INTRODUCTION

Proper positioning of the surgical patient is one of the most basic skills that perioperative nurses must understand and incorporate into daily practice; moreover, it requires special attention, since the potential for injury can occur at any time during a procedure on a sedated or anesthetized patient.[1] While patient positioning is an integral component of perioperative care, it is an area that may be compromised as staff try to accommodate surgeons and work through busy operating room (OR) schedules; inadequate padding and incorrect positioning can cause serious and long term injury and disability, and also lead to litigation against surgeons, staff members, and health care organizations.[2]

Undergoing any type of surgical procedure places a patient at risk for injury; all patients who receive general anesthesia are at risk for muscle or nerve injuries due to the loss of the body's protective reflexes.[3]

For example, overstretching of nerves can result in pain and short-term or long-term dysfunction.[4] Furthermore, patients who are immobile during a surgical or invasive procedure, are at increased risk for the development of pressure ulcers[5]; adding an extreme position further increases this risk.[6]

Moreover, all hospital-acquired injuries or complications, including surgical site infections (SSIs) are associated with significant clinical and economic implications, especially under the current Centers for Medicare and Medicaid Services (CMS) Hospital-Acquired Conditions (HACs) Reduction Program, which will impose financial penalties on poor-performing hospitals.[7]

For these reasons, all health care facilities are incentivized to prevent positioning-related injuries because they can be categorized as a "Never Event" or HAC and involve financial penalties. As a patient safety advocate, perioperative nurses play a critical role in safely positioning all surgical patients. Today, technological advancements in positioning systems used in combination with proper positioning techniques, can result in both clinical and economic benefits for surgical patients and health care facilities.

POSITIONING AND CARE OF THE PATIENT TO PREVENT ADVERSE EVENTS

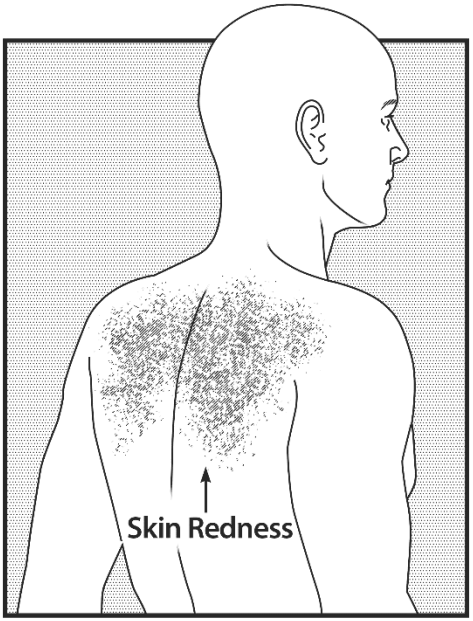
In order to understand the role of proper positioning techniques and advanced positioning systems, it is helpful to first review the physiological dynamics associated with patient positioning.

To properly and safely position patients, the perioperative nurse and other members of the surgical team must understand the anatomic and physiologic changes that occur with positioning.[8] The skin and underlying tissue, as well as the musculoskeletal, nervous, vascular, and respiratory systems are areas frequently affected by the changes that occur, as outlined below.

Anatomic and Physiologic Changes Related to Patient Positioning

- Skin and underlying tissue.[9] The physical forces used in establishing and maintaining a surgical position can injure the skin as well as the underlying tissue; these forces include pressure, shear, and friction (Figure 1). In addition, conditions inherent to the OR environment (eg, cold, heat, moisture, and negativity) further increase the susceptibility of the skin and underlying tissue to injury.
    - Pressure. Pressure is force that is placed on the underlying tissue, resulting from the weight of the patient's body, as gravity presses it downward toward the surface of the OR bed; it may also come from the weight of equipment resting on or near the patient's body (eg, Mayo stands, surgical instruments, rigid edges of the OR bed or attachments) or surgical team members leaning on the patient.
    - Shear. Shear is the folding of underlying tissue when skeletal structures move, but the skin remains stationary. It is important to note that a parallel force creates shear, in comparison with the perpendicular force created by pressure. This occurs when the patient is placed in either the Trendelenburg or reverse Trendelenburg positions; as gravity pulls the skeleton down, the stretching and folding of the underlying tissues as they slide with the skeleton obstruct vascular perfusion, leading to tissue ischemia.
    - Friction. Friction is the force of two surfaces rubbing against each other; on a patient's skin, this occurs when his/her body is dragged across bed linens instead of lifted. It can denude the epidermis, which makes the skin more vulnerable to higher stages of pressure ulcer formation, pain, and infection.
    - Cold. The cold ambient temperatures in the OR can lead to inadvertent hypothermia; a major surgical procedure further exposes the body to cold air. A cold core body temperature can decrease peripheral circulation, which reduces oxygen delivery to the skin and underlying tissue.
    - Heat. Heat on the body surface increases tissue metabolism and its oxygen and nutritional needs; if the tissue is also under pressure, vasoconstriction is likely to impede blood flow enough so that the increased demands are not met.
    - Moisture. In excess, moisture exacerbates the effects of pressure, shear, and friction. Prolonged moisture on the skin results in maceration. In these cases, moisture saturates the epidermis to a point where connective tissue fibers dissolve and can be torn apart easily; moreover, the skin weakens and is more vulnerable to the adverse effects of external forces.
    - Negativity. Negativity occurs when multiple layers of materials (eg, extra sheets) are placed over the OR mattress or padding. This additional linen can add rigidity and thus reduce the pressure-reducing properties of the OR mattress or padding. Furthermore, linen is absorbent as well as abrasive and therefore can produce high and inconsistent pressure.

