exogenous variables, and at the mean time they can be a predictor for other endogenous variables.

The significant output for multiple regression analysis is the coefficients table that reports the unstandardized regression coefficient (*B*), the standardized regression coefficient (beta or β), *t* and *p* values, and three correlation indices (Mertler & Vannatta, 2002). In this study, each path in the model used standardized regression coefficient or beta weight (β) to examine the contribution of each predictor variable in the model.

SEM methods: path analysis and model fit from LISREL. LISREL is a computer program that performs Structural Equation Modeling (SEM) (Kelloway, 1998). There are several ways of how to enter the data, such as syntax only, PRELIS data, SIMPLIS Project. For this study, the LISREL 8.8 (student version) using syntax only method for entering the data was used to conduct path analysis and assess the model "fit" to the data.

For path analysis, exogenous and endogenous were identified. In this study, there were three exogenous variables (years working in the hospital, support from physicians, and support from administrators) and four endogenous variables (perceived usefulness, perceived ease of use, attitude toward using, and intention to use). The correlation matrix was used as the data in the syntax file.

There were eight common fit indices that used in this study, which are;

1. Chi-square/degree of freedom, the value less than three indicate a good fit to the data.

2. GFI (goodness-of-fit index), values range from 0 to 1 with values above 0.9 indicating a good fit to the data.
3. AGFI (adjusted goodness-of-fit index), values range from 0 to 1 with values above 0.9 indicating a good fit to the data. The parameter for AGFI in some studies (Hu et al, 1999) suggests that a value above 0.8 indicates a good fit to the data.
4. NFI (Normalized fit index), values range from 0 to 1 with values above 0.9 indicate a good fit to the data.
5. NNFI (Non-normalized fit index), values range from 0 to 1 with values above 0.9 indicate a good fit to the data.
6. CFI (comparative fit index), values range from 0 to 1 with values above 0.9 indicate a good fit to the data.
7. RMR (root mean squared residual), values range from 0 to 1, and values less than 0.05 indicate a good fit to the data.
8. RMSEA (root mean squared error of approximation), values below 0.10 indicate a good fit, values below 0.05 a very good fit, and values below 0.01 indicate outstanding fit to the data (Steiger, 1990).

According to Kelloway (1998), the current version of LISREL 8.8 report 18 indices of model fit, only four of them address absolute fit, which are RMR, RMSEA, GFI, and AGFI. The absolute fit indices have to do with the ability of the model to reproduce the correlation/covariance matrix (Kelloway, 1998).

This study used four absolute fit indices as shown above to evaluate the model fit. The proposed research model is disconfirmed if a proposed model fits the data with some parameters having no significance and/or some parameters having significance, but being opposite in direction to the prediction (Kelloway, 1998).

Qualitative Data Analysis

The data from the additional comments section from the survey was analyzed by using Colaizzi (1978) guideline for analysis of qualitative data. Following the Colaizzi's method (1978) as cited in Streubert Speziale and Carpenter (2003), Colaizzi proposed nine steps for interpretation of the qualitative data as below:

1. Describe the phenomenon of interest
2. Collect participants descriptions of phenomenon
3. Read all participants' descriptions of the phenomenon.
4. Return the original transcripts and extract significant statements.
5. Try to spell out the meaning of each significant statement.
6. Organizing the aggregate formalized meanings into clusters of themes.
7. Write an exhaustive description
8. Return to the participants for validation of the description.
9. If new data are revealed during the validation, incorporate them into an exhaustive description.

In this study, qualitative data was collected by using the survey (see Appendix M). The participants wrote down their opinions on the additional comments (question number 16, Section VII of the survey). After the researcher finished reading and typing

all the additional comments from the survey on the paper, the original comments were reviewed again. The researcher extracted the significant statement and tried to spell out the meaning of each statement. Then, all the statements were organized and formalized meaning into categories.

CHAPTER IV

Results

This chapter first presents the results from the screening data and demographic data. That is followed by the presentation of the results from quantitative data analysis using the SPSS program and the LISREL program. Finally, the findings from the qualitative data analysis using Colaizzi's method are stated. The summary of results appears at the end of this chapter.

Data Assessment

There were two missing data elements, one was in support from physicians and the other one was in support from administrator, that were not completed by participants out of 117 responses. Those two missing data were replaced with a mean score of five.

Multivariate outliers were examined by using the Mahalanobis distance. There were three outliers (case number 19, 48, and 71) in this study with values that exceeded the critical value of chi-square. These three outliers were a direct result of the extreme values input by participants, and showed how the participants had strongly disagreed where others strongly agreed in another different construct. The researcher maintained the outliers' values because it was not an error from data entry or questionnaires, but rather resulted from the honest opinions of the participants. Therefore, the researcher decided to keep all three outlier cases in the sample.

To examine normality and linearity, Q-Q normal plots and scatterplots were performed. According to the results of testing assumptions, the normal plots from dependent variables and independent variables did show a straight line and scatterplots did show a rectangular shape with scores concentrated in the center, and most of the points clustering around the zero line. Therefore the normality and linearity are defensible for this study.

The Box's M test was used to examine homoscedasticity. The results were statistically significant (Box's M test = 0.000, $p < 0.05$). Therefore, the null hypothesis was rejected, leading to the conclusion of inequality of covariance. However, the violation of homoscedasticity was not fatal to an analysis for this study because the linearity assumption was met (See Chapter III for an explanation).

The tolerance statistics and variance inflation factor (VIF) were examined for multicolinearity. The results from multiple regression analysis have shown that tolerance values range from 0.479 to 0.913 (not approaching zero), and VIF values range from 1.095 to 2.088 (not greater than 10). The results indicated that there was no violation for multicolinearity in this study.

Demographic Information

Table 4.1 presents the demographic characteristics of the participants. There were 91.5 % (n = 107) women and 8.5 % (n = 10) men. Most of the participants worked day shift 47.9 % (n = 56), while 29.9% (n = 35) worked night shift, and 22.2 % (n = 26) worked both day shift and night shift. For level of education, there were 54.7% (n = 64) of the participants who had a Bachelor's degree in nursing (BSN), and 26.5% (n = 31)

who had an associate degree (AD). There were only 2.6% (n = 3) of participants who had Master's degree in nursing (MSN).

Most of the participants heard about eICU® from nurses who had prior experience with eICU® technology 46.2% (n = 54), and 33.3% (n = 39) heard about eICU from both nurses who had prior experience and from nurses who had not used eICU® technology. The statistics report only 0.9% (n = 1) of participants who had heard about eICU® technology from the Internet.

The majority of the participants 86.3% (n = 101) had never attended a conference on eICU® technology and 83.3% (n = 98) had never been trained to use eICU® technology. There were only 13.7% (n = 16) of participants who reported that they had attended a conference on eICU® technology, and 16.2% (n = 19) had been trained to use the eICU® technology before they worked in their current units. Also, most of the participants 94% (n = 110) reported that there were support personnel available for the technology, and 6% (n = 7) reported that there were no support personnel available.

Table4.1. Demographic characteristics for nominal and ordinal variables (n = 117)

Variables	Number	Percent (%)	Valid Percent (%)
1. Sex			
- Male	10	8.5	8.5
- Female	107	91.5	91.5
2. Working Shift			
- Day Shift	56	47.9	47.9
- Night Shift	35	29.9	77.8
- Day and Night Shift	26	22.2	22.2
3. Level of Education			
- Second Degree	8	6.8	6.8
- Diploma	6	5.1	5.1
- Associate Degree	31	26.5	26.5
- BSN	64	54.7	54.7
- MSN	3	2.6	2.6
- Other	5	4.3	4.3
4. Have heard about eICU® from			
- Nurses from other unit-used eICU®	54	46.2	46.2
- Nurses from other unit-not used eICU®	3	2.6	2.6
- Both 1 and 2	39	33.3	33.3
- Unit manager	4	3.4	3.4
- Internet	1	.9	.9
- Other	16	13.7	13.7
5. Attend a conference on eICU®			
- Yes	16	13.7	13.7
- No	101	86.3	86.3
6. Been trained to use eICU® at work place			
- Yes	19	16.2	16.2
- No	98	83.8	83.8
7. Support personnel available			
- Yes	110	94.0	94.0
- No	7	6.0	6.0

Table 4.2 presents descriptive statistics on continuous variables. The average age of the participants was 35.45 years (S.D = 9.37). The average number of years working

as a nurse was 10.44 years (S.D = 9.13), and the average number of years working in their current hospital was 6.83 years (S.D = 6.98). The statistics from this study reflected that the average number of years working in critical care units was 7.64 years (S.D=7.82). The average number of times that the participants heard about eICU® was 2.41 years (S.D = 1.45), and the average years working with any kind of computer were 14.77 (S.D = 5.97).

The mean scores of receiving support from physicians and from administrators were 4.78 (S.D = 2.73) and 6.65 (S.D = 2.53) respectively. The mean scores of the four constructs were; a) perceived usefulness (PU) was 19.57 (full scores = 35, S.D = 6.49), b) perceived ease of use (PEOU) was 20.57 (full scores = 30, S.D = 4.27, c) nurses' attitudes toward eICU® (NATE) was 69.55 (full scores = 105, S.D = 10.97), and d) intention to use (ITU) was 19 (full scores = 30, S.D = 5.43).

Table 4.2. Descriptive statistics for continuous variables (n = 117).

	Mean	Std. Deviation	Minimum	Maximum
1. Age	35.45	9.37	21	65
2. Years working as a nurse	10.44	9.13	.08 (1mth)	43
3. Years working in current hospital	6.83	6.98	.08 (1mth)	30
4. Years working in the critical care	7.64	7.82	.08 (1mth)	30
5. Time heard about eICU®	2.41	1.45	.01(1week)	9
6. Years working with any kind of computer	14.77	5.97	2	40
7. Support from physicians	4.78	2.73	1	10
8. Support from administrators	6.65	2.53	1	10
9. Perceived usefulness (PU)	19.57	6.49	7	35
10. Perceived ease of use (PEOU)	20.51	4.27	6	30
11. Nurses' attitudes toward eICU® (NATE)	69.55	10.97	42	101
12. Intention to use (ITU)	19	5.43	6	30

Analyzing and Testing Model

Bivariate Correlation. Pearson correlation analysis statistical results are presented on Figure 4.1 (see also Appendix O). Figure 4.1 presents bivariate relationships that were statistically significant on the original proposed research model.

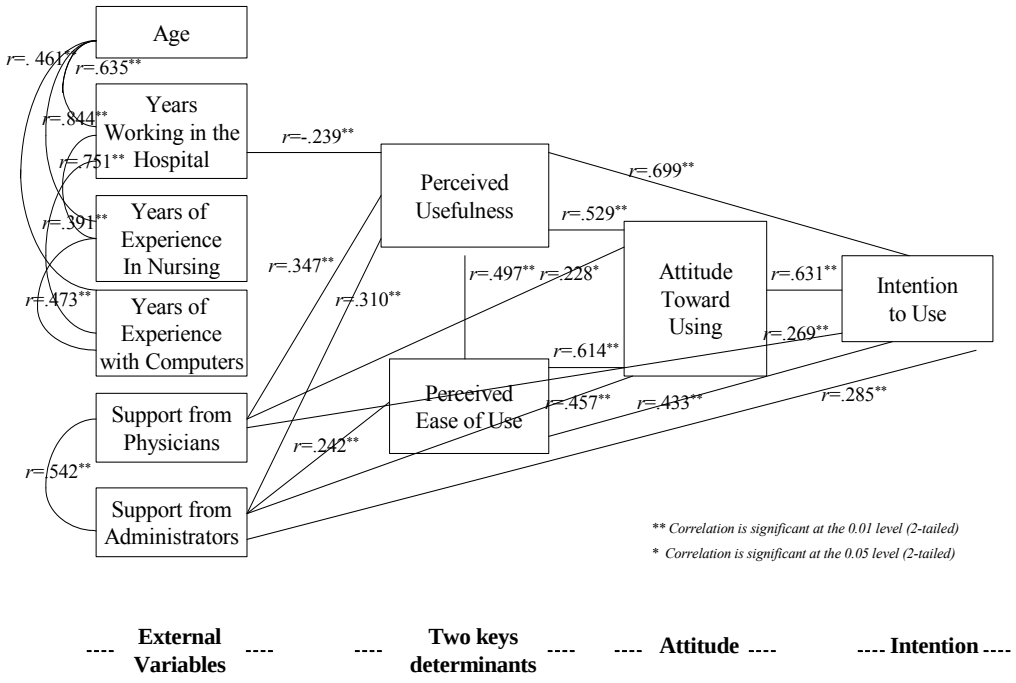


Figure 4. 1. Bivariate correlation on the original proposed research model.

