PERIOPERATIVE PROFESSIONAL NURSES' PERCEPTIONS AND EXPERIENCES WITH ROBOTIC-ASSISTED SURGERY

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DEDICATION

I dedicate this dissertation to my husband, Hans Schuessler, who has provided uninterrupted support and patience during this long journey.

I would also like to dedicate this work to my family and my true friend, Jane Stowell, who always encouraged and supported me.

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ABSTRACT

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The rapid introduction of technological innovations into health care systems creates new challenges for perioperative nurses. Especially, robotic-assisted laparoscopic surgery has changed both the physical and social context of the surgical team's work and subsequent surgical outcomes. Despite significant changes to perioperative nursing practice, the perceptions and experiences of the professional nurses who use this technology remain unexplored.

This qualitative descriptive study used interviews to examine professional nursing experiences with robotic-assisted surgeries. This qualitative descriptive research was based upon the *Determinants of Innovation Within Healthcare Organizations* conceptual framework. Seventeen professional perioperative nurses (preoperative, intraoperative, postoperative nurses, and nurse anesthetists) were interviewed. These encounters provided rich information about professional nurses' perceptions of robotic-assisted surgeries. Content analysis generated three overarching themes: *surgical innovation*, *interprofessional practice*, and *outcomes* with each theme composed of two categories.

Nurse perception and *workflow* emerged as the categories within *surgical innovation*. Professional nurse perceptions were characterized by optimistic attitudes

towards robotic surgery. They appreciated the improved visualization and dexterity that the robot provided the surgeon, despite increased surgical complexity and concerns for patient safety from prolonged Trendelenburg positioning. They also reported that robotic surgery affected workflow, with intraoperative staff experiencing demanding practice changes in order to accommodate the robot**.**

Standards and *teamwork* emerged as the categories within *interprofessional practice*. Professional nurses reported that *standards* in education and clinical competency requirements were needed for effective, safe robotic surgery. *Teamwork* during robotic surgeries necessitated different communication strategies and changes in professional nursing roles.

Patient outcomes and *system outcomes* emerged under the overarching theme of *outcomes*. Nurses reported that *patient outcomes* of robotic surgery improved for some, but not all diagnoses, and that optimal patient outcomes were determined by the surgeon's skill with robotic-assisted surgery. Nurses noted that some patients (e.g., those with heart and respiratory disease or glaucoma) were not candidates for robotic surgery because of the required positioning. Nurses also described various issues that affected *system outcomes,* such as longer time needed between surgeries. Despite describing negative aspects associated with being part of the robotic surgery team, these professional nurses were positive about this innovation and overwhelmingly committed to providing safe care to their patients.

TABLE OF CONTENTS

Appendices

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The goal of this qualitative descriptive research is to explore the perceptions and experiences of perioperative registered nurses (RNs) who provide care for patients having robotic-assisted surgery. This chapter will (a) provide an overview of the practice problems associated with robotic surgeries, (b) describe the existing gap in the literature, (c) list the research questions, (d) define the rationale for the study, and (e) describe the theoretical framework underpinning this study. Chapter II presents an in-depth review of the literature and summarizes existing knowledge on robotic-assisted surgery. The benefits and the unintended consequences of this novel surgical technology and its impact on nursing practice are described. Chapter III addresses the procedures for collection and treatment of data. Chapter IV describes the sample and the findings of the study. In conclusion, Chapter V summarizes the study, reviews the findings in relation to previous research and the theoretical framework, discusses the conclusions and implications of the study, and presents recommendations for future study.

Focus of the Inquiry

Early in the century, laparoscopic and endoscopic surgical procedures were transformed by the introduction and adoption of robotic-assisted laparoscopic surgery (RALS) (Bartkowski & Bonter, 2005). The da Vinci® Robotic Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA, USA) was the first to receive Food and Drug Administration (FDA) approval, and the company currently dominates the market. In

2016, the number of daVinci systems in clinical use increased from 3,597 to 3,919, and approximately 753,000 RALS were performed in the United States. This number represents a 15% increase from 2015 (Intuitive Surgical, 2016). More importantly, between 2007 and 2011 the number of U.S. performed RALS procedures increased by 400% and by 300% internationally (Cooper, Ibrahim, Lyu, & Makary, 2015). Introduction of any new technology, particularly such a complex surgical system, generates both benefits as well as unanticipated consequences. Unanticipated consequences of new technologies, by definition, are difficult to predict and may be negative or positive in nature (Randell et al., 2015; Sittig & Singh, 2012).

Documented advantages of the RALS over conventional laparoscopic surgery (CLS) include better visualization of the operative field and fine anatomical structures with improved three-dimensional magnification, enhanced dexterity of the robotic wrist, and elimination of the surgeon’s hand tremors. RALS is also more comfortable for the surgeon because of the improved ergonomic positioning during the surgery (Best et al., 2014; Buderath, Aktas, Heubner, & Kimmig, 2015; Köckerling, 2014). Some research studies and vendor documents propose that patients believe RALS is superior to open surgery and CLS (Ahmad, Ahmad, Carleton, & Agarwala, 2017; Harrop, Kelly, Griffiths, Casbard, & Nelson, 2016). Patient outcome studies have indicated that RALS is also associated with smaller incisions, reduced blood loss and pain, and shorter hospital stays when compared to open surgery (Barbosa et al., 2013; Chan et al., 2015; Croome et al., 2014; Martino et al., 2014; Yu, Friedlander, Patel, & Hu, 2013).

Intuitive Surgical, Inc. educates providers about their product and maintains a database of RALS surgical complications. Unanticipated consequences of RALS include organ perforation and equipment malfunction (Girad, 2017; Shields, Minion, Willmott, Sumner, & Monk, 2015). Vendor-associated education and monitoring of complications related to new medical technologies are not unusual in the United States. Often these expensive devices are marketed directly to physicians, hospital administrators, and consumers. As a result, the largest health profession, nursing, may not be consulted regarding how new medical technologies such as RALS affect nursing practice (Kang, Gagne, & Kang, 2016; Luck & Gillespie, 2017). RALS warrants new approaches and responsibilities for the nurses who provide care for these patients (Sun & Fong, 2017).

The rapid uptake of RALS, however, has generated a demand for trained perioperative nurses to assist with these types of surgeries. The core responsibilities of perioperative nurses are to ensure patient safety, manage risk, and to provide patient education (Jing & Honey 2015; Wasielewski, 2017). The responsibilities and nursing interventions vary in each of the perioperative phases: preoperative, intraoperative, and postoperative phase. Nursing care for RALS patients during the preoperative and postoperative phases involve knowledge of additional assessments, interventions, and teaching. For intraoperative nurses, the knowledge of different patient positioning and the complex robotic technology unit, its supplies, and equipment are required. Furthermore, the intraoperative nurse is responsible for troubleshooting issues associated with the surgical robot. Certified Registered Nurse Anesthetists (CRNAs) function within the surgical arena to administer anesthesia and keep patients hemodynamically stable during RALS. The critical issues for CRNAs during RALS are the physiologic consequences of placing patients in steep Trendelenburg position and pneumoperitoneum (Gupta, Mehta, Sarin Jolly & Khanna, 2012; Kaye et al., 2013). These interventions are usually used to ensure better visualization of surgical field; nevertheless, they can impose serious negative hemodynamic compromises. The negative consequences include: compromised oxygenation; increased arterial CO_2, vasodilation and hypotension, gas embolism, atelectasis, postoperative respiratory distress; nerve injury; subcutaneous emphysema; hypothermia; and restricted access to the patient due to the size of the robot (Kaye et al., 2013).

RALS has spread rapidly throughout the United States healthcare system, and perioperative nurses are often not part of the institutional approval process associated with the adoption of RALS. The review of the literature reveals a plethora of studies by medical professionals investigating patient outcomes, costs, and the impact of RALS on surgeons. The problem is that perceptions and experiences of nurses who are currently involved in perioperative care of patients with RALS are unknown. Such inquiry is essential to understand the concerns and factors that may influence nursing practice and the adoption of new safe approaches in the perioperative care of patients with RALS.

Statement of Purpose

The purpose of this qualitative descriptive study is to explore the factors that influence perioperative professional nurses' perceptions and experiences in the care of RALS patients during the three-perioperative phases: preoperative, intraoperative, and postoperative. One main theme with semi-structured and open-ended questions will lead this inquiry, thus the research question will be: What are the perceptions and experiences of preoperative professional nurses involved in providing care for patients with RALS?

Rationale for the Study

Nursing Practice

The number and complexity of RALS are increasing. For instance, combining electromagnetic navigational bronchoscopy with RALS to diagnose lung lesions and remove them immediately during one surgical procedure is now being used (Christie, 2014). Another example of surgical complexity is combining prostectomy with umbilical hernia repair (Kim, Abdelshehid, Lee, & Ahlering, 2012). RALS has transformed minimally invasive surgery and has consequently affected nurses' responsibilities and practices. This entails more challenges for perioperative nurses (Putnam, 2016). Preoperative and postoperative nurses do not have a choice for providing care for patients with RALS and non-RALS. However, intraoperative nurses do have a choice to be part of a RALS team, which may affect the perception and experience of perioperative nurses. The responsibilities of perioperative nurses are to ensure patient safety, manage risk, and provide patient education (Hortman & Chung, 2015; Cabral, Eggenberger, Keller, Gallison, & Newman, 2016; Morton, 2012; Wasielewski, 2017). However, nursing interventions and responsibilities vary in each surgical phase.

Preoperative nursing practice. The preoperative nurse is responsible for identifying the unique patient characteristics and comorbidities that may require additional precautions or change in plans for RALS (AORN, 2017; Lee, 2014). For instance, a patient with increased intraocular pressure, recent eye surgery, cardiovascular compromise, respiratory problems, history of deep vein thrombosis, or significant varicosities may require a change in plans or additional surveillance regarding planned RALS procedures (AORN, 2016a; Morton, 2012).

Intraoperative nursing practice. The intraoperative/circulating nurse must be knowledgeable about the unique hazards of RALS that may be caused by the steep Trendelenburg positioning and the intra-abdominal infusion of carbon dioxide (pneumoperitoneum). Although the steep Trendelenburg positioning and pneumoperitoneum are used for better visualization of internal organs, these interventions can cause inhalation/perfusion mismatch, gas embolism, lung atelectasis, and cardiac problems. Other potential problems include increased intraocular pressure, skin, brachial, and ulnar nerve injuries, as well as shoulder and abdominal pain (Awad et al. 2009; Hsu, Kaye & Urman, 2013; Kaye et al., 2013; Lowenstein et al., 2014; Savarkar, Bakshi, Thosar, & Sareen, 2016; Shveiky, Aseff, & Iglesia, 2010). The other effects of RALS on intraoperative nursing practice are ensuring safe patient positioning; calibrating the surgical robot before surgery; handling the robotic surgical supplies before, during, and after the surgery; troubleshooting problems associated with the surgical robot; and preparing for complications and emergency conversions to open surgery (Brooks, 2015; Raheem, Song, Chang, Choi, & Rha, 2017; Thomas, 2011). These issues require coordination among various specialists and technicians throughout the healthcare system.

Intraoperative nurses note that RALS requires longer operative time, particularly for a surgical team that is new to robotic surgery (Hsu et al., 2013; Paraiso et al., 2013; Girard, 2017). Consequently, the patient must be reassessed for biological, skin, muscle, and nerve injury immediately after the completion of RALS. RALS teams must be formed and educated to function effectively. Teams must also be educated in the rapid disassembly of the robot in case there is a malfunction or emergency, necessitating open surgery. Perioperative nursing assignments must be adjusted for a longer time in the operating room and team member availability. The surgical suite schedule must be modified to accommodate procedures that once were completed in far less time (Francis, 2006; Sorensen et al., 2010).

Postoperative nursing practice. Due to the short length of hospital stay after RALS and the subsequence transference of postsurgical patient-care responsibilities to the patient's family/caregivers, the postop nurse is newly accountable for the patient's discharge plan. The discharge plan, itself, must be modified to accommodate unique patient needs produced by the shorter hospitalization (Brenner, Salathiel, Macey, & Krenzer, 2011; Castiglia, Drummond, & Purden, 2011; Gadler, Crist, Brandstein, & Schneider, 2016). RALS has been used for some surgical procedures which were previously performed by open surgery and requiring longer hospitalization. At the same time, the postoperative nurse must be aware of possible complications related to the unique positioning of the patient during RALS such as shoulder pain, ulnar and brachial nerve damage, as well as other unanticipated injuries inherent to the novel surgical robot.

Nursing Theory Development

Scientific information is advanced by using theories. Several theories of technology adoption in nursing have been published (An, Hayman, Panniers, & Carty, 2007; Barrett, 2017; Kowitlawakul, 2011; Sharifian, Askarian, Nematolahi, & Farhadi, 2014). However, no theory addresses the unique aspects of a complicated technology such as RALS, which requires specialized knowledge and skills affecting multiple provider roles. Findings from this study can enhance current theories or refute their applicability to perioperative nursing in RALS and provide an impetus for further research and subsequent knowledge development in nursing.

Overall, there is a paucity of qualitative studies focusing on perioperative nursing care. Between 1996 and 2015, only 30 qualitative research studies were published. These studies focused on the role, procedure, and education of perioperative nurses (Van Wicklin, 2016). The use of qualitative studies is important because this research methodology explores the perceptions and lived experiences of participants, accounts for the real-world contextual conditions, and presents insights into relevant practical evidence from multiple sources (Yin, 2016). Often qualitative studies provide the bridge to theory creation, as well as knowledge regarding instrument development and future quantitative research strategies.

Nursing Education

At the present time upon purchase of the daVinci surgical robot, a surgeon and one or two nurses receive two days training from the Intuitive Surgical, Incorporation. The training includes education about the surgical robot and engagement in simulated RALS procedures (D. Morgan, RN, CNOR, CRNFA, personal communication, November 16, 2016; Intuitive Surgical, 2017). However, surgeons are the only healthcare personnel who are encouraged to return for additional training and simulation. Due to the lack of sufficient resources and cost containment policies, subsequent training of perioperative nurses takes place "on the job" through person-to-person guidance during real-time procedures (Francis, 2006). Such complex training without prior education and orientation is difficult for nurses and may not guarantee efficient surgical procedures and patient outcomes. Lichosik, Arnaboldi, Astolfi, Caruso, & Granata (2013), from the School of Robotic Surgery within the European Institute of Oncology in Milan, recommended joint training of the nurses and doctors on the robotic surgical team. The authors emphasized the importance of formal education, product training, clinical training, and most importantly, simulation as a part of the learning experience. The European Association of Urology Nurses in the Netherlands emphasized the importance of certification for nurses in robotic surgery (European Association of Urology, 2014). The results of this study can highlight the perceptions of perioperative nurses regarding their personal educational experiences with RALS. This knowledge may be transferable as to how to effectively educate perioperative nurses to other new technologies as they are implemented within the health care system.

Society/Policy

The RALS has been extensively marketed to physicians, hospitals, and patients. This widespread marketing has propelled the rapid diffusion and adoption of RALS. Lanfranco, Castellanos, Desai, and Meyers (2004) noted “Surgical robots have become the entry fee… for excellence in minimally invasive surgery” (p. 14). Many hospitals have acquired the daVinci surgical robot hoping to attract patients, secure institutional financial wellbeing, and compete effectively for the local market share despite insufficient clinical and economic data supporting the superiority of RALS to CLS (Barbash, Friedman, Glied, & Steiner, 2014; Jayne et al., 2017; Jeong et al., 2017; Wright et al., 2013). Furthermore, the vendor monitors and reports the deaths, injuries, and the robot malfunctions to the FDA (Cooper et al., 2015; Shields et al., 2015). The FDA is charged with approving new surgical devices; nevertheless, surgical innovations do not go through the same regulatory standards as do new drugs development. Consequently, the surveillance and unintended consequences associated with the new devices rely on the hospitals voluntary reporting to the manufacturer (Wright, 2017). The manufacturer is required to report the incidents to the FDA. These incidents are recorded in the FDA Manufacturer and User Device Experience Database (Alemzadeh, Raman, Leveson, Kalbarczyk, & Lyer, 2016; Cooper et al., 2015). The reimbursement for RALS is determined by the routine CLS per Current Procedural Terminology (CPT) codes, and the majority of the additional cost associated with RALS is covered by hospitals (American Academy of Professional Coders, 2017; Wright, 2017). Nevertheless, hospitals try to offset the extra cost by volume (Wright et al., 2016).

The Association of PeriOperative Registered Nurses (AORN) has issued guidelines for perioperative nursing practice in minimally invasive surgery, as well as a competency verification tool (AORN, 2016a; AORN, 2017). Despite the recommendations and competency guidelines promoted by AORN for RALS, little is known regarding the extent to which the perioperative nurses are educated about RALS. Similarly, there is a lack of standardized training for surgeons (Dulan et al., 2012; Sood et al., 2015). The results of this study can add to the existing evidence for policy development for RALS.

Summary of Rationale

The rationale for exploring perioperative nurses' perceptions of their experiences include the significant effects this technology has had on preoperative, intraoperative, and postoperative nursing practice. Although intraoperative nurses are generally given a choice regarding participation on RALS teams, preoperative and postoperative nurses do not. As with many new technologies, education for nurses involved with caring for RALS patients is provided by the vendor and not standardized. In this instance, the vendor only provides physicians with more opportunities to expand their skills with

RALS. Depending on the personal experiences of perioperative nurses regarding RALS, the results of this study may provide further evidence concerning the need for stricter FDA evaluation guidelines prior to approval of innovative surgical technologies. Additionally, mandating the reporting of complications following the implementation of innovative surgical technologies and standardized education of healthcare providers may reduce the unintended negative consequences. In summary, this study will provide important knowledge regarding perioperative technology theory development, perceptions of nurses who care for patients with RALS, and how this innovation has affected the work of the perioperative nurses.

The Researcher's Relation to the Topic

As a graduate student completing my Master of Science in Nursing Administration in 2010, I performed a practicum at the local community hospital. The Vice President of PeriOperative Services, a master's prepared nurse, had just purchased the daVinci surgical robot. I agreed to do a study and write a business plan for the hospital regarding that purchase. The business plan included the fixed cost and yearly maintenance charges for the surgical robot, depreciation, physician and employee time, the operating room time, and the estimated annual number of robotic-assisted surgeries. Based on those variables, the estimated number of years for the surgical robot to become profitable for the hospital was calculated. During this study, I witnessed nurses' involvement in this surgical technology by observing several robotic-assisted surgeries. Two years later, when I considered pursuing this topic for my doctoral dissertation, I found that hardly any research studies capture the perspectives and experiences of perioperative nurses involved in robotic-assisted surgery existed. This gap in the literature prompted me to investigate this important and timely subject.

Philosophical Underpinning and Conceptual Framework

Research Methodology

A qualitative design with descriptive methodology was utilized (Sandelowski, 1993; 2000). The qualitative descriptive or naturalistic inquiry is an eclectic approach that is rooted in the constructivist worldview. Sandelowoski (2010) stated the *factist perception* of data is the assumption that data are more or less truthful and present indexes of the truth from different perspectives. “Researchers do not have to force fit a theoretical formulation to their data” (Sandelowski, 1993, p. 216), and rather remain close to the data and provide a comprehensive summarization of a phenomenon. This methodology signals uncertainty—the uncertainty that is rooted in the interview data, therefore, an original framework being selected prior to data collection and analysis is subject to change, if the data warrant the change. Furthermore, due to the lack of qualitative research on perioperative nursing experiences in RALS, the results of the study can provide an entry point for future research.

This methodology is a living approach to address the questions of who, what, and where of the experiences under investigation (Sandelowski, 2000). Semi-structured open-ended questions were utilized to achieve this goal. Thorne (2008) contends the aim of the qualitative descriptive inquiry is to create evidence applicable to practice, which is a suitable approach for this research (Thorne, 2008, as cited in Polit & Beck, 2012, p. 506). According to Sandelowski (2010), the qualitative descriptive methodology is less interpretive than phenomenology, ethnography, and grounded theory; however, it conforms to the same rigorous principles for choosing a sample, collecting, analyzing, and representing data.

Conceptual Framework

A modified conceptual framework derived from the *Determinants of Innovation Within Healthcare Organizations* (Fleuren, Wiefferink, & Paulussen, 2004) guided the initial conceptualization of this study. This framework arose from implementation science, as it includes descriptive categories but does not provide an explanation. Nilsen (2015) contended that frameworks illustrate relationships among concepts/constructs/variables and intend to describe an empirical phenomenon. As such, this framework is an appropriate foundation for the qualitative descriptive methodology and further exploration of this phenomenon. The findings from the proposed study could either support or not support the framework. Fleuren et al. (2004) developed the determinants of innovation framework from a systematic analysis of related published articles from 1990 to 2000. The literature review was followed by a Delphi study from 44 participants who were experts in the healthcare field. The final framework was derived from the synthesis of ideas in the following publications and was validated by the Delphi study (Fleuren et al., 2004). The eight studies that guided the authors were:

- Diffusion of innovations (Rogers, 1995).
- Adoption and implementation of AIDS education in Dutch secondary schools (Paulussen, 1994).
- Determinants of innovations in healthcare organizations (Fleuren, Wiefferink, & Paulussen, 2002a).
- The implementation of public health guidelines (Fleuren et al., 2002b).

- The new meaning of educational change (Fullan, 1991).
- Health promotion planning: an educational and environmental approach (Green & Kreuter, 1999).
- Managing (imminent) miscarriage in primary health care (Fleuren, 1997).
- Towards a comprehensive interdisciplinary model of health care research use (Logan & Graham, 1998).

According to Fleuren et al. (2004), these studies were focused on a systematic description of the innovation process in healthcare organizations, changing the behavior of healthcare professionals, and were entirely empirical. The results of this literature review yielded 50 relevant determinants of the innovation process and four categories. Fleuren et al. (2004) conducted a Delphi study with 44 experts in the healthcare field. The experts included researchers, managers, and consultants in hospitals, public health institutions, and universities. The participants' opinions about the 50 determinants of the innovation process were sought through open-ended questions. The findings of the Delphi study confirmed the results of the literature review.

Fleuren et al. (2004) defined four stages for the *Innovation Process* and four factors as the *Innovation Determinants*. Since RALS has been adopted by many hospitals and the current study investigated the perceptions of perioperative nurses regarding robotic surgery, only the four *Innovation Determinants* were utilized as an initial framework for this inquiry. In this framework, exploring the perceptions of the adopters/non-adopters of a technology have been noted as one of the initial steps for investigation (de Veer, Fleuren, Bekkema, & Francke, 2011). The four determinants utilized were (a) characteristics of the innovation, (b) characteristics of the adopting person, (c) characteristics of the organization, and (d) characteristics of the socio-political context (de Veer et al., 2011; Fleuren et al., 2004), as illustrated in Figure 1. These factors could facilitate understanding of how perioperative nurses accept or do not accept and, ultimately, adopt or hinder the adoption of new approaches to patient care, which directly affect nursing care practice and patient outcomes.

