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Development of Evidence-based Clinical Practice Guidelines for the Prevention of Peripheral Neurological Injury During Robotic-assisted Prostatectomies for Patients in the Steep Trendelenburg Position

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Abstract

Robotic-assisted surgery (RAS) is becoming more prevalent in modern surgical practice and is currently being utilized in a range of surgical specialties from colorectal and gynecological procedures to bariatrics and orthopedics. Every surgical procedure has potential risk to patients, however robotic-assisted laparoscopic prostatectomies (RALP) in the steep Trendelenburg (ST) position poses unique risk for peripheral nerve injury (PNI). Despite attempts to reduce the incidence rate of PNI during RALP, injuries are still occurring to patients causing patient harm and anesthesia provider litigation. The implementation of a CRNA based safety checklist may reduce the incidence rate of PNI and provider litigation for these procedures. The overall purpose of this quality improvement project is to reduce the risk of PNI to patients undergoing anesthesia during RALP. The primary aim of the project is to create, implement, and evaluate the effects an evidence-based clinical practice safety checklist for use in conjunction with the surgical timeouts will have on the incidence rate of PNI. The following objectives have been established to achieve the aim of this project: 1) create and incorporate a practice safety checklist for CRNAs to use during surgical timeouts, using best practice evidence from the literature, 2) compare pre-and post-implementation outcome findings using clinical observations audits and lastly 3) provide project findings, identified barriers, and recommendations for sustainment and continued monitoring, using a SWOT analysis briefing and discussion format to the key stakeholders.

Keywords: robotic-assisted laparoscopic surgery, steep Trendelenburg, positioning, nerve, injury, prostatectomies

Problem Identification

Introduction

Robotic-assisted surgery (RAS) is becoming more prevalent in surgical practice. A multitude of surgical procedures are being assisted by robotics every year, and the benefits of RAS make it appealing to patients and surgeons. Given all the benefits of RAS, the potential complications are relatively understudied (Alemzadeh et al., 2016). A retrospective study by Alemzadeh et al. (2016) states that previous studies have attempted to examine the safety and effectiveness of robotic-assisted procedures, however "an important question left unanswered is whether the evolution of the robotic systems with new technologies and safety features over the years has improved the safety of robotic systems and their effectiveness across different surgical specialties" (p. 3). Colorectal surgery is quickly becoming one of the most common robotic-assisted surgical specialties, and with the help of robotics an array of different colorectal procedures may be performed. RAS laparoscopic prostatectomies account for the most common procedure done under robotics (Erkoc, 2022). As RAS continues to expand into colorectal surgical practice, it is the job of healthcare professionals to ensure the safety of patients undergoing these types of procedures, in particular prostatectomies.

Robotic-assisted laparoscopic colorectal procedures are unique since they often require patients to be in certain positions to maximize surgical exposure. Many of these procedures call for the patients to be in a degree of steep Trendelenburg (ST), or supine with the patient's head declined below the level of their feet. In these types of RAS, correct patient position remains a significant part of the perioperative process to prevent peripheral nerve injury (PNI) from occurring to the patient. According to Mangham (2016) improper patient positioning is one of the most common reasons that PNIs occur under general anesthesia. With general anesthesia, the

patient is unable to move or communicate with anesthesia providers and surgeons, leaving them vulnerable and powerless to covey discomfort or pain. Provides must be vigilant and ensure proper patient positioning to prevent PNI from occurring in this sensitive time. As the number of robotic-assisted laparoscopic prostatectomies (RALP) grows, a primary focus should be placed on the prevention of PNIs.

Background of Problem

In the operating room (OR) it is the responsibility of all staff to ensure the patient is safe while under anesthesia. Certified Registered Nurse Anesthetists (CRNAs) not only maintain the patient's state of unconsciousness but are major participants in patient positioning. Robotic-assisted surgeries for colorectal procedures are considered major or minor cases. On a case-to-case basis, a patient's time under general anesthesia may range from minutes to several hours. The longer a patient is anesthetized, the higher the risk of inadvertent PNI the patient accrues (Al-Temimi et al., 2017). A study by Costa (2017) examined all operations of 12 surgical specialties performed in one year at a public university hospital. The overall mean duration of anesthesia was 178.12 +/- 110.46 minutes, and the 80th percentile of cases was 252 minutes (Costa, 2017). The mean operative time was 130.45 +/- 97.23 minutes, with the 80th percentile being 285 minutes (Costa, 2017). The 3-hour average of general anesthesia leaves sufficient time for a PNI to occur to patients and makes proper preoperative positioning essential to the prevention of PNI. The addition of robotics into the surgical procedure, along with pre-anesthesia positioning, increases the challenges of PNI prevention. Robotics uniquely incorporates trocars and other mechanical equipment that also must be accounted for.

Proper patient position preoperatively and intraoperatively is vital to prevent damage to nerves, muscles, skin, and joints (Adedeji et al., 2010). Peripheral neuropathies and PNIs are an

uncommon but significant part of the associated risks of surgery, with estimates ranging from 0.02% to 21% of surgical cases (Bouyer-Ferullo, 2012). These injuries can extend a patient's hospital stay from 24 hours to multiple days, with patients unable to care for themselves at home (Bouyer-Ferullo, 2012). Many hospital systems implement general intraoperative guidelines to prevent these injuries; however, many hospitals lack specific CRNA driven guidelines and protocols for RALP.

Nerve injury can occur in two forms: central nerve injury and PNI. Central nerve injuries typically involve disrupting electrical signals from the spinal cord to the brain and vice versa (Tighe, 2009). The spinal cord carries "electrical signals away from the brain to nerves supplying muscles and organs" (Tighe, 2009, p.1). Damage to the central nervous system "affects both muscle power and sensation," and pain is a ubiquitous feature of this injury (Tighe, 2009, p.1). According to Tighe (2009), damage caused to the central nervous system is typically permanent and irreversible. A patient with a central nervous system injury can present with debilitating symptoms such as paraplegia, quadriplegia, and spinal shock typically immediately postoperatively (Tighe, 2009). The peripheral nervous system includes motor and sensory nerves in the body's periphery. Peripheral nerves are responsible for controlling muscles and bringing sensory information to the spinal cord to be relayed to the brain (Tighe, 2009). The sensory nerves transport information about "touch, pain, and other sensations" (Tighe, 2009, p.1). Damage to peripheral nerves is common under anesthesia due to improper patient positioning. Peripheral sensory nerve damage can present as "numbness, tingling, or pain" and vary from continuous aches to shape pains that onset immediately postoperatively to days/weeks later (Tighe, 2009, p.1). Peripheral motor nerve damage can cause weakness or paralysis to the patient. Depending on the degree of injury to peripheral nerves, the injury can be reversible or

permanent (Tighe, 2009). Some PNIs can resolve within a few days, several weeks, or several months and in rare incidences, full recovery can sometimes take a year or longer (Tighe, 2009).