According to the correlation results (see Appendix O and Figure 4.1), age had a statistically significant correlation with years working in the hospital ($r = 0.635$), years of experience in nursing ($r = 0.844$), and years of experience with computers ($r = 0.461$). Conversely, age did not have a statistically significant correlation with perceived usefulness and perceived ease of use.

Years working in the hospital had a statistically significant negative correlation with perceived usefulness (r = -0.239) and positive statistically significant correlation with years of experience with computers (r = 0.473). Years of experience with computers had a statistically significant correlation with years of experience in nursing (r = 0.473). However, both years of experience with computers and years of experience in nursing did not have a statistically significant correlation with perceived usefulness and perceived ease of use as proposed in the originally proposed research model.

Support from physicians and support from administrators had a statistically significant relationship (r = 0.543) between them, but neither variable had a statistically significant correlation with age, years working in the hospital, years experience in nursing, nor years experience with computers. However, support from physicians and support from administrators had a statistically significant correlation with perceived usefulness (r = 0.349 and r = 0.307 respectively). Support from physicians did not have a statistically significant correlation with perceived ease of use, although support from administrators did have a statistically significant correlation with perceived ease of use (r = 0.235). Interestingly, support from physicians had a statistically significant relationship with attitude toward using at significant level (r = .228).

Perceived ease of use had a statistically significant correlation with perceived usefulness (r = 0.497) and attitudes toward using (r = 0.614). Perceived usefulness had a statistically significant correlation with attitudes toward using (r = 0.529) and intention to use (r = 0.699). Also, attitudes toward using had a statistically significant correlation with intention to use (r = 0.631).

Based on the correlation statistical results, the researcher re-proposed and revised the original model, omitting age, years of experience in nursing, and years of experience with computers, and named it as Telemedicine Technology Acceptance Model (TTAM, see Figure 4.2). Then the researcher analyzed and tested the TTAM using multiple regression analysis and LISREL.

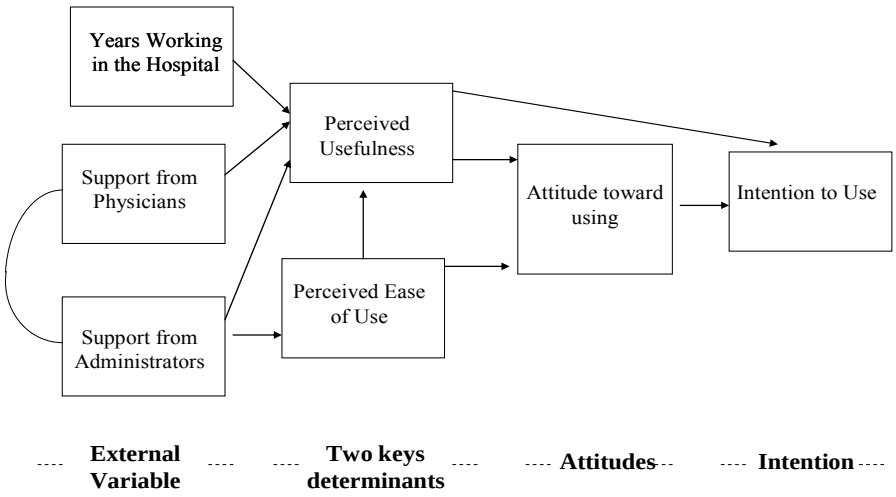


Figure 4.2. Telemedicine Technology Acceptance Model (TTAM)

Multiple regression analysis and path analysis. A path analysis was conducted to determine the causal effects among the variables in the revised proposed research model, TTAM (see Appendix A and Figure 4.2). The multiple regression analysis was conducted using enter on four paths based on the assumptions of causal closure of path diagram as presented in Table 4.4.

Table 4.3. Four paths in multiple regression analysis in TTAM.

Path analysis	Exogenous Variables	Endogenous Variables
Regression # 1	1. Years working in the hospital 2. Supports from physicians 3. Supports from administrators 4. Perceived ease of use	Perceived usefulness
Regression # 2	1. Supports from Administrators	Perceived ease of use
Regression # 3	1. Perceived usefulness 2. Perceived ease of use	Attitudes toward using
Regression # 4	1. Perceived usefulness 2. Attitudes toward using	Intention to use

According to the results of the path analysis (see Figure 4.3), regression #1, the path coefficient from years working in the hospital to perceived usefulness was statistically significant ($\beta = -0.200$, $p = 0.010$). The path coefficient from support from physicians to perceived usefulness was statistically significant ($\beta = 0.270$, $p = 0.003$). The path coefficient from support from administrators to perceived usefulness was not significant ($\beta = 0.051$, $p = 0.576$). The path coefficient from perceived ease of use to perceived usefulness was statistically significant ($\beta = 0.420$, $p = 0.000$).

The regression # 2 showed that the path coefficient from support from administrators to perceived ease of use was statistically significant ($\beta = 0.242$, $p = 0.009$).

The regression # 3 showed that the path coefficient from perceived usefulness to attitudes toward using was statistically significant (β = 0.297, p = 0.000). The path coefficient from ease of use to attitudes toward using was statistically significant (β = 0.466, p = 0.000).

Finally, the regression # 4 showed that the path coefficient from perceived usefulness to intention to use was statistically significant (β = 0.506, p = 0.000). The path coefficient from attitudes toward using to intention to use was statistically significant (β = 0.364, p = 0.000).

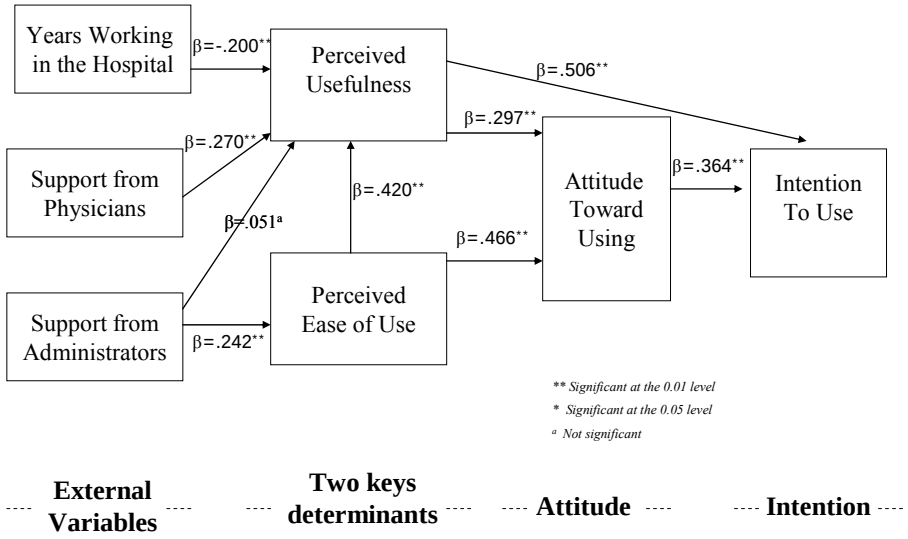


Figure 4.3. TTAM and multiple regression analysis results.

SEM methods: path analysis and model fit from LISREL. Next, path analysis was conducted using LISREL (see Appendix P for correlation matrix and syntax input). The β values of the path analysis using LISREL were equivalent to the previous analysis using multiple regression analysis (see Figure 4.4). However, an advantage of using the LISREL program was that it provided "fit" index values that were used to examine and determine the model fit to the data for this study.

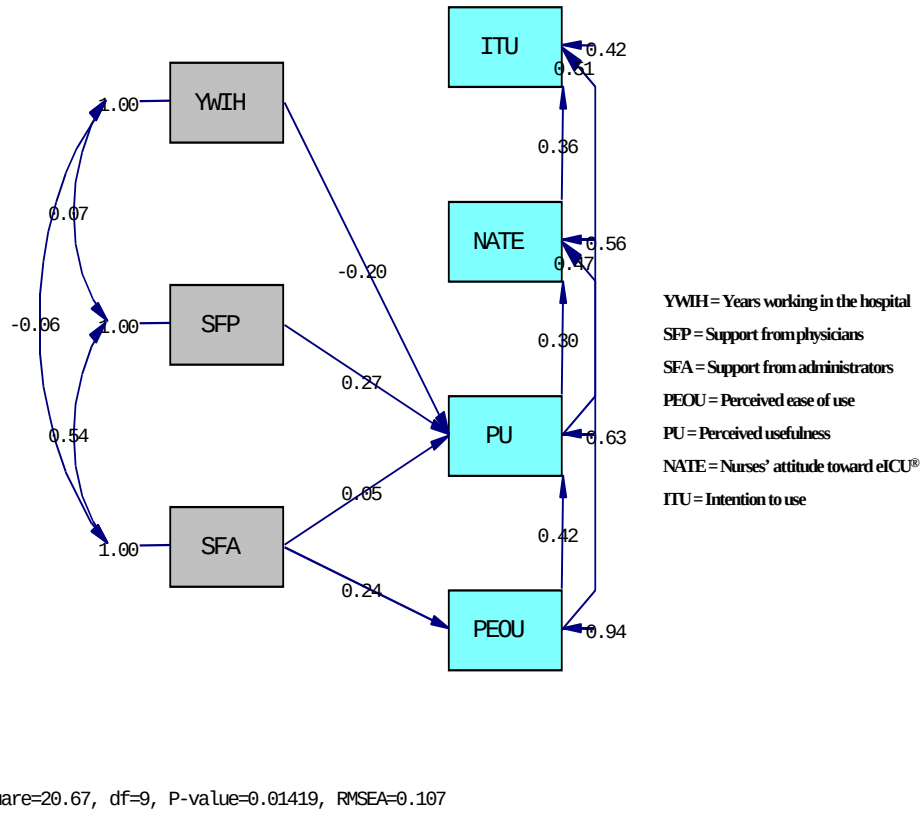


Figure 4.4. Path analysis using LISREL.

The overall model fit was examined by using multiple fit indices as suggested in the literature (Hartwick & Barki, 1994; Helloway, 1998; Hoyle, 1995; Hu, Chau, Liu Sheng, & Tam, 1999; and Segars & Grover, 1993). The chi-square statistic is an intuitive index for measurement goodness-of-fit between data and model. However, in this study the chi-square index was not used because of its sensitivity to sample size (Chau, 1997). According to the results in this study, Chi-square ($\chi 2$) was 20.67, degree of freedom (df) was 9, and P-value was 0.01419. The overall model fit analysis using common fit indices is presented on Table 4.4.

Table 4.4. Analysis of overall model goodness-of-fit using common fit indices.

Model goodness-of-fit indices	Recommended value	Results obtained from this study
Chi-square/degree of freedom	≤ 3.00	2.30
Goodness-of-fit index (GFI)	≥ 0.90	0.95
Adjusted goodness-of-fit index (AGFI)	≥ 0.80	0.85
Normalized fit index (NFI)	≥ 0.90	0.94
Non-normalized fit index (NNFI)	≥ 0.90	0.91
Comparative fit index (CFI)	≥ 0.90	0.96
Root mean square residual (RMR)	≤ 0.10	0.05
Root mean squared error of approximation (RMSEA)	≤ 0.10	0.10

The results of SEM methods in this study have shown that the model fit was reasonably adequate. Furthermore, the LISREL program provides the results of squared

multiple correlations for structural equations (R^2) that explain the power of the model for individual constructs (Hu, Chau, Liu Sheng, & Tam, 1999). The results of R^2 and β values on each path were presented on Figure 4.5.

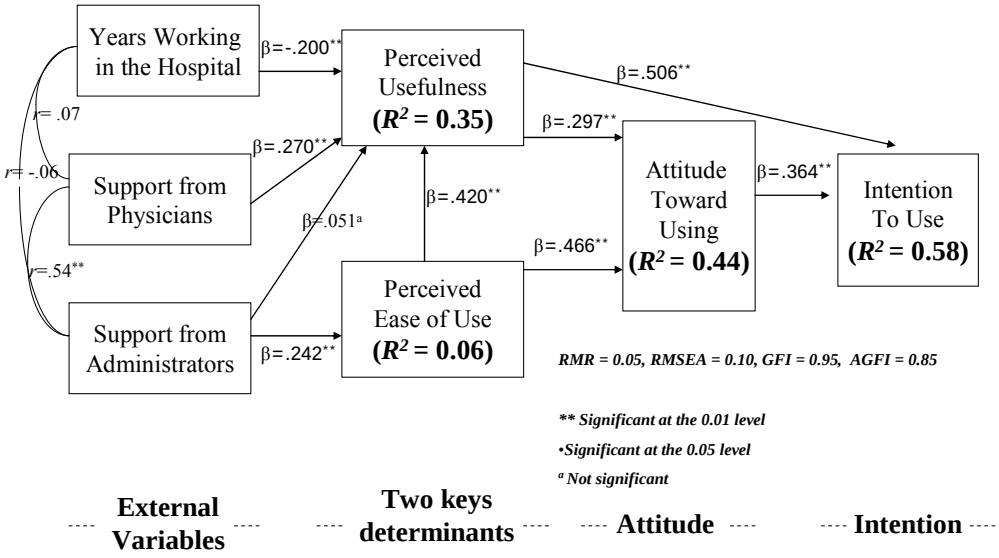


Figure 4.5. Structural equation modeling methods results.