In this study, “Characteristics of the Innovation” is the complex and interactive daVinci surgical system, its perceived advantages compared to open/CLS, unanticipated consequences, the potential involvement of users, and added work or stress. The “Characteristics of the Adopters” refer to the perioperative nurses’ knowledge, skills, perceptions, and experiences with this surgical technique. The “Characteristics of the Organization” are those of the organizational support, and decision-making process (de Veer et al., 2011; Fleuren et al., 2004). The “Characteristics of the Socio-political Context” in this study refers to the characteristics of the patient and the effects of organization competition with other health institutions for market share. It also discusses the impact of regulatory bodies such as the Joint Commission for Accreditation of Healthcare Organizations (JCAHO) and the Center for Medicare and Medicaid (CMM) on patient outcomes.

Assumptions

The basic assumption of the qualitative descriptive methodology is that precise certainty about the phenomenon (perioperative nurses’ perceptions and experiences with RALS) does not exist. The use of semi-structured interviews provided data that would potentially enhance knowledge about the phenomenon. It was assumed that the participants’ responses are true (the factist perspective), and that thematic analysis will enhance knowledge of the phenomenon (Sandelowski, 2010). The determinants of the innovation framework were based on the assumption that introducing innovation in healthcare is often complex, and several factors may produce unanticipated positive or negative effects. Another assumption related to an individuals' perception about an innovation. By exploring perioperative nurses' perceptions and experiences, sub-determinants might be identified.

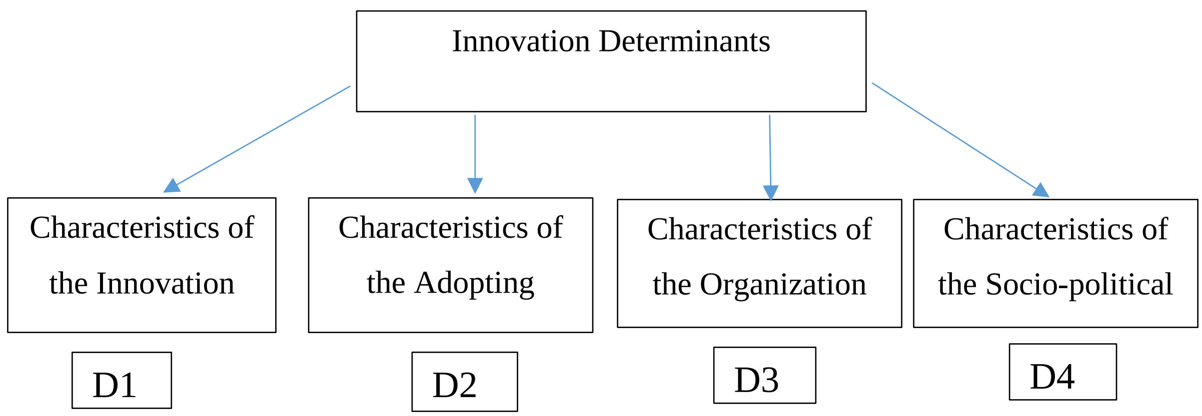

Figure 1. Framework representing the *Determinants of Innovation Within Healthcare Organizations.*

Often innovation is based on evidence-based research; however, RALS is still under evaluation and does not have strong clinical support for its superiority to the CLS (Ahmad et al., 2017). This information can be used to affect perioperative nurses' practice for RALS and ultimately patient outcomes. The results of the study can also shed light on this new surgical technology and the relationships among perioperative nurses, vendors, institutions, health care teams, patients, and those entities that regulate and protect consumers.

Summary

The goal of the first chapter of this dissertation was to provide a succinct description of the phenomenon from which this study and the problem under investigation were derived. The purpose and rationale for performing the study, the research methodology, the conceptual framework, and underlying assumptions were also addressed.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The numbers of robotic-assisted laparoscopic surgery (RALS) have increased exponentially (Buderath et al., 2015; Kirkpatrick & LaGrange, 2016). Gynecologic procedures especially hysterectomies constitute the highest number and proportion of all RALS. The emergence of RALS has created new challenges for healthcare providers and warrants new nursing approach to patient care (Lichosik et al., 2013; Wasielewski, 2017). Due to the variety of performed RALS procedures in different specialties, this literature review concentrates on research studies relevant to the current status of robotic-assisted gynecologic surgeries and its impact on nursing practice. Databases for the review included Google Scholar, MEDLINE (Ovid and Ebsco), CINAHL, and SCOPUS. Another major source of the literature search was the *Journal of Association of PeriOperative Nurses*.

The search was limited to peer-reviewed articles published in English from 2011 through 2017. Cross-referencing was used to find additional relevant articles. Three classic studies: Shveiky, Aseff, and Iglesia (2010); Francis (2006); and Lanfranco et al., 2004) were included because of their relevance and influence on the field. The search terms comprised a combination of the following words and phrases: robotic-assisted laparoscopic surgery, robotic-assisted gynecology, nursing, patient outcomes, comparison, laparoscopic hysterectomy AND abdominal hysterectomy, learning curve, cost, technology adoption, and unintended consequences. The combination of terms entered depended upon previous articles retrieved to acquire the most specific research relevant to this study. The initial review of the literature was through published abstracts, with whole-text articles obtained and reviewed based upon relevance to the topic. Preference was given to recent quantitative and qualitative research studies, systematic reviews, technology updates, and policies related to RALS.

This chapter summarizes the following topics: (a) advantages and disadvantages of robotic-assisted gynecologic procedures, (b) patient outcomes related to robotic-assisted laparoscopic hysterectomy versus conventional laparoscopic and abdominal hysterectomy for oncologic and benign indications, (c) costs, (d) perceptions of RALS versus evidence about RALS, (e) unintended consequences, (f) role and responsibilities of perioperative nurses during robotic-assisted surgery (preoperative, intraoperative, and postoperative), (g) preparation/education of surgeons and nurses, and (h) the existing nursing research on the topic of robotic-assisted surgery including gaps in the literature. Each area of the literature included a summary of that topic.

Background

Commercial manufacturers adopted robotic technologies for industrial use in the early 1960s (Malone, 2011). Subsequently, the National Aeronautics and Space Administration (NASA) and the United States Army explored the use of robotic-integrated telemedicine surgery for astronauts and soldiers in the battlefield (Bouquet de Joliniere et al., 2016; Takács, Nagy, Rudas, & Haidegger, 2016). This idea did not become a reality; however, this telemedicine/robotic vision served as a driving force in the development of surgical robots for civilian use (Lanfranco et al., 2004). In 1983, Canadian scientists developed an innovative surgical robot, *Arthrobot*, to perform minimally invasive surgery (Mohammad, 2013). In the United States in 1985, the *Puma 560* surgical robot successfully supported surgeons performing neurosurgical biopsies (Luck & Gillespie, 2017).

The latest generation of surgical robots, the *da Vinci* was manufactured by Intuitive Surgical Incorporated and was the first surgical robot to be approved by FDA in 2000 for a variety of pathologies (see Figure 2).

Figure 2. daVinci surgical system with three parts. Permission was obtained from Intuitive Surgical, Inc.

These conditions included cancers of the prostate, bladder, kidney, colon; rectum; ventral and inguinal hernia repair; mitral valve repair; head and neck surgery; and pulmonary resection, lobectomy, and mediastinal mass (Intuitive Surgical, 2016). In 2005, the FDA expanded approval of the da Vinci for several gynecology procedures (Bouquet de Joliniere et al., 2016).

Both surgeons and hospitals rapidly adopted the da Vinci RALS (Wright et al. 2016). According to Intuitive Surgical, in 2016 approximately 753,000 robotic-assisted laparoscopic surgeries were performed in the United States. This number represents a 15% increase from the previous year. During this period, the number of da Vinci surgical systems in clinical use increased from 3,597 to 3,919 (Intuitive Surgical, 2016).

Conventional laparoscopic surgery (CLS) has been used since 1987. This technique, which is also called minimally invasive surgery, involves small incisions, less blood loss, and postoperative pain. This technique employs a fiberoptic laparoscope attached to a camera for visualization of the surgical field and uses specialized instruments for performing surgeries (Medical Dictionary, 2018). CLS has experienced relatively slow adoption due to the increased surgeon's skills needed for CLS, the necessity for complex training, and the limitations of this technology (Buderath et al., 2015; Lanfranco et al., 2004). The lack of tactile feedback, the difficult task of hand and eye coordination needed to manipulate the surgical arms, and the limited visualization of the surgical field through the two-dimensional video monitor impeded rapid adoption by surgeons (Lanfranco et al. 2004).

Both surgeons and hospitals, on the contrary, have rapidly adopted the daVinci robot. The benefits of the daVinci platform as an alternative to CLS include the three-dimensional view of the surgical field, improved magnification and visualization of fine anatomical structures, enhanced dexterity of the robotic wrist, and elimination of problems related to the surgeon's hand tremors. Surgeons are more comfortable with the better ergonomic positioning offered by the da Vinci when compared to CLS (Best et al., 2014; Buderath et al., 2015; Köckerling, 2014). Nevertheless, both the daVinci RALS and CLS lack tactile feedback.

Currently, gynecologic procedures comprise the largest number of robotic-assisted surgeries. In 2016, approximately 250,000 robotic-assisted gynecologic procedures were performed worldwide (Intuitive Surgical, 2017). Because of the prevalence of robotic-assisted, laparoscopic gynecological surgeries (primarily hysterectomies), this literature review will focus on the robotic-assisted laparoscopic hysterectomy (RALH).

The majority of previous research compares RALH to conventional laparoscopic hysterectomy (CLH) and abdominal hysterectomy in terms of patient outcomes, surgical cost, required learning curve to master the procedures, and the effects of this technology on surgeons. RALH warrants new responsibilities for perioperative nurses and new approaches to patient care, yet there is a paucity of research capturing perioperative nurses' perceptions and experiences with RALH.

Patient Outcomes

Multiple numbers of retrospective, observational, and a few randomized controlled trials have evaluated patient outcomes and costs across multiple venues with several studies in process. Patient outcomes are particularly important to the preoperative, intraoperative, and postoperative nurses who must provide patient counseling, assessment, and teaching as well as management of surgical facilities.

Gynecologic Oncology

The safety and advantages of RALH over abdominal hysterectomy (AH) for gynecologic malignancies and non-malignancies have been consistently reported in many studies (Corrado et al., 2015; Dubeshter, Angel, Toy, Thomas, & Glantz, 2013; El Sahwi et al., 2012; Gala et al., 2014; Lim et al., 2016; Saceanu et al., 2013). The advantages reported included the decreased perception of postoperative pain, quicker recovery time, shorter length of stay (LOS), decreased estimated blood loss (EBL), lower blood transfusion rates; and fewer reports of postoperative infections, ileus, or other complications.

Researchers reported conflicting results in studies that compare RALH to CLH for gynecologic malignancies. In a systematic review of eight studies, the Society of Gynecologic Surgeons compared patient-centered outcomes related to endometrial cancer in a total population of 1,218 women who experienced RALH (n = 631) versus CLH (n = 587). This review indicated that the robotic group experienced decreased EBL and a shorter LOS. The researchers also reported a longer operative time for the robotic group. Although there was a trend towards a reduction in the operative time for the robotic group, the results were inconsistent among the reviewed studies (Gala et al., 2014).

A retrospective study compared the intraoperative and postoperative complications occurring within 30 days of surgery using the Clavien-Dindo classification system. The researchers examined records for 745 women who experienced RALH and 688 CLH from 2009 to 2014. Results were analyzed in relation to surgical staging for endometrial cancer. No difference in the rate of intraoperative and *major* postoperative complications was reported ($p > .1$). However, the RALH group had significantly fewer *minor* postoperative complications (16.6% vs. 25.6%, $p < .01$) and a significantly shorter median operative time, LOS, EBL, and conversion to laparotomy. In addition, fewer numbers of lymph nodes were retrieved compared to the CLH group (Barrie et al., 2016).

Nevis et al. (2016) evaluated 35 observational studies occurring between 2009 and 2014 to determine perioperative morbidity outcomes of women diagnosed with endometrial and/or cervical cancer. Nevis et al. (2016) reported that these studies provided a low quality of research evidence. Acknowledging this point, the researchers reported that women diagnosed with endometrial cancer who experienced RALH had decreased EBL compared to CLH. These studies did not indicate any difference in LOS, overall complications, and lymph node removal between RALH and CLH. For women diagnosed with cervical cancer, there was no difference between the two groups in the EBL and/or the number of lymph nodes removed. Nevis et al. contended that rigorous studies are needed to draw definitive conclusions. Nevertheless, this review seems to indicate that the clinical effectiveness of RALH could depend on the diagnosis.

A retrospective study compared the short-term surgical outcomes of 102 women diagnosed with early cervical carcinoma from December 2009 to May 2013. Sixty women experienced robotic-assisted hysterectomies and 42 experienced conventional laparoscopic radical hysterectomies (complete removal of the uterus, cervix, and upper vagina. Ovaries, fallopian tubes, and nearby lymph nodes may be removed [National Cancer Institute, n. d.]). The RAH group had a significantly reduced EBL (100 ml vs. 145 ml, $p = 0.037$), and fewer early postoperative complications (16. 7% vs. 30.9%, $p =.028$). Yim et al. reported no difference in the number of lymph nodes removed or LOS (Yim et al., 2014).

Park, Yun, Kim, and Lee (2017), conducted a systematic review and meta-analysis of studies of women treated for cervical cancer. Park et al. selected 15 eligible studies that compared RALH to AH and 11 studies that compared RALH to CLH for cervical cancer. The authors concluded that women who had RALH experienced fewer wound infections, fevers, urinary tract infections, blood transfusions, and decreased EBL. These women also had a shorter LOS and time from surgery to diet than the AH group. Nevertheless, the researchers concluded that there was inconclusive evidence that RALH was superior to CLH in either safety or clinical effectiveness. The authors recommended future long-term studies to overcome the limitations of the current evidence.

Long-term studies might be able to control for the time needed for surgical teams to acquire new RALS skills compared to the standard CLH procedure and, therefore, effectively evaluate experienced surgical teams for both procedures.

A few studies have investigated long-term oncological outcomes and complication rates after RALH. Hoogendam, Verheijen, Wegner, and Zweemer (2014) investigated the long-term complications after RALH for early-stage cervical cancer with a grade of IA1-IIB from 2008-2013. Hoogendam et al. documented 13 recurrences during a median follow up time of 29.5 months. The five-year progression-free rate was 81.4% and disease-specific survival rates were 88.7%. Hoogendam et al. noted that malignancy recurrence rates for RALS were comparable to long-term outcomes reported for AH.

Only one recent randomized controlled trial by Mäenpää et al. (2016) compared the short-term surgical outcomes of RALH (n = 50) with CLH (n = 49) for endometrial cancer. Patients were randomized to have a hysterectomy, bilateral salpingo-oophorectomy, and pelvic lymphadenectomy via one of the two techniques from December 2010 through October 2013. The results revealed shorter operating room time and surgical time in the robotic group (139 minutes for RALH versus 170 minutes for CLH, $p < .001$). There was no conversion in the robotic group to AH, while five patients in the laparoscopic group were converted to AH. There were no differences in the number of lymph nodes retrieved, EBL, or LOS. In contrast, Mäenpää et al. reported 18 cases (36%) of serious intraoperative and postoperative injuries in the RALH group compared to 12 injuries (24%) in the CLH group. The injuries included postoperative hemorrhage that led to a higher rate of blood transfusion among the robotic group, abscess, and a case of rectovaginal fistula that needed reoperation (Mäenpää et al., 2016). These complications may suggest the occurrence of serious intraoperative injuries from the insertion of surgical instruments by the bedside assistant or damage from electrosurgical arcing by monopolar instruments. Electrosurgical arcing occurs when two surgical instruments carrying electrical charges touch each other and the electric charges of one object jump to the other, or when their insulating sheath is damaged. This leads to unintended tissue damage (Cormier, Nehzat, Sternchos, Sonoda, & Leitao, 2012). These intraoperative injuries could have been unnoticed by the surgeon sitting at the console (Madhuri & Butler-Manuel, 2017). It is important to note that the surgical team in this study, had much experience with CLH, and had mastered the learning curve associated with robotic surgery by performing more than 100 procedures.

In summary, these studies seem to indicate that there is clear evidence supporting better patient outcomes when comparing RALH to AH. However, there exists an ongoing question whether there is enough evidence to clearly document the clinical benefits of RALH over CLH.

Benign Gynecologic Conditions

More studies investigate the effectiveness of RALS for women diagnosed with benign gynecological conditions than those with malignant pathologies. Research on benign conditions includes randomized controlled trials, two large cohort studies, and several smaller single-institutional retrospective studies that evaluated patient outcomes compared RALH to other surgical techniques.

Two randomized control trials compared RALH to CLH for benign indications (Paraiso et al., 2013; Sarlos et al., 2012). Both studies reported longer operation time for RALH and no significant difference between the two methods in terms of EBL, LOS, intraoperative and postoperative complications, pain, and return to daily activities. Although Sarlos et al. (2012) reported significantly higher scores on the Postoperative Quality of Life Index for the robotic group (13 ± 10 vs. 5 ± 14), the return to normal activities was not different from that reported by the CLH group.

Recent studies show that the intraoperative and postoperative complications were reduced as the surgeon and the surgical team gained more experience with RALH (Lim et al. 2016; Lönnerfors, Reynisson, Geppert, & Persson, 2015a). Deimling, Eldridge, Riley, Kunselman, and Harkins (2017) conducted a randomized controlled trial comparing the operative time of 144 hysterectomies with 72 patients in each surgical arm (72 RALH and 72 CLH). There was no statistically significant difference in the operative time between the two techniques (73.9 versus 74.9 minutes mean operative time for RALH and CLH respectively, $p < 0.025$). Deimling et al. concluded that the operative time of the two techniques was similar when experienced surgeons and surgical teams in high-volume practice settings perform the procedures. This finding supports the conclusion that with experienced practitioners, the two procedures have similar patient outcomes.

Sacrocolpopexy is one of the most common gynecological procedures for the treatment of pelvic organ prolapse. Anger et al. (2014) conducted a randomized controlled trial comparing patient surgical outcomes and costs of robotic-assisted sacrocolpopexy versus conventional laparoscopic sacrocolpopexy (n = 40 and n = 38 respectively). The measured outcome variables were the initial and readmission costs within six weeks of surgery, postoperative pain, pelvic organ prolapse quantification, adverse events, and quality of life. The results revealed a higher initial cost ($19,616 compared to $ 11,573, $p < .001$) and a cost of ($20, 898 versus $12,170) over six weeks for the robotic and laparoscopic group respectively. When the cost of the surgical robot purchase and maintenance were excluded, there was not a statistically significant difference between the two procedures. The operative time was longer in the robotic group (202.8 minutes versus 178.4 minutes respectively). Other postoperative outcomes such as complications and pelvic organ prolapse stage were similar. The robotic group reported slightly higher levels of pain scores one week after the surgery (3.5 ± 2.1 compared to 2.6 ± 2.2, $p = .044$).

The American College of Obstetrics and Gynecology (ACOG) recommends that the selection of the surgical procedure should be based on the available evidence and what is best for the patient rather than external pressure (ACOG, 2015). The latest Cochrane review, which included 47 studies with 5102 women, contends that vaginal hysterectomy for benign indications is associated with decreased blood loss, shorter operative time, fewer complications, and lower costs when compared with AH, CLH, and

RALH. The authors recommend that laparoscopic hysterectomy should only be considered when vaginal access is not possible (Aarts et al., 2015; Kho, Lee, & King, 2013). In addition, the safety and improved short-term surgical outcomes of RALH over AH for obese women have been reported in previous studies (Lavazzo & Gkegkes, 2016; Geppert, Lönnerfors, & Persson, 2011).

In summary, the current research does not provide clear evidence regarding RALS benefit when comparing patient outcomes for RALH, CLH, or vaginal hysterectomy in women who are diagnosed with benign gynecological conditions. RALH is a new surgical approach for many health care providers and institutions. The adoption of any novel surgical technology involves provider education. Continued research is needed to define the advantages and unintended consequences associated with new technologies. Staff nurses who deal with patients undergoing these procedures often are the providers who observe and work with these unintended consequences.

Costs

In order to be good stewards of institutional resources and provide patient counseling, nurses should be cognizant of the costs associated with the procedures they manage. Lönnerfors, Reynisson, and Persson (2015b) performed a randomized controlled trial in Sweden to compare the hospital cost and short-term surgical outcomes of 122 women who underwent RALH, CLH, or vaginal hysterectomy for benign indications. Vaginal hysterectomy was possible in 41% of the CLH group. The following costs were calculated for each procedure: (a) vaginal hysterectomy was $4579, (b) CLH was $7059, and (c) RALH was $8052 when the robot was a preexisting investment. The hospital cost for RALH increased by $1607 when the cost of the robot and its maintenance was added to the previous total. The RALH group had reduced EBL and fewer postoperative complications. The authors concluded that RALH "is not advantageous for treating benign conditions when a vaginal approach is feasible in a high proportion of patients." (Lönnerfors et al., 2015b, p. 78). This finding supports the proposition that RALS costs more than other procedures without increased clinical benefits (Albright et al., 2016; Wright et al., 2014).

Two large nationwide cohort studies compared the cost and the complication rates of RALH to CLH using propensity case score matching (Rosero, Kho, Joshi, Gisecke, & Schafeer, 2013; Wright et al., 2013). Propensity case score matching is a statistical procedure to control covariates in a treatment that occurs without random assignment. Both studies noted a rapid increase of RALH procedures, concurrent higher costs for RALH, and similar complication rates for both groups. Rosero et al. (2013) noted that the robotic group had a lower blood transfusion rate (2.1% versus 3.1%, $p < .001$), but higher frequencies of postoperative pneumonia. Wright et al. (2013) found that the LOS for the RALH group was less likely to be longer than two days (19.6% versus 24.9%, relative risk ratio of 0.78).

In summary, existing literature suggests RALH costs more than other surgical techniques. This higher cost might be attributed to the longer operative time, particularly for surgeons and nurses new to robotic surgery, and the cost of anesthetic agents during the longer operative time (Corrigan, 2014; Ehlert, Gupta, Park, & Sirls, 2016). Although a recent randomized controlled trial indicated comparative operative time for RALH and CLH when an experienced surgeon and surgical team performed the procedure. The cost was $700 more for the robotic supplies (Deimling et al., 2017). More studies are needed to verify this result.

Perception of RALS versus Current Evidence

In spite of insufficient evidence supporting the superiority of the RALS to CLS, the perception of patients, surgeons, and hospital administrators are that robotic-assisted surgeries foster better patient outcomes (Ahmad et al., 2017). In a qualitative study by Harrop, Kelly, Griffiths, Casbard, and Nelson (2016), patients declined randomization for a clinical trial comparing open, laparoscopic, and robotic-assisted cystectomy because they preferred robotic-assisted cystectomy. Robotic-assisted surgery had been widely advertised to physicians, hospitals, and patients directly and "market competition is strongly associated with utilization of robotic-assisted surgery" (Wright et al., 2016, p. 618). In a survey of 310 obstetricians and gynecologists regarding the utility of robotic-assisted gynecologic surgery, the surgeons stated that increased access to RALS and strong marketing campaigns were the primary drivers of RALS utilization (Wright, Raglan, Schulkin, & Fialkow, 2017a). Many hospitals have acquired the daVinci surgical robot expecting to attract more patients, secure institutional financial wellbeing, and compete effectively for the local market share. Additionally, this surgical technology has been advertised on the websites of many hospitals (Ahmad et al., 2017; Jin et al., 2011; Schiavone et al., 2012; Wright et al., 2016). Makarov, Li, and Lepor (2017) contend that teaching hospitals were among early adopters of this costly technology; however, they failed to generate robust comparative effectiveness research and sound scientific evidence for this adoption.