Figure 1 – Skin Redness: An Indicator for Underlying Tissue Breakdown



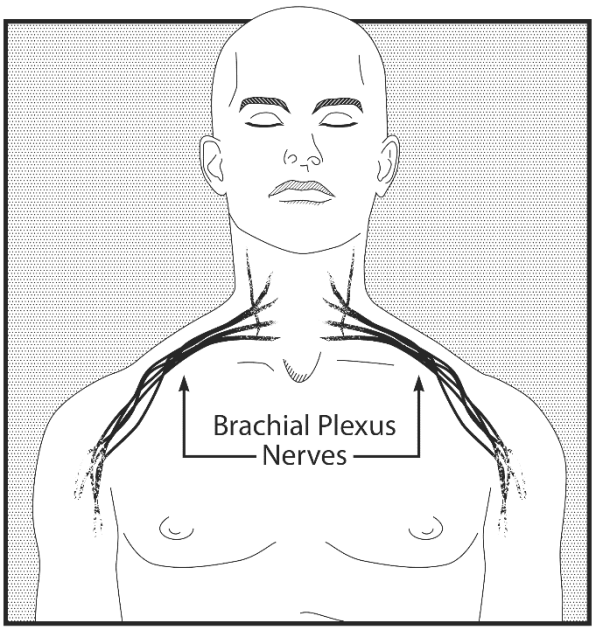
- Musculoskeletal system.[10] During positioning for surgery, the musculoskeletal system may be placed under unusual stress (eg, overstretching of muscles, tendons, and ligaments). Throughout a procedure, the patient's normal defense mechanisms cannot protect the body against muscle stretch and strain or joint damage. When positioning a patient, his/her natural body alignment should be maintained as much as possible; this is particularly important when transfers involve moving the patient from the supine position to lateral or prone. All members of the perioperative team must be aware of the limitations in range of motion and gently support the extremities during positional changes, refraining from excessive joint extension.

- Nervous system.[11] Anesthetic agents and other drugs administered during surgery depress the nervous system. The degree of depression depends on the level of general anesthesia or the type of regional anesthesia, as pain and pressure receptors can be affected either systemically or regionally. When the nervous system is depressed, the normal compensatory mechanisms no longer respond normally; therefore, the patient's body cannot compensate for the stresses associated with surgical positioning.
    - Peripheral neuropathies can occur during positioning, resulting in impaired motor or sensory function, or both.[12] The primary mechanisms that lead to position-induced nerve injuries are stretching and compression. Prolonged stretching due to hyperabduction of an extremity or pressure due to compression

results in ischemia that can progress to necrosis. Additionally, collateral damage to the surrounding tissues and capillaries impact circulation and nourishment to the nerves; these pathologic forces combine to cause functional or structural damage to the nerves.

- Upper extremity neuropathies[13] arise from lesions to the brachial plexus and the nerves that emerge from it. The brachial plexus is a bundle of nerve cords that runs through the shoulder; it innervates the lower shoulder, arm, and hand.
- In the OR, the most common nerve injuries are those to the ulnar nerve and brachial plexus. The ulnar nerve traverses behind the elbow, where it lies superficially in the shallow cubital tunnel of the humerus; here, it is subjected to pressure and stretching from flexion of the elbow. As shown in Figure 2, the brachial plexus is located in the shoulder, which is subject to abduction, manipulation, and pressure, depending on the position.

Figure 2 – Common Nerve Injuries Include the Brachial Plexus Located in the Shoulder Area



Shoulder braces should *not* be used to prevent a patient from sliding while in the Trendelenburg position, because they can compress proximal nerve roots and stretch the brachial plexus. Abduction of the arms on arm boards should be limited to 90 degrees or less. Excessive head rotation should also be avoided, particularly away

from the abducted arm, since this can compress and stretch the nerves between the clavicle and first rib. Many OR-induced upper extremity peripheral neuropathies can be prevented by properly securing the arms when they are tucked at the patient's side. The arms should be tucked in a manner that prevents them from sliding down the side of the OR bed and coming in contact with the edge of the bed or rigid bed attachments.

- The most frequent cause of lower extremity neuropathies[14] is prolonged lithotomy positioning; symptoms of these injuries typically are seen within hours after surgery. The nerves most frequently involved are the common peroneal, sciatic, and femoral nerves. In addition to the length of time in the lithotomy position, other intraoperative risk factors include high or exaggerated lithotomy and positioning of the extremities beyond their comfortable range of motion. The various types of stirrups differ in the degree that they control hip flexion. During positioning, hip extension should be limited to the minimum amount required for optimal access to the surgical site.

- Vascular system.[15] Depression of the sympathetic nervous system with general anesthesia causes peripheral vessels to dilate, which reduces overall blood pressure as blood pools in dependent areas of the body. Changes in position impacts where pooling of blood occurs; blood pools to the lowest body part. Muscle tone and peripheral vascular resistance are no longer able to counteract the forces of gravity on blood pooling. Deep vein thrombosis (DVT) and acute compartment syndrome are two serious complications of surgical positioning. The perioperative nurse should perform a vascular assessment of the upper and lower extremities preoperatively. Measures taken to reduce the assessed risks and evaluate vascular status intraoperatively and postoperatively should be documented.

- Respiratory system.[16] Surgical positioning can compromise the respiratory system. With few exceptions (eg, semi-Fowlers, sitting, and reverse Trendelenburg), in almost every type of position, the abdominal viscera shift upward toward the diaphragm. Consequently, the diaphragm shifts upward and outward and contributes approximately two-thirds of the ventilator force and significantly decreases tidal volume. Patients who are obese, pregnant, or have pulmonary disease have additional respiratory compromise in these positions. During surgery, external chest movement must be as unrestricted as possible to avoid further reducing tidal volume. Perioperative personnel should avoid placing the patient's arms across the chest, since this will not only restrict chest expansion, but also add pressure on the ulnar nerve in the elbow. In some positions (eg, lateral), positioning devices are needed to secure the patient to the OR bed without obstructing the surgical site. If safety straps are used, care should be taken to prevent excessive tightness; moreover, these positions should only be maintained as long as needed for the procedure.

- Obesity.[17] Obesity is another important consideration in regards to patient positioning, especially in light of its increasing incidence. Obese patients have diminished respiratory reserve and become distressed quickly when in the supine position. Because they have less tolerance for the Trendelenburg position, obese patients should not be positioned until they are intubated and mechanical ventilation can assist with breathing. Obese patients are at higher risk for various complications related to positioning and surgery, such as DVTs, sudden death from pulmonary embolism, pressure ulcers due to long periods of immobility, and rhabdomyolysis. Pressure from their large body mass on dependent tissues causes breakdown of muscle fiber and the release of myoglobin into the blood stream. Renal failure may result if this condition is not diagnosed early and treated aggressively with intravenous fluid hydration and diuretics.