Depending on the RAS, the patient will be placed in various positions and each position has unique, inherent risks to a patient's nerves. The most common patient positions for robotic-assisted surgical procedures are supine, ST, lithotomy, lateral decubitus, and prone position. In RALP, the most common patient position is ST. In the ST position, the most common peripheral nerve injuries are related to compression of nerves, stretching of nerves, ischemia, and inadvertent surgical damage to nerves (Tighe, 2009). Some of the most common nerves damaged in the upper extremities are the brachial plexus, suprascapular, circumflex, radial, and ulnar nerves (Nagelhout, 2017). The most damaged nerves in the lower extremities are the obturator nerve, sciatic nerve, common peroneal nerve, tibial nerve, saphenous nerve, and femoral cutaneous nerve (Nagelhout, 2017). Proper positioning technique and vigilance by the operating room staff are essential to prevent neurological injury from occurring to the patient when undergoing RALP in the ST position.

Significance to Nurse Anesthesia

According to the American Association of Nurse Anesthesiology (AANA) (2019), the certified registered nurse anesthetist's (CRNA) scope of practice includes "collaborating with the surgical team to position, assess, and monitor proper body alignment" (p. 3). The CRNA must "use protective measures to maintain perfusion and protect pressure points and nerve plexus" (AANA, 2019, p. 3). Proper patient positioning must be monitored by CRNAs, thus making it essential and required of their practice. Improper patient positioning during RALP can affect many stakeholder groups, especially CRNAs, with CRNAs being liable for patient injury. Stakeholders are an essential component of the development of healthcare policy and are

considered “a person, group, or organization that has interest or concern in an organization” (Lubbeke et al., 2019, p. 331). The 3 main stakeholders affected by improper patient positioning leading to PNI are the patient, anesthesia providers, and the hospital system. CRNAs must collaborate to create common goals of increasing patient safety, enhancing healthcare delivery, and reducing healthcare costs. The implementation of CRNA driven clinical guidelines, in the form of a preoperative checklist for patient positioning, could be instrumental in the prevention of PNIs during RALP.

According to Adedeji et al. (2010), "an anesthetized or sedated patient is unable to communicate if they have been placed in a compromising or dangerous position, hence a proactive approach should be taken to prevent deleterious effects of patient mal-positioning" (p.143). Preventable injuries such as peripheral and central nerve injuries can be avoided with a high level of vigilance from providers. CRNA's lack of vigilance is responsible for 79% of anesthesia-closed claims (MacRae, 2007). CRNAs are commonly involved in malpractice lawsuits when adverse, preventable injuries occur to patients under their direct supervision. One of the most common lawsuits involves PNI. According to Jordan et al. (2013), other commonly cited malpractice allegations for anesthesia providers include:

- Failure to monitor
- Improper patient management
- Improper technique
- Failure to recognize patient complications
- Failure to ensure patient safety
- Delay in performance
- Delay in treatment
- Patient positioning issues
- Equipment issues

- Improper performance
- Medication issues (wrong dosage, wrong medication, medication selection errors)

The listed malpractice allegations cause intraoperative PNI.

Litigation can cost the CRNAs and hospital system a large sum of money depending on the severity of injury to the patient and the preventability of the injury. Nerve injuries are temporary injuries (minor or major) or permanent injuries (significant, major, or grave) (Tighe, 2009). The least costly malpractice payment average for anesthesia providers was between $33,816.70-$65,103.20 for patients with minor injuries (Jordan et al., 2013). The median litigation cost for significant permanent patient injury was $947,804.90, with a maximum payment of $9,550,000 (Jordan et al., 2013). The prevalence of PNI litigation can be costly to CRNAs and the healthcare system. Prevention of one significant permanent neurological injury can save the hospital system upwards of $1 million (Ranum et al., 2014). Providers, healthcare executives, and financers must come together to make CRNA clinical guidelines and policies to prevent potential patient injury, decrease patient length of stay, and decrease litigation related to PNI. The hospital system could utilize the money saved from avoiding litigation more efficiently elsewhere.

Problem Statement

The general problem is that RALP in the ST position are becoming more common in modern surgical practice, and the potential patient complications regarding inadvertent PNI from this type of surgery should be investigated further (Alemzadeh et al., 2016). Many negative ramifications occur from PNI sustained during RALP. Complications include patient injury, increased length of stay, increased hospital costs, increased patient costs, decreased patient satisfaction, and anesthesia provider litigation. The most extreme injury that can occur is unintentional patient death. Many hospitals around the country need specific CRNA RALP

positioning guidelines for the ST patient position. Hospital systems must develop and implement clinical guidelines to prevent PNI to patients undergoing RALP in the ST position. A preoperative checklist for patient positioning could limit the incidence rate of PNI sustained during RALP.

PICOT Question

(P) In patients undergoing robotic-assisted laparoscopic prostatectomies who are in steep Trendelenburg position, (I) how does creating evidence-based clinical guidelines for patient positioning in steep Trendelenburg in the form of a preoperative positioning checklist (C) compared to patients who are having standard laparoscopic prostatectomies without the use of robotics (O) affect the patient incidence rate of postoperative peripheral neurological injury (T) during the first 24 hours of a patient's surgical admission?

DNP Project Objectives

The objectives of this DNP project are:

1. Develop an evidence-based practice timeout checklist that hospital systems can adopt to assist in the prevention of peripheral neurological injury during robotic-assisted laparoscopic prostatectomies for patients in the steep Trendelenburg position.
2. Develop a plan for the implementation of evidence-based clinical practice checklist
3. Develop a plan to measure the evidence-based clinical practice checklist
4. Develop criteria to disseminate the results and gauge the effectiveness and impact of implemented evidence-based checklist

Iowa Model

According to Brown (2014), it is essential that evidence-based practice models "are available to help nurses organize and systematically track progress in implementing evidence

into practice" (p 157). Evidence-based practice (EBP) models "provide step-by-step guides on how to take a clinical problem and match it with interventions based on research to make an organizational or departmental change to practice" (Brown, 2014, p. 157). The author's attempt to develop clinical guidelines in the form of a checklist for patient positioning during RALP in the ST position to prevent PNI requires an evidence-based model to guide the process. The Iowa Model is one of the most used frameworks for implementing evidence-based practice research in the healthcare setting and helps assist quality improvement projects such as implementing clinical guidelines to better professional practice (Brown, 2014). The Iowa Model adheres to a 9-step process that helps to identify a clinical problem in professional practice, guide the gathering of scholarly evidence to support the identified problem, oversee the creation of a stakeholder group to address the problem, and collectively assist in the creation of interventions to address the problem, and a way to disseminate the results of intervention implementation. The Iowa Model is an appropriate framework for implementing evidence-based clinical practice guidelines for preventing PNI during RALP in the ST position (see Appendix A).