Unintended Consequences

The application of any new technology has unintended consequences. In the case of RALS, there are reports of patient injuries and adverse events (Cooper et al., 2015; Girad, 2017; Gupta, Schomburg, Lund, Adejoro, & Konety, 2013; Shields et al., 2015). Currently, there is no mandatory reporting system for reporting adverse events associated with RALS. Hospitals voluntarily report RALS-associated adverse events and injuries to Intuitive Surgical Inc., the manufacturer of da Vinci surgical robot. Intuitive Surgical is then supposed to report patient injuries and robot malfunctions to the FDA for recording in the nationwide Manufacturer and User Device Experience (MAUDE) database (Wright, 2017). Although the MAUDE database is a valuable resource for identifying patterns of adverse events and foster quality control measures, the database is incomplete with inconsistent entries (Cooper et al., 2015; Kirkpatrick & LaGrange, 2016).

Alemzadeh, Raman, Leveson, Kalbarczyk, and Lyer (2016) developed an automated language processing tool to analyze the adverse events and deaths recorded in the MAUDE database from 2000-2013. The authors found 10,624 adverse reports including 144 deaths. From these adverse events, 1,391 incidents described patient injuries such as burns, cuts, and damage to organs (13.1%); 8,061 incidents described device malfunctions such as burnt or broken pieces of instruments falling into the body and electrical arcing of instruments (75.9%). Hysterectomies (30.1%) were the procedures cited most often as being related to adverse events followed by prostectomies (14.7%). These two procedures also constitute the highest percentages of the RALS procedures. Cardiothoracic and head and neck injuries were associated with fewer reports, however, they comprised a higher percentage of reported deaths.

The 30-day hospital readmission rate is a major healthcare and economic concern. The Centers for Medicare and Medicaid have been using the 30-day hospital readmission rate as a quality metric for payments to hospitals. There are inconsistent data regarding the 30-day readmission rates for RALH versus other types of hysterectomies. Friedman, Barbash, Glied, and Steiner (2016) examined the data from the HealthCare Cost and Utilization Project from eight states in 2011. Using matched paired propensity scores, the authors compared the 30-day hospital readmission, emergency room and outpatient visits after discharge in a group of women who had hysterectomies. The data included 86,804 inpatients and 29,201 outpatients who had undergone RALH, CLH, AH, or vaginal hysterectomy for benign indications. The conclusion was that the RALH group had a 32% increased likelihood of revisits (readmission, emergency room visit, outpatient visit) after discharge.

This conclusion has not been supported by smaller studies. Martino et al. (2014) also compared the 30-day readmission rates of 2554 inpatients who had RALH, CLH, AH, or vaginal hysterectomy. The researchers reported that the RALH group had the lowest rates of 30-day readmission rates. Penn et al. (2016) conducted a retrospective study using the American College of Surgeons National Database of 40,580 women who had hysterectomy. These researchers determined that vaginal hysterectomy had the lowest 30-day readmission rate. Other studies attributed an increased 30-day readmission rate to the higher number of comorbidities, perioperative complications, and operative time durations of more than two hours (Dessources et al., 2015; Jennings, Spencer, Medlin, & Rice, 2014; Lee, Venkatesh, Growdon, Ecker, & York-Best, 2016).

Nurses who care for patients undergoing RALS must be aware of the benefits and risks associated with these surgeries. The evidence presented in this literature review demonstrated that there are not definite conclusions that RALH is superior to CLH, despite the success of the manufacturer's advertising campaigns. In addition, despite many research studies examining patient outcomes, cost, and the perspectives of surgeons about RALS, the perioperative nurses' opinions and experiences with this technology remains uninvestigated.

Role of Nurses in Robotic-Assisted Surgery

Technological advances continue to transform nursing practice (Archibald & Barnard, 2017; Huston, 2013). The rapid expansion of the robotic surgical technology has created a myriad of opportunities and responsibilities for nurses. RALS technology, however, warrants new nursing approaches for the care of patients receiving RALS. The U.S. public has recognized nursing as the most trusted ethical profession (Tomajan, 2012). In order for the nurses to deserve the public's trust and advocate for patients, they must be knowledgeable about emerging innovations such as robotic surgery. A comprehensive understanding of the benefits and risks of new technologies is required in order to educate and care for patients. As the healthcare professionals who work most closely with the hospitalized surgical patient, nurses must be able to influence policies related to the adoption of these technologies by health care institutions (Tomajan, 2012).

The initiation of any new surgical approach requires training of perioperative healthcare personnel. In addition, nurses must engage in ongoing evaluation of patient safety issues related to the technology, as well as surgical outcomes (Best et al., 2014; Benham et al., 2017; Lichosik et al., 2013). Patient outcomes, experiences of the surgeons with RALS technology, the learning curve associated with surgical training, and the economic effects of RALS have been investigated; however, nurses' experiences and perceptions of RALS remain unknown. Nurses comprise the largest number of providers who care for surgical patients.

The rapid uptake of RALS by hospitals has generated a demand for trained perioperative nurses to assist with these types of surgeries. The core responsibilities of perioperative nurses are to ensure patient safety, manage risk, and to provide patient education (Jing & Honey 2015; Wasielewski, 2017). The responsibilities and nursing interventions vary in each of the perioperative phases: preoperative, intraoperative, and postoperative.

Nursing Care during the Preoperative Phase

Nursing care during the preoperative phase involves identifying unique patient characteristics and comorbidities that may require additional assessment strategies or changes in the plan for RALS (AORN, 2017; Lee, 2014). Preoperative nurses must assess RALS patients for age-specific risk factors; increased intraocular pressure; cardiovascular, respiratory, and kidney pathologies, and lower extremities ischemia (AORN, 2016a). For instance, patients with recent eye surgery, glaucoma, history of deep vein thrombosis, or significant varicosities may require either a change in plan related to RALS versus another procedure or additional surveillance during and following RALS. The other responsibilities of the preoperative nurse are to identify abnormal lab values related to RALS and communicate these results to the anesthesia professional and the surgeon (AORN, 2016a; Morton, 2012). The experiences of the preoperative nurses regarding the different aspects of care needed in order to provide a safe preoperative assessment of the RALS patient have not been addressed in the research literature.

Nursing Care during the Intraoperative Phase

Implementation of RALS has changed the responsibilities of the intraoperative/circulating nurses. The intraoperative/circulating nurse must be knowledgeable about two unique hazards associated with RALS: (a) the steep Trendelenburg position assumed for several hours and (b) the intra-abdominal infusion with carbon dioxide (pneumoperitoneum). Both steep Trendelenburg positioning and pneumoperitoneum are commonly used for better visualization and improved access to the surgical site. Placing the patient 25 to 45 degrees head down from the horizontal plane, particularly for longer than two hours, can induce serious hemodynamic problems and other adverse physiological effects (Gupta et al., 2012; Kaye et al., 2013; Lowenstein et al., 2014).

Steep Trendelenburg positioning is associated with upper airway and facial edema, increased intracranial and intraocular pressure, reduced ocular perfusion, and vision loss (Kaye et al., 2013; Molloy, 2011). Pneumoperitoneum in combination with steep Trendelenburg position can cause the cephalad movement of the diaphragm and lung through pressure from abdominal contents. This cephalad movement results in physiological consequences: (a) decreased lung residual capacity and pulmonary compliance, (b) ventilation-perfusion mismatch, (c) reduced cardiac output, and (d) bradycardia. These effects can be exaggerated in obese individuals or those with cardiopulmonary deficiencies (Gupta et al., 2012; Lee, 2014). Other potential problems include ulnar, brachial plexus, and skin injury, which is the result of compression or stretching of the nerves, particularly for an extended time (Shveiky et al., 2010). The circulating nurse is responsible for the safe positioning of the patient, which might vary for different types of robotic surgeries, and securing the patient to the surgical bed. The goal is to maintain adequate patient circulation and to protect skin, muscles, and nerves. Other circulating nurse responsibilities include calibrating the surgical robot before surgery; ensuring the integrity of the robotic supplies, handling the robotic surgical supplies before, during, and after the surgery; docking and undocking the robot; troubleshooting problems associated with the surgical robot; and preparing for complications and emergency conversions to open surgery (Brooks, 2015; Raheem, Song, Chang, Choi, & Rha, 2017; Thomas, 2011). Effective communication among the members of the surgical team is also crucial for efficiency and optimal patient outcome (Cabral et al., 2016; Corrigan, 2014; Schiff et al., 2016).

Nursing Care during the Postoperative Phase

Postoperative nurses must assess each RALS patient for biological homeostasis, skin condition, nerve injury, and shoulder and abdominal pain immediately after the completion of surgery (Madsen et al., 2016; Mills et al., 2013; Savarkar et al., 2016). Shveiky et al. (2010) reported that 12% of medical malpractice cases after laparoscopic and RALS procedures were related to peripheral nerve injuries, of which 57% were ulnar nerve or brachial plexus injuries. Infusion of carbon dioxide into the abdominal cavity often causes substantial shoulder and abdominal pain after RALS. In a survey of about 6000 patients who had laparoscopic procedures, 30% of the patients reported moderate to severe pain within 24 hours of surgery (Radosa et al., 2013). Due to the short length of hospital stay after RALS and the subsequence transference of postsurgical patient-care responsibilities to the patients and their family/caregivers, the postoperative nurse is newly accountable for the patient's discharge plan. A recent study of 1,239 patient who had gastric, colorectal, hepatic, and pancreatic resections reported that patients with lower levels of health literacy experienced longer hospitalizations (one day) in comparison to the patients with higher levels of health literacy (Wright et al., 2017). Low health literacy is also associated with increased hospital readmission within 30-days of surgery (Cloonan, Wood, & Riley, 2013). The discharge plan, itself, must be modified by the postoperative nurse to accommodate the unique patient needs produced by the shorter hospitalization (Castiglia et al., 2011; Gadler et al., 2016). Particularly in the case of robotic-assisted colon and rectal surgery, patients need detailed instruction to prevent dehydration at home and, thereby, reduce hospital readmission (Brenner et al., 2011).

Preparation/Education of Surgeons and Nurses

At the present time, professional organizations or government entities do not provide standardized education, training, or certification of surgeons and nurses involved in RALS (Dulan et al., 2012; Sood et al., 2015; Putnam, 2016). The daVinci robot manufacturer, Intuitive Surgical, Inc. provides initial training of surgeons and nurses. Upon the purchase of the surgical robot, a surgeon and one or two nurses receive two days training from the company (D. Morgan, RN, CNOR, CRNFA, personal communication, November 16, 2016; Intuitive Surgical, 2018). However, surgeons are the only healthcare personnel who are encouraged to return for additional training and simulation. In order to assure patient safety, the nursing team, including all of those involved in the surgical procedure, must be trained using standard guidelines and deemed competent about the RALS procedure/protocol (Benham et al., 2017; Neel, 2014;

Ramsey, 2012). Often due to the lack of sufficient resources and cost containment policies, subsequent training of perioperative nurses takes place “on the job” through person-to-person guidance during real-time procedures (Francis, 2006). Such complex training without prior education and orientation is difficult for nurses and may not guarantee effective surgical procedures or optimal patient outcomes. The Association of PeriOperative Registered Nurses has issued guidelines for perioperative nursing practice in minimally invasive surgery, as well as a competency verification tool (AORN, 2016a; AORN, 2017). Despite the recommendations and competency guidelines promoted by AORN for RALS, little is known regarding the extent to which perioperative nurses who care for RALS patients are educated about RALS.

RALS requires longer operative times, particularly for surgical teams who are new to robotic surgery (Paraiso et al., 2013; Sarlos et al., 2012; Sinha, Sanjay, Rupa, & Kumari, 2015). Sharma, Calixte, and Finamore (2016) in a retrospective study of 176 women who had robotic-assisted sacrocolpopexy measured the learning curve and point of efficiency for surgeons, anesthesia providers, and nursing staff. Surgeons required 30 to 60 cases to attain proficiency in RALS. The anesthesia providers and nursing staff required 110 cases to reach the point of efficiency. Team education, previous experience, and good communication skills can reduce the operative time needed for efficiency with new surgical procedures (Wasielewski, 2017). Most importantly formal education, product training, clinical training, and simulation are integral components of the RALS learning experience, and all of these are needed for operative teams to perform efficient, effective, safe surgeries (Lichosik et al., 2013).

Nurses' Perception and Experience

As RALS has been adopted, the new role of nurses in the perioperative care regarding patient assessment and safety (Chitlik, 2011; Morton, 2012), and their knowledge of robotic technology (Raheem et al., 2017) has been discussed. Other nursing literature on RALS includes case reports of complications (Girad, 2017; Lee, 2014), patient outcomes (Best et al., 2014; Brenner et al., 2011), commentary articles (Girards, 2011; Luck & Gillepsie, 2017; Ramsey, 2012; Putnam, 2016;), educational articles (Christie, 2014; Castiglia et al., 2011; Gadler et al., 2016; Hortman & Chung, 2015; Yee, 2017), and literature reviews (Brooks, 2015; Sun & Fong, 2016). There are only two qualitative research studies, however, investigating perioperative nurses' perceptions and experiences with RALS: Kang, Gagne, and Kang (2016) and Randell et al. (2015).

Kang et al. (2016), in a qualitative descriptive study, focused primarily on the intraoperative-nurses work experience with robotic surgery. The participants were 15 intraoperative Korean nurses from five university hospitals in Seoul. The data resulted in four themes:

> (1) constant checking on patients' safety and the robot's functions; (2) unexpected robotic machine errors or malfunctions; (3) feelings of burden in a robotic surgical team; and (4) need and desire for more information and education. (p. 152)

Kang et al. (2016) concluded that the advancement of the robotic surgery has expanded nurses' roles and responsibilities. This expansion places nurses at risk for increased stress due to concern for patient safety. The authors suggested more education and support for nurses involved in robotic surgery to enable them to acquire the skill in the extended role.

This study did not investigate preoperative and postoperative nurses’ perceptions and experiences with robotic surgery.

Randell et al. (2015) conducted a qualitative study with interviews of surgeons, nurses, anesthesiologists, and other personnel involved in the intraoperative phase of RALS. The primary focus was the surgeon’s decision-making process. The researchers used the snowball sampling approach to identify participants. Forty-four participants were included in the study: 12 surgeons, 5 trainee surgeons, 13 operative room nurses, 6 anesthesiologists, 7 operative room practitioners, and 1 manager from nine hospitals. The researchers applied *realist* evaluation, which is a theory-driven approach for data collection and analysis. In this approach, the authors attempt to hypothesize a theory (theories) based on their literature review and verify, refine, or refute the theory (theories) based on the gathered data from participants. The *realist* evaluation approach attempts to uncover users’ perceptions of a new intervention or technology (theories), explores how users interact with the new technology (mechanism) in different situations (contexts) to produce (outcome). The researchers in this study started with their own hypotheses about robotic surgery, which were driven by a literature search and refined them to fit to the users/participants experience. The researchers hypothesized that RALS would impact surgeons’ decision-making process during surgery due to the lack of tactile and visual perception with concomitant motor skills. The researchers derived the following theories:

1. The surgeon’s awareness of the environment and patient is potentially reduced. A positive relation among the surgical team members, good communication, and trust remediate the surgeon reduced situation awareness.

2. The lack of tactile sensation can create a major problem, but this was not a problem among surgeons who had experience with laparoscopic surgery. They relied on visual cues and learn to look for tension. Nevertheless, some of the surgeons reported that they more cautious not having tactile information.
3. The surgeon remaining at the console provides a sense of immersion and focus during robotic surgery. A few participants supported this assumption. Immersion also depends on the level of trust on the bedside assistant and the surgical team.
4. The impact of better ergonomics for the surgeon was perceived by most surgeons to be an advantage in this study. A few surgeons thought better ergonomics reduced the stress level during RALS. Other surgeons indicated that a challenging surgery is stressful regardless of opportunity for good ergonomics during the procedure.

Despite the inclusion of intraoperative nurses in this study, the focus was on the surgeon and the surgical decision-making process during robotic surgery. RALS is an exemplar of an innovative, technologically-advanced approach to surgery that affects all three phases of perioperative nursing practice, the workflow of the surgical team, and patient care. Perioperative nurses' experiences with RALS and their perceptions of these experiences warrant investigation. The results of this study will add to the existing nursing knowledge and will trigger areas for further research, practice, and policymaking. The results may also be helpful for nurse managers in clinical decision-making for allocation of the nursing resources to increase efficiency in workflow and productivity while ensuring safety and optimal outcomes of patients with RALH.

Summary

Technological advances in healthcare have profound effects on nursing practice (Archibald & Barnard, 2017). These effects include both positive and negative aspects, and often unanticipated outcomes. In order to optimize patient care and promote efficient workflow, nurses must acquire the education needed to optimally use these new technologies. The widespread diffusion and adoption of RALS add layers of complexity to perioperative nursing care. Perioperative nurses must develop new knowledge and skill proficiency in order to ensure patient safety and workflow efficiency are maintained (AORN, 2017). Nurses as the largest group of health care providers are the frontline technology users. However, their voices are often unheard when healthcare institutions acquire and adopt new technology. The rapid, widespread adoption of RALS by healthcare institutions provides an exemplar of this situation.

Surgical robots are becoming more prevalent each year. In October 2017, the Senhance™ surgical robot by TransEnterix Inc. received FDA approval (TransEnterix Surgical, Inc., 2017). Other manufacturers such as Cambridge Medical Robotics (England), Medical Micro Instruments (Italy), Auris Robotics, Medtronic, and Johnson & Johnson (United States) are developing surgical robots in the hope that the new product will overcome the limitations of the daVinci robot (e.g., the lack of tactile sensation). Some robots are being developed to perform enhanced microsurgeries (*The Economist,* November 2017). Nevertheless, surgical robots are costly to purchase and maintain, and research on patient outcomes may not provide clear guidance about the benefits of robotic technologies. Nurses' participation in decision-making regarding these technologies includes specific knowledge about purchasing, maintenance, needed supplies, workflow, and patient outcomes. Nursing input is needed, therefore, to reduce costs, improve patient safety, and effectively evaluate this technology (Stanton, 2017).

This chapter provided a complete, current review of the existing literature on the status of RALH. The review highlighted both advantages and disadvantages of RALS in comparison to other surgical techniques in terms of the patient outcomes, cost, and impact on nursing practice. The review also provided evidence for the gap in existing research regarding the perceptions and experiences of perioperative nurses with RALH. The rapid adoption of RALS throughout the United States provides a unique opportunity to examine how nurses adapt to new technologies in providing care for surgical patients. This study may provide a venue for the missing voice of the perioperative nurses to be heard.

CHAPTER III

METHODOLOGY

Introduction

Previous research on robotic surgery has focused on the surgeons and patients. The perspective of nurses as distinct professional health care providers is virtually unexplored. This study used a qualitative descriptive methodology, as described by Sandelowski (1993, 2000), to explore the perioperative nurses' perceptions and experiences with robotic-assisted surgery. A modified conceptual framework derived from the *Determinants of Innovation Within Healthcare Organizations* by Fleuren, Wiefferink, and Paulussen (2004) was used to guide the initial framework for this study.

The aim of this chapter is to provide the rationale for choosing the methodology and conceptual framework. In addition, a detailed explanation of the data collection process, protection of human subjects, management of data, analysis of data, and measures to preserve the trustworthiness of the study are presented.

Qualitative Descriptive Design

Qualitative methodology is particularly useful when there is a need for exploring complex issues, sharing individuals' stories, exploring concepts that are difficult to measure, or listening to populations that historically did not have a voice (Colorafi & Evans, 2016; Creswell, 2013). Data are in the form of words, personal stories, and experiences. Qualitative descriptive methodology is distinct within the qualitative paradigm, especially suitable for answering relevant clinical questions (Sandelowski, 1993; Thorne, Reimer Kirkham, & MacDonald-Emes, 1997). The qualitative descriptive methodology is a naturalistic and eclectic method that seeks to answer the questions of *who, what, and where* of the experiences under investigation in everyday language (Sandelowski, 2000). The qualitative descriptive methodology is less abstract and interpretive than traditional phenomenology, ethnography, or grounded theory methods. This methodology remains close to the data and provides a factual and comprehensive summarization of the phenomenon of interest (Lambert & Lambert, 2012). A qualitative descriptive methodology "seeks to generate new insights that can help shape applications of qualitative evidence to practice" (Thorne, 2008, as cited in Polit & Beck, p. 506). Sandelowoski (2010) states the *factist perception* of data is the assumption that data are more or less truthful and present indexes of different perspectives of truth. Interviews, observations, and field notes will be obtained to gain insights into the perioperative nurses' experience with robotic-assisted surgery. This research will potentially enhance nursing knowledge about this phenomenon.

The qualitative descriptive methodology allows for any theoretical/conceptual framework that supports the explanation of a phenomenon (Colorafi & Evans, 2016). Because robotic surgery is a relatively new technology, a modified conceptual framework derived from the *Determinants of Innovation Within Healthcare Organizations* by Fleuren et al. (2004) was used to guide the initial framework for this study. The determinants of the innovation framework were based on the assumption that introducing innovation in healthcare is often complex, and several factors may produce unanticipated positive or negative effects. In order to introduce a new technology successfully and achieve change for a better patient outcome, the factors that enhance or impede the implementation of that technology should be analyzed (de Veer et al., 2011). Fleuren et al. (2004) defined four factors as determinants of technology innovation adoption: (a) characteristics of the innovation, (b) characteristics of the adopting person, (c) characteristics of the organization, and (d) characteristics of the socio-political context. These four determinants provided guidelines for the initial steps of this research study. "Implementation research in healthcare is still in its infancy and there are few innovation theories" (Fleuren et al., 2004, p. 120). The results of this study may provide further evidence for developing innovation theories for nursing practice.

Setting

Respondents for this research study were solicited from a community hospital, located in central Texas, through professional organizations, and through an online venue accessed by perioperative nurses. All respondents practiced in the United States. The hospital used to observe surgeries and recruit part of the sample was a mid-size community hospital that provides a large variety of services. This facility acquired a daVinci surgical robot in 2010. Gynecologic surgeries comprise about 75%, urology, 20%, and general surgery 5% of the number of robotic-assisted surgeries in this facility. Additionally, the North Houston AORN Chapter members were invited to participate in this study. Because these two sources did not yield enough participants to achieve data saturation, the invitation was extended to the users of the ORNurseLink at (http://www.ornurselink.org/home), which is the official AORN social media website. This allowed recruitment of perioperative nurses throughout the United States and maximized the variation in the sample (Polit & Beck, 2012). The interviews were conducted outside participants' working hours in a convenient and private venue of their choosing.