ECONOMIC IMPLICATIONS OF POSITIONING-RELATED ADVERSE EVENTS

A discussion of the potential patient care issues associated with positioning must include a review of the economic implications associated with Never Events, HACs, and SSIs.

- Never Events.[18] The term "Never Event" dates back to 2001 when it was first presented by Ken Kizer, MD, former CEO of the National Quality Forum (NQF). The term referenced shocking medical errors (eg, wrong-site surgery) that should never occur. Over the years, the list has been expanded to signify adverse events that are unambiguous (ie, clearly identifiable as well as measurable), serious (ie, they result in substantial disability or death), and typically preventable. Initially, 27 Never Events were identified by the NQF in 2002; after its most recent revision in 2011, there are now 29 Never Events in seven categories: surgical, device or product, patient protection, care management, environmental, radiologic, and criminal. The development of a significant pressure ulcer (eg, stage 3, stage 4, or unstageable) acquired after admission to a health care facility is considered a Never Event.

  While most Never Events are rare, when they do occur, they are devastating to the patients; moreover, because they are devastating and usually preventable, health care organizations are under increasing pressure to eliminate them completely. In August 2007, CMS announced that Medicare would no longer reimburse health care facilities for the additional costs of care associated with many preventable errors, including those considered Never Events. Since that time, many states as well as private insurers have adopted similar policies regarding non-payment for the additional costs.

  Never Events are also being publicly reported in order to increase accountability and improve quality of care. Since the NQF publicized its original Never Events list in 2002, 11 states now mandate reporting of these events whenever they occur; an additional 16 states mandate reporting of serious adverse events (including many of the NQF Never Events). Health care facilities are held accountable to correct the

systematic problems that contributed to the event, with some states requiring that a root cause analysis be performed and the results reported. Positioning-related injuries can be classified as a Never Event in situations where there is a patient fall with serious injury or if there is a serious injury to a patient related to a positioning device failure or when a device is used for functions other than the use the device was intended to accomplish.

- Hospital-Acquired Conditions. In 2005, the Deficit Reduction Act led to a quality adjustment in Medicare Severity Diagnosis Related Group (MS-DRG) payments for certain HACs that:
    - are high cost, high volume or both;
    - result in the assignment of a case to a DRG that has a higher payment when present as a secondary diagnosis; and
    - could realistically have been prevented through the use of evidence-based guidelines.[19]

  On July 31, 2008, in the Inpatient Prospective Payment System (IPPS) Fiscal Year (FY) 2009 Final Rule, CMS included 10 categories of conditions that were selected for the HAC payment provision. Payment implications began October 1, 2008, for these HACs; stage III and IV pressure ulcers and surgical site infection following bariatric surgery for obesity are included.[20]

  On August 19, 2013, CMS issued its final rule that updated Medicare payment policies and rates under the IPPS for FY 2014; it affected discharges that occurred on or after October 1, 2013. In addition to setting the standards for payments for Medicare-covered inpatient services, the FY 2014 hospital payment rule described the process for implementing a new HAC Reduction Program, which began in 2015. The Affordable Care Act requires CMS to establish a program for IPPS hospitals to improve patient safety by imposing financial penalties on hospitals that perform poorly in regards to HACs, defined as conditions that patients did not have when they were admitted to the hospital, but which developed during the course of their hospital stay. Under the HAC Reduction Program, as of FY 2015, hospitals that have the highest frequency of medical errors or serious infections occurring in hospitalized patients are paid 99% of what they otherwise would have been paid under IPPS (ie, a 1% penalty is imposed).[21]

  Positioning injuries can be considered HACs when evidence-based guidelines are not used or if the injury is one that could have been prevented with proper use of equipment.

- Surgical Site Infections. One of the expected outcomes for every patient undergoing a surgical procedure is that he/she is free from the signs and symptoms of infection.[22] Today, SSIs remain common health care-associated infections (HAIs) and represent one of the leading causes of postoperative morbidity and mortality; they may also be associated with significant additional costs for hospitals and health

care systems.[23] A recent prevalence study reported that SSIs were one of the two most common hospital-acquired infections (HAIs), as they accounted for 21.8% of all HAIs among hospitalized patients.[24] The estimated 300,000 SSIs that occur annually in the United States increase hospital lengths of stay by 7 to10 days; in addition, the mortality rate associated with SSIs is 3%, with approximately 75% of deaths being directly attributable to the infection.[25]

The financial impact of SSIs has taken on greater importance over the years, as the changes in reimbursement described above have been implemented. The Institute for Healthcare Improvement (IHI) notes that the majority of SSIs are essentially preventable.[26] Therefore, hospitals and other health care facilities are incentivized to prevent SSIs, as well as other HACs.

In relation to patient positioning, the patient can be at a higher risk for SSI from a couple of perspectives. One involves reusable positioning devices when they are not properly cleaned or are in need of repair (eg, problem with surface integrity due to tears or wear). Another may be due to the use of tape when it is applied to equipment and adhesive remnants provide a barrier to proper cleaning and serving as a potential reservoir for pathogenic microorganisms.

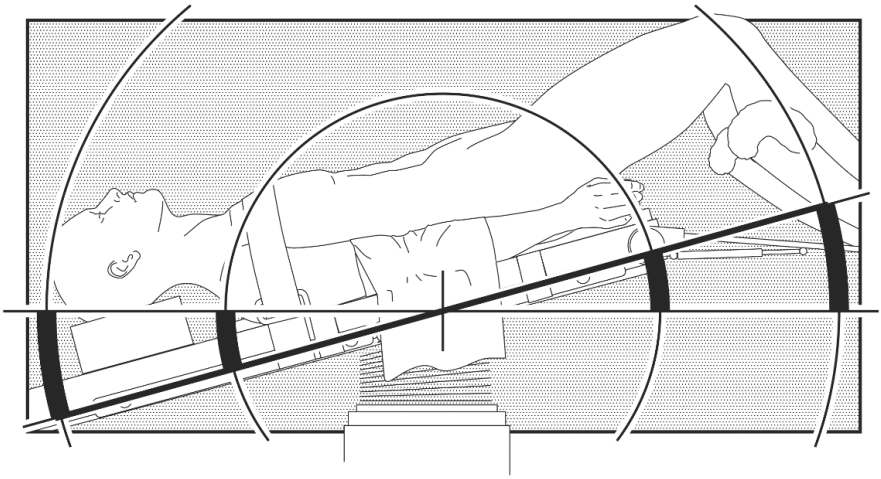
THE ROLE OF PROPER POSITIONING AND PATIENT SAFETY DEVICES

As discussed above, all surgical positions present certain risks for potential injuries. Extreme positions further increase the patient's risk for injury.[27] The remainder of this discussion will focus on patient care considerations and the use of new technology in positioning systems that enhance safety when advanced positions (ie, Trendelenburg, lateral tilt) are used.