Iowa Model Application

The Iowa Model, developed at the University of Iowa Hospital and Clinics, is a quality insurance framework utilized by nursing researchers to investigate problems in the healthcare field and explore different quality improvement measures (Cullen et al., 2017). The steps of the Iowa EBP Model can help healthcare professionals "translate research findings into clinical practice while improving outcomes for patients" (Brown, 2014, p. 157). This paper will discuss the utilization of the Iowa EBP Model to implement an evidence-based preoperative patient positioning checklist for CRNAs to assist in the prevention of PNI for patients undergoing RALP in the ST position (see Appendix C).

Step 1: Identifying Triggering Issues

The first step of the Iowa Model requires the user to identify a triggering issue that could be identified as a problem in clinical practice (Cullen et al., 2017). At the facility where this project is being implemented, specific CRNA-based clinical practice guidelines for patient positioning during RALP in the ST position do not exist. There is growing evidence supporting the need for the creation of clinical practice guidelines to reduce the incidence rate of PNI in the growing number of RALP in the ST position (Cornelius et al., 2021).

Step 2: State the Question or Purpose

The main objective of this project is to create clinical practice guidelines in the form of a checklist that a theoretical hospital system can adopt. The guidelines aim to reduce the incidence rate of patient PNI during RALP in the ST position. Additional project objectives include developing a proposal to implement CRNA positioning checklist, developing a plan to measure the PNI incidence rate in the first 24 hours of a patient's surgical admission, and developing assessment criteria to gauge the effectiveness and impact of implemented CRNA positioning checklist. The established PICOT question will be used as a template to aid in the organization of thoughts and to guide key search terms utilized in the literature review.

Step 3: Is This a Priority?

The identification of priority issues is essential in healthcare. A hospital system may annotate high-priority topics as ones that "address high volume issues, high-risk issues, high-cost issues, issues that are closely aligned with the institution's strategic plan, or other institutional market forces such as patient safety or organizational reimbursement" (Cullen et al., 2017, p. 17). According to the Iowa Model, an initial step is identifying a problem in practice related to patient positioning during RALP (Cullen et al., 2017). A facility needs assessment will be conducted to

determine the prevalence of PNI in the system and determine how many PNIs are reported within the first 24 hours of a patient's surgical admission post RALP. A systematic review by Cornelius et al. (2021) examined 4,975 articles, one randomized controlled trial, and five retrospective studies examining 63,667 patients concluding that the incidence rate of peripheral neuropathies varies between 1.3% and 10.8% of all general surgical cases. A high range of variability occurs in the incidence rate of PNI during surgical procedures for reasons that include long intraoperative times and improper patient positioning. Cornelius et al. (2021) states that due to the high degree of variability of PNI during RAS "there is an urgent need for high quality, well- designed, prospective randomized controlled studies to build more knowledge of how to prevent peripheral neuropathies after RALP" (p. 366). The incidence rate of PNI reported during RALP in the ST position will be investigated further.

Step 4: Form a Team

It is essential for the researcher to carefully construct a team of stakeholders early in the EBP process (Cornelius et al., 2021). Stakeholders are "a person, group, or organization that has interest or concern in an organization" (Lubbeke et al., 2019, p. 331). "Stakeholders can affect or be affected by an organization's actions, objectives, and policies" (Lubbeke et al., 2019, p. 331). According to Lubbeke et al. (2019), the primary healthcare stakeholders are "patients, providers, financiers, and policymakers" (p. 331). Healthcare stakeholders must collaborate to create common goals of increasing patient safety, enhancing healthcare delivery, and reducing healthcare costs. The patient, anesthesia providers, and the hospital system are the three main stakeholders in implementing clinical guidelines for patients in the ST position during RALP. Essential elements of team building include proximity of members, small team size, interprofessional diversity, free and open communication, commitment, and leadership

(Cornelius et al., 2021). Project leaders will compose a team of medical professionals from minimally invasive surgeons, anesthesiologists, CNRAs, operating room nursing staff, healthcare executives, and hospital financers/billing representatives.

The clinical issue will first be presented to the anesthesia staff, including the Chief Anesthesiologist and Chief CRNA. The project team will present data showing the prevalence of PNI during RALP, a proposed template and timeline for implementation of the CRNA positioning checklist, an overview of monitoring the implemented checklist, and how the results will be disseminated. The top figureheads must obtain project buy-in to proceed.

The clinical issue will also be presented to surgeons. Surgeons constitute a significant part of the surgical procedure and therefore will be made aware of the identified issue and the goals of implemented clinical practice guidelines. The surgeons will first be made aware of the CNRA positioning checklist via email and then later educated in-person at a monthly meeting. The proposed intervention may slightly delay the onset of a surgical procedure by a few minutes; however, the extra time reserved for ensuring the patient is appropriately positioned can lead to the safer delivery of care to surgical patients undergoing RALP in the ST position.

The information technology department (IT) must also be involved with implementation. IT is capable of "acquiring, deploying, and adapting resources to improve organizational processes and performance" (Khatri, 2015, p. 42). The IT department can assist in creating a subsection in the patient medical record where CRNAs can chart the new interventions. The implemented intervention will be a checklist that staff will acknowledge during the surgical procedure timeout. The checklist will be based on evidence-based guidelines to prevent PNI (see Appendix C). The CRNA must chart on this checklist for all RALP in the ST position.

Members of the quality assurance/quality improvement (QA/QI) department will also be part of the team. The QI team will establish the incidence rate of PNI during RALP. The members will help monitor the incidence rate of PNI post-implementation of the timeout checklist. The team will assess for patient reported symptoms of PNI within the first 24 hours of patients' surgical admission. Key symptoms that team members will assess for will include numbness, tingling, burning, pain, and muscle weakness in the upper and lower extremities.

Lastly, risk-management team members will also be included as part of the team. Risk management is essential for documentation and information regarding litigation. Litigation can cost the provider and hospital system a large sum of money depending on the severity of injury to the patient and the preventability of the injury. A study by Kang et al. (2020) shows that 11.7 per 1000 anesthesia providers per year face malpractice claims. The malpractice claims can reach over one million dollars. The research shows that a large sum of money is lost from litigation from a PNI obtained under anesthesia. The prevention of one PNI could save millions of dollars for the provider and the hospital system.

Step 5: Assemble, Appraise and Synthesize Body of Evidence

Literature Search

In order to obtain the most current and highest level of evidence-based practice articles, a literature search was conducted using Otterbein University Library OneSearch and PubMed research data bases. The databases are scholarly search engines that maintain access to over 33 million professional citations and over 300 professional resources. A multitude of different search engine topics were imputed to establish scholarly resources.