Together, years working in the hospital, support from physicians, support from administrators, and perceived ease of use were able to explain 35 percent of the variance observed in perceived usefulness. Perceived ease of use has contributed the most of those fours variables (β = 0.420). Support from administrators has contributed the least (β = 0.05, and it was not statistically significant p = 0.576). Years working in the hospital has contributed to perceived usefulness in the negative result (β = -0.200).

Support from administrators had explained only 6 percent of the variance observed in perceived ease of use. However, perceived usefulness and perceived ease of use were able to explain 44 percent of the variance observed in nurses' attitudes toward the eICU® technology system. Perceived usefulness (β = 0.297) has contributed less than perceived ease of use (β = 0.466).

Perceived usefulness and nurses' attitudes toward using the eICU® technology system were able to explain 58 percent of the variance observed in intention to use the eICU® technology. However, perceived usefulness (β = 0.506) has contributed to intention to use more than nurses' attitudes toward using (β = 0.364) this technology.

Table 4.5. Summary of causal effects for the research model.

Constructs	Determinant	Causal Effects		
		Direct	Indirect	Total
Perceived usefulness (PU) (R^2 = .35)	Years working in the hospital	-.200**	-	-.200
	Support from physicians	.270**	-	.270
	Support from administrators	.051[a]	-	.051
	Perceived ease of use	.420**	-	.42
Perceived ease of use (PEOU) (R^2 = .06)	Support from administrators	.242**	-	.242
Attitudes toward using (NATE) (R^2 = .44)	Years working in the hospital	-	-.124 [a]	-.124
	Support from physicians	-	-.010 [a]	-.010
	Support from administrators	-	.455**	.455
	Perceived usefulness	.297**	-	.297
	Perceived ease of use	.466**	-	.466
Intention to use (ITU) (R^2 = .58)	Years working in the hospital	-	-.067 [a]	-.067
	Support from physicians	-	.612 [a]	.612
	Support from administrators	-	.102 [a]	.102
	Perceived usefulness	.506**	-	.506
	Perceived ease of use	-	.376**	.376
	Attitude toward using	.364**	-	.364

[a] Non-significant , ** - Significant at the 0.01 level.

Table 4.5 and Figure 4.6 present the direct and indirect effects in the model. Years working in the hospital, support from physicians, and support from administrators had indirect effects on nurses' attitudes toward using the eICU® technology system. However, only support from administrator had statistically significant (β = 0.455, p = 0.000) indirect effect on nurses' attitudes toward using this technology.

Years working in the hospital, support from physicians, support from administrators, and perceived ease of use had indirect effect on intention to use the eICU® technology system. However, only perceived ease of use had statically significant (β = 0.376, p = 0.000) indirect effect on nurses' intentions to use this technology (see Figure 4.6 for indirect path of the model).

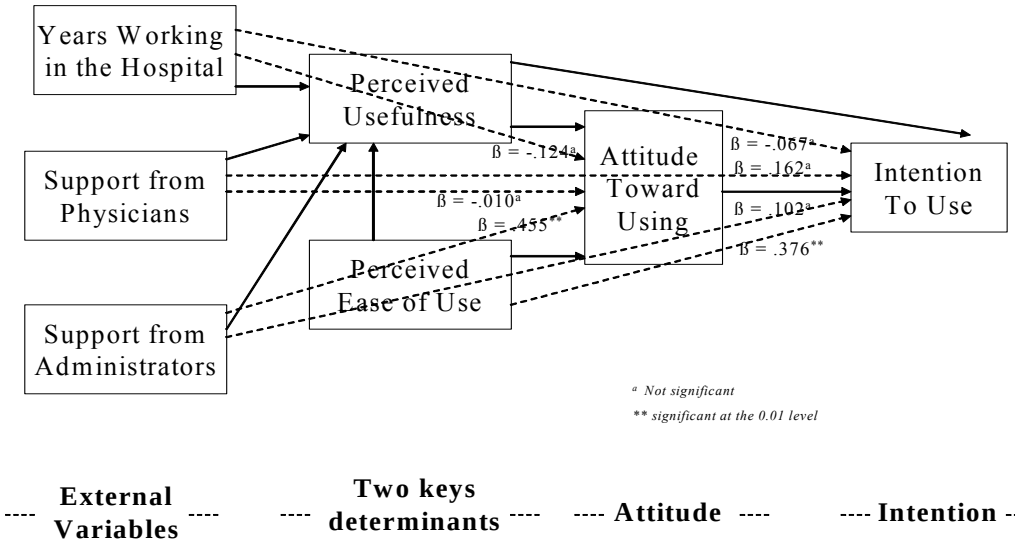


Figure 4.6. Path diagram for indirect effects of research model.

Results from Qualitative Data

Out of 117 participants, there were 34 participants (29%) who provided their written opinions in the additional comments section. The data were organized and categorized by meaning into categories by the researcher and 10 doctoral students in a qualitative research. The researcher and the doctoral students reached consensus that the data could be categorized into two main categories, which were resources and work related conflict.

1. Resources

The majority of the critical care nurses who made additional comments thought that the eICU® technology system would be a good resource to the units that did not have physician coverage 24 hours a day. "…I think it would be helpful especially when MD is not readily available". "I think eICU technology is a great resource and asset to hospitals outside the ICU setting or ones that don't have 24/7 critical card MDs readily available". "…It is most effective in ICUs without a teaching staff because they then have instant access to a MD…". "I feel that appropriate use of eICU is in smaller hospitals with less support and or physician coverage…".

In addition, the critical care nurses who made additional comments thought that the eICU® technology system would be more helpful and beneficial during the night and weekend hours, and be more helpful for the units that had many new graduated nurses. "I think it would be safer and feel safe on evenings nights and weekends knowing there was no a physician available". "I think it would help at night, so you did not have to wake up the on-call attending doctor". "I think eICU would be especially beneficial for

pts and RNs (new grades) to give the extra support". "…I like the concept for units with many new grads".

2. Work Related Conflict

The critical care nurses who made additional comments also thought that the eICU® technology system was a waste in the critical care units that had a physician cover a patient all the time. "It could work in units without 24 hrs coverage, but seems like a waste of energy/costs for units that have MD coverage..". "…I feel that in this environment, eICU is not needed and is double coverage…". "I feel that an eICU is not needed because there are more MDs available around the clock".

Additional comments were that there were conflicts between off-site and on-site physicians and those conflicts were not beneficial to the patient's outcome. "…there were some medical management issues, which were the conflict between medical doctors and surgical doctors who had different approaches…". "CVICU open heart surgery unit only heart surgery manage their patients". "eICU would be difficult to use in our unit because our doctors would like to be notified for everything first". "…I do not think our cardiac surgeons would allow other MDs to manage their patients".

The critical care nurses made additional comments on some extra work that they had to deal with when they used the eICU® technology system.

"My experience with eICU in SICU has been pretty negative. There seem to be excessive phone calls with petty issues (leads off) that nurses can handle without taking time to answer a call from another nurse. It feels belittling…, it could be handle quicker for a better pt outcome – just not silly, petty issues". "I do not want eICU, too much

extra work". "…it took away time from bedside nursing care, and it was a time consuming".

Some critical care nurses were afraid of the future that if the eICU® technology system was implemented, the patient and nurse ratio would be increased. "I do fear that eventually eICU will lead to administration believing that eICU monitored units can have a higher pt to nurse ratio".

Many critical care nurses who made additional comments said that they do not need the eICU® technology system. "I feel if you have well trained confident, strong nurses ICU, you don't need eICU. Also, may give you a false sense of comfort". "If implemented, will not be working here". "We don't need it. It's too much to handle". "No eICU".

According to the results from the additional comments, the critical care nurses expressed their feelings and opinions based on their experiences and the information that they had at the time. The majority of the nurses did not have experience with the eICU® technology system (83.8% of nurses in this study have never been trained to use this technology).

Summary

Prior to analyzing the data for this study, the 117 cases were initially screened for missing data, outliers, normality, linearity, homoscedasticity, and multicolinearity. The only intervention with the data was to replace missing data with the mean score. Data transformation procedures on outliers and homoscedasticity were not performed for reasons stated previously.

The statistics from this study indicated that the reliability of the measurements was satisfied and content validity was adequate. The correlation statistical procedure was performed before analyzing and testing the originally proposed research model. There were relationships among all variables. Some relationships were statistically significant, but some relationships were not. The variables of age, years experience in nursing and years experience with computers were deleted from the originally proposed research model because there were no statistically significant relationships with the key constructs (perceived usefulness, perceived ease of use, attitudes toward using, and intention to use). Therefore, the final proposed research model had a total of seven variables with three exogenous variables and four endogenous variables.

The results of multiple regression analysis for path analysis using the SPSS program had the same results of path analysis from the LISREL program. However, the SPSS program did not provide the model fit measurement for the model to the data. The LISREL 8.8 (student version) was used to analyze the data for the model fits.
The results of model fit using the SEM strategy demonstrated that the revised proposed research model fits the data. Overall, the model fit indices for the total sample were within an acceptable range (see Table 4.4).

The results from the qualitative data from additional comments of nurses were reported in five categories, which were resource and work related conflict. However, only 34 out of 117 participants provided answers in this section.

All of the results from quantitative data analysis and qualitative data analysis were used to answer research questions and were further discussed in Chapter V.

CHAPTER V

Discussion

The primary purposes of this study were to examine the applicability of the TAM in explaining nurses' acceptance of telemedicine technology (eICU®) in a health care setting, and to determine factors and predictors that influence the probability of the nurses' acceptance of this technology. The Telemedicine Technology Acceptance Model (TTAM) was developed from the original TAM (Davis, 1986). The psychometric properties of the instruments for this study were examined and the results have shown that the reliabilities of the instruments were acceptable and the content validity was examined.

The original proposed research model was revised based on the Pearson correlation results (see the discussion under research question number one p. 70). The final proposed research model was reduced to three external variables (years working in hospital, support from physicians, and support from administrators), and kept the four constructs drawn from the original TAM (perceived usefulness, perceived ease of use, attitudes toward using, and intention to use). The final proposed research model is called Telemedicine Technology Acceptance Model (TTAM) (see Appendix A).

Answer Research Questions

1. What is the relationship among the study external variables, the key determinants, the attitude toward using, and the intention to use telemedicine technology (eICU®)?

According to the Pearson correlation results, there were significant relationships among the constructs that were drawn from the original TAM (perceived usefulness, perceived ease of use, attitude, and intention to use) and there were significant relationship between TAM constructs and three external variables (years working in the hospital, support from physicians, and support from administrators).

Interestingly, there were no statically significant correlations among the constructs that were drawn from the original TAM with age, years of experience in nursing, and years of experience with computers. According to the literature review (see Chapter II), the results of the relationship between those three variables and attitudes toward computerization were conflicting. However, the studies mentioned in the literature review (Stronge & Brodt, 1985; Stockton & Verhey,1995; Jayasuriya & Caputi, 1996; McBride & Nagle, 1996; Simpson & Kenrick, 1997; Liu, Pothiban, Lu, & Khamphonsiri, 2000) were done at least a decade ago. The concern is that the significance of the results at that time may not have relevance in the twenty first century.

In this day and age, modern information technologies are accessible and affordable, and are a part of life's routine. Nurses are more familiar with computerized technology systems and use them on a daily basis. Predictably, in this study, those three variables (age, years of experience in nursing, and years of experience with computers)

had no significant relationship with the TAM constructs. Therefore, they were omitted from the originally proposed research model before running path analysis.

2. Which variables are most influential in predicting intention to use telemedicine technology (eICU®)?

The results from path analysis have shown that perceived usefulness was the most influential predictor ($\beta = 0.506$, $p = 0.000$) to the intention to use the eICU® technology system. Attitudes toward using this technology had less contribution ($\beta = 0.364$, $p = 0.000$) to predict the intention to use than perceived usefulness.