Trendelenburg & Lateral Tilt Positions

The Trendelenburg position is a variation of the supine position; in Trendelenburg, the patient's upper torso is lowered, his/her legs are raised, often with knees bent by flexing the leg section of the OR bed to prevent the patient from sliding (Figure 3).[28] For some procedures, the legs are placed in stirrups during steep Trendelenburg (eg, laparoscopic gynecologic, colorectal, urologic procedures). When patients are in the steep Trendelenburg, shearing is a significant risk, as the skeletal structures slide toward the head of the bed. Historically, shoulder braces were used to limit the patient's upward sliding; however, these braces present a risk to the brachial plexus and should *not* be used, as previously noted. During robotic-assisted and other complex laparoscopic procedures, even the slightest movement as a result of sliding can increase the risk of port trauma and adversely affect the delicate nature of these procedures performed under high magnification.

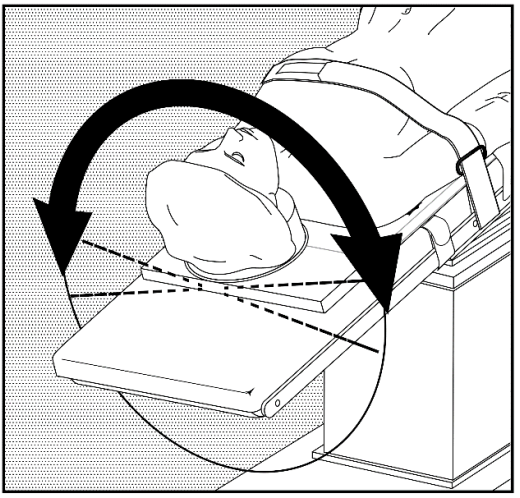
Figure 3 – Patient in the Trendelenburg Position



Several adverse events may be associated with steep Trendelenburg and/or lateral tilt positions (Figure 4), resulting from:

- patients slipping;
- nerve damage;
- skin and tissue breakdown leading to the development of pressure ulcers;
- improper arm tucking/protection;
- potential facial injury; and
- extremities (eg, pinch points).

Figure 4 – The Lateral Tilt Position Can Increase the Risk for Adverse Events



Challenges Associated with Extreme Positioning

Technologic advances in one realm often create new challenges in another; this is the case with certain laparoscopic procedures (eg, pelvic laparoscopy) and the use of the steep Trendelenburg position, which is used to replace packing and retractors for keeping the bowel out of the operative field.[29] This position, combined with gravity, can cause patients to slip on the OR bed and also place excessive pressure on the shoulders and upper extremities, which can lead to injuries. While the risks of these types of injuries have traditionally been considered low, the studies on which these data were based are older and usually involved less advanced surgical procedures than those being performed today and less sophisticated positioning systems than what are available today. With the added complexity of cases and the introduction of robotic technology being used with both steep Trendelenburg and reverse Trendelenburg positions, the risk for injury related to slipping and increased pressure on tissues are even higher than previously thought.

In the lithotomy position, there is still a risk for the patient to shift on the OR bed, particularly when moving into or out of Trendelenburg, as this position is often used in conjunction with lithotomy.[30] One study reported that for every hour a patient is in the lithotomy position, he/she has a 100-fold increase for the risk of developing a nerve injury.[31] The use of steep Trendelenburg position for prolonged periods has been associated with Erbs palsy, particularly when shoulder braces are used.[32]

Patient slippage also alters the original position of the extremities, which may subsequently lead to nerve injuries.[33] Perioperative nerve injury is a considerable source of patient injury. In the American Society of Anesthesiologists Closed Claims Project database, ulnar nerve neuropathy was the most common injury overall, representing one-third of all nerve injuries.[34]

The use of shoulder restraints or braces is *not* recommended because of the documented occurrences of brachial plexus injuries.[35] Brachial plexus nerve injuries occur in approximately 0.16% of advanced laparoscopic procedures.[36] Use of the lithotomy position for prolonged time periods can lead to injuries of the lower extremity nerves, including the femoral, lateral femoral cutaneous, obturator, sciatic, and common peroneal nerves. Sensory deficits from these injuries are reported after 1.5% of procedures performed in lithotomy position; persistent motor deficits are reported after 0.03% of cases.

If a brachial plexus injury does occur, it has many negative consequences for patients, including loss of sensation or motor control of the arm or hand; therefore, preventing this type of injury through proper positioning and padding, is essential.[37]

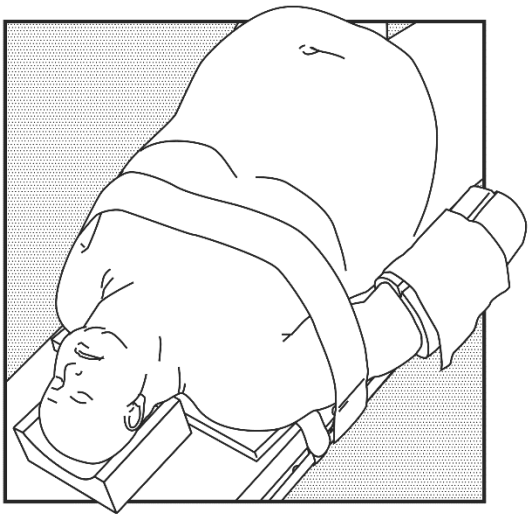
Sliding may also lead to dermal injuries.[38] Therefore, maintaining the patient's skin integrity is another aspect of care that must be at the forefront of patient preparations.[39] For example, during robotic surgery, shear-related injuries are a risk and appropriate preventive measures should be implemented; securing the patient to the OR bed with

proper padding and movement-limiting devices can reduce the likelihood of this type of injury.[40] The use of tape may increase the risk of dermal injuries, especially for patients with fragile skin or other patient characteristics that are recognized as risk factors for skin tears.[41] When positioning patients with tape to keep them from sliding, there is an increased risk for poor tissue profusion secondary to immobilizing the skin with wrinkles present and increased pressure because tape does not have redistribution properties. The risk of skin tears also increases when the tape is being removed.