Literature abstracts were searched using the key operators of robotic-assisted laparoscopic surgery AND steep Trendelenburg AND positioning AND nerve AND injury. The

results were limited to academic journals within the last five years. The search yielded 152 articles, and the researcher utilized over fifteen articles for academic support. The articles analyzed contain systematic reviews, literature reviews, randomized controlled studies, and peer-reviewed scholarly articles.

Summary of Literature

Topic Background. Establishing the history of robotics is essential to the creation of this project. An article by Shah et al. (2014) explains the origins of robotics in healthcare. The da Vinci robotic surgical system is the most common robotic system used in modern robotic-assisted procedures. Shah et al. (2014) establishes that robotics is a growing field and will continue to expand in the future. The benefits and limitations are discussed in depth in this article.

An article by Lanfranco et al. (2004) adds additional context to RAS's background, benefits, and limitations. Advantages of RAS includes 3-D visualization, improved surgical dexterity, stability, accuracy, seven degrees of freedom, elimination of surgeon tremors, the ability to scale motions, and telesurgery (Lanfranco et al., 2004). Disadvantages include the absence of touch sensation, machine price, staff requirements, and understudied complications and results (Lanfranco et al., 2004). Robotic systems approved by the Food and Drug Administration (FDA) and their applications are discussed.

The selected articles build a strong background on robotics and explain the growth and development of RAS since its implementation over 30 years ago. A foundation of RAS and its implications are essential to show that these types of procedures will continue to grow and develop.

Peripheral Nerve Injury. Information about PNI is essential to the development of the problem for this research paper. A study by Tighe (2009) explains the basics of the nervous system from an anatomical and physiological perspective. The symptoms of PNI and central nervous system injury are discussed in detail. PNI symptoms include numbness, tingling, pain, weakness, and paralysis (Tighe, 2009). PNI effects are variable. According to Tighe (2009), PNI symptoms can resolve within days, weeks, months, or years depending on injury severity. The most common causes of PNI are stretching, compression, surgical damage, ischemia, and unknown causes (Tighe, 2009).

A study by Walsh (1994) is essential in discussing the most common surgical positions for patients during surgery and the most common neuropathies associated with each position. The ST position is one of the most used patient positions. ST's extreme head-down position can reduce pulmonary compliance, create pulmonary edema, displace the endotracheal tube, mask intraoperative blood loss, and decrease stroke volume (Walsh, 1994). The most common nerves associated with neuropathy in the ST position include obturator, sciatic, common peroneal, anterior tibial, posterior tibial, saphenous, lateral femoral cutaneous, and pudendal nerves.

A study by Adedeji et al. (2010) describes the importance of correct patient positioning during surgical procedures. Proper patient position is vital to prevent damage to nerves, muscles, skin, and joints (Adedeji et al., 2010). The patient position allows optimal exposure for the surgeon to operate. Poor patient positioning can result in skin pressure sores, nerve damage, deep vein thrombosis, and compartment syndrome (Adedeji et al., 2010). The article examines recommendations on how to prevent patient mispositioning. Adequate preparation by staff, the safe transfer of the patient, routine intraoperative repositioning and monitoring by CRNAs, and immediate postoperative assessment in PACU by nurses are recommendations to prevent patient

PNI from occurring (Adedeji et al., 2010). The study explains that patient safety is the focus of care and that every healthcare practitioner has a responsibility to prevent intraoperative patient injury (Adedeji et al., 2010).

The selected articles build a strong background of the anatomy and physiology of the nervous system that the author can reference. Information about the most common surgical positions and forms of PNI is essential to explaining the problem of PNI during RALP.

Significance to Anesthesia. A study by Lubbeke et al. (2019) is essential in establishing stakeholders for the project and identifies the CRNA as a major stakeholder. The American Association of Nurse Anesthesiology (AANA) governs the guidelines that certified registered nurse anesthetists (CRNAs) practice by. The CRNA is responsible for ensuring patient safety while under anesthesia. The CRNA scope of practice includes working with the operating room staff to position, assess, and monitor proper patient positioning (AANA, 2019). CRNAs are responsible for protecting patient pressure points, ensuring patient perfusion, and preventing injury to patient nerves (AANA, 2019).

A literature review by MacRae (2006) examines closed claims related to anesthesia. A malpractice claim is considered a "demand for financial compensation for an injury resulting from medical care" (MacRae, 2006, p. 267). The article establishes that continuing projects are in place to monitor all closed claims related to anesthesia. Nerve injury consists of 17% of all malpractice claims since 1990 (MacRae, 2006). According to the AANA, proper padding was undocumented in 57% of claims, and improper patient positioning was evident in 36% of claims (MacRae, 2006). The study suggests that provider vigilance prevents PNI (MacRae, 2006). Other suggestions include the preoperative identification of patients at increased risk of injury, staff collaboration, and continuous monitoring devices (MacRae, 2006).

An article by Jordan et al. (2013) conducts a retrospective analysis of the National Practitioner Data Bank (NPDB) on anesthesia-related malpractice payments from 2004 to 2010. 369 anesthesia claims were examined. The least costly malpractice payment average for anesthesia providers was between $33,816.70-$65,103.20 for patients with minor injuries (Jordan et al., 2013). The median litigation cost for significant permanent patient injury was $947,804.90, with a maximum payment of $9,550,000 (Jordan et al., 2013).

The incidence rate of peripheral neuropathies is discussed in an article by Bouyer-Ferullo (2013). PNIs are uncommon but result in 0.02% to 21% of all surgical cases (Bouyer-Ferullo, 2013). Improper patient positioning, the length of surgery, patient comorbidities, and surgical equipment are all responsible for PNI (Bouyer-Ferullo, 2013). The article echos that proper patient positioning is the responsibility of all surgical staff (Bouyer-Ferullo, 2013). The article recommends assessing a patient's baseline of peripheral pulses, mobility impairments, comorbidities, and tissue perfusion are beneficial to the prevention of PNI (Bouyer-Ferullo, 2013).

The selected articles are essential for explaining how PNI is significant to nurse anesthesia. The CRNA is responsible for patient positioning and preventing intraoperative neurological injury. The CRNA is liable for PNI sustained under their supervision. The alarming incidence rate of PNI supports the idea that PNI is a significant issue. The litigation amounts regarding PNI show that PNI is very costly to the patient, the anesthesia provider, and the hospital system. The money saved by the prevention of one PNI could be immense.

Statistical Data. A study by Alemzadeh et al. (2016) examines the adverse events in RAS. A comprehensive data analysis examines all the reported events during RAS from 2000 to 2013 (Alemzadeh et al., 2016). The article concludes that the overall number of complications

and patient deaths has remained stable since the implementation of RAS (Alemzadeh et al., 2016). Within the article, the authors reported that common causes of complications include surgeon mistakes (7.1%), device malfunction (62%), improper patient positioning (4.1%), accidental surgical burns (2.2%), and unknown causes (18.8%) (Alemzadeh et al., 2016). Alemzadeh et al. (2016) recommends developing surgical team training regimens and uniform standards to prevent intraoperative PNI from occurring.