Perceived usefulness was predicted by the following factors; years working in the hospital ($\beta = -0.200$, $p = 0.010$), support from physicians ($\beta = 0.270$, $p = 0.003$), support from administrators ($\beta = 0.051$, $p = 0.576$), and ease of use ($\beta = 0.420$, $p = 0.000$). Ease of use was the most influential predictor to perceived usefulness. Support from administrators was not statically significant to predict perceived usefulness, but support from physicians was statically significant to predict perceived usefulness in this study. Interestingly, years of working in the hospital was negatively statistically significant to predict perceived usefulness.

Perceived ease of use was predicted only by support from administrators ($\beta = 0.242$, $p = 0.009$). Nurses' attitudes toward using this technology was predicted by perceived ease of use ($\beta = 0.466$, $p = 0.000$), and perceived usefulness ($\beta = 0.297$, $p = 0.000$). Perceived ease of use of this technology was a more influential predictor to nurses' attitudes toward using than perceived usefulness.

3. Is the proposed hypothesized model consistent with the empirical data in the study?

According to the structural equation modeling results, the model fit was reasonably adequate. Four indices for the absolute fit, which are RMR (0.05), RMSEA (0.10), GFI (0.95), and AGFI (0.85), demonstrated that they were within an acceptable range. Therefore, the proposed research model has the ability to reproduce the correlation/covariance matrix.

Previous Technology Acceptance Model (TAM) Studies and Telemedicine Technology Acceptance Model (TTAM) in This Study

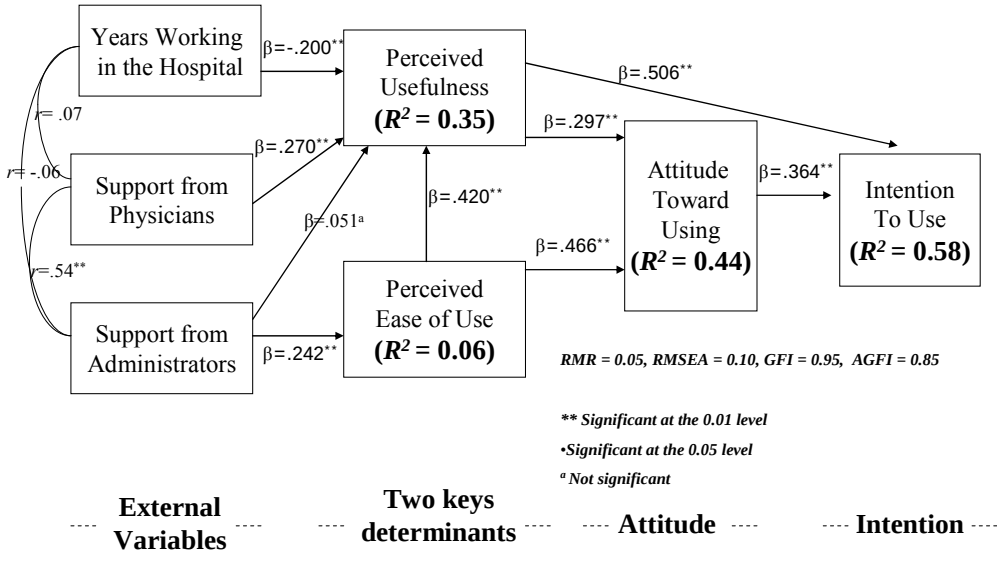


Figure 5.1. Telemedicine Technology Acceptance Model (TTAM) and Results

Based on the data collected from 117 nurses from two healthcare systems, the applicability of TAM in explaining nurses' acceptance of telemedicine technology

(eICU®) was evaluated. The Telemedicine Technology Acceptance Model (TTAM) was able to explain 58 percent of the variance ($R^2 = 0.58$) in intention to use eICU® technology with the nursing population. The intention to use this technology was predicted by perceived usefulness ($\beta = 0.506$, $p = 0.000$) and attitude toward using ($\beta = 0.364$, $p = 0.000$). Compared to the prior TAM study ($R^2 = 0.45$) in healthcare settings (Hu, Chau, Liu Sheng, & Tam, 1999), the TTAM in this study appeared to have a stronger applicability in explaining the intention to use the telemedicine technology.

Intention to Use

In the original TAM study (Davis, Bagozzi, & Warshaw, 1989), the variance in intention to use the technology appeared to be slightly weaker ($R^2 = 0.45$ for the first study and $R^2 = 0.57$ for the second one) than that which was reported in this study ($R^2 = 0.58$). Moreover, in the original TAM study and this research study, the variance in intention to use was less than that which was reported of 70 percent of variance ($R^2 = 0.70$) by Mathieson (1991).

Based on the results of structural equation modeling analysis, all of the model fit indices were within the normal range. Therefore, the TTAM in this study appears to adequately specify the intention of nurses to use the eICU® technology system. The model has the ability to reproduce a correlation matrix with this nursing population as the original TAM. The suitability and applicability of TAM in the nursing population were confirmed as indicated by reasonable model fit indices. Nevertheless, "it is important for researchers to recognize that "model fit" does not equal to 'truth' or 'validity'. Finding

the expected pattern of correlation is a necessary but not sufficient condition for the validity of the theory that generated the model predictions" (Kelloway, 1998. p. 40).

Attitudes

Nurses' attitudes toward the eICU® technology system was also a significant factor that predicted the intention to use this technology, even though it had less contribution to predicting the intention to use this technology than perceived usefulness. In this sense, it had shown that nurses' attitudes were also relatively important to nurses' acceptance of the eICU® technology system.

The quantitative results of this study have indicated that perceived usefulness had less effect on attitude toward using than perceived ease of use. Similar to the results from qualitative analysis, the critical care nurses had more negative attitudes than positive attitudes toward using this technology. They viewed this technology as another workload, and they were fearful that the administrators would increase the nurse to patient ratio.

In addition, to support why perceived usefulness has less effect than perceived ease of use on the attitudes toward using, the work dynamics, work environments, and cultures in the critical care units are different from other settings. Nursing practice requires particular knowledge and skill in dealing with patient care within the critical care environment. Any situations that interfere with or interrupt the patient care, such as time spent with issues unrelated to patient care, would lead to resistance. The nurses are very focused on their patients because those patients are in very serious condition. Any new

technology that appears to take the nurses away from patient care would lead to the belief that it would not be useful or helpful.

Two Key Determinants (Perceived Usefulness and Perceived Ease of Use)

Perceived usefulness. In terms of prediction, in agreement with the original TAM and previous studies (Adams, Nelson, & Todd, 1992; Chau, 1996; Davis, 1989; Davis, Bagozzi, & Warshaw, 1998; Hu, Chau, Liu Sheng, & Tam, 1999; & Mathieson, 1991), perceived usefulness was found to be a key determinant that has a statistically significant and strong influence on nurses' intentions to use the eICU® technology system. This may claim that nurses in critical care units tend to focus on the usefulness of this technology itself.

In this study, perceived usefulness was significantly impacted by perceived ease of use as TAM hypothesizes, contrary to what Hu, Chau, Liu Sheng, and Tam (1999) found. They found that perceived ease of use had no significant effect on perceived usefulness of the telemedicine technology in Hong Kong. Their claim, the particular technology and user population in their study were limited to TAM's applicability.

Perceived ease of use. Contrary to the original TAM and previous TAM studies (Adams, Nelson, & Todd, 1992; Chau, 1996; Davis, 1989; Davis, Bagozzi, & Warshaw, 1998; Hu, Chau, Liu Sheng, & Tam, 1999; & Mathieson, 1991), perceived ease of use was found to have more significant effect ($\beta = 0.466$) on nurses' attitudes toward using the eICU® technology system than perceived usefulness ($\beta = 0.297$). The previous studies as mentioned above had found that perceived ease of use (β ranges from 0.08 to 0.20) had a significantly weaker effect on attitudes toward using the eICU® technology

system than perceived usefulness (β ranges from 0.45 to 0.79). This might reflect a limitation of TAM's application with the nature of the nursing population and the context in this study.

In that implication, the critical care nurses are professionals with high competence, autonomy, and cognitive capacity regarding the nature of their work. Most of the critical care nurses were familiar with using computers and technology equipment (average number of years using computers was 14.77). They have already been charging, ordering, and documenting, using computers with various types of software programs. According to the results of this study, 94 percent of nurses reported that they had personnel support in their facilities to help them solve technical problems whenever they were struggling with new technology features or operations. If the new eICU® technology system were to be implemented, those nurses could learn and become familiar with its operation quickly.

As determined by the qualitative data, the difficulty of using the eICU® technology system was not mentioned by the critical care nurses. The majority of those nurses who provided comments reported that the eICU® technology system was not useful or helpful for critical care units. Those nurses did not perceive that this technology would help them to perform their job. They suggested that the eICU® technology system would be more helpful and appropriate for units and hospitals that did not have physician coverage 24 hours a day, during nights and weekends, and for units with many new graduate nurses.

External Variables

In the original TAM, the two key determinants were influenced by external variables that were hypothesized as a priority of user acceptance that provided more generalization to different computer systems and user populations (Davis, Bagozzi, & Warshaw, 1989). The external variables in this study (years working in the hospital, support from physicians, and support from administrator) are different from the original TAM because of differences in social context and the particulars in the nursing profession.

Years working in the hospital. The numbers of years working in the hospital had a negative statistically significant correlation with perceived usefulness. At this point, the results from the data did not support either assumption, that nurses who worked in the hospital longer believed less in the usefulness of this technology, or nurses who worked in the hospital for a short period of time would believe this technology was useful.

The preceding statement suggests that nurses who worked in the hospital for a long time or for a short period of time had received some information that impacted their belief of usefulness about the eICU® technology system. As the data had shown, 46.2 % of critical care nurses have heard about eICU® technology from a nurse who has used this technology. They have seen some struggling from their peers, some conflicts and anxiety that happened to nursing professional with this technology, or they may have heard positive information about the technology. Therefore, providing proper user training is essential for directing nurses' perceptions of the usefulness of the technology.

Support from Physicians. The results from path analysis have shown that perceived usefulness was also influenced by support from physicians. Conceivably, critical care nurses have excellent clinical judgment and skill that they use in cooperation with patient care. If nurses perceived that an order was unproductive and they knew it would cause a conflict, they would try to escalate to the other physician.

Critical care nurses have to work with many health care providers from several medical management teams such as a surgical team, medical team, and trauma team. Based on the qualitative data, the nurses reported that while using the eICU® technology system, there were often conflicts or discrepancy of orders between physicians. Nurses often confront conflicts of treatment between off-site and on-site physicians. That conflict negatively impacted individual nurses' perception of usefulness of the eICU® technology system.

In addition, the statement above was supported by the qualitative data which had shown discrepancies on the treatment between physicians. *"CVICU open heart surgery unit only heart surgery manage their patient". "…there were some medical management issues, which were the conflict between medical doctors and surgical doctors who had different approaches…". "…I do not think our cardiac surgeons would allow other MDs to manage their patients".*

Physicians had a great impact on nurses' belief about how this technology would be beneficial for their patients. Therefore, in order for the nurses to accept the eICU® technology system, it is necessary to have immense support from the physicians as

suggested by the findings. Physicians have to demonstrate that this technology has enormous potential to help improve patient outcomes.

Support from administrators. The support from administrators as an external variable from this study showed a significant influence on perceived ease of use, but not a significant influence on perceived usefulness. Most of the administrators or directors in critical care units were registered nurses. They have similar backgrounds with nurses who work at the patient's bedside. However, the nursing administrators had a different focus on the eICU® technology system. Their focus was on how to provide all nurses with user support and proper training before the technology were to be implemented. The administrators often reassure the nurses that using this technology would be free from mental efforts and it would improve patient outcomes.

In conclusion, the TTAM that was developed from the original TAM, was able to explain and predict the intention to use the eICU® technology system in the nursing population. However, the applicability of the TTAM in explaining the factors that influenced nurses' attitudes toward using the eICU® technology system was different from the original TAM. This may be due to the unique characteristics of the healthcare setting and the nature of the nursing profession.

Measurement

The constructs included in this research study were basically drawn from the original TAM studies and the external variables were drawn from the literature reviews and the suggestions from the experts. However, the instruments had to be modified to adapt to the nursing population before administering to the potential subjects. Even

though the reliability was high and the content validity was examined, the construct validity has not yet been tested. Future evaluation of construct validity of the instrument is suggested by using confirmatory factor analysis for the perceived usefulness, perceived ease of use, and intention to use scales, and using exploratory factor analysis for the attitude scale.