Sample

Participants were recruited from the population of perioperative registered nurses (RNs) and Certified Registered Nurse Anesthetists (CRNAs). A purposive sample of perioperative RNs and CRNAs who provide care for patients with robotic surgery were included in this study. The exclusion criteria were non-RN personnel, RNs who did not have experience with robotic-assisted surgery, and RNs who practiced outside of the United States. The initial sampling strategy used the non-probability purposive sampling method and solicited informants who could provide relevant and rich information (Patton, 1990). Following the initial purposive sampling, the snowball strategy was used to find more participants who could contribute to data acquisition (Polit & Beck, 2012). Participation in the study was voluntary. The sample size and the end-point of data collection were determined when data saturation occurred (Creswell, 2013).

Protection of Human Subjects

Prior to data collection, approval of the Texas Woman's University Institutional Review Board (IRB) was obtained. Additionally, permission from the Director of Trauma and Perioperative Services and the IRB from the local hospital was attained. Appropriate measures were taken to protect the rights and privacy of the participants and their hospitals. To ensure the participants' rights and privacy, they were asked to sign a consent form prior to the interview. This consent form is in Appendix B. The consent form explained the purpose of the study, the potential benefits and harm. The participants were informed that participation was voluntary, and they could opt to withdraw from the study at any time. Each participant was assigned a unique number to warrant confidentiality. Data were audio recorded on the researcher's iPhone and uploaded to a private computer. The two devices were password secured and only the researcher could access the data.

Data Collection

Data were collected via face-to-face, Skype®, FaceTime®, and over the phone interviews. Maximum efforts were taken to see the participants during interviews to avoid losing nonverbal information. When the participant was unable to use social meeting media, the interview was performed via telephone. A semi-structured questionnaire was used to ensure all issues relevant to the phenomenon under study were discussed (as presented in the Appendix J). Open-ended questions and probing were used to elicit more detailed information (Polit & Beck, 2012). The interviews were performed in a quiet, private venue; only the researcher and the interviewee were present. Interviews were audio recorded via an iRecording application on the researcher's iPhone. Field notes and observations were used to reflect the participants' non-verbal cues and expressions. Additionally, an audit trail was kept throughout data collection and analysis for organizing the data (Colorafi & Evans, 2016).

Data Analysis

Data analysis proceeded simultaneously with data collection. The data recordings were transcribed verbatim. The NVivo-12 qualitative data management analysis software was used for initial word frequency counts. The data were compared for commonalities and meaning units/coding units (a group of words that relates to a central meaning) were established (Graneheim & Lundman, 2004). Then meaning units were shortened into more condensed and abstract units while preserving the meaning of the text (Cavanagh, 1997). The condensed and abstract units were merged to create categories and subcategories. Ultimately multiple categories with similar concepts were linked together to generate themes.

Scientific Rigor and Trustworthiness

Measures were taken to make this research study authentic and trustworthy. Four standards were used to assess the trustworthiness and quality of this research study: credibility, dependability, confirmability, and transferability (Colorafi & Evans, 2016). Although these measures are described separately, they are interwoven and together represent the quality of a research study (Graneheim & Lundman, 2004).

Credibility

Credibility or validity lays the foundation for the trustworthiness of a study. Credibility is defined as the truth of the study findings and how believable are the study results. To achieve credibility, substantive engagement, and sufficient time with each participant is required. Sufficient time enables the researcher to establish rapport with the participants and to understand their perspectives and experiences (Graneheim & Lundman, 2004; Miles, Huberman, & Saldana, 2014). Other strategies to attain credibility include triangulation. Triangulation involves collecting and analyzing data using different methods. Interviews, observations, field notes, participants' variation in age, gender, and experiences are examples of data triangulation. Seeking member checking such as the participant's evaluation of the accuracy of the transcript and the evaluation of the expert opinion are examples of method triangulation. Ultimately connecting the findings of the study to the selected conceptual framework lays the foundation for a credible research study (Colorafi & Evans, 2016).

Dependability

Dependability or reliability is demonstrated through procedural consistency and inclusiveness of new data collected over the course of study (Colorafi & Evans, 2016). Strategies to preserve reliability include using the same semi-structured questions for all participants, using observation, and writing field notes throughout the study. The inclusiveness throughout the data collection and analysis period was accomplished by thorough documentation of data. An audit trail should be maintained from the start to the end of the research process. The audit trail includes the transcription of the interviews, field notes, researcher observations, transcript coding, tables, and schemes to organize data and to demonstrate the logic behind the steps taken. The audit trail ensures inclusion of the important details and works as a guide to develop and report the findings (Colorafi & Evans, 2016).

Confirmability

Confirmability validates whether the findings of the study are free from researcher bias and are shaped by participants' words and narratives. Two measures facilitated confirmability; audit trail and reflexivity. The audit trail was described earlier. Reflexivity is the researcher's awareness of own values, assumptions, and biases. Thus, having experts, the dissertation chair, and a committee member experienced in qualitative research, evaluating data will remediate bias (Colorafi & Evans, 2016). These data evaluation strategies occurred through multiple meetings with the researcher, the dissertation chair, and the qualitative committee expert.

Transferability

Transferability is the extent to which the study findings can be used in other settings or among different groups (Graneheim & Lundman, 2004, Creswell, 2013). A detailed description of the study process along with participants' actual words and examples should enable readers to interpret and judge the findings of the study, thus, facilitate transferability. Stating limitations and potential threats to the study results are important considerations for the reader. The researcher provided a clear description of the study process and results and leaves it to the readers to judge the transferability of the study findings.

Summary

This chapter provided a detailed description of the design, methodology, conceptual framework, and the rationale for using them. The procedural steps for collecting, analyzing, and preserving trustworthiness of the study were described.

CHAPTER IV

ANALYSIS OF DATA AND FINDINGS

Introduction

This chapter presents the results of a qualitative descriptive study aimed at exploring the perceptions and experiences of professional registered nurses (RNs) involved in providing care for patients having robotic-assisted Laparoscopic surgery (RALS). The following overarching research question provided a foundation for studying this phenomenon.

What are the perceptions and experiences of perioperative professional nurses who care for patients who undergo RALS?

Data collection for this study included in-depth interviews with 17 professional nurses: preoperative RNs, intraoperative RNs, postoperative RNs, and Certified Registered Nurse Anesthetists (CRNAs). Other modes of data collection included observation of five RALS procedures and questioning professional RNs and others involved with RALS, discussions with surgical professionals, field notes, the audit trail, and reflexive journaling documentation. Chapter IV provides the description of the sample and demographic responses, data collection processes, thematic analysis, and triangulation strategies for data collection and analyses. These approaches facilitated answering the research question of this unexplored phenomenon.

Description of Sample

Among the perioperative nurses who responded to the original invitation, some potential participants chose not to participate, and some respondents were not eligible to participate in the study. Nevertheless, most of the professional RNs who contacted the researcher agreed to participate in an interview and signed the consent form prior to the interview. A total of 17 English-speaking professional nurses (*n* = 17) who met the inclusion criteria were selected to take part in this study. The participants were 16 females and 1 male from nine different hospitals in five different states in the United States. The 17 participants included 6 preoperative and postoperative nurses, 7 intraoperative nurses, and 4 nurse anesthetists. Fifteen nurses were Caucasian, one was African American, and two were of American Hispanic ethnicity. Participants' ages ranged from 30 to 65 years, with an average of 48.65 years. Perioperative nurses averaged 23.41 years of experience as a preoperative, intraoperative, and/or postoperative nurse. CRNAs averaged 12.63 years of anesthesia experience. Table 1 illustrates participants' demographic data: age, gender, roles of professional nurses, levels of education, years of experience with RALS, and the estimated number of RALS procedures in which they participated.

Data Collection

Interviews were conducted between April 26, 2018, and June 24, 2018. Interview durations ranged from 22 minutes to 93 minutes. Five interviews were performed through face-to-face conversations with the researcher, 1 through telephone communication, 10 using FaceTime, and 1 via the Skype social media application. All interviews were audio recorded, and field notes were drafted simultaneously with the interviews. Data collection and analysis were performed concurrently. As a part of data collection and immersion into the problem under investigation, the researcher observed five RALS procedures.

Table 1

Participants' Characteristics (*n* = 17)

Age	Gender	Role of Nurse	Level of Education	Nursing Experience (Years)	CRNA Experience (Years)	RALS Experience (Years)	RALS Procedures
30	F	Intraop	BSN, RN	9	NA	2	50
32	F	CRNA	MSN, RN	9	4	4	175
35	F	PACU	ADN, RN	13	NA	8	50
36	F	PACU	ADN, RN	13	NA	8	1248
38	F	CRNA	MSN, RN	16	11	8	500
40	F	CRNA	MSN, RN	12	5.5	7.5	100
46	F	Intraop	MSN, RN	19	NA	12	500
46	F	Intraop	MSN, RN	23	NA	9	500
52	F	Pre & Post-op (day surgery)	Diploma, RN	30	NA	10	1000
54	F	Intraop	ADN, RN	32	NA	17	750-900
56	F	Pre & Post-op (mainly preop)	BSN, RN	22	NA	12	50-100
56	F	Intraop	BSN, RN (RNFA)	35	NA	10	700
56	F	Pre & Post-op (mainly preop)	BSN, RN	37	NA	8	250
60	F	CRNA	MSN, RN	4	30	5	50
60	F	PACU	MSN, RN	27	NA	8	200
65	M	Intraop	MSN, RN	43	NA	16	100s
65	F	Intraop	MSN, RN (RNFA)	44	NA	5	75

Preop and Postop (*n* = 6). Intraop (*n* = 7). CRNA (*n* = 4). Total (*n* = 17). Average Age = 48.65. Average Years of Experience as Perioperative Nurse = 23.41. Average Years of Experience as CRNA = 12.63

For some of these observations, the patients were followed from the preoperative area to the post-anesthesia care unit (PACU) to observe the care provided to the patient by different types of professional nurses. Data collection continued until saturation was achieved; that is, no new information was attained (Mandal, 2018). Table 2 illustrates the list of demographic and interview questions. Table 3 presents the date of the interviews, the participants' states of residence, the duration of the interviews, and the observation dates of different types of RALS.

Table 2

List of Demographic and Interview Questions

Demographic Questions
1. Age?
2. Gender?
3. Education level?
4. Years (months) in nursing?
5. Years (months) working as a perioperative nurse?
6. Years (months) working on robotic surgery team?
7. How long has your institution performed RALS?
8. Which type of surgical robotic technology have you used?
9. How may robotic surgery procedures have you been involved in?

Interview Questions
1. Can you tell me about your experience with robotic-assisted surgery?
2. How do you compare this technique to conventional laparoscopic technique for different procedures, urology, gynecology, general surgery? For instance, the duration of surgery, patient outcomes, and cost?
3. In your experience, what impact does RALS have on the nurse-patient relationship?

4. What comes to your mind when you think of robotic surgery in terms of patient outcomes? (positioning, pneumoperitoneum).
5. Tell me about your experience with these types of patients and their perception of RALS?
6. Did you have a choice to be a member of robotic-assisted surgery team? How do you feel about that?
7. Tell me about your role in robotic surgery?
8. What effects do you think robotic surgery has on your duties/work as a nurse?
9. What changes, if any, do you make, or you have made in the provision of care for patients who have robotic surgery?
10. Did you receive training when you started working with patients who have robotic surgery and did the training prepare you?
11. In your experience, how many times does a nurse need to care for a patient with RALS to be really good at this?
12. Did your organization provide any incentives and support for being on the robotic surgery team?
13. How can the provision of care for patients receiving robotic surgery be improved?
14. Has the implementation of RALS affected the resources (staffing) and workflow at your work?
15. What do you think of standardization of the training for surgeons and nurses?
16. Please tell me more about that…do you have an example? (probing question). Is there anything that you would like to share?

Table 3

Partial Description of Data Collection Process and Participants Characteristic

Date of the Interview	State	Duration of the Interview (minutes)	Observations: Type and Date
April 26, 2018	Texas	32	Robotic-assisted hysterectomy February 8, 2018
May 5, 2018	New York	93	Robotic-assisted prostectomy February 21, 2018
May 8, 2018	Texas	40	Robotic-assisted hysterectomy, March 12, 5018
May 16, 2018	Pennsylvania	41	Robotic-assisted hysterectomy, March 26, 2018
May 20, 2018	Texas	30	Robotic-assisted hernia repair, May 28, 2018
May 24, 2018	Texas	25	
May 30, 2018	Texas	22	
May 31, 2018	Texas	28	
June 4, 2018	Texas	24	
June 5, 2018	Colorado	37	
June 5, 2018	Iowa	28	
June 8, 2018	Texas	36	
June 9, 2018	Texas	51	
June 12, 2018	Texas	25	
June 14, 2018	Texas	30	
June 14, 2018	Texas	25	
June 24, 2018	Colorado	41	

Data Analysis Process

The interviews were transcribed verbatim using the NVivo software audio play option (NVivo version12). The researcher spent the time needed to obtain accurate and complete transcription of each interview. Each interview was replayed many times to make certain to obtain the correct verbatim transcription. This process of complete and repeated transcription by the researcher facilitated data immersion, enhancing the ability of the researcher to ascribe meaning to the participants' experiences with RALS. The main issues developed through the deep understanding that was obtained concerning the participants' meaning. Potential themes, therefore, emerged and were conserved throughout the transcription process. Notes, memos, and reflexive journaling were employed during the entire course of data collection and analysis. After the completion of the transcriptions, all interviews were reviewed again to identify trends of the participants' thoughts (Vaismoradi, Jones, Turnen, & Snelgrove, 2016).

As the next step, the transcripts were organized according to interview questions in QRS International's NVivo-12 qualitative data management analysis software. Following this merger 16 nodes emerged. A node is defined as a collection of references or participants' verbatim comments about a specific theme or concept (QSR International's NVivo, version 12). Node identification in NVivo allowed specific comparisons of all responses to a specific question.

Data were then further analyzed using techniques described by Graneheim and Lundman (2004) and Vaismoradi et al. (2016). After reading the transcripts several times, meaning units were highlighted. The meaning units were summarized, and codes were constructed. Recurrent codes were clustered, combined, and compared for similarities and contrasts (Bernard & Ryan, 2010). The codes were condensed and abstracted further to extrapolate categories and themes. This was accomplished by examining the data many times and revisiting areas of importance and congruence (Graneheim & Lundman, 2004; Schuessler et al., 2018; Vaismoradi et al., 2016). During the process of identifying codes, categories, and themes, the creation of outlines and tables was instrumental and facilitated the systematic comparisons of data (Bernard & Ryan, 2010). Additionally, weekly meetings with the faculty adviser and a committee member who was an expert in qualitative design provided peer review evaluation. Table 4 is an example of code construction, category identification, and the emergence of one theme.

Trustworthiness

Validation criteria were used to establish the trustworthiness of this qualitative research analysis (Creswell, 2013; Lincoln & Cuba, 1985). These criteria included: credibility, dependability, confirmability, and transferability.

Credibility demonstrates the truthfulness and plausibility of the study results (Graneheim & Lundman). This criterion was attained through the extensive review of the existing literature on the topic and spending sufficient time with each participant so that a deep understanding of the phenomenon was achieved. Other strategies used to attain credibility were triangulation and member checking (Colorafi & Evans, 2016). Triangulation was achieved through multiple means of data collection: observation, in-depth interviews, discussion, and questioning participants. The fact that participants were from five geographical locations with different ages and levels of experiences provided variation in sampling, which is recommended for a non-random purposive sampling method (Patton, 1990). Table 4 illustrates an example of theme extrapolation.

Table 4

Example of Data Analysis: Meaning Units, Condensed Meaning Units, Codes, and Extrapolation of One Category and One Theme

Meaning units	Condensed meaning unit	Code	Category	Theme
"I think it is a very complex technology. You know, you have the responsibility to really be…, oversee all the different ends of that, in other words like any surgical procedure you have to be aware of how the equipment works, you have to be able to troubleshoot if things go wrong, and you have to have working knowledge of the technology, and you also have to have working knowledge of laparoscopic surgical procedures. There are just a lot of different areas that come into play. I think you have to have a very broad working knowledge of a lot of different things."	Must have a lot of knowledge about robotic and laparoscopic surgery	Knowledge of the Technology		
"it is incredible, you can really hurt someone if do not position them properly." "I think that [positioning] was one of our big challenges initially was figuring out how to keep the patient on the table."	Patient positioning is challenging	Positioning	Workflow	Surgical innovation
"So, initially we were cutting out all these different layers of foams and tractions and try to hold them to the bed and as new different types of padding and so forth for the patient came out, we would bring it in and we would put each other on the table, so we would experiment with each other how much we move [on the table] and how far. Uh, I wish I had done a research study when I was doing all that because it would have been really neat to look back on that." "I modeled how [to] take care of my patients…I am looking for those little things that potentially go wrong, I'm trying to reduce or eliminate them."	Trying different techniques to overcome deficiencies	Streamlining and efficiency		

To validate the accuracy of the information discussed during each interview, the investigator summarized the highlights of each interview at the end of the encounter and asked the participant for verification. The participants confirmed the accuracy of the information and sometimes added more evidence. The validity of this analysis process; initial coding, category construction, and identification of emerging themes was evaluated through meetings with the research dissertation advisor and the dissertation committee member who is an expert in qualitative research strategies. Additionally, the researcher had weekly meetings with the qualitative research NVivo support professional from the TWU Center for Research Design and Analysis (CRDA) during the data collection and investigation processes. The CRDA offered professional appraisal each step of the process, provided feedback, and offered NVivo guidance. Three participants provided member checking: one CRNA, one intraoperative RN, and one postoperative RN. These professional nurse participants validated the accuracy and comprehensiveness of the findings; however, they did not offer changes or additional information. One validator wrote, “You nailed it! I think it's perfect and wouldn't change a thing.” The other validator noted:

> I did receive your final conclusion summary. I felt that it was very well put together with information from several different sources that have experience with patients throughout robotic-assisted laparoscopic surgeries. I agree with your summary and find it to be very well done.

The last evaluator commented, “Your summary is concise and well written. There aren’t any suggestions for improvement that I could make at this time.”

Dependability or reliability was assured through continuous consistency, which was maintained during the process of data collection and analysis. This consistency was accomplished by using the list of semi-structured interview questions (see Appendix J), keeping field notes, maintaining the audit trail, constructing tables, and implementing schemes for organizing data.

Confirmability is having confidence that the findings are shaped by the participants' narratives and not by potential researcher biases (Colorafi & Evans, 2016). Confirmability was accomplished through the provision of multiple exemplars of participants' narratives to validate each finding. The investigator was aware of her personal biases, which were noted in the audit trail and revealed through reflexive journaling. Additionally, member checking and the peer review appraisal of the data analysis supported confirmability.

Consequently, the investigator provided a rich description of data analysis and the sample characteristics. This description allows the reader to determine whether the results of this study are transferable to other situations and venues.

Findings

Three main themes were derived from the data:

- Theme 1. Surgical innovation
- Theme 2. Interprofessional practice
- Theme 3. Outcomes

Figure 3 illustrates the merged codes, categories, and themes in this study.

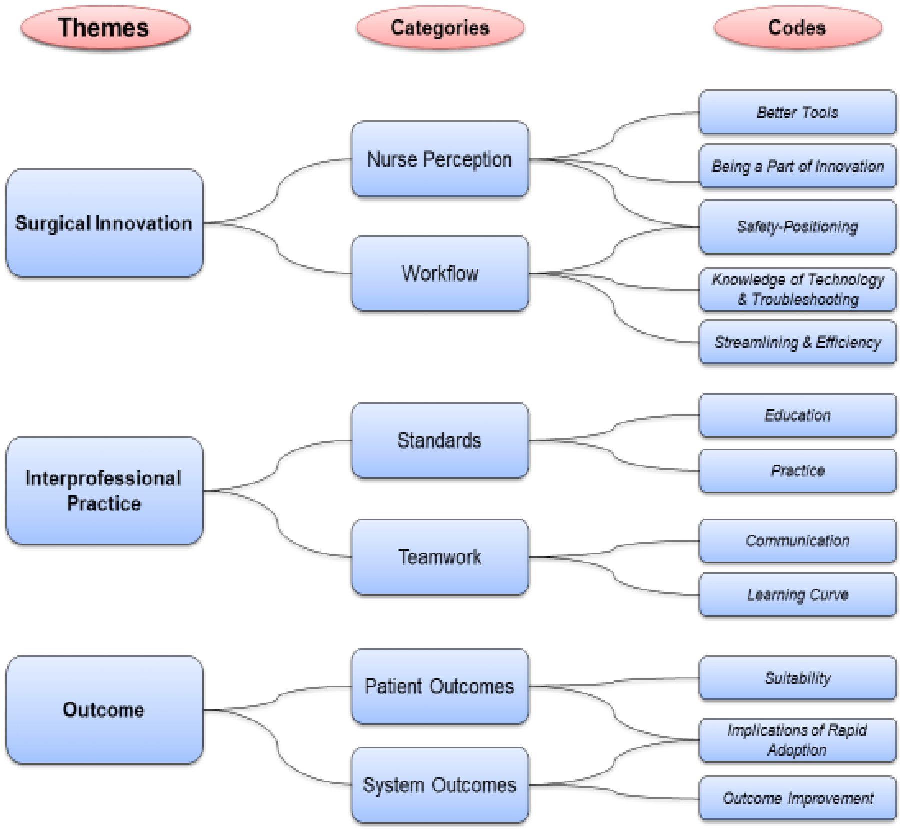

Figure 3. The merged codes, categories and themes.

Theme 1. Surgical Innovation

The daVinci RALS is an exemplar of one major surgical innovation that has developed during this millennium. Since the inception of the daVinci robot in 2000, this device has been widely adopted by healthcare institutions for a variety of surgical procedures, especially in the United States. The Intuitive Surgical Inc. (Sunnyvale, CA, USA) pioneered a novel surgical approach, as compared to either laparotomy or conventional laparoscopic surgeries. One consequence was that nursing practice and workflow had to change to accommodate this technology. Hospital mandates for the incorporation of technological innovation into nursing practice are common, often without nursing staff input into the decision. Nevertheless, successful integration of innovation requires a positive attitude and transformation (Archibald & Barnard, 2017). At times, the initial human response is positive regarding “new” technologies and embracing innovation is seen as a constructive adaptation that may be followed by a more critical appraisal of the effort required to incorporate mandated innovative technologies into the workflow (Paul, McCulloch, & Sedrakyan, 2013; Wright, 2017). Two main categories emerged from the data that were incorporated under the theme of surgical innovation: nurse perception and workflow.

Category 1a. nurse perception. Professional nurses, particularly perioperative nurses, practice at the forefront of rapidly evolving surgical advances and need to adapt to new technology in order to provide safe patient care. Within the category of nurse perception, the participants expressed two main concepts: *better tool* and *being a part of innovation*.

Participants in this study voiced positive views about the incorporation of relatively new robotic surgical technology into their everyday practice. They thought the daVinci surgical robot was a *better tool* for laparoscopic surgery when compared to conventional laparoscopic technique. They commented that the daVinci RALS mimics an open surgical environment by providing better visualization and the flexible wristed instrument that provides the surgeon natural dexterity during operation. One intraoperative nurse stated, “the visualization and they [surgeons] have a better control especially for those bleeders, a greater control for hemostasis.” Others stated, “The ability to have [the] wristed instrument, uh, enables surgeons to reach and do things that [surgeons] wouldn't be able to do with the conventional laparoscopic technique." Another participant noted:

> I feel that it brings the best quality of minimally invasive surgery, uh, to the surgeons' fingertip, uh, allowing them to do things that they would normally do in an open procedure with their hands, to attach that to a laparoscopic instrument and be able to do the same thing with less invasive [procedures].