A systematic review by Oblak and Gillespie (2021) examined research from 2019 to 2021 from academic libraries on complications from patient positioning during RAS in the ST position. The overall incidence rate of PNI ranged from 0.16% to 10.8% for all RAS (Oblak & Gillespie, 2021). Oblak and Gillespie (2021) conclude that hospital systems should develop protocols and procedures to support practice and to prevent PNI from occurring intraoperatively.

A systematic review by Bjoro et al. (2020) examined 11 quantitative studies, including 6 registry-based studies, 3 prospective longitudinal studies, 1 randomized controlled trial, and 1 combined register-based study related to PNI. The incidence rate of PNI was reported to be 0.16% to 10% of all surgical cases (Bjoro et al., 2020). Risk factors were reported to be related to patient position, procedure time, comorbidities, and increased ASA and BMI scores (Bjoro et al., 2020).

Statistical based studies are essential to support the project. Systematic reviews are the highest level of evidence available and can help to validate the author's ideas in the project. The evidence-based studies unveil valuable information to strengthen the claim that prevention of PNI during RALP is essential to healthcare.

Step 6: Is There Sufficient Evidence?

The project's literature review unveiled scholarly articles showing a prevalence of PNI in patients undergoing RAS. The studies show that PNI is one of the most common causes of provider litigation. The evidence provided supports the need for implementation of CRNA positioning guidelines for RALP in the ST position.

Steps 7-9: Design, Implementation, Integration

Setting

The setting for implementing the proposed clinical practice guidelines is a large, urban level one trauma center in the midwestern United States. The hospital includes access to the da Vinci Robotic Surgical System for inpatient and outpatient surgical procedures under United States Food and Drug Administration (FDA) approval. The robotic-assisted surgical procedures approved at the hospital include robotic use for cardiac surgery, colorectal surgery, gynecological surgery, thoracic surgery, urological surgery, orthopedic surgery, general surgery, and head/neck surgery. The American Society of Anesthesiologists (ASA) and AANA guidelines are upheld by anesthesia staff at the theoretical hospital. The ideal facility undergoes a high tempo of RALP procedures yearly. The patient population is plentiful and diverse, with people of different ethnicities, backgrounds, ages, and comorbidities. The ASA physical status of the surgical patients ranges from I to V. The ASA physical status system is a tool utilized by clinicians to help categorize patients and help to predict operative risks (Doyle et al., 2022). ASA I is considered a normal, healthy patient (Doyle et al., 2022). ASA II are patients with mild systemic disease (Doyle et al., 2022). ASA III are patients with severe systemic disease that is non-life threatening (Doyle et al., 2022). ASA IV are patients with severe systemic disease that is a constant threat to life (Doyle et al., 2022). ASA V are patients that are not expected to

survive without immediate surgical intervention (Doyle et al., 2022). The higher the ASA score, the more likely a patient is to sustain PNI under general anesthesia.

Inclusion Criteria

The patients that the researcher will include will be all patients that undergo RALP in the ST position over six months. The sample population will be categorized as a convenience sample. The background and comorbidities of the patients will not exclude any patients, unless established nerve injury is reported/documented. The data collected will be stronger and more representative of the patient population with a large sample size. The goal is to create data from 200 RALP over six months. The research project is classified as a quality improvement (QI) project and does not typically require patient consent (Hunt et al., 2021). The QI/QA team will handle the data obtained from implementing the clinical practice guidelines, and all Health Insurance Portability and Accountability Act (HIPAA) laws will be followed per standards of care.

Methods/Timeline

The proposed timeline for project implementation spans a total of 10 months, with 6 months being intervention implementation (see Table 1).

Table 1

Proposed Timeline

Task	Month									
	1	2	3	4	5	6	7	8	9	10
Clinical Practice Guidelines "Time Out" Checklist finalized										
Guidelines introduced to staff via email/department flyers										
Guideline roll-out during FTE monthly meeting/Training										
Implementation of "Time Out" checklist										
Collection and review of data										
Indicated adjustments made to plan/guidelines										

During the first month, hospital stakeholders will develop, analyze, and finalize the CRNA time out checklist. The team will work together to ensure that the created clinical practice checklist is ethical, achievable, and that there are no conflicts of interest to implementation. The stakeholder team will work with the IT department to develop the checklist into a subsection of the patient chart where CRNAs can document on during every RALP.

During the second month, all anesthesia staff, operating room nursing staff, and surgeons will be emailed an information packet that contains the new timeout checklist. The purpose of the email is to provide staff with the background information on PNI. The email will contain the statistics on the problem, the effects of the problem on patients and providers, and the CRNA time out checklist to be implemented to reduce the incidence rate of PNI.

In the following month, a staff meeting built into staff full-time equivalent (FTE) will be conducted. At the staff meeting, an educational session will readdress all the information sent out in the prior month's email. Staff will be able to ask questions and give insight into the identified problem and the newly implemented checklist. The CRNA educators will explain to the staff their new individual responsibilities and expectations. The CRNA educators will establish that it is a collaborative effort between all operating room staff and will require dedication and commitment to create a successful role out of the new clinical practice guidelines. The CRNA will ultimately be responsible for the checklist and the documentation. The goal is to prevent PNI to help keep patients safe and enhance the care delivered by staff. After the meeting, staff must sign off on the newly implemented expectations and clinical practice guidelines checklist.

Over the next six-month period, the timeout checklist will be integrated into practice. The post-implementation data will come from these six months. In the post-operative period, during post anesthesia care unit (PACU) assessment, numbness, tingling, burning, and muscle weakness will be assessed in patient’s upper and lower extremities. The PACU nurses will alert the anesthesia team if signs of PNI are present and document them appropriately in the chart. The data will be collected by the CRNA educator, and the prevalence of PNI symptoms recorded.

After the final month, the data will be collected and analyzed. The stakeholders and QA/QI teams will gather the data from the six-month implementation period and compare the results to the data collected before implementation. The incidence rate of PNI during RALP for patients in the ST position will be compared before and after implementation.

Proposed Budget

The proposed budget includes an estimation of the costs of the creation of informational posters (see Table 2). The posters will display in every operating room and breakroom for staff to see and easily follow. The midwestern level-one trauma hospital where the guidelines will be implemented contains 20 operating rooms and four staff breakrooms. Twenty-four posters will be budgeted for in total. The breakdown of costs will be as follows:

Table 2

Table of Expected Expenditures

Expenditures	**Estimated Costs**
• 36x24 inch posters with print • 256-count poster hanging strips	• $30/poster x 24 displays = $720 • $40 **Total = $760**

The timeout checklist will be implemented with an educational session during regularly scheduled FTE hours for staff. The educational session during regularly scheduled hours will eliminate the costs of paying out hourly overtime to all staff in attendance.