Based on the researcher's experience while working on this study, the return rate of data collection was increased with the researcher being at the sites to answer any questions.

Limitations

Responses to this study were voluntary and subjected to self-selection biases. Regarding qualitative data, only 34 participants (29%) expressed their opinions and made comments. Due to the nature of the questionnaire, the researcher did not send the qualitative data results back to the participants for member checks.

Implications

Nursing Practice

To improve nurses' acceptance of the eICU® technology system, cultivating perceived usefulness and attitudes toward using this technology are very crucial. In critical care units, nurses have high autonomy and are competent with patient care. Patients' outcome is of most concern when it comes to adapting to new technology and new environments.

According to this study, communication between physicians and nurses needs to be clear and have precise direction. A physician who would be in charge of patient care

management should be identified before the eICU® technology system is implemented. The plan of escalation of treatment must be clearly stated and focused on patients' safety.

Nursing Administration

When planning a new technology system for an organization, administrators should have the ability to predict whether the new system will be acceptable to users, investigate reasons why a planned system may not be fully acceptable, and then take corrective action to increase acceptability. This action would help to improve the business investment in time and money (Davis, Bagozzi, & Warshaw, 1989). According to this study, the factors that influence perceived usefulness that was a key determinant to nurses' acceptance were perceived ease of use, support from physicians, and years working in the hospital.

Prior to introducing the new eICU® technology system to the nursing population, administrators can increase the acceptability of the system by having physicians and nurses involved in the implementation process, assessing nurses' and physicians' perception, and providing corrective information. Perceived ease of use is a main factor to increase attitude toward using. Therefore, nurse administrators can foster this factor by having on-site user training and reassure the staff that they will have personnel support at the units at all times.

Based on the suggestions from critical care nurses, the implementation of this technology might be better able to help nurses in the units that lack physicians and experienced nursing staffs. Also, this technology might be more beneficial for the hospitals that do not have physician coverage 24 hours a day.

Nursing Education

It is very imperative that education pertaining to the eICU® technology system is needed not only for nurses, but also for physicians and other health care providers. According to the results from this study, nurses received information from other nurses, physicians, and administrators, who were working in the hospital. That information impacted their beliefs and attitudes toward using this technology.

Education sessions should emphasize the effectiveness and usefulness of this technology. In addition, education on effective communication strategies among health care providers should be emphasized to foster better communication and help to avoid conflicts. The information and training session should primarily focus on how the eICU® technology system can help improve patients' safety and outcomes.

Nursing Research

This research study provides the effectiveness of TAM in explaining, predicting, and identifying factors that influence nurses' acceptance of the eICU® technology system in critical care units. The TTAM in this study provides the framework for research to understand the acceptance of this technology specifically in the nursing population. This preliminary study provides a theoretical framework and psychometric properties for future research in nursing practice.

Recommendations

Additional research is needed to address construct validity with larger sample size and improved model fit. The indirect path coefficient (ease of use and intention to use) which is statistically significant, and the direct path coefficient (support from

administrator and usefulness) which is not statistically significant, may need to have further investigation for model modification to improve the "fit" of the research model.

The external variables were the primary factors that influenced the two key determinants. In the healthcare setting, there might have been more than three factors that influenced those two key determinants specified in the TTAM. More investigation on external variables, such as knowledge, participation in the decision-making process, peer support, individual awareness, is needed.

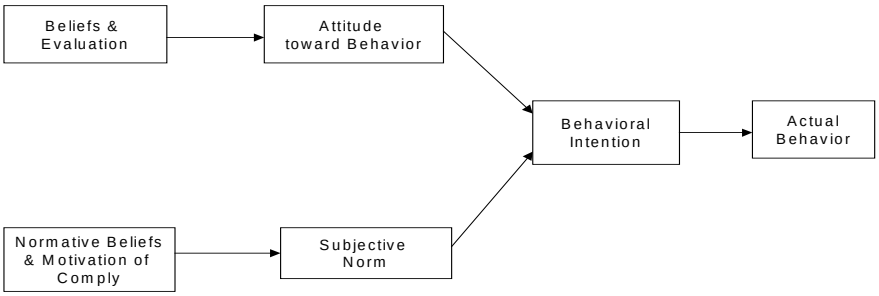
The TTAM worked well in explaining, identifying, and predicting the acceptance of telemedicine technology. The replication of this study is highly recommended.

Conclusion

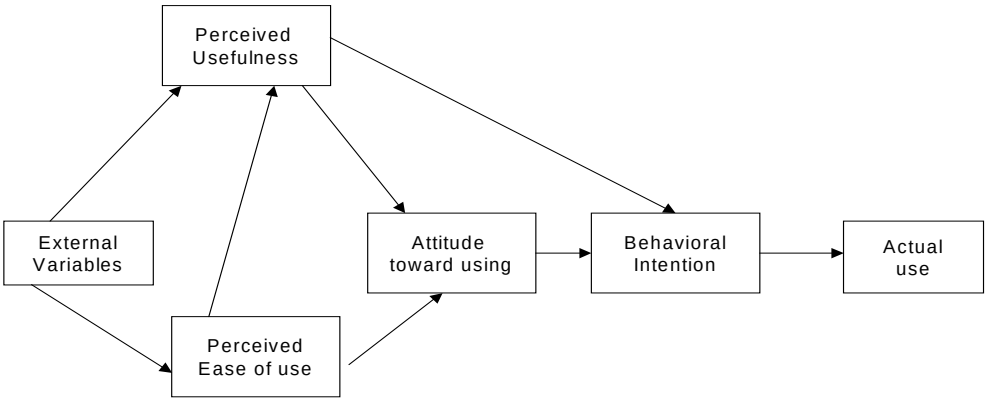
This preliminary study tested theoretical model and instruments that had been developed from the discipline of social psychology. The Telemedicine Technology Acceptance Model (TTAM) established a valuable model for predicting acceptance of telemedicine technology with nurses in healthcare. The fact that 58 percent of the variance ($R^2 = 0.58$) in intention to use the technology is explained by the model in this study. Therefore, it suggests that the TTAM has applicability across disciplines and across settings in explaining, predicting, and identifying an acceptance of telemedicine technology.

Appendix A

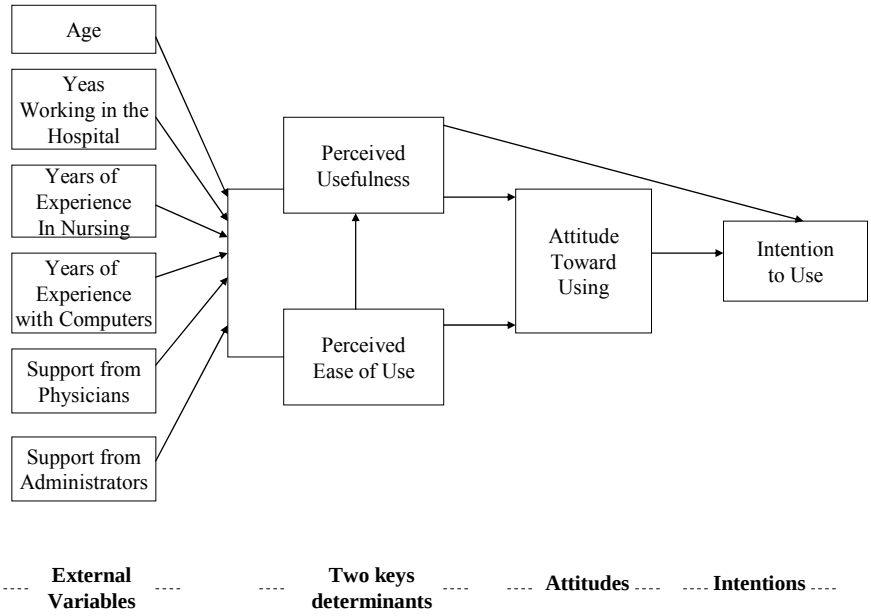
1. TRA: Theory of Reasoned Actions



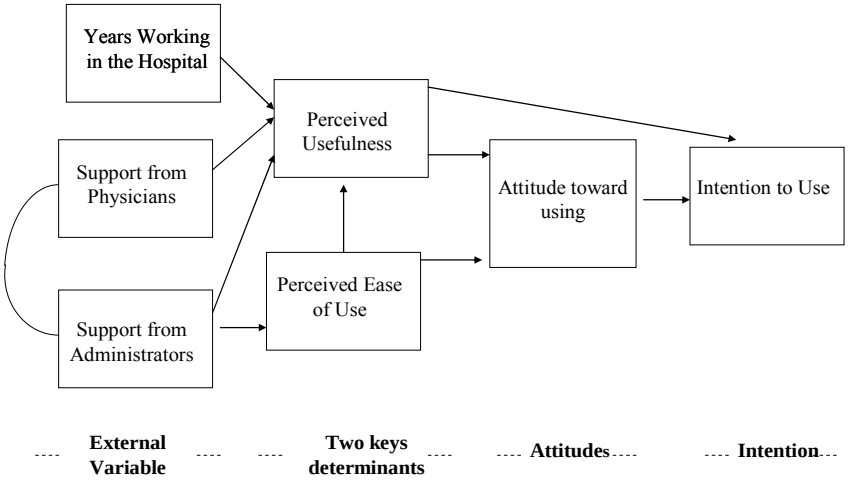
2. TAM: Technology Acceptance Model



3. Original Proposed Research Model



4. Telemedicine Technology Acceptance Model (TTAM)



Appendix B

Content Validity from the experts

The results from the expert survey have shown as below:

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. All items are clear and easy to understand.				40%	60%
2. This instrument is appropriate for nurses.				20%	80%
3. Section I adequately measures the perceived usefulness of an eICU® technology system.				80%	20%
4. Section II adequately measures the perceived ease of use of an eICU® technology system.				80%	20%
5. Section III adequately measures the nurses' attitudes toward an eICU® technology system.				60%	40%
6. Section IV adequately measures the intension to use an eICU® technology system.				40%	60%
7. Questions in section V are appropriate for demographic data.				20%	80%
8. Questions in section VI are appropriate for additional comments.				20%	80%
9. Overall, this instrument is useful for eICU® technology acceptance measurement.				40%	60%

Appendix C

Pilot study: Testing the reliability of the instrument

The questionnaire was provided directly to 40 nurses working in the critical care unit within the Health System. Of the 40 questionnaires, 31 responses were returned showing a 78 % rate. All the participants completed the questionnaire within 5-8 minutes. The results of the reliabilities show as below:

Reliability from 31 participants (Pilot study)

Constructs	**C**oefficient Alpha
Perceived usefulness (PU)	.94
Perceive ease of use (PEOU)	.94
Nurse attitudes toward eICU® (NATE)	.86
Intention to use (ITU)	.88
Over all reliability	.95

Appendix D

GEORGE MASON UNIVERSITY

Office of Research Subject Protections

Research I Building, 4400 University Drive, MS 4C6, Fairfax, Virginia 22030
Phone: 703-993-4121; Fax: 703-993-9590

TO: Jean Moore, College of Health and Human Services

FROM: Sandra M. Sanford, RN, MSN, CIP
Director, Office of Research Subject Protections

PROTOCOL NO.: 5345 Research Category: Doctoral Dissertation

TITLE: Technology Acceptance Model: Predicting Nurses' Acceptance of Telemedicine Technology (eICU)

DATE: September 5, 2007

Cc: Yanika Kowitlawakul

On September 5, 2007, the George Mason University Human Subjects Review Board (GMU HSRB) reviewed and approved the amendment dated September 4, 2007 for the above-cited protocol following expedited review procedures.

You may proceed with data collection. **Please note that any further modifications to your protocol must be submitted to the Office of Research Subject Protections for review and approval prior to implementation.** Any adverse events or unanticipated problems involving risks to subjects including problems involving confidentiality of the data identifying the participants must be reported to the GMU Office of Research Subject Protections and reviewed by the GMU HSRB.

The anniversary date of this study is September 4, 2008. You may not collect data beyond that date without GMU HSRB approval. A continuing review form must be completed and returned to the Office of Research Subject Protections prior to the anniversary date, or upon completion of the project. A copy of the continuing review form is attached. In addition prior to that date, the GMU Office of Research Subject Protections will send a letter to you regarding continuing review procedures.

If you have any questions, please do not hesitate to contact me at 703-993-4015.

Appendix E

Cover letter

Dear Critical Care Nurse,

I'm a Ph.D student at George Mason University, Farifax, VA, and I need your assistant. I would like to invite you participate in a research project to study nurses' acceptance of telemedicine technology (eICU®). Completion of the survey should take approximately 10-15 minutes.