Many participants were enthusiastic and felt proud of *being a part of the innovation.* They expressed satisfaction even without financial or career recognition by their hospital. One of the participants who had been involved in the expansion of the robotic surgery program in her hospital stated: "Being able to see those improvements over the years - and how far we have come - and how we have perfected this process is really exciting. I am proud to have that legacy." Other participants shared: "I like the challenge of it, I like the option that it gives to our patients, and I like that our patients are able to recover a whole lot quicker." "I was privileged to enter this program [robotic surgery] when it was coming to [name removed] hospital. I was really excited because I like learning new things."

Category 1b. workflow. Adoption of a new technology can be stressful and entails extra job demands. Implementation of RALS into practice has created changes in workflow for perioperative professional nurses. Among the professional nurses in this study, the intraoperative nurses expressed experiencing more challenges regarding how the adoption of robotic surgery affected their work. The CRNAs also expressed perceiving new demands that required changes in anesthesia workflow. Most of the preoperative and postoperative nurses, however, did not feel that robotic surgery had a major effect on their duties. The intraoperative nurses described three types of competencies needed in order to work effectively with RALS: *patient safety/positioning, knowledge of the technology and troubleshooting, and efficiency.*

Positioning was one of the most frequently cited changes in workflow described by intraoperative nurses. Correct positioning and providing support during the operation was important to provide patient safety and prevent injuries. Participants expressed much concern about patient safety and correct patient positioning. “It is incredible. You can really hurt someone if [you] do not position them properly.” Another intraoperative nurse shared:

> I do a lot of positioning prep, and I am meticulous about my patients’ position, I tend to pay really close attention to the hand position, shoulder position. We have done a lot of work to prevent shear.

An intraoperative nurse who was managing the robotic surgical program in a large metropolitan hospital stated:

> The Trendelenburg [position] is difficult for [an] extended time, protecting the patient from shearing and not sliding in bed - particularly in heavy patients. That is quite a task. [The] patient is secured to only four points at the trocar sites, so care must be taken to assure no skin damage [occurs]. The robotic arms must be handled by trained staff so as not to damage the trocar sites while mounting and freeing the robotic arms.

Another intraoperative nurse who was involved since her hospital initiated the RALS commented: “I think that [positioning] was one of our big challenges initially. [It] was figuring out how to keep the patient on the table.”

The intraoperative nurses expressed that *knowledge of the technology* preceded acquiring the competencies needed to be a skilled member of the robotic surgical team. “I have to know a lot more technology related stuff and a lot more troubleshooting than you do in a lot of other cases.” One of the registered nurses first assistants (RNFAs) stated:

> I think it is a very complex technology. You know, you have the responsibility to really be…, oversee all the different ends of that, in other words like any surgical procedure you have to be aware of how the equipment works, you have to be able to troubleshoot if things go wrong, and you have to have working knowledge of the technology, and you also have to have working knowledge of laparoscopic surgical procedures. There are just a lot of different areas that come into play. I think you have to have a very broad working knowledge of a lot of different things.

Another RNFA shared:

> Because I am dodging the robot’s arms and [it] also depends on the surgeon. We have a surgeon - it is like [a] bull in the china shop - arm [robotic arms] swinging. If you don’t pay attention you get hit. I have been hit on the back of my head with the arms when they are swinging.

Adopting a new surgical technology into practice, particularly a surgical method such as daVinci robotic-assisted operations that does not have standard procedure guidelines, requires thoughtful effort to maintain workflow, *streamlining, and efficiency* in order to ensure the best patient outcome. The intraoperative nurses described many strategies including “workarounds” to streamline the process. One of the intraoperative nurses stated:

> Over time you review instrument sets and packs - those types of thing to try to be more efficient and not be wasteful, [such as] how we clean the room. So, there would be certain amount of room cleaning and preparation during turnovers, trying to be more efficient over time…. We also bought a device to help with uterine manipulation to hold the uterine manipulator during hysterectomy. That was because we had some shoulder injuries with the surgical scrub tech. So, we brought a device in to help hold uterine manipulator and keep [the] surgical tech safe.

Another intraoperative nurse shared:

> We basically pioneered our robotic program at [name deleted] hospital…. It was very slow. It was very painful for the staff in terms of time. Sometimes we would do a prostate, it would take eight hours, and we had to convert to open. There was probably a two-year learning curve before we could [get] our instrumentation perfectly streamline [d] and [we perfected] preference cards, positioning, what worked and what did not work.

One of the concerns of two intraoperative nurses was the problem of reducing the turnover time between RALS procedures.

> Our biggest struggle, I am sure, like other institutions, is … get the room cleaned and turned over so [it] is ready for the next patient. So, I think that is what we struggle with is the time factor more than anything else and not the time from the robotic surgery itself, but the time between the cases…particularly with gynecology cases. Uh, there tends to be some splatter, as they pull the uterus out

> from the vagina, [we're] trying to make sure the room is cleaned adequately before we start the next case.

Another intraoperative nurse commented:

> We try [to keep] our turn-over time short…so for urology at least we try to keep it less than 26 minutes…. What we were finding [was] that with robotic cases it takes us a lot longer than 26 minutes because [of] the cleanup and also because we would have to move the equipment. Because with [the] robot depending on what case we do with the robot either it has to be on the right side or the left side.…It takes time to shift the whole room around. So, we were finding that it takes us a lot longer to get the next patient in the room. So, we did have a little bit of issues as far as timing... It has improved, but it still takes longer than 26 minutes.

The CRNAs described some additional work requirements and voiced concern over the steep Trendelenburg positioning, particularly for an extended time, combined with pneumoperitoneum and other comorbidities that patients may experience.

> You have to change the way you ventilate to help them prevent getting atelectasis. Uh, you have to hemodynamically monitor…the compression of the pneumoperitoneum can affect the hemodynamics; blood pressure, heart rate, entire CO2…. You have to be attentive to what is going on.

Other CRNAs commented:

> Laparoscopy always adds a condition of risks with the pneumoperitoneum…. There is a problem with the very sick population. There would be more things that we would be thinking about and creating plans for in our heads and preparation

> for… arterial lines for blood pressure management or have more long-term IV access for those types of cases because they're expected to go [a] longer duration - those sicker populations.
>
> Uh, there are a couple of more things to be more vigilant about, like patient positioning, Uh, making sure that there are no injuries from the robot to the patient - like protecting patient's legs, making sure there is good IV access because [the] robot is attached.

Most of the preoperative and postoperative nurses did not think that RALS itself had created any extra job requirements. They assessed and monitored patients as they typically did for either open or conventional laparoscopic surgeries. However, they expressed concerns over the longer duration of the RALS procedures and the negative effects of longer surgeries on patient recovery. They commented, "No change really, I still recover them as with any surgery, just being aware that usually, their surgery was a little longer than normal." "I don't think it's any different for us for preparation for them [patients] - robotic versus non-robotic." Another nurse commented:

> I feel like sometimes it might be a little bit more challenging due to the duration of the surgery. Someone has been under anesthesia a lot longer than they would have, so they might have a little bit [of] trouble waking up, and I might have to pay a little bit attention to level of sedation or even respiratory status, ventilation.

Another preop nurse, who also provided postop care for day-stay patients, shared:

> I would go, "Oh, my God!" This is going to be hard to recover them because they were in so much pain …. I think it's more comparable now…. I don't know

whether everyone has gotten better, or they've gotten more precise [surgeons] but [RALS] seems to have not as much problem as before.

Theme 2. Interprofessional Practice

The execution of surgical processes requires both collaboration and communication of various healthcare professionals with specific roles and competencies (Espinoza et al., 2016). In order to complete surgical tasks successfully, these health care providers and technicians must work together efficiently. RALS had been adopted into practice without standardization of education or training and without the adoption of accreditation guidelines, which professional organizations propose are imperative for patient safety (Sood et al., 2015). The modern healthcare models emphasize interprofessional education, collaboration, and teamwork in addition to the core competencies that guide team functioning. These factors are required to provide effective and comprehensive patient care (Schmitt, Blue, Aschenbrener, & Vaggiano, 2011). Two main categories within the interprofessional practice theme were drawn from the data: standards and teamwork.

Category 2a. standards. All participants in this study proposed that a uniform standard of *education and practice* for RALS would be beneficial in order to ensure that every patient received the same level of care from providers who met established criteria. Currently, there are no uniform standards for either the education or the practice of surgeons and professional nurses who are involved in performing RALS. The competencies of the surgical team are determined by each individual hospital, and there are variations among these institutional standards (Dulan et al., 2012; Sood et al., 2015). The participants believed that the surgeon's training, skill, and experience with robotic surgery are the most significant, indispensable factors needed for successful robotic surgeries. One PACU nurse shared:

> I definitely think it [robotic surgery] increases the duration, but I think that might be due to the surgeon's lack of experience … but I don't blame it on the robot, I think it is the surgeon that needs more experience.

A CRNA stated: "If you are going to be doing robotic surgery, [you] should have standardized amount of time being taught because there are so many different procedures that you could do with the robot." Other participants shared:

> Having standardized [care] enhanced recovery, having protocols for these types of patients that receive those surgeries [are needed] as far as fluid limitations and restrictions, specific monitoring devices, having something that we use for all standardized cases. I think [we] would benefit so that we [could] truly look at outcomes and know if the protocol [is] making a difference versus none and adjust [accordingly].
>
> It really depends on the practitioner doing the surgery, what the outcome is going to be …. If they have good dexterity and good control over the robot, they can do things quickly, but I am not sure if it takes them eight hours or something that takes them four or five times longer to do with a robot compared to what they did previously. I'm not sure that necessarily is a good thing, because the cost increases, the comorbidity increases.

Generally, following the purchase of the daVinci surgical robot one surgeon and a couple of surgical team members (including the intraoperative nurses) will receive training by Intuitive Surgical in one of their training centers (D. Morgan, RN, CNOR, CRNFA, personal communication, November 16, 2016). The training comprises modules, simulations, hands-on practice with the robot, education about robot components, troubleshooting strategies, and team practice using animal models, typically pigs (Intuitive Surgical, 2018). Surgeons are encouraged to return to daVinci for further training; however, not all professional nurses involved in robotic surgery have the opportunity to go to these training centers. As a result, the training will take place "on the job" through person-to-person communication and during real-time surgeries (Francis, 2006; Putnam, 2016). One of the participants shared:

> But our staff never really ever had hands-on until we had real patients. Surgeons don't really know how to troubleshoot when we got robotic arms that aren't coming in the right ways, you can't get them [to move] here where she wants to get, or he wants to get. Those were the kind of things and glitches that needed to be worked out. I'm sure there is a way to work that out without having the patient on the table or having somebody who is [a] real expert scrubbed in there would be a helpful thing.

One RNFA stated:

> I went there [Intuitive Surgical in California], there was more troubleshooting stuff, and I gained better understanding, and I also got to see how things were built. I'm a kind of interested to know how things are done, and then it makes more sense. So, it was good information that I could bring back to the group. They sent only one of us. I wish they would have sent more of us.

Category 2b. teamwork. Teamwork was cited by many of the participants as being important to RALS. This group of professional nurses noted that teamwork is essential for efficient surgeries and optimal patient outcomes: “Having the people in there who know what is exactly going to happen next in the procedure makes a difference.”

> We are a well-oiled machine for urology. He [the surgeon] tells his patients, “my pet crew will take care of you.” We know exactly what he wants. It is seamless, the patient always says, “where is the robot, and you are the guys who work with him.” We have a great rapport with these patients.

An RNFA shared:

> When I am there, I do suture passing, clip vessels with [a] hemoclip, retraction with laparoscopic instruments, manage the Foley, things like that. I know his routine stone cold in [my] head. I know what he is doing next. So, I am always prepared for passing instruments before he asks because I know what he is doing next. It flows.

Within the category of teamwork, two important topics were drawn from the data: *communication and learning curve*. In the case of RALS, the physical proximity of the surgeon apart from the rest of the team and the patient during surgery makes the surgeon more dependent on the surgical team for gathering information and subsequent decision making (Randell et al., 2015). Therefore, effective *communication* and trust among the surgical team members are crucial. One of the intraoperative nurses commented:

> I think it’s unique because in our case we all learn together. If the surgical tech says, “I see an issue here or maybe we need to go here, or somebody moved the arm this way,” the surgeon is much more open, I think, in these robotic surgery cases than they are in probably any other case right now. It’s just a unique relationship. That way there is a lot of mutual trust. When they’re [surgeon]

> sitting at the console, they have to trust in what we're doing and what we should be doing. If we say go this way or let me move this arm that way, then they've really been trusting in the rest of us in the room.

Another intraoperative nurse commented:

> We drill … with our team to make sure. Ok, if something goes wrong these are the steps that we are going to take. We discuss with [the] surgeon in advance. Are there any critical components that we are doing today that require more focus, or you feel that you might have to convert the procedure, and then we prepare for that. We make sure there is [an] additional gown, so the surgeon can gown back …. Our emergency plan [is] laid out and OR emergency nurses are readily available as well …. We are constantly working with anesthesia to make sure that the patient is doing fine. Uh, in case of laparotomy we have those instruments readily available that we can put our hands on them immediately.

The implementation of any new technology into practice is associated with a learning curve for the users of that technology. Most of the participants in this study had many years of experience working with the daVinci robot and caring for those patients who have robotic surgery. Although all of the participants in this study had attained mastery and completed the *learning curve*, they expressed different experiences when they were undergoing RALS training. It seemed that some participants experienced a learning curve that was not as steep. These nurses perceived that they had more organizational support. They had completed modules, engaged in daVinci simulations, and performed operations on animals. They described engaging in hands-on experiences with the surgical team at the daVinci training centers. Those who were only trained by their colleagues within their institutions reported a steeper learning curve and more difficulty attaining mastery. Two intraoperative nurses commented:

> Sometimes you become overwhelmed with the amount of information, so I remember them talking to us extensively about the need for undock for any position changes, or anything like that …. But until it really happened, I'm not sure it 100% sank in - until that actually happened ….Uh, definitely the more hands-on practice and more simulation kind of training you get the better.
>
> It was stressful because it was so new and docking the robot and taking the robot and undocking, you know it was scary. That was a long time ago, so it [the robot] was not automated, it was a push, pull, heavy robot, so it was very different.

One intraoperative nurse who was managing the robotic surgery program in her hospital and was pleased with her diverse training and educational opportunities shared one of her learning experiences:

> We actually went to [name removed] center. They have a pig lab. They had multiple daVinci units set up. We were actually able to mimic the whole surgical procedure from draping to docking, to assisting intraoperatively, to completing the robotic surgery on pigs. It was very interesting. I had never been a part of that kind of thing before.

Another participant shared:

> Before we start our first case, the entire team went through multiple training sessions. We had mock surgery, a kind of see how the flow goes. We also talked about how to fix [it] if there is a fault in the equipment. We also had the

> representatives of the company. They were with us the first couple of times that we did the cases to help us with the technology part.

Theme 3. Outcome

Surgical innovations are vital to the advancement of practice and patient outcomes. According to the American College of Obstetricians and Gynecologists Committee Opinion (ACOG, 2006, reaffirmed 2018):

> Innovative practice frequently is approached very differently from formal research, which is governed by distinct ethical and regulatory frameworks. Although opinions differ on the distinction between research and innovation practice, the production of generalizable knowledge is one defining characteristic of research. (p. 1)

Healthcare providers must discuss the potential risks and benefits of new surgical innovations with patients and choose the clinical approaches that they presume best serve their patients (ACOG, 2018). RALS has been rapidly adopted into practice without strong clinical evidence for its advantages over existing laparoscopic techniques and its suitability for all types of surgeries (Aarts et al., 2015; Jayne et al., 2017; Jeong et al., 2017; Kho et al., 2013). Within the theme of outcomes two categories resulted from the data: patient outcomes and system outcomes.

Category 3a. patient outcome. Although most of the participants perceived that RALS was an advanced approach to laparoscopic surgery, they questioned its suitability for all patients and for all surgical procedures. Consequently, two main topics within the category of patient outcomes were discussed by the participants; *suitability for all patients and suitability for all surgical procedures.* One of the CRNAs stated:

> There are patients who are not good candidates for being in those positions for a long period of time. We don’t stand on our head all the time. It’s not good for you to be in that steep Trendelenburg position …. Pneumoperitoneum affects your ability to ventilate, can affect the blood gases, the hemodynamic status. Sicker patients don’t manage those changes as well or morbid [ly] obese patients. They don’t manage changes as well and can’t tolerate that.

A PACU nurse stated:

> I would say that positioning can play a factor in our obese population that are being scheduled for robotics; whereas, if we weren’t using robots we would not have to put them in those steep positions, and hyperventilation through the duration of the case can lead to problems postoperatively. So, the robot can add more complications as far as management of the obese population strictly because of positioning versus regular laparoscopy.

One RNFA commented:

> You know, I really become aware of the dangers of Trendelenburg position in any kind of long-term surgery, especially robotic prostectomy patients, because those patients tend to be older men, not all of them are in a really good physical shape. We know that Trendelenburg position increases the intraocular pressure, so I think there is a very serious concern [that] needs to be weighed [to determine if] the benefit of that nerve-sparing approach compared [outweighs] with the potential harm from increased intraocular pressure. Again, it goes back to the surgeon, if the procedure last [s] a very, very long time that increases the potential for intraocular pressure.

The participants collectively believed that robotic-assisted urology procedures, particularly prostectomy, offered improvements in terms of patient outcomes when the duration of surgery was shortened:

> So, again the important part is the timing. If it takes [surgery] all day to do a robotic procedure, and it takes a couple of hours to do it the other way [open] the anesthesia time makes a difference in recovery as well.

A CRNA commented:

> Specifically, I think laparoscopic prostectomy is very much improved. It is really much safer, the visualization and their [surgeons'] ability to work in that small space of [a] man's pelvis. It is significantly enhanced. The blood loss without a doubt [is] much lower, and the recovery time is significantly quicker for those patients.

Two participants discussed the advantage of robotic-assisted prostectomy for nerve and tissue sparing: "The nerve-sparing potential makes that worthwhile … it's going to make a difference in the life of the patient". Another participant stated, "It's only effective in terms of some tissue sparing." Other participant reported the following benefits:

> Best thing on the planet…. So, if you compare one with the other, the open versus robotic, the patients go home in 23 hours versus extended recovery. The average blood loss is maybe somewhere from 50-100 ml as opposed to one liter of blood. Our surgeon is amazing.

The common beliefs are that robotic surgery is an innovation and can produce better results (Ahmad et al., 2017). Some of the participants in this study stated that robotic-assisted hysterectomy provides a better patient outcome when compared to conventional laparoscopic hysterectomy:

> So, they don't have to give a lot of narcotic pain medication post-op. We're having patients come back because they are doing too much because they feel very good … and start doing too much and start bleeding …. So, from that population of patients, the outcomes are great.

Another intraoperative nurse shared:

> I absolutely think that the robot is better. I think the outcome is better, the patient recover [s] a whole lot quicker, for example, I had a coworker who had a surgery. She felt she was ready to come back to work three days after she had robotic surgery [hysterectomy] compared to another friend who had laparoscopic procedure. It took longer to recover.

However, other participants did not see additional benefits in performing robotic-assisted gynecology and did not share the same opinion:

> I wasn't as clear with the gynecology whether the patient received the same benefit [as prostectomy] because you are not so much worried about nerves, nerve sparing, or the need for that.

A CRNA stated:

> For hysterectomies, robotic versus laparoscopic hysterectomies LAVH, I don't know whether there is a huge benefit. I think for certain kinds of things, like if you have horrible adhesions …. In the immediate postop period, I don't see a big difference … our doctors say the patients get out a little bit earlier and they have less pain, uh, there might be small improvement there.

One postoperative nurse commented: “I think it’s extremely helpful - more so for hysterectomies and the prostectomies, in my opinion.” When the same participant was asked how these patients recover, she stated: “I don’t know about further out - may be their recovery is quicker, but their immediate wake up from anesthesia I would say it take [s] a little bit longer than somebody that had laparoscopic surgery.”

Five participants shared the newly adopted Enhanced Recovery after Surgery (ERAS) protocol at their hospitals for pain management following robotic-assisted hysterectomy. The ERAS proposes that administration of particular medications by mouth and intravenously (IV) before surgery facilitates pain management and postoperative recovery. These medications included: Gabapentin (Neurontin), Celecoxib (Celebrex), Cetirizine (Zyrtec), Pepcid (famotidine) IV, and Scopolamine patch.

Some of the participants did not perceive that the robotic surgical procedure was as efficient as similar laparoscopic procedures for general surgeries. “I don’t think it’s [robotic surgery has] much more advantage from laparoscopic gallbladder surgery.” A CRNA stated:

> I’ve seen a lot of just general laparoscopy for hernias and lap cholies, and honestly timewise as far as cost to the patient [and] duration of time intraoperatively, the robot adds more time, so to me it doesn’t seem cost effective for the marginal benefit of minimal incision, or what they think robotics can do.

One of the postoperative nurses commented about the pain level after robotic-assisted hernia repair: “The initial coming back for the hernias, they are in more discomfort because [there] may be more gas, I don’t know, but they are in more discomfort immediately after the surgery than the laparoscopic." Another intraoperative nurse commented:

> It does not pay to do a gallbladder on a robot. It is just the way it is still running … For example, doing cholecystectomy laparoscopically was the stepping stone … to the hernia repair or bowel resection …. You know, I think it is grossly still running efficiently doing laparoscopic. We got surgeons that can do lap-chole in 30 minutes. It is silly to put them through the paces of the robot and spend all that money, and the patient is on the table a little longer.

Another CRNA shared her experience with using daVinci robot for thyroidectomy and harvesting saphenous veins for coronary bypass surgeries:

> They also did robotic thyroidectomy, but they realized that there is no benefit in doing it robotically versus open. The only robotic procedure that I've done, and I found pretty, uh, I don't wanna say silly uh, was robotic harvesting of the veins for coronary bypass surgery …. To me, it was very wasteful. It added a lot of time. It took three hours to harvest this vein - whereas if you do it standard it would take 45 minutes. So, it added unnecessary anesthesia time.

Category 3b. system outcome. The daVinci robotic-assisted surgical procedures have disseminated widely into practice, particularly in the United States. This rapid uptake by hospitals has affected how the system operates. Within the category of system outcomes, two topics were emerged from the data: *implications of rapid adoption and outcome improvement.*

Robotic surgery has been extensively marketed to physicians, hospitals, and even directly to patients. Hospitals have adopted this technology to gain market share and safeguard their financial status (Wright et al., 2016). The rapid adoption naturally entails unintended consequences. First, innovative surgical devices do not go through the same level of scrutiny by the FDA as new medications (Paul et al., 2013; Wright, 2017). Second, the education, training, and practice of RALS are not standardized. Two of the intraoperative nurses commented on their hospital, where they perceived that surgeons promoted the use of surgical robot: “All surgeons want to push robotics constantly.”