In addition, during robotic surgery, the potential for abdominal wall and underlying structural injury exists if the patient slides cephalad while the robotic arms are fixed in relation to the patient's abdomen; this extreme position makes the patient vulnerable to other positioning- related complications, such as DVT and compartment syndrome,[42] as described above.

For overweight and obese patients, the perioperative nurse should frequently reassess the patient's position since, these patients have a higher incidence of sliding when they are in the steep Trendelenburg position (Figure 5).[43]

Figure 5 – Obese Patients Have a Higher Risk of Sliding When in Steep Trendelenburg



Advantages of Proper Patient Positioning Techniques and Devices

The implementation of proper positioning techniques, combined with the appropriate use of positioning devices, are an integral components of safe perioperative patient care. As noted, perioperative nurses and other members of the surgical team must understand the physiological changes associated with positioning and proper positioning techniques; they should also be aware of technologically advanced positioning systems available today.

The clinical advantages of proper a positioning device include that it:

- prevents patient slippage;
- reduces the risk of nerve damage;
- adds skin protection;
- eliminates the need for shoulder braces;
- facilitates access for monitoring patient vital signs;
- helps maintain body temperature;
- saves time and therefore reduces the amount of time the patient is under anesthesia;
- eliminates the use of adhesive tape; and
- decreases the risk for HAIs and SSIs when it is a single-use product.

Positioning devices should be able to effectively[44]:

- absorb compressive forces;
- prevent uneven and potentially excessive distribution of pressure;
- prevent excessive compression or stretching; and
- permit chest expansion for proper gas exchange and ventilation.

Perioperative nursing leaders should select and purchase appropriate positioning devices and also ensure that they are kept in good working order and have a decreased risk of cross-contamination (eg, single-use versus reusable). Because perioperative nurses have a strong influence in this area, they should be knowledgeable of the latest technological advancements in positioning devices and systems in order to protect their patients.[45] This includes playing an integral role in the evaluation and selection of patient care products by considering factors related to the effectiveness, safety, efficiency, cost, and the environment as part of a multidisciplinary product selection committee.[46] When evaluating positioning products, a key consideration that can be used to differentiate is whether or not the item is specifically designed for the purpose for which it is intended or whether it will need to be adapted to meet the need. One question that can be asked is whether the item has been patented. Patents can reflect that an item has been designed for a specific intent.

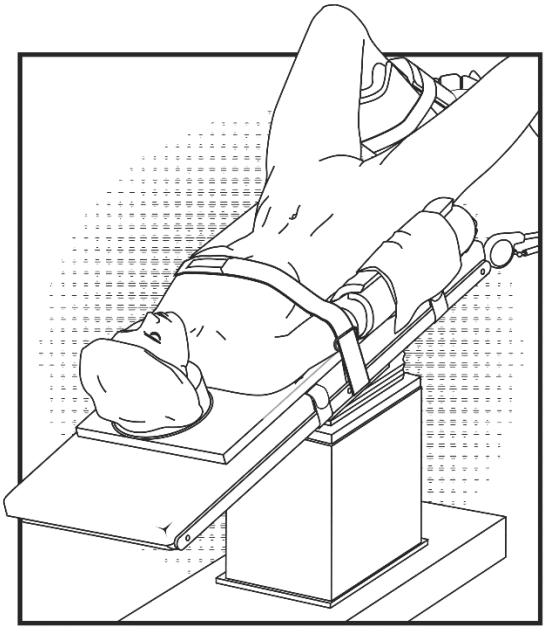
Advanced Positioning System

Technologic advancements in positioning devices have led to the development of new, safer systems. Historically, to address the problem of patient slippage during steep Trendelenburg positioning, OR teams have used a variety of positioning solutions such as the use of odd combinations of pads, egg-crates, bean bags, straps, hook and loops fasteners, and tape.[47] Today, an advanced, single-use positioning system has been designed for use in robot-assisted and laparoscopic colorectal, hysterectomy, and prostate procedures to reduce the risks for patient injuries associated with advanced surgical positions.

In this system, the positioning device is composed of an open-cell, breathable material that can help to maintain body temperature; the special formulation pad is latex-free with viscoelastic, shape-conforming properties. It is designed to be secured directly

to the OR bed with hook and loops straps at each of the four corners.[48] Because the specially formulated material has a high coefficient of friction, it molds and conforms to the individual contours of each patient's body to minimize slippage. The 2-layer lift sheet is designed to be positioned in between the patient's scapulae and sacrum; it serves two roles: first, it is a lift sheet that can be used to lift the patient to adjust his or her position on the OR bed while he or she lies on the pad, and secondly, it can be used to tuck the patient's arms. There is also a body strap designed to be positioned across the patient's chest that does not restrict chest expansion. Figure 6 depicts the advanced positioning system in use with the patient's rotating into the Trendelenburg position.

Figure 6 – Advanced Positioning System

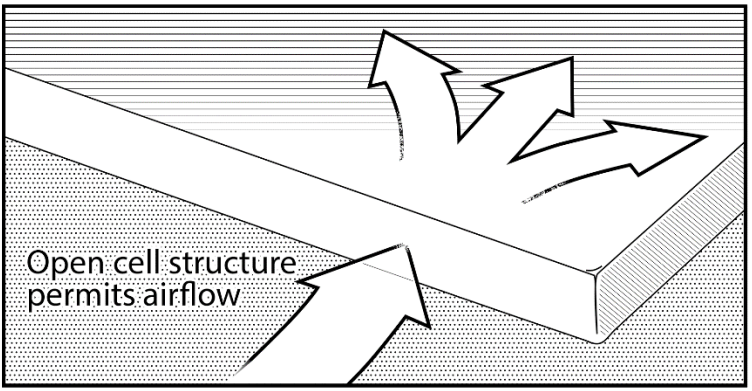


It is important to note that the unique material of this type of positioning device is designed specifically for direct skin contact (ie, the weight of the patient on the pad provides the stability; the heavier the patient, the greater the hold) and must be placed directly on the OR bed. Additional characteristics and properties of the positioning device include that it:

- is non-shearing;
- decreases skin friction, which is beneficial to patients who are already compromised due to poor circulation or skin breakdown;
- provides anti-motion properties;
- is open-cell and breathable (Figure 7);
- is insulative, which helps maintain a safe body temperature and is beneficial to the healing process;

- remains soft to the touch for the duration of the surgical procedure; and
- is latex-free.