The purposes of the study are:

- To examine the applicability of the TAM (Technology Acceptance Model) in explaining nurses' acceptance of telemedicine technology (eICU®) in health care settings.
- To determine factors and predictors that influence nurses' acceptance of the eICU®.
- To provide psychometric evidence (validity and reliability) of the measurement scales used in the study.

The results of this study will be useful information for policy makers, administrators, researchers, and educators in planning for implementing eICU® technology systems.

Along with this letter are a informed consent form and a questionnaire that asks a variety of questions about your perception of eICU®. If you choose to participate, please sign the informed consent form and complete the questionnaire. Please return the questionnaire in the attached envelop to the large box that is provided at your unit. Regardless of whether you choose to participate, please let me know if you would like a summary of my findings by including your email address.

If you have any questions or concerns about completing the questionnaire or about being in this study, you may contact me anytime (Please see the contact information as below). This project has been approved by the Institutional Review Board at your hospital (703-776-3167) and the Human Subjects Review Board at George Mason University (703-993-4121).

Sincerely.

Yanika Kowitlwakul, RN, MSN
Doctoral Candidate, GMU
Tel: (703) 608-4397
ykowitla@gmu.edu

Appendix F

CJW Medical Center
Chippenham & Johnston-Willis
HCA Virginia

HUMAN RESEARCH COMMITTEE
APPROVAL LETTER

September 12, 2007

Barbara Leedom, RN, BSN, CCRN
Henrico Doctors' Hospital
eICU Watch
7702 East Parham Road, MOB III
Richmond, VA 23294

Re: **Technology Acceptance Model: Predicting Nurses' Acceptance of Telemedicine Technology (eICU®)**
Initial Review

- Cover Letters and Application
- Follow Up Letter, dated August 13, 2007
- CVs, License and Conflict of Interest Disclosure form
- Revised Dear Critical Nurse letter, dated August 31, 2007
- Revised eICU Acceptance Survey (EAS), dated August 2, 2007
- Revised Protocol, dated August 2, 2007
- Revised Informed Consent Form, dated August 31, 2007
- Revised Protocol Summary, dated August 2, 2007

Dear Ms. Leedom:

The Chippenham & Johnston-Willis Medical Center Human Research Committee began review of the above mentioned study at the July 25, 2007 meeting. At that meeting, the Committee requested modifications to the protocol, informed consent form, Dear Critical Nurse letter, and the eICU Acceptance Survey that qualified for expedited review. Subsequently, the site made additional changes. As a result, the revised documents were reviewed at a fully convened meeting of the Human Research Committee on August 22, 2007. At that meeting, the Committee requested additional modifications to the revised Dear Critical Nurse Letter and the revised Informed Consent Form that qualified for expedited review. The purpose of this letter is to inform you that the requested changes have been reviewed and approved by the expedited review process. The above mentioned study is approved to take place at Chippenham & Johnston-Willis Medical Center and Henrico Doctors' Hospital. This approval includes approval of the above mentioned documents.

Chippenham Campus 7101 Jahnke Road, Richmond, VA 23225 / tel: 804.320.3911 / main fax: 804.323.8953 / admin. fax: 804.323.8049
Johnston-Willis Campus 1401 Johnston-Willis Drive, Richmond, VA 23235 / tel: 804.330.2000 / main fax: 804.330.2233 / admin. fax: 804.330.2313
AN HCA RICHMOND HOSPITAL • www.CJWmedical.com

Attached, please find a copy of the consent document containing the Chippenham & Johnston-Willis Medical Center Human Research Committee approval stamp. Please copy this document and ensure that all patients sign the document containing the approval stamp.

Renewal for this study will be due July 23, 2008. The submission deadline is July 3, 2008.

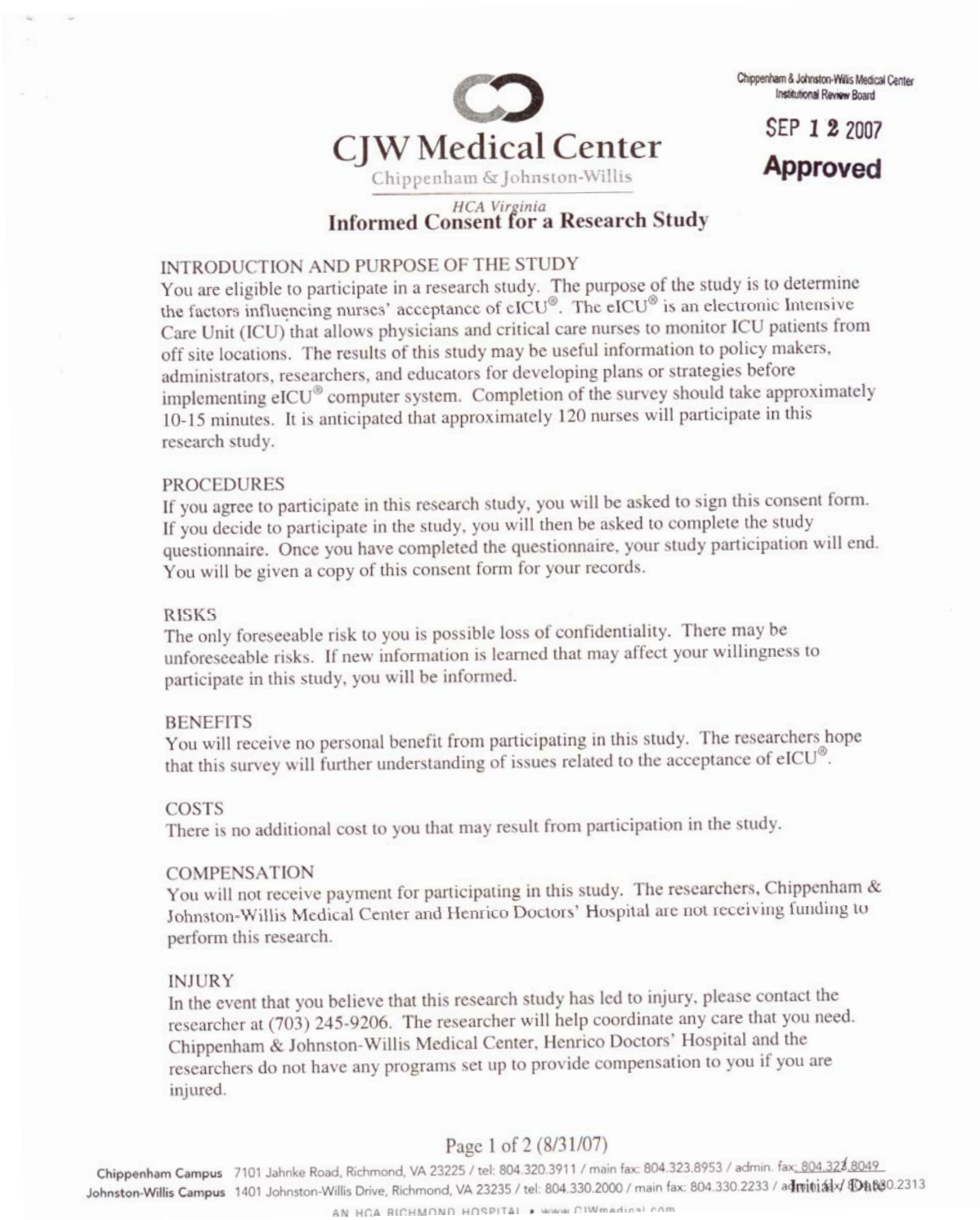
Please note that the Committee determined that the researchers must be available, in person, for an interactive discussion with the potential subjects. The potential subjects must be able to ask the researchers questions in person. Consents may not be signed and left in an unsecured box. A subject should not be provided with a questionnaire until prospective written informed consent has been obtained. This process will help ensure that subjects are adequately informed.

With this approval, you will be responsible for ensuring that the Federal Regulations governing research and the HCA Richmond Division Institutional Review Board Policies and Procedures are adhered to. Additionally, no changes may be implemented to this project without prospective written Institutional Review Board approval, unless the changes are necessary to eliminate or reduce an apparent immediate hazard to the safety of subjects already participating in the project. For questions regarding these requirements, or for any additional assistance, please feel free to contact Lisa Shawler, R.N., HCA Richmond Division IRB Director, at 804-254-5440.

BY: _____
David Geckle, M.D.
HRC Chairman

CC: CJW Administration

Appendix G



CJW Medical Center
Chippenham & Johnston-Willis
HCA Virginia

Chippenham & Johnston-Willis Medical Center
Institutional Review Board
SEP 12 2007
Approved

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 determine the factors influencing nurses' acceptance of eICU®. The eICU® is an electronic Intensive Care Unit (ICU) that allows physicians and critical care nurses to monitor ICU patients from off site locations. The results of this study may be useful information to policy makers, administrators, researchers, and educators for developing plans or strategies before implementing eICU® computer system. Completion of the survey should take approximately 10-15 minutes. It is anticipated that approximately 120 nurses will participate in this research study.

PROCEDURES
If you agree to participate in this research study, you will be asked to sign this consent form. If you decide to participate in the study, you will then be asked to complete the study questionnaire. Once you have completed the questionnaire, your study participation will end. You will be given a copy of this consent form for your records.

RISKS
The only foreseeable risk to you is possible loss of confidentiality. There may be unforeseeable risks. If new information is learned that may affect your willingness to participate in this study, you will be informed.

BENEFITS
You will receive no personal benefit from participating in this study. The researchers hope that this survey will further understanding of issues related to the acceptance of eICU®.

COSTS
There is no additional cost to you that may result from participation in the study.

COMPENSATION
You will not receive payment for participating in this study. The researchers, Chippenham & Johnston-Willis Medical Center and Henrico Doctors' Hospital are not receiving funding to perform this research.

INJURY
In the event that you believe that this research study has led to injury, please contact the researcher at (703) 245-9206. The researcher will help coordinate any care that you need. Chippenham & Johnston-Willis Medical Center, Henrico Doctors' Hospital and the researchers do not have any programs set up to provide compensation to you if you are injured.

Chippenham Campus 7101 Jahnke Road, Richmond, VA 23225 / tel: 804.320.3911 / main fax: 804.323.8953 / admin. fax: 804.323.8049
Johnston-Willis Campus 1401 Johnston-Willis Drive, Richmond, VA 23235 / tel: 804.330.2000 / main fax: 804.330.2233 / admin. fax: 804.330.2313
AN HCA RICHMOND HOSPITAL • www.CJWmedical.com

Initial / Date

Chippenham & Johnston-Willis Medical Center
Institutional Review Board

SEP 12 2007

Approved

CONFIDENTIALITY

Efforts have been made to protect your identity. The signed consent form will be separated from the completed survey by the researcher immediately upon receipt. The survey will not contain any identifiers linked to you. Only group data will be reported and responses will not be identified with you or any other participant. Once data analysis is complete and the research results are reported, the individual surveys will be kept in the locked drawer. For monitoring purposes, the United States Food and Drug Administration, the Department of Health and Human Services, other regulatory agencies, and the Chippenham & Johnston-Willis Medical Center Human Research Committee may have access to your study consent form and your study questionnaire. You may request a copy of the research results by contacting the researcher at (703) 245-9206.

VOLUNTARY PARTICIPATION/ALTERNATIVE

Taking part in this research study is voluntary. You have the option of not participating in this study. If you choose not to participate, there will be no penalty or loss of benefits and your employment will not be affected.

WITHDRAWAL

You may withdraw from this study at anytime by contacting the researchers at (703) 245-9206. Additionally, the researchers may end your participation if they decide to stop the study before you complete the questionnaire.

QUESTIONS

If you have any questions regarding this research study, please contact Yanika Kowitlawakul, RN, BSN, MSN, by mail (14309 Climbing Rose Way, # 303, Centreville, VA 20121) or by phone (703/245-9206). If you have any questions about your rights as a research participant, please contact the Chippenham & Johnston-Willis Medical Center Human Research Committee at (804) 254-5335.