Step 10: Dissemination of Results

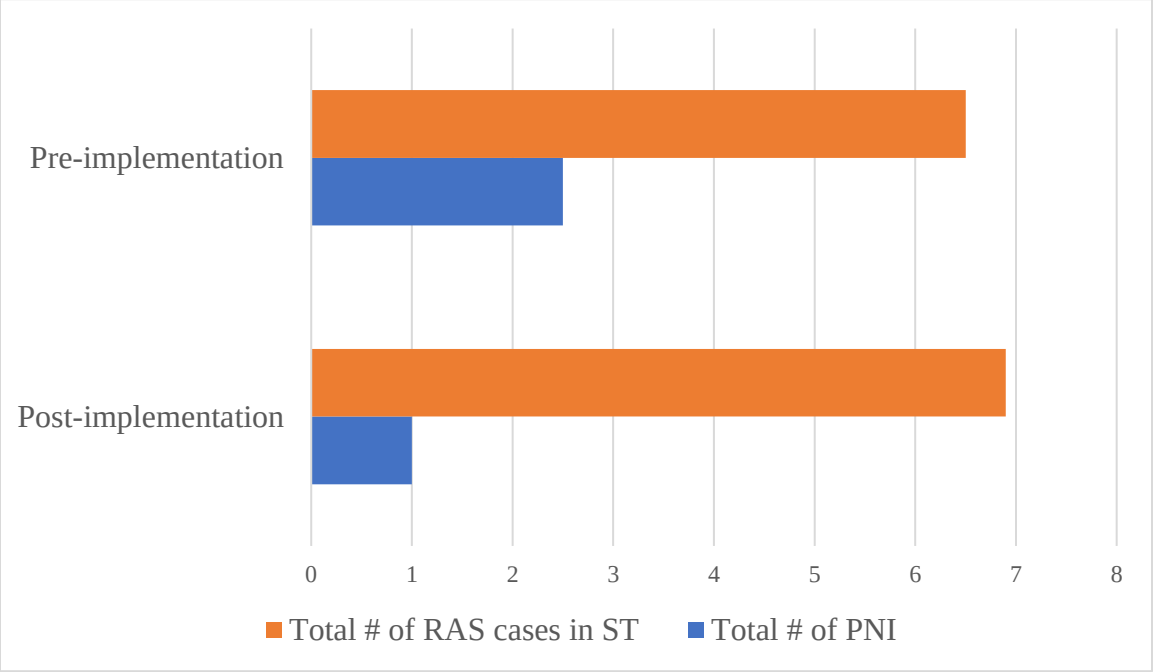
The tools utilized for the outcome analysis plan include direct data collection and comparison. The number of neurological injuries that occur during RALP for patients in the ST position at a mid-west level one trauma hospital over six months prior to intervention implementation will be compared to the number of neurological injuries that occur over six months post-implementation. The focus will be on PNI symptoms reported within the first 24 hours of a patient's surgical admission. The data collected will have a high level of validity

because the numbers measure their intended variable. The reliability of the data is variable because if the study were to be repeated, the results would yield different incidence rates of PNI. The QA/QI team will be responsible for data collection. The QA/QI team will dedicate time to thoroughly investigate prior RALP cases over the 6-months prior to intervention implementation and note the incidence rate of PNI that occurred to patients in the ST position.

Descriptive statistics will be utilized to analyze the data collected. According to Vetter (2017), "descriptive statistics are specific methods used to calculate, describe, and summarize collected research data in a logical, meaningful, and efficient way" (p. 1). A simple summary of the numbers pre-implementation versus post-implementation will be collected (see Table 3). The distribution of the data will be utilized to analyze the results. The total number of PNI that occur in both periods divided by the total number of RALP that meet the inclusion criterion during both periods will yield two different percentage values. The data compiled can be placed into a histogram or bar chart to show a visual representation of the data. The project will be considered successful if the post-intervention percentage of PNI compared to the total sample size of the time frame is lower than the pre-intervention implementation percentage values.

Table 3

Example Comparison of Results Table



Limitations to the research include the inability to disseminate the actual reason behind the neurological injury occurrence. PNI can occur for many reasons, including improper patient positioning, lack of provider vigilance, and mechanical issues. The implemented timeout checklist will address the most common research-backed reasons for intraoperatively PNI. The research project will be unable to pinpoint particular deficits in the methodology of care provided due to the variability of reasons PNI can occur.

Conclusion

The number of robotic-assisted surgical procedures are increasing daily and it is essential that anesthesia providers work to keep their patients safe. PNI is a common occurrence during RALP and can be costly to the patient, the anesthesia providers, and the healthcare system. The implementation of a timeout positioning checklist, supported by research, can decrease the

incidence rate of PNI that patients accrue and decrease provider litigation. Patient satisfaction will be increased with higher quality care and the money saved from potential litigation can be utilized more efficiently elsewhere.

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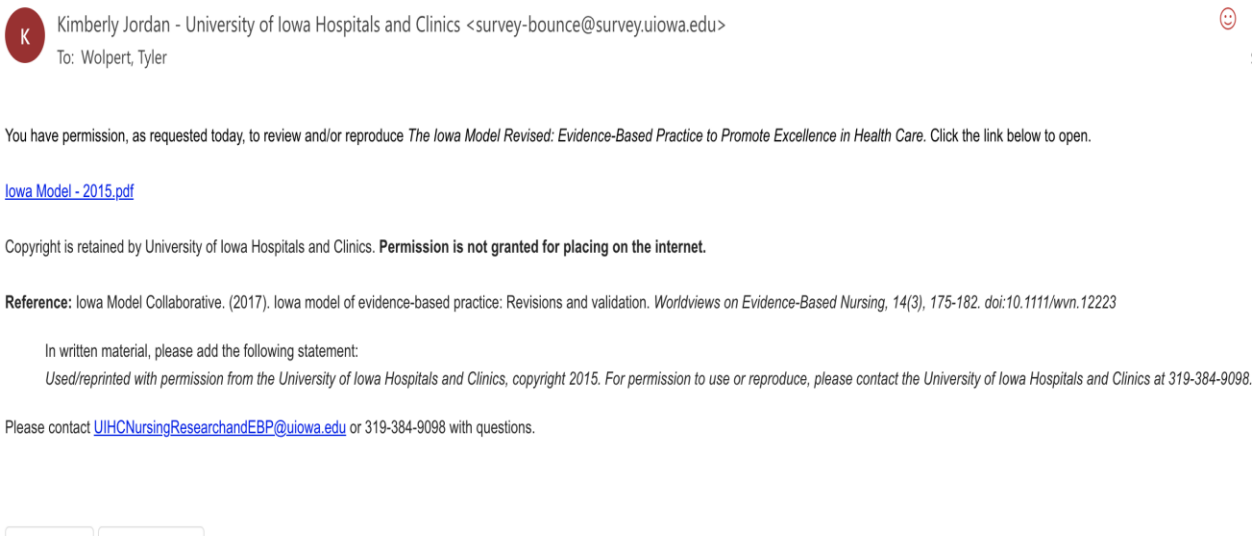
Appendix A