> I would think the hospital purchases the robot and would want it utilized as often as possible. I'm not sure how you could justify a robotic gallbladder and hernia if there are larger and more complex surgical procedures that could be done utilizing this technology.

A CRNS shared:

> There have been complications and problems arising … related to air getting trapped in between the trocar and the fascia layers and actually creating subcutaneous emphysema …. I think that risk is complicated by robotics more so than just general laparoscopy for gynecology.

Another intraoperative nurse commented:

> I think for the patient when we initially started the program and we were doing first cases, probably there was increased risk to the patient robotically. Maybe the surgeon [s’] first 100 cases as they became more skilled and comfortable. We had a couple of patients that ended up in intensive care from injuries that were not discovered initially…but now it’s been a long time. We don’t have any of that.

A PACU nurse shared: “The most adverse issues I’ve seen … is facial swelling, orbital swelling, and pain in thigh.” One of the RNFAs commented on the large size of the robot and the many attached wires:

> The robots are very, very large…. There needs to be some discussion of cleaning and disinfection of the equipment because there are so many cords, so many different pieces, large cumbersome pieces, and we drape the robot but there are parts of it still that are exposed, and I think it is very important that we do environmental cleaning to keep our ORs clean and our patients safe.

Two of the intraoperative participants shared their difficulties with their administration:

> There were some challenges with the leadership to understand that we could be more efficient…. If you’re doing a case that take [s] 3.5 hours there is a lot of running, and it takes two nurses to do, and then you’re going to take a lunch break, and then the other one take [s] lunch break during the next case. So, we found we could continue to be efficient if we had two circulating and one scrub nurse in each case. Especially when you’re doing [a] hysterectomy, [which] may be 1.5 hours long. It’s very labor intensive at the beginning and at the end and the time in the middle got shorter and shorter, so it helps to do those cases quickly.

Another intraoperative nurse shared, “I can tell you whenever we first started … to do robotics, like I said we encountered a lot of resistance administratively, the staff had a lot of fears about it.”

Participants perceived robotic surgery as the next phase in surgical techniques. These professional nurses predicted that robotic surgery will become common during the coming decades and suggested ways for *outcome improvement*. All participants believed that working efficiently as a team is essential in robotic surgery: All participants believed that working efficiently as a team is essential in robotic surgery:

> We always try to be efficient …. So, the anesthesia is minimized, the time in the operating room is minimized …. Being efficient in every aspect from setting up and working as a team. I think the team concept is the most important part.

One of the nurse specialists suggested insufflation of the abdomen with warm, humid CO2 to facilitate tissue healing, reduce postoperative hypothermia, decrease shoulder pain, and lessen the inflammatory response. “I think providing heat and moisture to the tissue would help with the healing process because the insufflation of the abdomen with dry cool air can lead to dissection of the tissue over a very short time.” Another participant shared:

> I think continuing education and monitoring competencies and the number of cases per year and also the follow-ups if there is a negative outcome. I think it is extremely important for the staff to be informed if there is a positioning error, there is a complication postoperatively because a lot of times we don’t know that information, and so in order to improve patient outcome [s] you need to have that communication so that everyone can learn.

One RNFA commented:

> Well, I think that it could be improved by having patients that are going to be in that Trendelenburg position who are at risk for intraocular pressure increase. All patients are at risk, but obviously, those patients who are older, obese, have comorbidities like glaucoma, cardiac, or respiratory condition. I think those patients really need to be screened. I think it would be good for those patients

> have [an] ophthalmological exam before the procedure and be cleared by an ophthalmologist. That would definitely improve the care for those patients so that we are using technology appropriately…. Ultimately the surgeon does have the control, but we need to be aware of the potential harms that can occur, and I think our responsibility is to raise the issues so that the anesthesia professional and the surgeon can make the best decision for the patient…. For example, for glaucoma patient you want to … raise that concern.

Other participants commented: “Folks coming in giving breaks to [an] individual, you have to be careful, have enough education and training that can fill that role. I think the supplies are hugely expensive.” A few participants recommended patient education prior to surgery to prevent unrealistic expectations. They suggested developing educational materials and videos. Other recommendations were: “Because we know that organisms can live for days …. [We must ensure correct] cleaning of the equipment and how that should be done so that we know it [OR] is cleaned for the next patient.”

Summary

The purpose of this chapter was to report the findings of this research study. Seventeen professional nurses involved in RALS were interviewed. Sixteen interview questions facilitated gathering information about this phenomenon. Among the interview questions two did not yield meaningful data for analysis. One was the impact of RALS on the nurse-patient relationship, and the other one was the experience required for a nurse to be good at RALS. The participants commented that the nurse-patient relationship has not been affected by RALS. The participants were hesitant to provide a definitive answer as to how many procedures or how long it would take to be proficient at RALS. They provided answers ranging from 5 to 100 procedures or 2 to 3 consecutive weeks. They also thought that interruptions in performing RALS are not productive in maintaining their skills. Other questions yielded a rich descriptive summary of the participants' perceptions and experiences with RALS. Three major themes and six categories emerged from the data.

Theme 1. Surgical innovation

Category 1. Nurse perception

Category 2. Workflow

Theme 2. Interprofessional practice

Category 1. Standards

Category 2. Teamwork

Theme 3. Outcome

Category 1. Patient outcomes

Category 2. System outcomes

The participants expressed positive views about the incorporation of innovative RALS procedures into daily practice and believed this novel technique provided a better tool for surgeons. The superiority of the robotic technique over standard procedures varied depending upon the procedure being done and the patient comorbidities. Participants wished to be a part of this innovation, even though being a member of the RALS team involved additional demands and changes in daily work. They also perceived that there were additional demands inherent in the use of RALS. These included the need to become knowledgeable about the technology, patient positioning requirements, more intraoperative interventions, and the necessity for streamlining the surgical procedures. All the above were needed in to optimize patient outcomes.

The participants believed that successful robotic surgery procedures required interprofessional cooperation and teamwork. They noted that successful teamwork is contingent upon the expertise of team members, particularly the surgeon. Participants suggested that uniform standardization of education and practice for the surgical team should be implemented. They believed the team learning concept is essential in robotic surgery. Having the opportunity to learn as a team, engage in mock surgeries on pigs, practice simulations, and roleplay troubleshooting facilitated learning and subsequent performance of efficient robotic surgeries. Although RALS was perceived as an advanced approach to laparoscopic surgery that contributed to improve patient outcome for some surgical procedures, participants questioned the suitability of RALS for all types of patients and procedures. They believed that patient comorbidities, namely morbid obesity, respiratory, and visual problems should be taken into consideration when selecting patients for these surgical procedures. They reported the rapid adoption of daVinci RALS has been accompanied with unintended consequences, which included an increased risk of injury for both patients and staff members. The CRNAs and some of the perioperative nurses expressed concern about having patients in steep Trendelenburg positioning and with the accompanying pneumoperitoneum for an extended time during these types of surgeries. They offered practical suggestions related to ways to improve RALS.

CHAPTER V

DISCUSSION

Introduction

The rapid adoption of robotic-assisted surgery has transformed minimally invasive surgery, and, as a result, has altered the responsibilities of perioperative nurses and impacted subsequent patient outcomes. The purpose of this study was to explore perioperative professional nurses' perceptions and experiences with the newly-adopted daVinci robotic-assisted laparoscopic surgery (RALS) procedures using a qualitative descriptive methodology. This study was performed to fill the gap in the existing literature and give a voice to perioperative nurses involved in the care of patients having RALS. Perioperative nurses are vital to the functioning of the surgical team, the provision of a safe patient care, and the optimal utilization of surgical resources.

Chapter V presents the findings of the qualitative descriptive research study described in this dissertation, compares these finding with current scientific evidence, and relates these findings to the initial conceptual framework. This chapter concludes with the implications of this study for nursing practice, education, theory development, and recommendations for future studies.

Summary of the Findings

The main findings of this study suggest that professional nurses maintained optimistic attitudes towards incorporating the innovative and complex RALS procedures into their daily practice, and they proposed that RALS has the potential to improve patient outcomes. Participants reported that RALS had the most effect on the workflow of intraoperative nurses. RALS also created new demands on the duties of Certified Registered Nurse Anesthetists (CRNAs), as they provide care to these patients. Participants also reported that RALS had the least effect on the work of preoperative and postoperative nurses.

Increased responsibilities of intraoperative nurses included the need to (a) acquire new technological knowledge; (b) be aware of threats to patient safety, particularly related to patient positioning (c) learn how to troubleshoot problems with the equipment; (d) streamline workflow to increase efficient operating-room turnover between surgeries; and (e) remain vigilant for the additional intraoperative interventions. Perioperative nurses proposed that in order to be more successful RALS implementation should involve standardization of both the education and the interdisciplinary practice of surgical team members. They also reported that RALS team communication, team learning, and the work of every surgical team member is important. RALS implementation and the required changes in workflow were most pronounced for surgeons, intraoperative nurses, and CRNAs.

Despite the rapid adoption of the RALS and efforts to increase the number of these types of surgeries, professional nurses reported that its applicability for all types of patients and procedures is questionable. RALS is an advanced approach to laparoscopic surgery with reported benefits. Nevertheless, RALS proponents convey the misconception that RALS itself can automatically produce better patient outcomes. The surgical robot adds a layer of risk that is inherent to the technology, and this innovation is only a tool that is as good as the skill of the surgeon and the support provided by the surgical team.

Relationship to Previous Research

Previous research focusing on the experience of the perioperative professional nurses with RALS is limited with only one study cited in the literature. Kang et al. (2016) reported on challenges that South Korean intraoperative nurses encountered as RALS was implemented in Korean hospitals. Consistent with the findings of this research, Kang et al. stated that Korean nurses expressed pride at being part of surgical innovation. However, these Korean nurses also reported that they felt burdened by the necessity of being on the robotic surgical team. These feelings of "being burdened" originated from their perceptions of increased responsibilities related to handling expensive robotic equipment, the constant fear of robot malfunctions, lack of education about RALS, and insufficient opportunities to network with other RALS providers. In addition, these Korean intraoperative nurse respondents tended to have fewer years of experience with RALS compared to the U.S. intraoperative nurses sampled in this study. One explanation for the increased comfort with RALS reported by the intraoperative nurses in the present study would be the U.S. nurses were more experienced with the technology.

Unlike the present study, Kang et al. only included intraoperative nurses. The present study included four classifications of professional nurses involved with RALS: preoperative nurses, postoperative nurses, intraoperative nurses, and those CRNAs who usually provide anesthesia care for RALS patients. Three overarching themes and six categories emerged from interviewing professional nurse participants:

- Surgical innovation: Nurse perception and workflow
- Interprofessional practice: Standards and teamwork
- Outcomes: Patient outcomes and system outcomes

The section below relates the emergence of these three themes within the context of current theoretical perspectives of each theme and category, which enrich the understanding of each theme. The findings of this research are then related to the initial conceptual framework, *Determinants of Innovation Within Healthcare Organizations.*

Surgical Innovation

The number of medical and surgical innovations introduced into the health care system has accelerated during the last two decades (PharmaJet ®, 2018). A common perception of technology among health care professionals is that innovative technological interventions would improve the quality of patient care and subsequent patient outcomes. Nevertheless, many innovations in health care fail to be accepted and do not ever diffuse into the provider practice. Ongoing investigations have attempted to determine how and why an innovation is accepted and used (or not) in the health care arena, focusing on the characteristics of the environment, the end users, and the particular technology (Nilsen, 2015).

Rogers's Diffusion of Innovation theory is one model that has been widely accepted as a guide to how innovation permeates society. This theory suggests that the human capital investment is one of the most important factors affecting the adoption of innovation (Rogers, 1962). Rogers further classified the temporal characteristics of adopters into four categories: (a) early adopters, (b) early majority, (c) late adopters, and (d) laggards (Rogers, 1962). To expand upon the previous research about intraoperative nurse perception, Kang et al. noted that the Korean nurses sampled reported RALS experience that ranged from 8 months to 6 years. In the present study, U.S. nurses reported 2 to 16 years of experience working with RALS. From the perspective of Rogers' theoretical propositions about time, the perioperative nurses in both studies were in different stages of adoption, which would affect their perceptions and experiences of adopting this innovation. The positive attitudes of U.S. nurses towards RALS would provide support of Roger's theory, as would the time needed to incorporate needed workflow changes into daily practice. Rogers also addressed the context of the social system affecting the diffusion of an innovation, which would provide an additional explanation for differences in the perceptions of intraoperative Korean nurses when compared to those from the United States. The Korean nurses experience occurs in a different cultural context than that of the U.S. nurse experience.

The concept of human capital and its importance was further verified by implementation theories. These theories propose that successful adoption of innovation entails the input of the adopters in the innovation process (de Veer et al., 2011; Sharifian et al., 2014). In this study, none of the perioperative nurses were involved in the decisions related to the purchase of RALS equipment for their hospitals, although they were involved with subsequent implementation of the technology.

Nurse perception. The participants expressed positive attitudes about adopting the robotic surgical innovation into daily practice. This optimism toward RALS was pervasive, despite the additional work requirements and new challenges that RALS added to intraoperative workflow activities, as described in the section on workflow. These nurse participants embraced technological development without financial compensation or opportunities for professional recognition or promotion. Their drive was based on their personal interest in innovation to improve patient outcomes and the desire to support their surgical team members. “I like the challenge of it [robotic surgery], I like the option that it gives to our patients, and I like the fact that our patients are able to recover a whole lot quicker.”

This phenomenon of embracing new technology expressed by professional intraoperative nurses contradicts the observations of neuroscience and change theories, which propose that the first human response to innovation or change is resistance (Dibrov, 2015; Hwang, 2013; Langley, 2012; Kritsonis, 2004-2005). Nevertheless, innovations are often derived from the perceived need for improvement of the current status. In 1519, William Horman in his book *Vulgaris* stated, “Mater artium necessitas” [(necessity is the mother of invention), Horman, 1519]. In this case, the limitations of the conventional laparoscopic technique, the difficulties with the task of hand-and-eye coordination needed to manipulate the surgical arms, and the limited visualization of the surgical field through the two-dimensional video monitor drove the initiatives to create better surgical tools. The participants noted that the daVinci surgical robot provided surgeons with a superior tool that had potential to facilitate better patient outcomes.

These perioperative nurse respondents were concerned about patient welfare, and the possibility of improving patient outcomes drove their desire to be a part of the implementation of this innovation. The participants in this study collectively believed that robotic-assisted prostectomy produced much better patient outcomes as evidenced by decreased blood loss, shorter hospitalization, preservation of neural functioning, and an improved quality of life after surgery.

Workflow. Workflow is defined as a set of tasks and activities needed to accomplish a common goal (Cain & Haque, 2008). In the operating room completion of the surgical tasks require the coordination of "a number of professionals who understand their own roles and responsibilities, as well as those of the team." (Espinoza et al., 2016, p.189). In the present study, the specific changes needed to work with RALS were most pronounced for those who were in the actual operating room: intraoperative nurses and CRNAs. This change in role and work has been well documented in the literature (Brooks, 2015; Christie, 2014; Gupta et al., 2012; Kaye et al., 2013; Lee, 2014; Molloy, 2011; Raheem et al., 2017; Thomas, 2011). The added responsibilities included the need to be extremely careful to ensure safe patient positioning during the surgery, acquisition of knowledge about the technology, and the ability to troubleshoot equipment problems. The CRNA's change in work included an emphasis on keeping the patient hemodynamically stable while the patient was in steep Trendelenburg position - sometimes for many hours.

> "You have to change the way you ventilate to help them [patients] prevent getting atelectasis, uh, you have to hemodynamically monitor, it depends on the ventilation. If pneumoperitoneum changes, your ventilation would change. You have to be attentive to that. The compression of the pneumoperitoneum can affect the hemodynamics: blood pressure, heart rate, the entire CO2."

A concern of intraoperative nurses was the effect of RALS on surgical workflow, with an emphasis on the longer turnover time between robotic surgeries. One nurse noted that, "I think for our institution, the only thing that we can improve upon is the turnover time, probably to get the patient back to the OR quicker, so there is less waiting time for the subsequent patient."

The timing related to RALS and effective operating suite use is a subject of debate among surgical staff members (OrNurseLink, June 19, 2018; September 30, 2018, November 21, 2018). Intraoperative nurses are pressured to reduce the turnover time between procedures, which would increase operating room utilization and, ultimately, increase subsequent revenues. Intraoperative nurses have to change the location of the robot and its accessories for each type of robotic surgery, as well as ensue that the operating room is properly cleaned, and patient-specific data are collected. The intraoperative nurse respondents reported that they actively planned and implemented methods to increase efficiency and provide rapid turnover following RALS procedures.

The preoperative nurses did not express any change in their workflow and responsibilities. Thus, the data did not support the assumption of extra responsibilities that was originally proposed for this group of perioperative nurses. This assumption was based on the competency guidelines developed by the Association of PeriOperative Registered Nurses' for preoperative nurses and recommendations for patient safety (AORN, 2016a; AORN, 2017). Thus, nurse perception of the change in work to care for patients experiencing RALS related directly to changes in workflow and the duties associated with each of the perioperative nursing roles, which varied among preoperative, intraoperative, postoperative nurses and CRNAs.

Interprofessional Practice

The change in population demographics and the increasing complexity of health care demands and services necessitate greater collaboration among health care providers (Nowak, Jung, Schäfer, & Reif, 2016). The measurement of quality of care in the current health care environment has moved from volume-based care to patient-centered, value-based care. This movement, which was initiated by the Affordable Care Act (ACA), emphasizes the provision of comprehensive health services to patients through collaboration of multiple health care providers to deliver quality care (Nester, 2016). The successful completion of surgical tasks, particularly in RALS, is highly dependent on the collaboration and communication of various healthcare professionals who are competent in their specific roles (Espinoza et al., 2016). One intraoperative nurse shared:

> The hospital I work in across the board we have a good communication with our surgeons. We talk to them if there is something new going on or anything special, or they come to us and say on this next case I need this because …and we are prepared. So, it facilitates the whole process. So, I think it is very important in robotics when that happens.

Competency through interprofessional teamwork requires education and practice. Currently, there is a lack of standardization of education and practice of surgeons and professional nurses involved in performing RALS.

Standards. The standards of education and practice for health care providers aim to protect the public from harm (Bahler & Sundaram, 2014). While standardization in all aspects of modern life promotes a culture of safety and reliability, the creation and enforcement of standardized competencies and the education needed to achieve these competencies has received little attention in the health care delivery system when compared to other industries. Other high-risk industries, such as the automotive, aviation, and the nuclear industry, rely on standardization of the process to ensure public safety. Nevertheless, the health care system has not followed the same path (Hanscom, 2018). The participants in this study expressed the need for unified interprofessional education for surgeons and nurses involved in RALS. Standardized educational processes would facilitate efficient surgeries and optimal patient outcomes, “I am 100% for standardization. The surgeons and nurses get trained together as a team.” The need for standardization of education/practice for surgeons and nurses in RALS has been discussed in several scholarly venues (Dulan et al., 2012; Putnam, 2016; Sood et al., 2015; Walters & Eley, 2011).

Currently, each individual hospital determines the level of education and practice of the health care practitioners involved in RALS (Sood et al., 2015). The FDA performed a survey inquiring about the surgeons’ experience with the daVinci surgical robot. The surgeons reported different training experiences. Examples of educational experiences included (a) three to eight hours of online training, (b) simulation training for system set-up and surgeries, (c) practice operations on dogs and pigs, and (d) coaching by a proctor for three to five cases. Educational experiences and training varied among different hospitals. Some hospitals implemented comprehensive team-focused training, and some hospitals relied totally on each surgeon’s personal decision regarding how much education and practice were required (FDA, 2013). The daVinci manufacturer encouraged surgeons to return to one of the daVinci epicenters for further training. Hospitals and the manufacturer were not as concerned about the training of nurses who work with the surgeon to complete the robotic surgeries. As a result, not all professional nurses involved in robotic surgery have the opportunity to go to the training centers for education. Training often occurred "on the job" through person-to-person communication and during real-time surgeries.

> …it's more on the job [training] just like any new cases where sometimes whoever in the room with you does the training. They [hospital] have expectations [for the nurses] to do online modules, but it's not standardized as it was initially.

"On the job" training was particularly stressful for professional nurses, who were primarily concerned about the welfare of the individual patient and anxious about their perceived personal knowledge or skill deficits. These nurses reported that without the identification of standard clinical competencies, "on the job" training did not guarantee efficient surgeries. Furthermore, the new models of education for health care providers recommend interprofessional education and learning programs of the healthcare team in order to achieve high levels of clinical competency and the best patient outcomes (Nowak et al., 2016).

Teamwork. Effective teamwork, communication, and situation awareness during RALS have been a topic of research during the last few years (Corrigan, 2014; Cabral et al., 2016; Gill & Randell, 2017; Schiff et al., 2016). Randell et al. (2015), in a qualitative study, interviewed 44 operating room personnel with the aim of exploring how the surgeon's physical distance from the rest of the team and the patient during RALS affected decision-making process. The authors concluded that the surgeons in RALS are more dependent on the surgical team for gathering information and subsequent decision-making process than with other types of surgeries. Thus, effective communication among the team members and trust in each other's expertise is crucial for timely acquisition of information about the patient and the status of the robot. The data obtained from this study confirmed the importance of teamwork and communication during RALS:

> I think it's unique because in our case we all learn together. If the surgical tech says, "I see an issue here or maybe we need to go here," or somebody moved the arm this way, the surgeon is much more open, I think, in these robotic surgery cases than they are in probably any other case right now. It's just a unique relationship that way. There is a lot of mutual trust. When they're [the surgeon] sitting at the console, they have to trust in what we're doing and what we should be doing. If we say, "Go this way," or "Let me move this arm that way." [then the surgeon follows the suggestion], then they've really been trusting the rest of us in the room.

Typically, the surgical team includes the surgeon, the anesthesia administrator, the circulating nurse, and the scrub nurse. In the case of RALS, the physician who conducts the surgery is positioned at a console away from the operating table and the rest of the OR team. Therefore, the surgeon needs a bedside assistant who acts as the surgeon's link to the patient for entering and removing different types of robotic instruments from the surgical field. The duties of the bedside assistant include irrigation, suctioning, retraction, removing the specimen, suturing, and any other assistance that the surgeon may require (Yuh, 2013). During RALS, the surgeon works synergistically with the bedside assistant to complete the surgery. Depending on the type of facility the bedside assistant may be another physician, a Registered Nurse first assistant (RNFA), or a physician assistant (Yuh, 2013).

> When I am there, I do suture passing, clip vessels with [the] hemoclip, retraction with laparoscopic instruments, manage the Foley, things like that. I know his [the surgeon's] routine stone cold in [my] head. I know what he is doing next. So, I am always prepared for passing instruments before he [the surgeon] asks because I know what he is doing next. It flows.