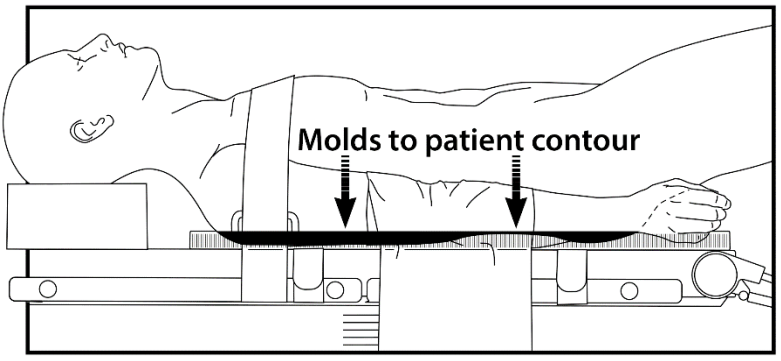
Figure 7 – Properties Include Open Cell Structure



This type of positioning system offers a safe, effective method for preventing patients from slipping, while also protecting them against tissue breakdown, brachial plexus nerve injuries, and infection. Clinical advantages of this type of system include the following.

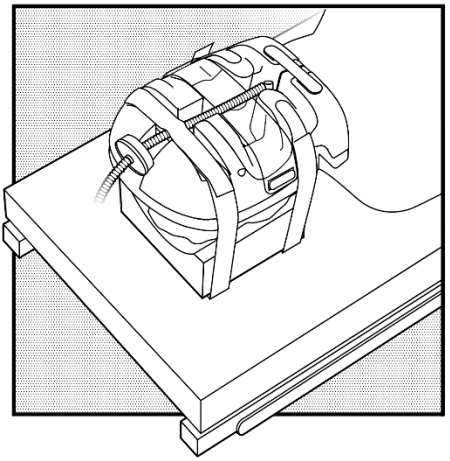
- Effective, even dispersal of pressure reduces the risk of pressure ulcers and pressure-related complications.
- The skin-friendly material greatly reduces the risk of post-operative skin redness and irritation caused by shearing and abrasion.
- The patient is completely secure because this type of pad is shape-conforming. It molds to the patient's body, which provides stability, maintains the patient's position throughout the procedure, and safely eliminates patient movement in the Trendelenburg and lateral positions (Figure 8).

Figure 8 – Advanced Positioning System Conform to the Patient to Provide Stability



- The patient is protected against nerve damage and pressure ulcers. The unique construction eliminates movement while it supports and secures the patient, without unnecessary pressure on the neck, shoulders, or arms.
- Bulking positioning pads or devices that deter the surgeon's access can be avoided while still addressing risks of injuries when it is necessary to tuck the patient's arms at his or her side (as discussed below).
    - The patient's face can be protected from contacting robotic arms that extend over the patient's head when the reverse Trendelenburg position is used (Figure 9).

Figure 9 – Face Protector

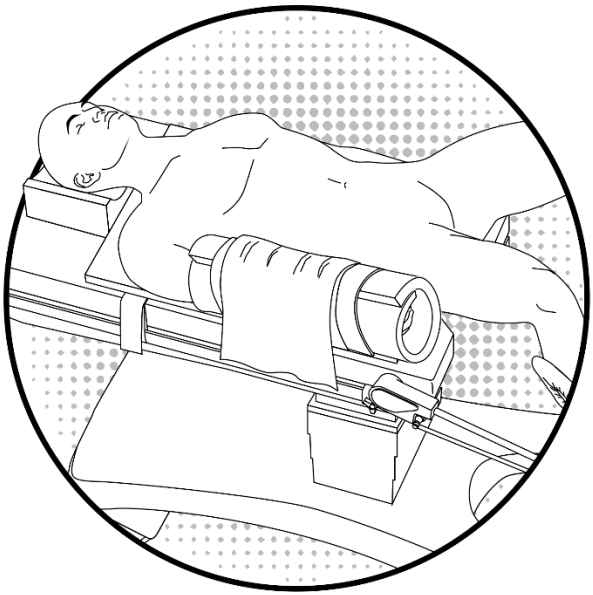


- Equipment storage can be reduced by replacing obsolete positioning devices (eg, shoulder braces, tape, bean bags) that do not meet patient positioning demands of today's advanced surgical procedures and the Trendelenburg position or comply with professional practice recommendations.
- The risk of cross-contamination is eliminated, thereby improving infection control standards. As a single-use device, the potential for cross-contamination associated with the use of reusable positioning devices is eliminated. It also eliminates the cross-contamination risks associated with tape/adhesive residue remaining on OR beds.
- It can contribute to improved surgical outcomes and the avoidance of CMS Never Events.
- Liability may be decreased because the risks associated with outdated positioning methods are addressed.
- There may be improved patient safety, comfort, and satisfaction, which often results in better outcomes and faster recovery times.

An added-layer of skin-friendly material lines the specialized arm protectors that are also available as part of an advanced positioning system (see Figure 10) that can be used for

tucking the patient's arms on the OR bed or on an arm board. A one-piece arm protector not only minimizes valuable set-up time, but enhances patient protection and safety by protecting the arm, ulnar nerve, and fingers throughout a surgical procedure and also during stirrup adjustments. Velcro straps on the arm protector provide easy access to the IV site and pulse oximeter.

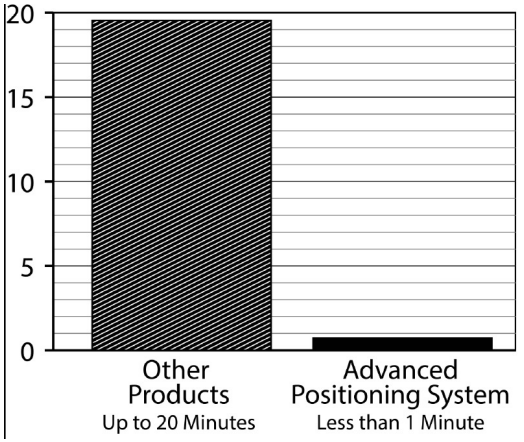
Figure 10 – Specialized Arm Protector



In addition to the clinical and patient safety benefits, utilizing proper positioning techniques in combination with the latest technologic advances in positioning systems can also positively impact worker safety and OR efficiency, as described in the following examples.