Iowa Model Permission



Kimberly Jordan - University of Iowa Hospitals and Clinics <survey-bounce@survey.uiowa.edu>
To: Wolpert, Tyler

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Appendix B

Literature Review Table

Citation	Purpose	Study Setting/Sample & Size	Research Design and Theoretical Framework	Variables	Validity & Reliability	Results	Conclusions	Limitations	How article supports paper
Nilsson, L., Lindberget, O., Gupta, A., & Vegfors, M. (2010). Implementing a preoperative checklist to increase patient safety: a 1-year follow-up of personnel attitudes. *Acta anaesthesiologica Scandinavica*, *54* (2), 176–182. https://doi.org/10.1111/j.1399-6576.2009.02109.x	To determine how well received an intraoperative checklist titled "Time Out" by staff and their thoughts and attitude on the implementation.	A cross-sectional study was developed. A questionnaire was sent by email to 704 people in the operating room department at two Swedish hospitals.	There was no theoretical framework noted.	There were no variables noted. The questionnaire assigned a numerical value 1-4 to rate the importance of the implemented checklist. Number 1 was least importance and number 4 was of most importance to the responder..	A survey is valid form of data collection however it has the potential risk of people falsify their true beliefs. There is potential that the results could be skewed.	The questionnaire was answered by 331/704 (47%) people. 93% of respondents answered that the "Time Out" checklist implementation contributes to increased patient safety.	The conclusion is that a standardized checklist during the intraoperative period is believed to contribute to better patient care provided by staff and an increase in patient safety.	The limitations are that a survey was sent out by email and only had a 47% response rate. Responders may have forgot to answer, or the email list may have been not updated.	The article supports the paper because it shows that a standardized checklist is viewed by staff to enhance the delivery of patient care and prevent injury from occurring.
Bjoro, B., Mykkeltveit, I., Rustoen, T., Altinbas, B. C., Roise, O., & Bentsen, S. B. (2020). Intraoperative peripheral nerve injury related to lithotomy positioning with steep Trendelenburg in patients undergoing robotic-assisted laparoscopic surgery – A systematic review. *JOURNAL OF ADVANCED NURSING*, 76(2), 490-503. https://doi.org/10.1111/jan.14271	The purpose is to examine the incidence rate of peripheral nerve injury and the results of these injuries for patients undergoing robotic surgery in Steep Trendelenburg position.	11 quantitative studies were examined that focused on intraoperative peripheral nerve injury related to robotic surgery in steep Trendelenburg position.	A systematic review was developed to analyze studies from PubMed, Cochrane Library, EMBASE, and CINHAL databases.	No variables noted.	No research instrument noted to gauge validity or reliability.	The incidence rate for intraoperative peripheral nerve injury during RAS in ST position was found to be 0.16%-10.0% with symptoms appearing after surgery.	The conclusion is that PNI is a rare but serious complication of RAS in the ST position that can have drastic effects on the patient. It is noted that it is up to OR staff to ensure injury does not occur to patients.	A systemic review may not represent all current research on the topic. Only 11 studies were utilized, which could potentially misrepresent the data and skew the results.	This article supports the paper because it is similar to the research being conducted. The research supports that PNI occurs during RAS in the ST positioning and is a prevalent enough problem that needs addressed.
Walsh, J. (1994). Update for nurse anesthetists—Patient positioning. *Journal of American Association of*	The article aims to review the effects and complications of the different intraoperativ	N/A	Peer-reviewed scholarly article.	N/A	The study has a high degree of validity and reliability. The author has special training in	N/A	The findings show that each unique intraoperative patient position has certain	Potential author bias could be a limitation of peer-reviewed articles.	This article supports the paper because it gives information on the different patient positions for surgery and the potential

Nurse Anesthetists, 64(3), 289-298.	e patient positions for surgery. Supine, ST, lateral, lithotomy, and prone positions are all examined.				the science of surgical patient positioning and has been a pioneer in the field since 1972. The article was peer-reviewed and published in the American Association of Nurse Anesthesiology.		risks and benefits. There are areas of focus for each position to ensure that injury to the patient does not occur. Different injuries can occur in different positions and can be debilitating to the patient.		risks of each position.
Tighe, S. (2009). Risks associated with your anesthetic: nerve damage. *The Royal College of Anesthetists, 10*(1), 1-6.	The article aims to examine the types of nerve injuries that can occur during anesthesia.	N/A	Peer-reviewed scholarly article.	N/A	The study has a high degree of validity and reliability. Other experts have examined the article in the field, which makes the article more valid and reliable.	N/A	The findings show that nerve injury to the patient can be broken down into central and peripheral injury. Furthermore, the damage can be permeant or temporary. Symptoms of each injury are presented in the article. A thorough review of the anatomy and physiology of the neurological system is presented in the article.	Potential author bias could be a limitation of peer-reviewed articles.	This article supports the paper because it helps identify the signs and symptoms of the different types of neurological injuries commonly sustained under surgery. The article also gives a detailed anatomy and physiology breakdown, which is beneficial to supporting ideas and thoughts by the researcher in the research paper.
MacRae M. G. (2007). Closed claims studies in anesthesia: a literature review and implications for practice. *AANA journal*, *75*(4), 267–275.	This article examines the most frequent closed malpractice claims in anesthesia and investigates the causes of adverse anesthesia	N/A	The article is a literature review that examines the ASA's Closed Claims Project, which reports closed claims in	N/A	The article is valid and reliable. National governing boards have reviewed the results mentioned in the article for anesthesia, and hundreds of physician	N/A	The findings show that anesthesia closed claims have been prevalent since the development of the anesthesia field. On	The limitations to the article are that only the ANA and AANA claims were analyzed. The article	The article supports the paper because it shows the prevalence of closed claims related to nerve injury. Nerve injury is most related to improper patient positioning and lack of