Due to the rising cost and reimbursement pressure, sometimes a scrub nurse performs the role of a bedside assistant (Personal observations of RALS, February 8, 2018; May 28, 2018). This practice may have negative patient implications and, ultimately, may not be cost-effective. The robotic supplies are costly. Thus, having knowledge of each instrument's functions and the associated costs of instruments and supplies is required for effective resource stewardship. Several studies by perioperative nurses recommend designating a robotic nurse specialist as the manager and coordinator of the robotic surgery program (Francis, 2006; Thomas, 2011; van Brenk, 2009). The nurse specialist would work with the surgeons to perform several functions: (a) create preference cards and checklists, (b) order and supervise the use of the robotic supplies, (c) educate and train team members, and (d) schedule robotic surgeries effectively (Francis, 2006; van Brenk, 2009). Stewardship of operating room supplies, and effective scheduling would be positive measurable outcomes related to the appointment of a designated robotic nurse coordinator.

A common theme of RALS implementation was the professional nurse perception that there was an initial steep learning curve for staff members who joined the robotic surgical team. Those intraoperative nurses who had the opportunity to learn as a team at one of the daVinci epicenters and engage in mock surgeries and simulations had a positive experience. Those nurses who were trained by their colleagues at their hospitals without participating in standardized learning experiences perceived that the initial learning required for RALS nurses was difficult and problematic. They felt as if they had to acquire RALS-specific knowledge and skills in isolation without knowing what was needed to be clinically competent. Both the steep learning curve associated with implementation of RALS and strategies for facilitating the learning process (e.g., completing modules, product training, clinical training, team participation in mock surgeries on animals, and RALS simulation) have been supported in the literature (Sridhar, Briggs, Kelly, & Nathan, 2017; Lichosik et al., 2013).

Outcomes

Two major categories emerged from the theme outcome in this study: patient outcomes and system outcomes. The World Health Organization (WHO) defined health outcomes as, "A change in the health of an individual, group or population that is attributable to a planned intervention or series of interventions" (WHO, 1998). Measuring health outcomes is inherently complex; nevertheless, this measurement provides an indication of the relative benefits or harms associated with the intervention. The goal is to improve the health of individuals and populations, improve the experience associated with healthcare, and to reduce cost of healthcare (Tinker, 2018). Two major categories emerged from the theme *outcome* in this study: *patient outcomes* and *system outcomes*.

Patient outcomes. The U. S. system of healthcare payments/reimbursements has shifted towards focusing on patient-centered outcomes. As a result, the Center for Medicare and Medicaid Services (CMS) has instituted many measures based on the quality of care provided to patients (CMS, 2018; Duncan, Jacobs, Christensen, Nunley, & Macaulay, 2017; Sung-Heui, 2016). One of the most cited models for evaluation of the quality of health care services is the Donabedian quality assessment model. Donabedian proposed that the quality of healthcare could be assessed through its *structure*, *process*, and *outcomes* (Donabedian, 1988). The structure is defined as the attributes of the setting where health care services are offered (e.g., hospitals, finance, equipment, health care providers, characteristics of providers). Process refers to the interaction of the healthcare providers and patients. Outcome is the product of the structure and process and denotes the effects of health care on the patient (Donabedian, 1988).

There exists a plethora of contradictory evidence on the efficacy of RALS in comparison to conventional laparoscopic surgery (CLS) on patient outcomes (Anger et al., 2014; Gala et al., 2014; Han et al., 2018; Jayne et al., 2017; Jeong et al., 2017; Macias, Jacome, & Punshon, 2017; Sarlos et al., 2012; Walker et al., 2018; Wright et al., 2013). Nevertheless, research studies indicate that when a skilled surgeon and competent surgical team performed RALS, the potential for better patient outcomes for complicated cases is increased (Lim et al., 2016; Mäenpää et al., 2016; Sinha et al., 2015). This was reflected in the participants' views. "Some of the things like endometriosis, you can see better [such as] the small details with the robot. Whether it is necessary for all procedures is questionable."

The participants in this study believed that robotic surgery produced better patient outcomes for prostectomies. These professional nurses questioned the efficacy of RALS for all types of gynecologic and general surgery cases. There were concerns over the longer duration of RALS and its impact on the patient's biological status during and after the surgery. "If the surgical time becomes shorter, the recovery becomes faster. Then it [robotic surgery] can be beneficial." This concern has been reported in many research articles (Borahay et al., 2013; Gupta et al., 2012; Kaye et al., 2013; Lowenstein, et al., 2014; Molloy, 2011; Paraiso et al., 2013). Nevertheless, in this study, participants reported that the longer duration of RALS procedures, which was associated with the steep learning curve needed for the surgical team to become competent with the robot, was perceived to be remediated as the surgeon and surgical team gained experience with RALS surgeries and learned to work together effectively as a team.

Patients rely on health care providers for advice and assistance to make an informed decision about their surgical choices. The choice of the surgery should be based on the patient's characteristics and the surgeon's competency level (ACOG, 2015, 2018; Smorgick, 2017). Novel medical and surgical equipment updates are constantly being introduced into practice that "may or may not receive formal research protocols" (ACOG, 2018, p.1). In the case of daVinci RALS and the manufacturer's extensive advertisement campaigns, the evaluation of this surgical technique is occurring after its wide spread adoption in the majority of U.S. hospitals.

Currently, there is little strong clinical evidence supporting the superiority of daVinci RALS over the conventional laparoscopic surgery (CLS) for all types of surgeries, especially considering the high cost of robotic procedures (Ahmad et al., 2017;

Gala et al., 2014; Nevis et al. 2016; Park et al., 2017; Yun et al., 2018). The professional nurse participants of this study expressed mixed views about the efficacy of RALS for all types of gynecologic and general surgeries, particularly taking into account possible patient comorbidities. Thus, these professional nurse respondents expressed the opinion that more clinical evidence is needed to assure that RALS is superior to CLS for all patients and conditions.

Systems outcomes. The cost of acquisition of the daVinci surgical robot for hospitals averages $2 million per unit plus an annual maintenance fee of about $150,000 (MIT Technology Review, 2017). Robotic supplies are complex and costly. The reimbursement for RALS is determined by the routine CLS charges per Current Procedural Terminology (CPT) codes. The majority of the additional cost associated with RALS is absorbed by hospitals (AAPC, 2017; Wright, 2017). Nevertheless, hospitals try to offset the extra cost by increasing volume, which may not be indicated for all patients and all conditions (Wright et al., 2016).

Additionally, the hospitals are charged with examining the patterns of negative consequences, determining root causes, and implementing remediation and preventative measures for any untoward events. There are reports of unintended consequences after the adoption of RALS, including a pattern related to patient injuries (Alemzadeh et al., 2016; Cooper et al., 2015; Kirkpatrick & LaGrange, 2016). This theme also emerged from the data collected in this study. These professional nurses described patient injury incidents that were associated with RALS. One participant reported the need to transfer patients to the intensive care unit due to unintended injuries during the robotic surgery operations.

Alemzadeh et al. reported that between the years 2000 to 2013, there were 10,624 adverse events associated with RALS. Among these injuries 75 % were related to device malfunctions and defects. Some of the reported injuries included patient burns or damage from broken pieces of instruments falling into the patient's body (Alemzadeh et al., 2016). In May 2018, the FDA issued a safety communication report addressed to operating room personnel: surgeons, anesthesia administrators, and nurses that warned about the risk of surgical fires on or near the patient experiencing RALS (FDA, 2018). Intraoperative nurses are charged with checking the safety and integrity of the robotic instruments. Additionally, both the number and the complexity of surgical devices used in the modern operating room environment are rapidly increasing (Espinoza et al., 2016). Thus, adequate education regarding the technology and robotic supplies is warranted for nurses.

Another source of injury is the possibility of postoperative infection due to bacterial contamination of robotic equipment. Saito, Yasuhara, Murakoshi, and Komatsu (2017) measured the number of residual contaminants on surgical instruments immediately after the surgery and after cleaning. Unfortunately, robotic instruments carried the highest number of residual contaminants. This data indicated that the robotic instruments might need different approaches rather than standard cleaning because of the complex structure of robot parts. Patient injuries, surgical fires on or near the patient, and contaminated equipment are now reported as some of the unintended consequences of RALS. These consequences create another level of challenge for intraoperative nurses.

The perioperative professional nurses provided many suggestions to improve patient outcomes of RALSs. These suggestions included team-learning educational experiences and designating a specialized team for one type of robotic surgery that would always work together for these particular procedures. Professional nurse participants recommended the insufflation of the abdomen with warm, humid CO2 to facilitate tissue healing, reduce postoperative hypothermia, decrease shoulder pain, and lessen the inflammatory response. Other suggestions were to implement continuing education for surgeons and nurses and to monitor RALS competencies, including the number of cases performed per year. Participants also reported a lack communication after the patient leaves the surgical suite. The RALS team members should be informed about postoperative complications in order to learn from mistakes and prevent future adverse events. Another recommendation promoting patient safety was for elderly individuals to have an ophthalmic exam before robotic-assisted prostectomy to make certain that intraocular pressure was not increased prior to surgery.

Nursing research addressing robotic surgery is limited to commentary and literature reviews. This qualitative research study provided rich grounding information for nursing science in the area of research, education, practice, and theory development.

The Relevance of the Conceptual Framework

A modified conceptual framework derived from the *Determinants of Innovation Within Healthcare Organizations* (DIHO) by Fleuren et al. (2004) formed the initial conceptualization for this study (Figure 4). The purpose of the DIHO is to assist healthcare researchers and administrators with the systematic implementation of new technologies into practice and further exploration of the impeding and/or enhancing factors affecting implementation of new technology into health care systems (de Veer et al., 2011). The DIHO is composed of four main components (figure 4): (a) characteristics of the innovation, (b) characteristics of the adopting person, (c) characteristics of the organization, and (d) characteristics of the socio-political context. These factors impact the adoption of an innovation into practice. In the following section, the elements that emerged from the data from the respondents of this research study will be discussed.

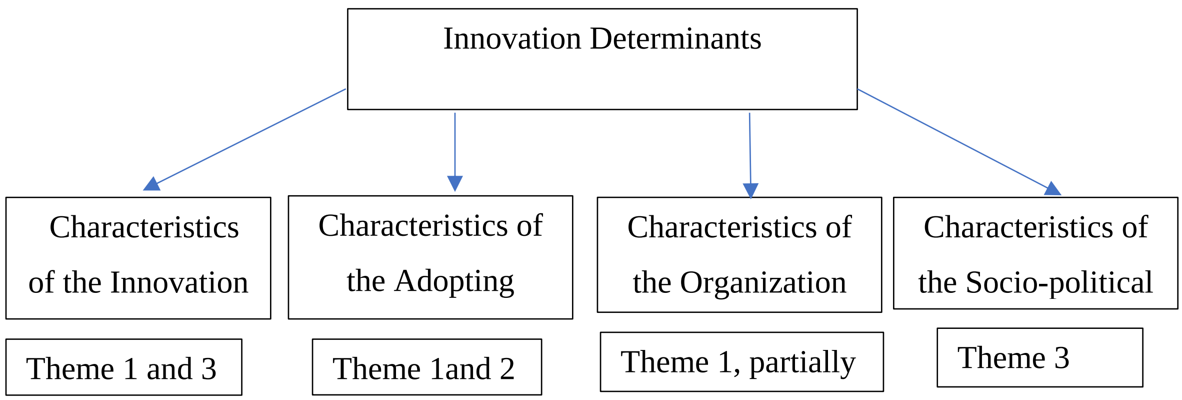

Figure 115. Determinants of Diffusion of Innovation Within Healthcare Organizations.

Characteristics of the Innovation

Fleuren et al. (2004) and de Veer et al. (2011) described characteristics of innovation as perceived advantage, complexity, and unintended consequences. These characteristics emerged from the present study as contributing factors in adopting RALS into practice.

These characteristics were evident in themes One and Three, *surgical innovation and outcome.* The nurse participants perceived the relative advantage of RALS as better visualization of the operation site and increased dexterity when compared to the conventional laparoscopic technique. Participants believed this could potentially contribute to better patient outcomes. RALS was viewed as “the next step” in surgical procedures. Neither the complexity of the surgical robot nor added work in daily practice impeded participants from adopting this technology. Having access to resources such as training from the robot manufacturer, a helpline, and an available representative from the robot manufacturer was perceived as contributing to a more successful adoption of RALS. The interviewed nurses were proud and satisfied with their choice of participating in the innovation and felt that there was a potential for better outcomes in patients experiencing RALS. The extreme Trendelenburg positioning required for RALS and the longer duration of these surgeries were perceived as shortcomings of this surgical technique. Other stated shortcomings were the size of the robot, the pressure of the robot arms against the trocar sites, electrosurgical burning, and the limited range of vision associated with the laparoscope. These participant observations were consistent with the *characteristics of the innovation* as described by Fleuren et al. (2004).

Characteristics of Adopting Person(s)

Characteristics of the adopting person are defined as the knowledge, skill, and experience of the person who adopts the innovation (Fleuren et al., 2004). This factor emerged from Theme One: *surgical innovation* and its components – *nurse perception.*

The functioning of an operating room department requires multidisciplinary teamwork with the surgeon making the ultimate decision and leading the course of the procedures. Other surgical team members include the anesthesiologist or nurse anesthetist, surgical technician or scrub nurse, and the circulating nurse. Sometimes due to the nature of the surgery, a second surgeon will assist the surgeon (Time, 2018). The operating room department more than any other departments of the hospital is dependent on a specialized surgical team to complete different types of surgeries. In robotic surgery, the “team leader” or top of the hierarchy (surgeon) is mediating the surgery by the robot while sitting at the console separated from the patient and the rest of the team.

The adopting persons in this study were perioperative professional nurses. Their educational level ranged from associate degree to master's degree in nursing. Their participation in RALS procedures ranged from 2-17 years with a median of 8 years of experience.

The participants expressed positive attitudes towards adopting the new innovative technology (RALS) into their practice. Positive attitudes towards innovation/change promote adoption of that innovation. The characteristics of the adopting person also were embedded in the second theme: *interprofessional practice* and its components – *standards and teamwork.* The successful execution of robotic surgeries was dependent on the skill of the surgeon and a knowledgeable team that worked and communicated effectively. Negative consequences, such as longer durations of robotic surgeries and unintended patient injuries, were blamed on the surgeon's lack of experience. Nevertheless, participants proposed that the surgeon and the surgical team could overcome these negative consequences through additional practice and experience. The intraoperative nurses interviewed as part of this study generally volunteered to be part of the RALS team, and they perceived that being asked to function in this role was an honor. The preoperative and postoperative nurses were not given the opportunity to decline care of RALS patients; they assumed that care of these patients was part of their general duties.

Characteristics of the Organization

Characteristics of the organization are defined as the organizational support and decision-making process (Fleuren et al., 2004). The commitment of the organization to support employees plays an important role in the stability and dedication of the workers

(Woznyj et al., 2017). The execution of activities in the operating room is highly dependent on complex technologies and interprofessional teamwork. The operating room is considered the financial engine of the hospital, with an average 55% to 65% profit margins, and its operation is regulated by the CMS (Dewes, 2018; Government Publishing Office, 2011).

The participants reported that the organization provided no incentives or individual support for those staff members who chose to be a part of the robotic surgical team. However, this was not perceived as an impeding factor for engaging in the innovation, and they reported that being asked to function as part of the RALS team was an honor and would promote their careers. These factors were partially embedded in theme one, *surgical innovation* and its components, *nurse perception.* Characteristics of the organization were identified as difficulties with the administration in obtaining enough staff and supplies. The data did not reveal whether the professional nurse participants were included in the decision-making process for implementing the RALS into the health care system. This situation occurred despite the fast adoption of the RALS technology by the hospitals' administration personnel and surgeons. Some of the participants mentioned that their organizational supportive actions, such as providing team learning opportunities, simulations, and mock surgeries, eased the learning process. Other participants, who did not have these opportunities and received insufficient training, reported experiencing stress and a steeper, more painful learning curve to become competent in this technology.

Characteristics of the Socio-Political Context

Characteristics of the socio-political context refer to the impact of health care regulatory bodies on practice and patient's characteristics. The FDA is charged with evaluation and safety of innovative medical and surgical devices. Nevertheless, the evaluation process of novel devices is different than for new drugs. The new drugs follow a restricted pathway before approval and widespread use. The novel surgical devices usually develop from "a clinical need and diffuse into practice with limited formal assessment" (Wright, 2017, p. 1546). Consequently, the evaluation of the efficacy of the device will occur after its adoption. While RALS has shown some positive patient outcomes, its adoption has not been without unintended consequences. There are numerous reports of patient injuries (Alemzadeh et al., 2016). Hospitals voluntarily report the injuries associated with the robot malfunctions and the operating of the robot to the manufacturer of the daVinci. The manufacturer, Intuitive Surgical Inc, is mandated to report the incidents to the FDA for recording in the nationwide Manufacturer and User Device Experience (MAUDE) database (Wright, 2017). Given the voluntary reporting system in place for RALS, the number of incidents is underreported (Cooper et al., 2015; Kirkpatrick & LaGrange, 2016).

The report of injuries emerged from Theme Three, *outcome* and its components: *patient outcomes and system outcomes.* The participants did not report any information on the effects of regulatory bodies on the RALS; however, they provided rich information on whether RALS is suitable for patients with comorbidities. This information is important for future policy development and standardization of the procedures.

Overall, the DIHO is a comprehensive conceptual framework that promotes understanding of the multifaceted factors to be considered for adopting new health care technologies into practice. Introduction of new technologies in health care and nursing practice are becoming more common (De Veer et al., 2011). Many new technologies can potentially improve patient quality of care and outcomes if these innovations are supported by sufficient evidence-based research. This study contributes to the limited clinical evidence on the RALS from *professional nurses' perspectives* and offers strategies for improvement of this surgical technology in practice. Additionally, the findings further support the application of the DIHO model in the health care services and the systematic implementation of other new technologies into practice.

Conclusions and Implications

This is the first study solely capturing professional nurses' perceptions and experiences with RALS in the United States. A qualitative descriptive methodology and the determinants of innovation within healthcare organizations conceptual framework proposed by Fleuren et al. (2004) guided this study. A strength of this study is the rich data reported through the experiences of a wide range of professional nurses from different hospitals and regions in the United States. The findings indicate that RALS has the potential to produce improved patient outcomes when performed in a timely fashion by a skilled surgeon and an effective surgical team. However, for the patient to experience the full benefit of RALS, the patient characteristics, the underlying reason for the surgery, the type of surgery, and cost should be taken into consideration.

One significant finding of this study was the concern of professional nurses for patients while unconscious and under the influence of anesthesia. The concern was the long duration of surgery and its effect on patient wellbeing even when nurses had minimal contact with the patient as a conscious human. This finding supports the belief that the "essence of nursing" is to care for another human being. For perioperative professional nurses, this care and concern occurs at the most vulnerable time during the life of a human. During surgery, individuals are unconscious and dependent upon others for all life processes. The safety concerns of perioperative nurses that were expressed support the principles of nursing ethics and one theoretical focus would be Orem's self-care deficit theory (Hasanpour-Dehkordi, Mohammadi, & Nikbakht-Nasrabadi, 2016). In the following section, the contribution of this study to nursing practice, education, theory development, and research will be discussed.

Practice

Robotic surgery adds to the complexity of surgical procedures and requires completion of many more steps such as checking the robotic equipment, calibration of devices, and preparing the operating room (van Brenk, 2009). Creating comprehensive checklists specific to robotic surgeries reduces errors, decreases missing steps, lessens frustration, and increases patient safety (Benham et al., 2017; Jing & Honey, 2015). Currently, AORN provides a surgical checklist that is non-specific for robotic surgery (AORN, 2016b).

Additionally, there is a need for incorporating an intraoperative recording system specific to RALS in the electronic health record (EHR). Currently, the circulating nurse uses the EHR recording system that was designed for other surgeries; therefore, the interventions specific to robotic surgery are not completely recorded (Kang et al., 2016; personal observation, February 8, 2018, February 21, 2018). Current standard practice regarding recording surgeries in the EHR does not reflect interruptions in the intraoperative nurse's workflow during RALS procedures. Furthermore, the EHR deficit is counterproductive for the purpose of data acquisition, nursing research, and documenting system outcomes.

The results of this study highlight the necessity of promoting teamwork and facilitating communication during RALS procedures. This finding is consistent with other research findings indicating that effective surgical team communication is directly related to patient outcomes (Schiff et al., 2016). One of the strategies to improve team communication is using the evidence-based training program, TeamSTEPP. This program, developed by the Agency for Health Research and Quality (AHRQ) and the Department of Defense, offers a complete curriculum on interprofessional team functioning and communication with the ultimate goal to promote patient safety (AHRQ, 2017; Cabral et al., 2016).

Education

This study demonstrates the need for universal standardized education and certification programs for those surgeons and professional nurses involved in robotic surgeries. The joint educational program should include modules, simulations, education on the components of the surgical robot, and the performance of mock surgeries.

Previous research shows that teamwork and communication are even more essential in robotic surgery than other types of surgeries due to the surgeon's reliance on the rest of the team for gathering information about the status of the patient and the robot (Randell et al., 2015). Thus, effective education for intraoperative nurses who participate in RALS surgical teams includes knowledge of the components of the surgical robot, training in troubleshooting robot malfunctions, and verification of basic clinical competency in laparoscopic surgeries. Some of the reported unintended consequences include: “lack of training,” “inadequate troubleshooting of technical problems,” “inadequate system/instrument checks before procedure,” “incorrect port placement,” and “incorrect manipulation or exchange of instruments” (Alemzadeh et al., 2016, p. 14). Often the surgical team is dependent on the circulating nurse for resolving these technical problems and troubleshooting the robotic equipment.

RALS is only one example of the effects of rapid technological innovation on health care. The content that the typical undergraduate nursing student receives as part of prelicensure education is out of date within two years of graduation. The duty of nursing educators, therefore, is not to inform about “what is,” but rather to teach the student to adapt to a technological future that is difficult to predict. All nursing students, but particularly future perioperative nurses, must become resilient, lifelong learners.

Theory

Implementation theories recommend involvement of users of the technology in the innovation process (de Veer et al., 2011). In this case, the users of technology are not only the surgeon but also the surgical team, which includes the anesthesia administrator, professional nurses, and other staff members. The data from this study supported most of the components of the DIHO conceptual framework for the implementation of innovative robotic-assisted surgery. The rapid technological advances in this millennium have spurred creation of theories and conceptual frameworks associated with human adaptation to technology and the effects of ubiquitous access to information throughout all levels of society (Davis 1989; Venkatesh, Morris, Davis, & Davis, 2003; Yen, McAlearney, Sieck, Hefner, & Huerta, 2017). These theories must be developed and refined to help our health care system to adapt and benefit from innovation (Yen et al., 2017).

At the same time, implementation of new technologies has been associated with unanticipated, negative consequences. These findings relay the need to develop theories and conceptual frameworks that focus on explanations of the "processes" of technology implementation. Examples of these processes include "workflow redesign, user training, and technology maintenance" (Yen et al., 2017, p.5). Understanding the processes associated with the adoption of technology (implementation science) will enable health care systems to try new technologies appropriately within the context of being aware of and minimizing potential harm and unintended consequences.