SIGNATURE:

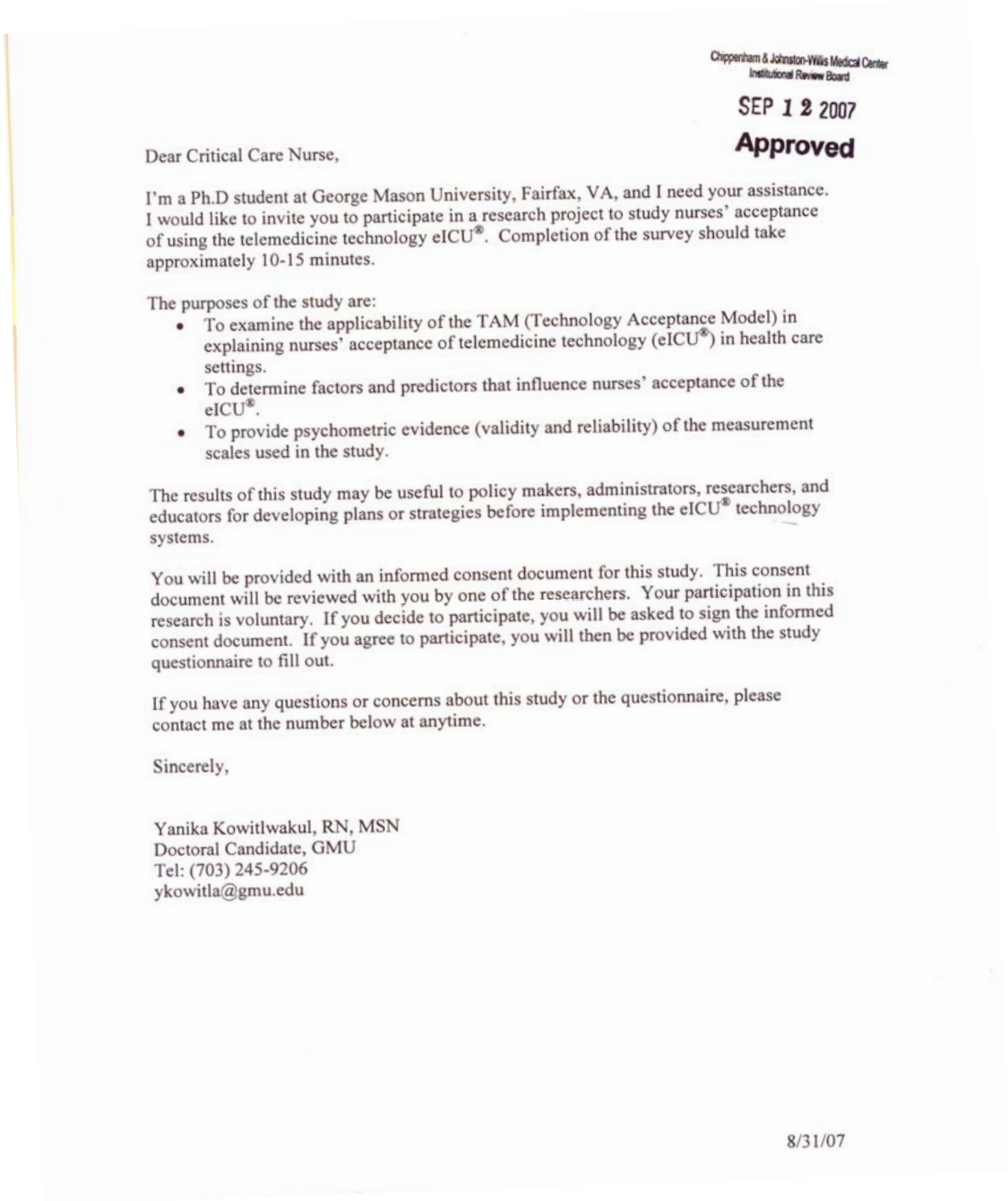
I have been informed about this research study's purpose, procedures, and possible risks and benefits. I understand that my participation in this study is voluntary. I will contact a member of the research team if I have any questions.

Signature of Participant	Printed Name of Participant	Date
Signature of Witness	Printed Name of Witness	Date
Signature of the researcher	Printed Name of the researcher	Date

____/____
Initial / Date

Appendix H

Cover letter



Chippenham & Johnston-Willis Medical Center
Institutional Review Board

SEP 12 2007

Approved

Dear Critical Care Nurse,

I'm a Ph.D student at George Mason University, Fairfax, VA, and I need your assistance. I would like to invite you to participate in a research project to study nurses' acceptance of using the telemedicine technology eICU®. Completion of the survey should take approximately 10-15 minutes.

The purposes of the study are:

- To examine the applicability of the TAM (Technology Acceptance Model) in explaining nurses' acceptance of telemedicine technology (eICU®) in health care settings.
- To determine factors and predictors that influence nurses' acceptance of the eICU®.
- To provide psychometric evidence (validity and reliability) of the measurement scales used in the study.

The results of this study may be useful to policy makers, administrators, researchers, and educators for developing plans or strategies before implementing the eICU® technology systems.

You will be provided with an informed consent document for this study. This consent document will be reviewed with you by one of the researchers. Your participation in this research is voluntary. If you decide to participate, you will be asked to sign the informed consent document. If you agree to participate, you will then be provided with the study questionnaire to fill out.

If you have any questions or concerns about this study or the questionnaire, please contact me at the number below at anytime.

Sincerely,

Yanika Kowitlwakul, RN, MSN
Doctoral Candidate, GMU
Tel: (703) 245-9206
ykowitla@gmu.edu

8/31/07

Appendix I

INOVA HEALTH SYSTEM

Inova Health System Institutional Review Board
Inova Fairfax Hospital
3300 Gallows Road,
Falls Church, Virginia 22042-3300

Tel 703-776-3167
Fax 703-776-6678

April 25, 2006

Yanika Kowitlawakul, RN, BSN, MSN
Inova Fairfax Hospital, ICU 1
3300 Gallows Road
Falls Church VA 22042

IRB Study # 06.051 **At:** IRB Group 2 **Meeting Date** 5/17/2006

Predicting Factors Influencing Nurse's Acceptance of Telemedicine Technology (eICU) in Intensive Care Units (Pilot Study)

Dear Ms. Kowitlawakul:

This letter is to inform you that the above-cited research protocol was approved by the Inova Health System Institutional Review Board (Inova IRB) via expedited review procedures for a period of one year.

This study falls under category 7: Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note that changes in the protocol, consent form, sites or investigators must be reported to the Inova IRB for approval prior to implementation.

To ensure review within 365 days you will receive a request for study reapproval Form in approximately ten months to initiate the review process. To close this study, please notify the Inova IRB office when all enrollment and follow-up are completed.

If you have any questions about this action, please contact the IRB Administrative office at (703) 776-6197 or (703) 776-3370

Internal #:	2440
On Agenda For:	Initial Submission
Date of Change:	4/25/2006
Expedited:	Yes
Expiration Date:	4/24/2007
IRB Action:	Approved

Sincerely,

Laura Miller, MSHA
IRB Manager

IRB # 06.051 **Title:** Predicting Factors Influencing Nurse's Acceptance of Telemedicine Technology (eICU) in Intensive Care Units (Pilot Study)	APPROVED: Inova Institutional Review Board Date 04/25/06 Sign VA File # 06.051 Expires 04/24/07

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 investigate the factors influencing nurses' acceptance of eICU®. The results of this survey will be useful information for policy makers, administrators, researchers, and educators for the plan or strategies before implementing eICU®. Completion of the survey should take approximately 5-10 minutes.

PROCEDURES

If you agree to participate, please sign this consent form and retain the extra copy for your records. Please complete the attached survey. Place both the consent form and the survey in the return envelope and return to the researcher.

RISKS AND BENEFITS

The only foreseeable risk to you is possible loss of confidentiality. The researcher hopes that this survey will further understanding of issues related to the acceptance of eICU®.

INJURY

In the event that you believe this research study has led to injury, contact the researcher (see QUESTIONS for contact information). Neither Inova Health System, the researcher, nor the Federal Government has any programs to provide compensation for injury to research participants.

CONFIDENTIALITY

Efforts have been made to protect your identity. The signed consent form will be separated from the completed survey by the researcher immediately upon receipt. The survey will not contain any identifiers linked to you. No one outside will have access to the individual completed surveys. Only group data will be reported and responses will not be identified with you or any other participant. 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 the researcher (see QUESTIONS for contact information).

VOLUNTARY PARTICIPATION

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.

QUESTIONS

If you have any questions regarding this research study, please contact Yanika Kowitlawakul, RN, BSN, MSN, by mail (14309 Climbing Rose Way, # 303, Centreville, VA. 20121) or by phone (703/245-9206). If you have any questions regarding your rights as a research participant, please contact the Inova Health System Institutional Review Board Administrator at 703/698-3167.

SIGNATURE:

I have been informed about this research study's purpose, procedures, and possible risks and benefits. I understand that my participation in this study is voluntary. I will contact a member of the research team if I have any questions.

Signature of Participant, Date and Time	Printed Name of Participant	Approval for the use of this document EXPIRES
Signature of Witness, Date and Time	Printed Name of Witness	JUN 07 2007
Signature of the researcher, Date and Time	Printed Name of Witness	Protocol # 4832 George Mason University

Initials: _____
Date: _____
Consent Version 1, April 25, 2006

Page 1 of 1

Appendix K

INOVA HEALTH SYSTEM

Inova Health System Institutional Review Board
Inova Fairfax Hospital
3300 Gallows Road,
Falls Church, Virginia 22042-3300

Tel 703-776-3167
Fax 703-776-6678

September 7, 2007

Yanika Kowitlawakul, RN, BSN, MSN
Inova Fairfax Hospital, ICU 1
3300 Gallows Road
Falls Church VA 22042

IRB Study #06.112

Protocol Title: Technology Acceptance Model: Predicting Nurses' Acceptance of Telemedicine Technology (eICU)

Dear Ms. Kowitlawakul:

Today the Inova Health System Institutional Review Board ("IRB") reviewed and approved your submission described below. This action will be reported to the IRB on the "On Meeting Date" noted below.

Please note that effective January 1, 2007, Subcommittee Group 2 is known as Group B and Subcommittee Group 4 is known as Group A. If you have any questions about this action, please contact the IRB administrative office at (703) 776-3167 or (703) 776-3370.

Our Internal #:	3768
Type of Change:	Amendment
Expedited:	Yes
Expiration Date:	5/13/2008
On Meeting Date:	10/17/2007
Description:	Amendment dated August 31, 2007 Addition of the MSICU at Fairfax Hospital and IMCU at Mount Vernon Hospital to the study sites.

Sincerely,

Laura Miller, MSHA
IRB Manager

Appendix L

Technology Acceptance Model: Predicting Nurses' Acceptance of Telemedicine Technology (eICU)	APPROVED, Inova Institutional Review Board Date 05/17/07 Sign File # 06.112 Expires 05/13/08

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 determine the factors influencing nurses' acceptance of eICU®. The results of this survey will be useful information for policy makers, administrators, researchers, and educators for the plan or strategies before implementing eICU® computer system. Completion of the survey should take approximately 5-10 minutes.

PROCEDURES
If you agree to participate, please sign this consent form and retain the extra copy for your records. Please complete the attached survey. Place both the consent form and the survey in the return envelope and return to the researcher.

RISKS AND BENEFITS
The only foreseeable risk to you is possible loss of confidentiality. The researcher hopes that this survey will further understanding of issues related to the acceptance of eICU®.

INJURY
In the event that you believe this research study has led to injury, contact the researcher (see QUESTIONS for contact information). Neither Inova Health System, the researcher, nor the Federal Government has any programs to provide compensation for injury to research participants.

CONFIDENTIALITY
Efforts have been made to protect your identity. The signed consent form will be separated from the completed survey by the researcher immediately upon receipt. The survey will not contain any identifiers linked to you. No one outside will have access to the individual completed surveys. Only group data will be reported and responses will not be identified with you or any other participant. 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 the researcher (see QUESTIONS for contact information).

VOLUNTARY PARTICIPATION
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.

QUESTIONS
If you have any questions regarding this research study, please contact Yanika Kowitlawakul, RN, BSN, MSN, by mail (14309 Climbing Rose Way, # 303, Centreville, VA. 20121) or by phone (703/245-9206). If you have any questions regarding your rights as a research participant, please contact the Inova Health System Institutional Review Board Administrator at 703/776-3167.

SIGNATURE:
I have been informed about this research study's purpose, procedures, and possible risks and benefits. I understand that my participation in this study is voluntary. I will contact a member of the research team if I have any questions.

Approval for the use of this document EXPIRES
SEP 04 2008

Signature of Participant and Date

Printed Name of Participant

Protocol Date: May 15, 2007

Consent Version #2 / Date: May 15, 2007

Protocol # 5345
George Mason University

Appendix M

The eICU® Acceptance Survey (EAS)

This survey consists of seven sections. Please complete all questions.