	patient outcomes.		anesthesia from 1970 to 1999. Over 6,894 claims were included in the analysis. The AANA closed claims were also examined. 223 closed claims were identified since 1989.		anesthesiologists have analyzed the results.		average closed claims take five years to be resolved. Many different types of patient injuries result in closed claims. Nerve injury represents the second most common injury at 21% of all claims. The data shows that in 57% of nerve injury claims that padding was undocumented, and in 55% of nerve injury claims, patient positioning was undocumented,	states that it did not include anesthesia claims related to dentistry. The data was analyzed by over 100 physician anesthesiologists, potentially lacking consistency in analysis.	documentation. Nerve injury is the second most common closed claim in anesthesia, and the prevalence of these claims shows that there is room for improvement regarding injury prevention. Additional findings show that lack of CRNA vigilance was a factor in 79% of all claims. Nerve injury to patients should be preventable.
Lübbeke, A., Carr, A. J., & Hoffmeyer, P. (2019). Registry stakeholders. *EF ORT open reviews*, *4*(6), 330–336. https://doi.org/10.1302/2058-5241.4.180077	This article aims to educate the reader on the different types of registry stakeholders in large systems. The article discusses stakeholder importance and the challenges stakeholders face in making valued decisions that impact companies.	N/A	Peer revied scholarly article.	N/A	The article is peer-reviewed. The authors have a high degree of reliability and are professionally trained in orthopedic surgery and traumatology. The article is reliable due to the author's credentials and the fact that it is published in an national scholarly journal for general orthopedics.	N/A	The article concludes that hospital stakeholders help mold the hospital system. Stakeholders face a difficult job making decisions that affect the whole system. According to the article, collaboration, transparency, and open knowledge generation are essential to making	The authors are the heads of the Division of Orthopedic Surgery and Traumatology in Switzerland. The study is European based, so the results may not apply to American studies. The authors could have some bias in	The article supports the paper because it gives the reader an idea of what it takes to make policy changes in the healthcare field. When considering a change, it is important to interview and gather information from key stakeholders. The patient, the anesthesia providers, and the hospital system are all critical stakeholders in refining patient positioning policy. The challenges that the stakeholders

							informed decisions. Stakeholders will continue making difficult decisions as the population ages and healthcare costs increase.	their opinions.	face are applicable to the obstacles that a patient positioning policy would face to be implemented into practice.
Shah, J., Vyas, A., & Vyas, D. (2014). The History of Robotics in Surgical Specialties. *American journal of robotic surgery*, *1*(1), 12–20. https://doi.org/10.1166/ajrs.2014.1006	This article aims to explain the origins and history of robotic-assisted surgery. The article explains how robotics were first used in surgery, the different types of robotic systems, and the different surgeries that robotics can be utilized in.	N/A	Peer reviewed descriptive scholarly article.	N/A	The article is peer-reviewed. The authors have a high degree of reliability and are professionally trained medical doctors. Two of the authors are involved the study of advanced robotics related to surgery. The article is published in the national Robotic Surgery manuscript.	N/A	The article concludes that robotics is a growing field and that its potential is relatively unknown. The future of robotics is expanding into tele-surgical procedures and nanobot technologies. The authors conclude that additional research is required in robotics as the field expands and grows.	The limitation of the article is that there is the potential of personal bias by the authors. Most of the information presented is factual however some personal opinions of the authors are added to the literature.	The article supports the project because it explains the foundations of robotic-assisted surgery. Important information about the growth of the field of robotics is listed in this article. The information and facts presented in this article are important to reference when discussing what types of procedures are available to be robotic assisted.
Mattei, A., Di Pierro, G. B., Rafeld, V., Konrad, C., Beutler, J., & Danuser, H. (2013). Positioning injury, rhabdomyolysis, and serum creatine kinase-concentration course in patients undergoing robot-assisted radical prostatectomy and extended pelvic lymph node dissection. *Journ*	This article aims to examine the cause of positioning injuries and rhabdomyolysis in patients undergoing robotic-assisted prostate surgery in the steep Trendelenburg position.	The sample utilized was the first 60 patients undergoing robotic-assisted prostate surgery at a German institute.	A prospective study was created for 60 patients undergoing robotic-assisted radical prostatectomy in steep Trendelenburg position. Positioning injuries were examined by the authors and graded by degrees of severity (1-3).	Body Mass Index, operative time, and steep Trendelenburg time were all individual variables of each surgery.	The article has validity however the results may not be reliable. If the same test study was done at another hospital, the results could be different. There are variables such as positioning protocols that may affect the repeatability of the results.	The results of the study show that during a mean operating time of 317 minutes, 21/60 (35%) patients showed positioning-related injuries. 16 patients (27%) had grade 1 injury, 2 patients (3%) had grade 2 injury, and 3 patients (5%) had	The article shows that prolonged and extended periods of time in the steep Trendelenburg position led to higher incidence rates of positioning related injuries during robotic surgery.	The limitations to the article include the lack of data over time. The study needs to prospectively examine a cohort of patients over a long period of time to have more accurate results.	The article supports the research because it shows data that positioning injury does and can occur to patients undergoing robotic-assisted surgery in the steep Trendelenburg position.

al of endourology, *27*(1), 45–51. https://doi.org/10.1089/end.2012.0169						grade 3 injury.			
Oblak, T., & Gillespie, B. M. (2021). The incidence of peripheral nerve injuries related to patient positioning during robotic assisted surgery: An evidence summary. *Journal of Perioperative Nursing,* 34(4), e-49-e53. https://doi.org/10.26550/2209-1092.1166	The article aims to describe the most common anatomical locations of nerve injuries that occur during robotic-assisted surgery in urological, gynecological, and colorectal procedures.	Articles published 2019-2021 that included the key terms listed in the research design section.	A systematic review was created to analyze articles published between 2019 and 2021 from the major online research databases that included the key terms: patient positioning, injury, and robotic-assisted.	N/A	The systematic review has the highest form of reliability and validity because it examines a large pool of peer reviewed articles and creates data from those articles.	The results of the study show an incidence rate of peripheral nerve injury associated with patient positioning to range between 0.16% and 10.8%.	The authors concluded that operating room teams should develop policies and procedures to carefully monitor patients during surgery and prevent neurological injury from occurring.	Limitations of the study are that most data was retrieved from retrospective reviews. The analyzed studies were not designed to evaluate nerve injury at the time of the incident.	This article supports the research because it shows that there is a need for intraoperative intervention to prevent neurological injury from occurring in patients. This article supports the need for a patient positioning checklist.

Appendix C

Timeout Checklist

	YES	NO
Does the patient have one or two working intravenous catheters (IVs) for medication administration?		
Is the patient in a neutral position (arms, legs, head, neck)?		
Are the arms tucked and padded appropriately? Are the arms secured on arm boards less than a 90-degree angle at the shoulder with elbows flexed and palms supinated?		
Are the hips positioned properly and hyperextension avoided?		
Is the patient secured to the table to prevent sliding? Is the cross-torso strap secured adequately?		
Are gel mats in place to pad patient pressure points?		
Is the patient free of the robotic trocars?		
Will patient position be routinely (Q15min) reassessed during RALP?		