The findings also support the impact that technology may have on traditional roles. In order to ensure patient safety within the context of novel technologies, there is need for a more horizontal organizational hierarchy. The surgeon being the undisputed "captain of the ship" characterizes the defined hierarchy that is present in most modern operating rooms suites. (Van Norman, 2015). This has implications on the development of socio-technical change theories that include changing roles and improving communication among members of interprofessional teams. How should we best educate nursing personnel to withstand the challenges of the fast pace of innovation of science and technology? How should we best educate perioperative nurses to communicate with surgeons, patients, and surgical team members optimally about information on patient care and the status of the robot? Effective communication requires relationships that are exemplified by each team member's trust in other's expertise. Often these relationships are best fostered during team educational experiences. The future of RALS includes the possibility that an expert surgeon may direct a robot in a different city or a different country, which would impose a new layer on team communication that has not been addressed in current telehealth practices. Theories and conceptual frameworks must be developed that will help nurses communicate with the patient, the surgical team, and the possibility of a surgeon who is even more distant from the patient.

Policy

Professional nurses should be involved in the decision-making process for adoption, purchasing, and evaluation of the medical and surgical equipment (de Veer et al. 2011; Shanton, 2018). Research has shown the involvement of nurses in product and process evaluation improves quality of care and saves costs (Grundy, 2016). The health care organizations need to provide support for surgical team training by the manufacturer of the daVinci surgical robot. A surgical team with expertise and efficiency impacts workflow and cost. Other policy measures include establishing a national governmental base and state registry system that uses the hospitals' and day surgery centers' electronic health records as a platform for recording patient injuries, robot malfunctions, and other problems. Such a mandatory reporting system would document the actual number of incidents and would facilitate root cause analysis and guide efforts to identify solutions.

Recommendations for Future Research

Nursing science is grounded in the assumption that objective appraisal of scientific evidence is fundamental to both the practice and education of practitioners. The findings of this study provide the impetus for further research on RALS that will affect the work of those nurses who work in the RALS arena, as well as the provision of knowledge that can be transferred to the implementation of other technological innovations within healthcare. These findings have implications for nursing practice, nursing education, and theory development, as well as future research initiatives. Specific to the surgical context, participant comments spurred ideas about research needed within preoperative, intraoperative, and postoperative venues.

Potential Preoperative Studies

- Would clinical decision algorithms designed for preoperative-nurse assessment of RALS-specific risk factors affect patient selection for RALS and subsequent patient outcomes?
- Are there unidentified conditions that are contraindications for RALS procedures?

Potential Intraoperative Studies

- What are the effects of a team-education approach for technological innovations such as RALS versus education of surgeons only on patient outcomes?
- Does use of surgical simulation strategies for education provide equivalent outcomes as use of animal models for technological innovations such as RALS?
- Do patient outcomes differ when nurses participate in organized team education versus “on the job” education when implementing technological innovations such as RALS?
- What is the extent of pathogen-contamination of robotic equipment following the current autoclave standard cleaning for robotic equipment?

Would other sterilization strategies be more effective than current standard practice?

- What is the effect of the application of warm humid CO_2 for abdominal insufflation on postoperative shoulder pain, abdominal pain, hypothermia, and tissue healing compared to standard practice?
- What are the effects of standardized RALS education on patient outcomes?
- What are the effects of implementation of RALS clinical competency standards for surgeons and team members on patient outcomes?

Potential Postoperative Studies

- What is the postsurgical infection rate following RALS versus other procedures such as laparoscopy or laparotomy?
- How do patients who experience RALS compare to other procedures on subsequent emergency room visits or 30-day readmission rates?

In addition, research is needed regarding governmental procedures, such as those of the FDA, for approval of medical technological innovations for patient use. Currently critics of the FDA propose that standards for medical apparatuses and devices are not as rigid as drug standards.

Limitations

Although this was the largest population of professional nurses interviewed regarding RALS, the number of participants and the locations limit the study results. Another limitation of this study is that discharge nurses and the intraoperative nurses who did not choose to be a part of the robotic surgical team were not included. This decision was made during the data collection process. Adding another group of professional nurses required additional number of participants. In addition, this study did not explore nurse managers' experiences regarding their input or lack of input in adopting and purchasing the surgical robot. Future research should strive to include a larger demographic and geographically dispersed sample of professional nurses, which may be more reflective of the current situation regarding nurse perceptions of RALS.

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APPENDIX A

Recruitment Script

Appendix I

Invitation Script

My name is Zohreh Schuessler, MSN, MPH, RN. I am a doctoral candidate at the College of Nursing at Texas Woman's University, Denton, Texas. I would like to invite you to participate in my research study. I am seeking perioperative registered nurses who are currently working full or part time providing care for patients with robotic-assisted laparoscopic surgery (RALS) and intraoperative nurses who have chosen not to participate in RALS surgical teams. Participation in this study is voluntary and you may withdraw from the study at any time.

I am planning to explore the perceptions and experiences of perioperative nurses who are involved in providing care for patients who undergo robotic-assisted surgery.

As a participant, you will be asked to give 30-45 minutes of your time for an audio-taped interview. A few of you might be invited to review and evaluate the accuracy of your transcribed interview. All personal information will remain confidential during the study and no name or personal information will be used in data analysis or the results of the study. The recorded interviews will be destroyed after the completion of the study. However, in all emails, downloading data, electronic meetings, and internet transactions, there is a potential risk of loss of confidentiality. Prior to participation in this study, you will sign a consent form that will explain the details of this research study. I will be happy to provide you with the result of the study once it is completed.

A $20 gift certificate will be provided to you at the completion of the interview. If you would like to participate in this research study, please contact me at zschuessler@twu.edu or call at 979 739 0297. Please don't hesitate to contact me with any questions that you may have.

Thank you,

Zohreh Schuessler

APPENDIX B

Consent Form

TEXAS WOMAN'S UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

A Qualitative Descriptive Study:

Perioperative Nurses' Perceptions and Experiences with Robotic-assisted Surgery

Principal Investigator: Zohreh Schuessler, Doctoral Candidate 979-739-0297 zschuessler@twu.edu

Research Advisor: Peggy Mancuso, Ph.D. 940-898-2425 PMancuso@twu.edu

EXPLANATION OF THE RESEARCH

You are being asked to participate in this research study because you are a perioperative registered nurse. The eligibility requirements of this study are: perioperative registered nurses who are currently working full or part time providing care for patients with robotic-assisted laparoscopic surgery (RALS) and intraoperative nurses who have chosen not to participate in RALS surgical teams.

Participation in this research study is voluntary, and you may stop participating at any time. There will be no penalty to you if you decide not to participate, or if you start the study and decide to stop early.

This consent form explains what you have to do as a participant in this study. It also describes the possible risks and benefits of participation. Please read the form carefully and ask as many questions as you need before deciding to participate in this research.

This research study is part of the requirements for earning a Doctor of Philosophy degree in Nursing Science at Texas Woman's University. Perioperative nurses from the United States will be interviewed. Zohreh Schuessler is the principal investigator, and Peggy Mancuso, Ph.D., is the faculty mentor and research advisor for this study.

BACKGROUND

Technological advances continue to transform nursing practice and affect patient outcomes. The rapid expansion of the robotic surgical technology has created new opportunities and responsibilities for nurses. There is insufficient knowledge about nurses' perceptions and experiences with robotic-assisted surgery.

PURPOSE

The purpose of this qualitative descriptive study is to explore the factors that influence perioperative nurses' perceptions and experiences with the care of patients who undergo robotic-assisted surgery. This study will shed light on the role of nurses care for patients that use this technology and how robotic-assisted surgery affects their practice.

Initials _____

PROCEDURES

If you are eligible and decide to participate in this study, your participation will last approximately 30 minutes to 45 minutes for an interview. If you want to talk longer than this, just let the researcher know. The researcher may need to contact you for a follow-up interview that would last 30 minutes or less to get your opinion about the transcripts or the ongoing research. Your total participation will involve the following items:

- The interviews will take place face-to-face or via communication technology such as Skype or Face Time. Telephone interviews may occur if you are unable to meet the PI or do not have access to Skype or Face Time. Please choose a location that is private to minimize the loss of confidentiality.
- An individual interview with the researcher who will ask questions about your perception and experience with robotic assisted surgery.
- The interviews will be digitally recorded and transcribed by the researcher and a transcriptionist who has signed a confidentiality agreement contract. Your identity will be held confidential by assigning a number to you as the identity marker for your transcribed interview comments.
- All proper nouns and names in the transcripts will be replaced with a neutral noun, for example if you say Houston it will be replaced with a southern metropolitan city, or if you say a patient's name, "Sylvia," "Sylvia" will be replaced with "patient."
- All audio recordings will be permanently erased from the principal investigator's iPhone after they are downloaded to her computer and at the completion of data collection to protect confidentiality. All transcribed interviews will be permanently deleted from the principal investigator's computer after data collection and analysis are completed.
- The signed consent forms and transcription from each interview will be maintained in a locked cabinet in the principle investigator's desk. The digital data stored on the principal investigator's cell phone or computer is password protected, and only the principal investigator can access them.

Potential Risks

Risks of participating in this study include potential loss of confidentiality and loss of time. There is a potential risk of loss of confidentiality in all email, downloading documents, electronic meetings and internet transactions. The treatment of this information will be confidential. In order to minimize these risks, your name will not be used, and all identifying information will be removed from the transcripts of the interviews. Research data will be stored in a locked cabinet in the principal investigator's desk at her home. The researchers may publish the results of the study. Your name or name of your employer will not be used in any publication or

Initials ______

presentation about the study. The interview will take place at a place and time convenient for you and will last approximately 30 to 45 minutes or longer if you wish to talk more.

BENEFITS

Each participant will receive a $20 gift certificate at the completion of the first interview. Sharing your perception and experience with robotic-assisted surgery may provide you with reflection, satisfaction. The researcher hopes that capturing perioperative nurses' experience with robotic-assisted surgery contribute to the existing nursing knowledge.

INSTITUTIONAL DISCLAIMER STATEMENT

The researcher will try to prevent any problem that could happen because of this research. You should let the researcher know at once if there is a problem, and she will help you. However, TWU does not provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

QUESTIONS

Before you sign this form, the researcher will answer all your questions. If you have any questions about the research study, you should ask the researcher. Her phone number is listed at the top of this form. If you have questions about your rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940- 898-3378 or via e-mail at IRB@twu.edu.

CONSENT

The researcher has given you information about this research study. She has explained what will be done and how long it will take. She explained any inconvenience, discomfort or risks that may be experienced during this study. By signing this form, you say that you freely and voluntarily consent to participate in this research study. You have read the information and had your questions answered.

Initials _____

Approved by the
Texas Woman's University
Institutional Review Board
Approved: April 24, 2018

You will be given a signed copy of the consent form to keep for your records.

____

Print Participant's Name

____________________________________ ______________

Signature of Participant Date

____

Print Name of Person Obtaining Consent

____________________________________ ______________

Signature of Person Obtaining Consent Date

If you would like to know the results of this study tell the researcher where you you want them to be sent:

Email:
or
Address:

Approved by the
Texas Woman's University
Institutional Review Board
Approved: April 24, 2018

APPENDIX C

TWU IRB Approval # 20074

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378
email: IRB@twu.edu
http://www.twu.edu/irb.html

DATE: April 25, 2018

TO: Ms. Zohreh Schuessler
Nursing

FROM: Institutional Review Board (IRB) - Denton

Re: Approval for Perioperative Nurses' Perceptions and Experiences with Robotic-Assisted Surgery (Protocol #: 20074)

The above referenced study has been reviewed and approved by the Denton IRB (operating under FWA00000178) on 4/24/2018 using an expedited review procedure. This approval is valid for one year and expires on 4/24/2019. The IRB will send an email notification 45 days prior to the expiration date with instructions to extend or close the study. It is your responsibility to request an extension for the study if it is not yet complete, to close the protocol file when the study is complete, and to make certain that the study is not conducted beyond the expiration date.

If applicable, agency approval letters must be submitted to the IRB upon receipt prior to any data collection at that agency. A copy of the approved consent form with the IRB approval stamp is enclosed. Please use the consent form with the most recent approval date stamp when obtaining consent from your participants. A copy of the signed consent forms must be submitted with the request to close the study file at the completion of the study.

Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any adverse events or unanticipated problems. All forms are located on the IRB website. If you have any questions, please contact the TWU IRB.

cc. Dr. Anita Hufft, Nursing
Dr. Peggy Mancuso, Nursing
Graduate School

APPENDIX D

Modified Consent Form

TEXAS WOMAN'S UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

A Qualitative Descriptive Study:

Perioperative Nurses' and Certified Registered Nurse Anesthetists' Perceptions and Experiences with Robotic-assisted Surgery

Principal Investigator: Zohreh Schuessler, Doctoral Candidate 979-739-0297 zschuessler@twu.edu

Research Advisor: Peggy Mancuso, Ph.D. 940-898-2425 PMancuso@twu.edu

EXPLANATION OF THE RESEARCH

You are being asked to participate in this research study because you are a perioperative registered nurse or Certified Registered Nurse Anesthetist (CRNA). The eligibility requirements of this study are: perioperative registered nurses and CRNAs who are currently working full or part time providing care for patients with robotic-assisted laparoscopic surgery (RALS) and intraoperative nurses who have chosen not to participate in RALS surgical teams.

Participation in this research study is voluntary, and you may stop participating at any time. There will be no penalty to you if you decide not to participate, or if you start the study and decide to stop early.

This consent form explains what you have to do as a participant in this study. It also describes the possible risks and benefits of participation. Please read the form carefully and ask as many questions as you need before deciding to participate in this research.

This research study is part of the requirements for earning a Doctor of Philosophy degree in Nursing Science at Texas Woman's University. Perioperative nurses from the United States will be interviewed. Zohreh Schuessler is the principal investigator, and Peggy Mancuso, Ph.D., is the faculty mentor and research advisor for this study.

BACKGROUND

Technological advances continue to transform nursing practice and affect patient outcomes. The rapid expansion of the robotic surgical technology has created new opportunities and responsibilities for nurses. There is insufficient knowledge about nurses' perceptions and experiences with robotic-assisted surgery.

PURPOSE

The purpose of this qualitative descriptive study is to explore the factors that influence perioperative nurses' perceptions and experiences with the care of patients who undergo robotic-assisted surgery. This study will shed light on the role of nurses care for patients that use this technology and how robotic-assisted surgery affects their practice.

Initials _____

PROCEDURES

If you are eligible and decide to participate in this study, your participation will last approximately 30 minutes to 45 minutes for an interview. If you want to talk longer than this, just let the researcher know. The researcher may need to contact you for a follow-up interview that would last 30 minutes or less to get your opinion about the transcripts or the ongoing research. Your total participation will involve the following items:

- The interviews will take place face-to-face or via communication technology such as Skype or Face Time. Telephone interviews may occur if you are unable to meet the PI or do not have access to Skype or Face Time. Please choose a location that is private to minimize the loss of confidentiality.
- An individual interview with the researcher who will ask questions about your perception and experience with robotic assisted surgery.
- The interviews will be digitally recorded and transcribed by the researcher and a transcriptionist who has signed a confidentiality agreement contract. Your identity will be held confidential by assigning a number to you as the identity marker for your transcribed interview comments.
- All proper nouns and names in the transcripts will be replaced with a neutral noun, for example if you say Houston it will be replaced with a southern metropolitan city, or if you say a patient's name, "Sylvia," "Sylvia" will be replaced with "patient."
- All audio recordings will be permanently erased from the principal investigator's iPhone after they are downloaded to her computer and at the completion of data collection to protect confidentiality. All transcribed interviews will be permanently deleted from the principal investigator's computer after data collection and analysis are completed.
- The signed consent forms and transcription from each interview will be maintained in a locked cabinet in the principle investigator's desk. The digital data stored on the principal investigator's cell phone or computer is password protected, and only the principal investigator can access them.

Potential Risks

Risks of participating in this study include potential loss of confidentiality and loss of time. There is a potential risk of loss of confidentiality in all email, downloading documents, electronic meetings and internet transactions. The treatment of this information will be confidential. In order to minimize these risks, your name will not be used, and all identifying information will be removed from the transcripts of the interviews. Research data will be stored in a locked cabinet in the principal investigator's desk at her home. The researchers may publish the results of the study. Your name or name of your employer will not be used in any publication or

Initials _____

presentation about the study. The interview will take place at a place and time convenient for you and will last approximately 30 to 45 minutes or longer if you wish to talk more.

BENEFITS

Each participant will receive a $20 gift certificate at the completion of the first interview. Sharing your perception and experience with robotic-assisted surgery may provide you with reflection, satisfaction. The researcher hopes that capturing perioperative nurses' experience with robotic-assisted surgery contribute to the existing nursing knowledge.

INSTITUTIONAL DISCLAIMER STATEMENT

The researcher will try to prevent any problem that could happen because of this research. You should let the researcher know at once if there is a problem, and she will help you. However, TWU does not provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

QUESTIONS

Before you sign this form, the researcher will answer all your questions. If you have any questions about the research study, you should ask the researcher. Her phone number is listed at the top of this form. If you have questions about your rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940- 898-3378 or via e-mail at IRB@twu.edu.

CONSENT

The researcher has given you information about this research study. She has explained what will be done and how long it will take. She explained any inconvenience, discomfort or risks that may be experienced during this study. By signing this form, you say that you freely and voluntarily consent to participate in this research study. You have read the information and had your questions answered.

Initials ______

You will be given a signed copy of the consent form to keep for your records.

____

Print Participant's Name

________________________________ ____________

Signature of Participant Date

____

Print Name of Person Obtaining Consent

________________________________ ____________

Signature of Person Obtaining Consent Date

If you would like to know the results of this study tell the researcher where you you want them to be sent:

Email:
or
Address:

Approved by the
Texas Woman's University
Institutional Review Board
Approved: April 24, 2018
Modifications Approved:
June 7, 2018

APPENDIX E

TWU IRB Modification Approval

TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378
email: IRB@twu.edu
https://www.twu.edu/institutional-review-board-irb/

DATE: June 7, 2018

TO: Ms. Zohreh Schuessler
Nursing

FROM: Institutional Review Board - Denton

Re: Notification of Approval for Modification for Perioperative Nurses' and Certified Registered Nurse Anesthetists' Perceptions and Experiences with Robotic-assisted Surgery (Protocol #: 20074)

The following modification(s) have been approved by the IRB:

The researchers will now recruit Certified Registered Nurse Anesthetist in addition to Perioperative nurses. As a result, the title of the study has also been modified to reflect this change. The consent form and recruitment invitation have been modified to reflect this change as well.

cc. Dr. Peggy Mancuso, Nursing

APPENDIX F

Agency Administration Approval

CHI St. Joseph Health
Imagine better health.℠

2801 Franciscan Drive
Bryan, TX 77802

P 979.776.3777
chistjoseph.org

May 17, 2018

To Whom It May Concern,

Zohreh Schuessler has been approved to pursue her study at CHI St. Joseph Health Regional Hospital in Bryan, Texas. I will be serving as her local mentor. Please contact me with any questions or needs during this process.

Sincerely,

Sherry Jennings, RN, MSN
Director of Trauma and Perioperative Services
CHI St. Joseph Health Regional

APPENDIX G

Agency IRB Approval # 1190316-1

CHI Institute for Research and Innovation

FWA Number: FWA 00019514
OHRP IRB Number: IRB00009715

DATE:	May 23, 2018
TO:	Zohreh Schuessler, Doctoral Student
PROJECT TITLE:	[1190316-1] Perioperative nurses' perceptions and experiences with robotic-assisted surgery
SUBMISSION TYPE:	Other
ACTION:	Request to Cede IRB Review APPROVED
EFFECTIVE DATE:	May 23, 2018
REVIEW TYPE:	Facilitated Review

Thank you for your submission to the Catholic Health Initiatives Institute for Research and Innovation Institutional Review Board (CHIRB). The CHIRB has APPROVED your request to rely upon the Texas Women's University IRB.

Please note that it is your responsibility to obtain any additional local institutional or departmental required approvals prior to initiating your study.

If you have any questions at any time, please feel free to contact the CHIRB at 1-844-626-2299 or CHIRB@CatholicHealth.net. Please include your project title and reference number in all correspondence with the CHIRB so that we can best assist you.

Thank you.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Catholic Health Initiatives Institute for Research and Innovation Institutional Review Board (CHIRB)'s records.

APPENDIX H

OrNurseLink Recruitment

Zohreh Schuess...

1Like

Quote Need participants for a research study on robotic surgery

posted by Zohreh Schuessler on May 21, 2018 9:42 pm

Dear colleagues,

My name is Zohreh Schuessler, a Ph.D. candidate, and an AORN member. I am performing a research study on "Robotic Surgery" and need your participation in this study. The participation involves a 30-45 minutes interview. I am interested to gain insight into your experience with robotic surgery. I need to interview preop, intraop, and PACU nurses as well as perioperative nurse managers. Your participation in this study is appreciated.

Please contact me at zschuessler@twu.edu if you are interested. Thank you

Sincerely,

Zohreh

APPENDIX I

Permission from Intuitive Surgical For Using The Image

Katy
Please forward this on to Zohreh for her to use. Thank you for checking with me prior to her using images. It is fine for her to do so.
JH

Jared Henson
Sr. Clinical Sales Representative
Intuitive Surgical
979-255-2130

Begin forwarded message:

From: Joe Giuffrida <Joe.Giuffrida@intusurg.com>
Date: October 5, 2018 at 10:49:17 AM CDT
To: Jared Henson <Jared.Henson@intusurg.com>
Cc: DVRC <DVRC@intusurg.com>
Subject: Image Library - Intuitivesurgical.com

Jared,

Please see the link below to our corporate website which should take you to a screen below regarding the use of our photos:

https://www.intuitive.com/en/about-us/press/image-library

APPENDIX J

Interview Guide

Demographic Questions

1. Age?
2. Gender?
3. Education level?
4. Years (months) in nursing?
5. Years (months) working as a perioperative nurse?
6. Years (months) working on robotic surgery team?
7. How long has your institution performed RALS?
8. Which type of surgical robotic technology have you used?
9. How may robotic surgery procedures have you been involved in?

Interview Questions

1. Can you tell me about your experience with robotic-assisted surgery?
2. How do you compare this technique to conventional laparoscopic technique for different procedures, urology, gynecology, general surgery? For instance, the duration of surgery, patient outcomes, and cost?
3. In your experience, what impact does RALS have on the nurse-patient relationship?
4. What comes to your mind when you think of robotic surgery in terms of patient outcomes? (positioning, pneumoperitoneum)
5. Tell me about your experience with these types of patients and their perception of RALS?
6. Did you have a choice to be a member of robotic-assisted surgery team? How do you feel about that?
7. Tell me about your role in robotic surgery?
8. What effects do think robotic surgery has on your duties/work as a nurse?
9. What changes, if any, do you make or have made in the provision of care for patients who have robotic surgery?
10. Did you receive training when you started working with patients who have robotic surgery and did the training prepare you?
11. In your experience, how many times does a nurse need to care for a patient with RALS to be really good at this?
12. Did your organization provide any incentives and support for being on the robotic surgery team?

13. How can the provision of care for patients receiving robotic surgery be improved?
14. Has the implementation of RALS affected the resources (staffing) and workflow at your work?
15. What do think of standardization of the training for surgeon and nurses?
16. Please tell me more about that…do you have an example? (probing question). Is there anything that you would like to share?