Section I: **Perceived Usefulness (PU)**

Direction: The following statements refer to whether the eICU® can enhance patient care. Please read each statement carefully, and then circle only one answer for each statement.
1= Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree

Items	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. Using an eICU® technology would enable me to accomplish tasks more quickly.	1	2	3	4	5
2. Using an eICU® technology would improve my job performance.	1	2	3	4	5
3. Using an eICU® technology in my job would increase my productivity.	1	2	3	4	5
4. Using an eICU® technology would enhance my effectiveness on the job.	1	2	3	4	5
5. Using an eICU® technology would make it easier to do my job.	1	2	3	4	5
6. I would find an eICU® technology useful in my job.	1	2	3	4	5
7. Using an eICU® technology would improve communication on my job.	1	2	3	4	5

Section II: Perceived Ease of Use (PEOU)

Direction: The following statements refer to whether an eICU® system is easy to use. Please read each statement carefully, and then circle only one answer for each statement.
1= Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree

Items	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. Learning to operate an eICU® technology would be easy for me.	1	2	3	4	5
2. I would find it easy to get an eICU® technology to do what I want it to do.	1	2	3	4	5
3. My interaction with an eICU® technology would be clear and understandable.	1	2	3	4	5
4. I would find an eICU® technology to be flexible to interact with.	1	2	3	4	5
5. It would be easy for me to become skillful at using an eICU® technology.	1	2	3	4	5
6. I would find an eICU® technology easy to use.	1	2	3	4	5

Section III: Nurses' Attitudes toward eICU® (NATE)

Direction: The following statements refer to your attitude toward an eICU®. Please read each statement carefully, and then circle only one answer for each statement.

1= Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree

Items	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. The use of an eICU® technology improves patient care by giving the nurse more time with the patients.	1	2	3	4	5
2. An eICU® technology can be adapted to assist nurses in many aspects of patient care.	1	2	3	4	5
3. An eICU® data system offers nurses a remarkable opportunity to improve patient care.	1	2	3	4	5
4. An eICU® technology represents a violation of patient privacy	1	2	3	4	5
5. An eICU® technology causes nurses to give less time to quality patient care.	1	2	3	4	5
6. An eICU® technology increases costs by increasing the nurse's workload.	1	2	3	4	5
7. It takes as much effort to maintain patient records in an eICU® technology as it does by hand.	1	2	3	4	5
8. An eICU® technology creates more problems than they solve in nursing practice.	1	2	3	4	5
9. The use of an eICU® technology dehumanizes nursing care.	1	2	3	4	5
10. Part of the increase in costs of health care is because of an eICU® technology.	1	2	3	4	5
11. Confidentiality will not be sacrificed by an eICU® technology.	1	2	3	4	5
12. I would be comfortable using an eICU® technology.	1	2	3	4	5
13. Working with an eICU® technology would make me very nervous.	1	2	3	4	5
14. I feel threatened when others talk about an eICU®.	1	2	3	4	5
15. An eICU® technology does not scare me at all.	1	2	3	4	5
16. I feel hostile toward an eICU®.	1	2	3	4	5
17. An eICU® technology makes me feel uneasy and confused.	1	2	3	4	5
18. I have a lot of self-confidence when it comes to working with an eICU® technology.	1	2	3	4	5
19. Confidentiality is nearly impossible if patient records are in an eICU® technology.	1	2	3	4	5
20. Nursing data does not lead itself to an eICU® technology.	1	2	3	4	5
21. An eICU® technology would make nurses' job easier.	1	2	3	4	5

Section IV: Intention to Use (ITU)

Direction: The following statements refer your intention to use an eICU® system with patient care. Please read each statement carefully, and then circle only one answer for each statement.

1= Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree

Items	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. I intend to use an eICU® technology with my patient care and management when it is available in my department or hospital.	1	2	3	4	5
2. I intend to use an eICU® technology to provide health-care services to patients as often as needed.	1	2	3	4	5
3. I intend NOT to use an eICU® technology in my patient care and management routinely.	1	2	3	4	5
4. Whenever possible, I intend NOT to use an eICU® technology in patients care and management.	1	2	3	4	5
5. To the extent possible, I would use an eICU® technology to do different things, clinical or non clinical.	1	2	3	4	5
6. To the extent possible, I would use an eICU® technology in my patient care and management frequently.	1	2	3	4	5

Section V: eICU®Knowledge

Direction: Please answer "T = True" or "F = False"**.**

1. _____ eICU® technology will assist in managing your patient.
2. _____ eICU® technology is called eCare Manager which displays organized clinical information such as vital signs and I/O.
3. _____ eICU® technology allows remote monitoring and communication with hospital staff.
4. _____ eICU® technology is interfaced with our bedside monitors and our health information systems such as IDX Carecast.
5. _____ eICU® technology is a communication tool that is used only between nurses.

Section VI: eICU® Awareness

Direction : Please tell me which of the following statement is best describes you.

1. _____ I have never heard of eICU® technology.
2. _____ I have heard of eICU® technology, but don't know much about it.
3. _____ I know about eICU® technology, but have not used it yet.

4. _____I have used eICU® technology before.

If you choose number 3 and 4, please answer question number 4 or 5

5. At this time, _____ (a) I prefer not to use eICU® technology in my unit.

_____ (b) I prefer to use eICU® technology in my unit.

_____(c) I am not sure, and need more information

Section VII: Demographic Data

Direction: Please fill out each item and select the item that best describe you.

1) Age:_____ Which shift are you working? ___(1) day shift ___(2) night shift ___(3) other

2) Sex: (1)____ Male (2) _____Female

3) Years worked as a nurse? _____ Job Title? _____

4) Educational Level: Check highest degree obtained

(1)_____ Second Degree Nursing program (2) _____Diploma (3) _____ Associate Degree

(4) _____BSN (5) _____ MSN (6) _____ Ph.D (7) _____other (please describe)_____

5) How many years have you worked in this hospital? _____

6) How many years have you worked in critical care unit (ICU)? _____

7) How long have you heard about eICU®? _____

8) I have heard about eICU® technology from

(1) ___Nurses from other units who have used eICU®

(2) ___Nurses from other units who have not used eICU®

(3) ___Both number 1 and 2 (4) ___Physicians (5)___unit managers or administrators

(6) ___Internet (7) ___Television (8) other _____

9) Have you ever attended a conference on eICU® (1) ___Yes (2) ___No

10) If "Yes", how many times did you attend conferences? _____

11) Number of years you have worked with any kind of computers _____

12) Have you been trained to use an eICU® system at your workplace?

(a) _____Yes (b) ____ No

13) Do you have user support personnel available to help you with any computer problems?

(a) _____Yes (b) ____No

14) How much support do you think you would have from your administrative team if an eICU® is implemented? Please rate the score form 1-10 (1 is no support and 10 is the most support) _____

15) How much support do you think you would have from Physicians if an eICU® is implemented? Please rate the score form 1-10 (1 is no support and 10 is the most support) _____

16) Please write any additional comments that you think about an eICU® system

_____

_____

THANK YOU SO MUCH!!!!

This instrument was adapted from the references below:

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-339.

Hu, P. J., Chau, Y. K., , O. R., & Tam, K. Y. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology [Electronic version]. *Journal of Management Information Systems, 16*(2), 91-112.

Jayasuriya, R., & Caputi, P. (1996). Computer attitude and computer anxiety in nursing: Validation of an instrument using an Australian sample. *Computers in Nursing, 14*(6), 340-345.

Appendix N

Power analysis

Cohen's formula (1987) as cited in Munro (2001), for a moderate effect size (0.13) with α = .05 and power level = .80.

$$N = \frac{L\,(1 - R^2)}{R^2} + U + 1$$

N = total sample size

L = effect size index = 15.6 (Cohen, 1988)

U = number of independent variables = 9

R^2= 0.13 refers as a moderate effect size (Munro, 2001)

Therefore, N = 114, the target number is at least 114.

Appendix O

Bivariate Pearson Correlations

Correlations

		Age	Years working as a nurse	Years working in the hospital	years working with any kind of computers	Support from physicians	Support from administrative team	Perceived Usefulness (PU)	Perceived Ease of Use (PEOU)	Nurses' Attitudes toward eICU (NATE)	Intention to Use (ITU)
Age	Pearson Correlation	1	.844**	.635**	.461**	.062	-.016	-.031	-.095	-.005	.134
	Sig. (2-tailed)	.	.000	.000	.000	.506	.863	.736	.310	.956	.151
	N	117	117	117	117	117	117	117	117	117	117
Years working as a nurse	Pearson Correlation	.844**	1	.751**	.473**	.040	-.090	-.107	-.150	-.068	-.010
	Sig. (2-tailed)	.000	.	.000	.000	.666	.337	.250	.106	.468	.911
	N	117	117	117	117	117	117	117	117	117	117
Years working in the hospital	Pearson Correlation	.635**	.751**	1	.391**	.065	-.057	-.239**	-.127	-.150	-.111
	Sig. (2-tailed)	.000	.000	.	.000	.487	.543	.009	.171	.106	.235
	N	117	117	117	117	117	117	117	117	117	117
years working with any kind of computers	Pearson Correlation	.461**	.473**	.391**	1	-.079	-.040	-.109	-.007	.052	.041
	Sig. (2-tailed)	.000	.000	.000	.	.396	.672	.240	.944	.577	.662
	N	117	117	117	117	117	117	117	117	117	117
Support from physicians	Pearson Correlation	.062	.040	.065	-.079	1	.542**	.347**	.148	.228*	.269**
	Sig. (2-tailed)	.506	.666	.487	.396	.	.000	.000	.112	.013	.003
	N	117	117	117	117	117	117	117	117	117	117
Support from administrative team	Pearson Correlation	-.016	-.090	-.057	-.040	.542**	1	.310**	.242**	.457**	.285**
	Sig. (2-tailed)	.863	.337	.543	.672	.000	.	.001	.009	.000	.002
	N	117	117	117	117	117	117	117	117	117	117
Perceived Usefulness (PU)	Pearson Correlation	-.031	-.107	-.239**	-.109	.347**	.310**	1	.497**	.529**	.699**
	Sig. (2-tailed)	.736	.250	.009	.240	.000	.001	.	.000	.000	.000
	N	117	117	117	117	117	117	117	117	117	117
Perceived Ease of Use (PEOU)	Pearson Correlation	-.095	-.150	-.127	-.007	.148	.242**	.497**	1	.614**	.433**
	Sig. (2-tailed)	.310	.106	.171	.944	.112	.009	.000	.	.000	.000
	N	117	117	117	117	117	117	117	117	117	117
Nurses' Attitudes toward eICU (NATE)	Pearson Correlation	-.005	-.068	-.150	.052	.228*	.457**	.529**	.614**	1	.631**
	Sig. (2-tailed)	.956	.468	.106	.577	.013	.000	.000	.000	.	.000
	N	117	117	117	117	117	117	117	117	117	117
Intention to Use (ITU)	Pearson Correlation	.134	-.010	-.111	.041	.269**	.285**	.699**	.433**	.631**	1
	Sig. (2-tailed)	.151	.911	.235	.662	.003	.002	.000	.000	.000	.
	N	117	117	117	117	117	117	117	117	117	117

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix P

Correlation Matrix

	ITU	NATE	PU	PEOU	YWIH	SFP	SFA
ITU	1.00						
NATE	.631	1.00					
PU	.699	.529	1.00				
PEOU	.433	.614	.497	1.00			
YWIH	-.111	-.150	-.239	-.127	1.00		
SFP	.269	.228	.347	.148	.069	1.00	
SFA	.285	.457	.310	.242	-.057	.542	1.00

ITU = Intention to Use
NATE = Nurses' Attitudes toward eICU
PU = Perceived Usefulness
PEOU = Perceived Ease of Use
YWIH = Years Working in the Hospital
SFP = Support from Physicians
SFA = Support from Administrators

Syntax Input for LISREL

```
TAM IN NURSING PRACTICE
DATA   NI = 7  NO = 117  MA = KM
KM  SY
 1.00
 .631    1.00
 .699    .529    1.00
 .433    .614    .497    1.00
-.111   -.150   -.239   -.127    1.00
 .269    .228    .347    .148    .069    1.00
 .285    .457    .310    .242   -.057    .542    1.00
LA
'ITU'  'NATE'   'PU'  'PEOU'  'YWIH'  'SFP'  'SFA'
MODEL  NX = 3  NY = 4  PS = DI, FR   BE = FU, FI  GA = FU, FI
FR  BE(1,2)  BE(1,3)  BE(2,3)  BE(2,4)  BE(3,4)
FR  GA(4,3)  GA(3,1)  GA(3,2)  GA(3,3)
Path Diagram
OU  ML  TO  MI  SS  TV  EF
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