- Room turnover/setup times are improved; tear down and clean up times are also reduced. An advanced positioning system takes only one minute to set up, versus other systems that often take up to 20 minutes to set up (see Figure 11).

Figure 11 – Comparison of Set-Up Times: Traditional versus Advanced Positioning Systems



- OR efficiency and cost savings are increased as a result of the minimal set up time. The average OR cost per hour is $6,000; an advanced positioning system that takes only one minute to set up versus other systems that take up to 20 minutes, reduces both set up and room turnover times, potentially resulting in a cost savings of $1,400 per procedure (see Table 1).

Table 1 – Cost Savings with the Use of Advanced Positioning System

Average OR cost per minute ($6,000/hour)	$100
Average reduction in set-up time	6 minutes
Average reduction in turnover time	8 minutes
Dollars saved per procedure ($100 x 14 minutes)	$1,400

- Proper patient positioning can also reduce overall facility costs related to the additional costs of care associated with treating positioning-related injuries and extended lengths of hospital stays.[49] As noted above, the current CMS HACs Reduction Program no longer reimburses a health care facility if a patient develops a pressure ulcer or SSI after admission to the facility. This has significant financial implications for all facets of the health care system.[50] Surgical patients are at risk for development of pressure ulcers and SSIs; therefore, perioperative nurses must take a proactive approach in protecting their patients in order to avoid these adverse outcomes, including minimizing the risks related to positioning injuries.[51,52]

- The work environment is safer for the perioperative team because of the reduced risk of a patient shifting on or falling from the OR bed and the associated need for unexpected rescue without proper ergonomics.

POSITIONING POLICIES AND PROCEDURES: CREATING A FACILITY-SPECIFIC STANDARD OF CARE

Every health care facility should develop policies and procedures for safe patient positioning that are readily available for perioperative staff; these policies should include[53]:

- criteria for assessment and evaluation;
- required documentation;
- safety interventions;
- care and maintenance of positioning equipment and devices; and
- ergonomic safety.

Perioperative patient positioning policies should also be consistent with the organization's risk-control plan for prevention and management of pressure ulcers.[54]

A single-use, advanced positioning system is one component of a repeatable standard of care for patient positioning that can greatly enhance patient safety, comply with CMS guidelines to prevent Never Events, and also improve OR efficiency and cost-effectiveness by addressing the following risks:

- patient slippage during extreme table manipulations;
- nerve injury;
- skin /tissue breakdown;
- injuries to the arms and fingers; and
- cross-contamination.

As a part of a universal standard of care, this type of complete system eliminates the need for makeshift positioning solutions; therefore, every patient benefits from a safe, repeatable setup protocol.

SUMMARY

Proper patient positioning is a key component of perioperative nursing practice. For certain surgical procedures, placing the patient in the steep Trendelenburg, reverse Trendelenburg, lithotomy, and lateral tilt positions presents unique patient safety challenges and increases the risk for certain positioning-related injuries. These injuries are associated with significant clinical implications for the patient and significant economic consequences associated with the current CMS payment system that imposes financial penalties on facilities that perform poorly in regards to HACs. Therefore, all health care facilities are incentivized to eliminate these injuries by safely securing all surgical patients and protecting them from nerve, skin, and extremities damage associated with increased OR bed manipulations.

The use of an advanced positioning system that completely secures the patient in the Trendelenburg, reverse Trendelenburg, and lateral positions is one component in the development of a repeatable standard of care for patient positioning. As the patient's

advocate, perioperative nurses play an integral role in safe patient positioning by understanding proper positioning techniques and remaining aware of technological advancements in positioning systems available today that enhance patient safety and outcomes, while also improving OR efficiency and cost-effectiveness.

GLOSSARY

Friction	The force of two surfaces rubbing against each other; it can denude the epidermis and increase the skin's susceptibility to higher stages of pressure ulcer formation.
Hospital-Acquired Condition (HAC)	A reasonably preventable condition, which was not present or identifiable at the time of hospital admission, but was present during discharge.
Maceration	The softening and breaking down of skin, resulting from prolonged exposure to moisture.
Never Events	Medical errors that should never occur; the term signifies adverse events that are unambiguous, serious, and usually preventable.
Positioning Device	Any piece of equipment or device that is used for patient positioning and/or providing optimal anatomic exposure of the surgical site. Examples of positioning devices include support devices for the head, chest, and arms; pads for pressure points; and securing devices.
Pressure	The force placed on tissue; it results from the weight of the body as gravity presses it downward on the surface of the OR bed and from the weight of equipment resting on or against the patient.
Rhabdomyolysis	A serious syndrome due to direct or indirect muscle injury; it results from the death of muscle fibers and release of their contents into the bloodstream. Complications include renal failure and in rare cases, death.
Shearing	The sliding movement of the skin and subcutaneous tissue which leaves the underlying muscle stationary.
Trendelenburg Position	A supine position on an operating room bed, in which the bed is inclined at varying angles so that head is low and the torso and legs are elevated; it is sometimes used in robotic-assisted procedures and pelvic surgery to displace the abdominal organs upward.

REFERENCES

1. Spruce L, Van Wicklin SA. Back to basics: positioning the patient. *AORN J.* 2014; 100(3): 299-303.
2. Beckett AE. Are we doing enough to prevent patient injury caused by positioning for surgery? *J Periop Pract.* 2010;20(1):26-29.
3. Chitlik A. Safe positioning for robotic-assisted laparoscopic prostatectomy. *AORN J*. 2011;94(1):37-45.
4. Lopes CM, Galvão CM. Surgical positioning: evidence for nursing care. *Rev Lat Am Enfermagem.* 2010;18(2):287-294.
5. Association of periOperative Registered Nurses. Guideline for positioning the patient. In: *Guidelines for Perioperative Practice*. 2015 ed. Denver, CO: AORN, Inc; 2015:565.
6. Beckett AE. Are we doing enough to prevent patient injury caused by positioning for surgery? *J Periop Pract.* 2010;20(1):26-29.
7. CMS final rule to improve quality of care during hospital inpatient stays. August 2, 2013. Centers for Medicare & Medicaid. http://www.cms.gov/newsroom/mediareleasedatabase/fact-sheets/2013-fact-sheets-items/2013-08-02-3.html. Accessed September 16, 2015.
8. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:155.
9. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:155-156.
10. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:159-160.
11. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:160.
12. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:160.
13. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:160-163.
14. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:163-165.
15. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:165.

16. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:165-166.

17. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:166.

18. Never events. December 2014. Agency for Healthcare Research and Quality. http://psnet.ahrq.gov/primer.aspx?primerID=3. Accessed September 16, 2015.

19. Hospital-acquired conditions. August 19, 2015. Centers for Medicare & Medicaid Services. https://www.cms.gov/medicare/medicare-fee-for-service-payment/hospitalacqcond/hospital-acquired_conditions.html. Accessed September 16, 2015.

20. Hospital-acquired conditions. August 19, 2015. Centers for Medicare & Medicaid Services. https://www.cms.gov/medicare/medicare-fee-for-service-payment/hospitalacqcond/hospital-acquired_conditions.html. Accessed September 16, 2015.

21. CMS final rule to improve quality of care during hospital inpatient stays. August 2, 2013. Centers for Medicare & Medicaid. http://www.cms.gov/newsroom/mediareleasedatabase/fact-sheets/2013-fact-sheets-items/2013-08-02-3.html. Accessed September 16, 2015.

22. Infection. In: Petersen C, ed. *Perioperative Nursing Data Set: The Perioperative Nursing Vocabulary,* 3rd ed. Denver, CO: AORN, Inc.; 2011:254.

23. Graf K, Ott E, Vonberg RP, et al. Surgical site infections-economic consequences for the health care system. *Langenbeck's Arch Surg.* 2011:396(4):453-459.

24. Magill SS, Edwards JR, Bamberg W, et al. Multistate point-prevalence survey of health care-associated infections. *N Engl J Med*. 2014;370(13):1198-1280. http://www.nejm.org/doi/full/10.1056/NEJMoa1306801#t=articleResults. Accessed September 16, 2015.

25. Awad SS. Adherence to surgical care improvement project measures and post-operative surgical site infections. *Surg Infect (Larchmt).* 2012;13(4):234-237.

26. Surgical site infection. Institute for Healthcare Improvement. http://www.ihi.org/topics/ssi/pages/default.aspx. Accessed September 16, 2015.

27. Beckett AE. Are we doing enough to prevent patient injury caused by positioning for surgery? *J Periop Pract*. 2010;20(1):26-29.

28. Heizenroth PA. Positioning the patient for surgery. In: Rothrock JC, ed. *Alexander's Care of the Patient in Surgery,* 15th ed. St. Louis, MO: Elsevier Mosby; 2015:175.

29. Greenberg JA. The Pink Pad – Pigazzi Patient Positioning System™. *Rev Obstet Gynecol*. 2013;6(2):97-98. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3848666/. Accessed September 14, 2015.

30. Association of periOperative Registered Nurses. Guideline for positioning the patient. In: *Guidelines for Perioperative Practice.* 2015 ed. Denver, CO: AORN, Inc; 2015:573.

31. Shveiky D, Aseff J, Iglesia C. Brachial plexus injury after laparoscopic and robotic surgery. *J Minim Invasive Gynecol*. 2010;17(4):414-420.

32. Hurd WW. Gynecologic laparoscopy treatment & management. October 29, 2013. Medscape. http://emedicine.medscape.com/article/265201-treatment#d14. Accessed September 14, 2015.

33. Hortman C, Chung S. Positioning considerations in robotic surgery. *AORN J*. 2015;102(4):435-439

34. Nerve injury. Closed Claims Project and Its Registries. https://depts.washington.edu/asaccp/pubs/tags/publications/nerve-injury. Accessed September 14, 2015.

35. Association of periOperative Registered Nurses. Guideline for positioning the patient. In: *Guidelines for Perioperative Practice*. 2015 ed. Denver, CO: AORN, Inc; 2015:572.

36. Hurd WW. Gynecologic laparoscopy treatment & management. http://emedicine.medscape.com/article/265201-treatment#d14. Accessed September 14, 2015.

37. Chitlik A. Safe positioning for robotic-assisted laparoscopic prostatectomy. *AORN J*. 2011;94(1):37-45.

38. Hortman C, Chung S. Positioning considerations in robotic surgery. *AORN J*. 2015;102(4):435-439.

39. Zender J, Thell C. Developing a successful robotic surgery program in a rural hospital. *AORN J*. 2010;92(1):72-83.

40. Zender J, Thell C. Developing a successful robotic surgery program in a rural hospital. *AORN J*. 2010;92(1):72-83.

41. Skin tears: the clinical challenge. *Patient Safety Advisory.* 2006;3(3):1-8. http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2006/Sep3(3)/documents/01b.pdf. Accessed September 14, 2015.

42. Adedeji R, Oragui E, Khan W, Maruthainar N. The importance of correct patient positioning in theatres and implications of mal-positioning. *J Perioper Nurs*. 2010;20(4):143-147.

43. Chitlik A. Safe positioning for robotic-assisted laparoscopic prostatectomy. *AORN J.* 2011;94(1):37-45.

44. St-Arnaud D, Paquin M. Safe positioning for neurosurgical patients. *AORN J*. 2008;87(6):1156-1168.

45. Chitlik A. Safe positioning for robotic-assisted laparoscopic prostatectomy. *AORN J.* 2011;94(1):37-45.

46. Association of periOperative Registered Nurses. Guideline for product selection. In: *Guidelines for Perioperative Practice.* 2015 ed. Denver, CO: AORN, Inc; 2015:179.

47. Greenberg JA. The Pink Pad – Pigazzi Patient Positioning System™. *Rev Obstet Gynecol*. 2013;6(2):97-98. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3848666/. Accessed September 14, 2015.

48. Greenberg JA. The Pink Pad – Pigazzi Patient Positioning System™. *Rev Obstet Gynecol*. 2013;6(2):97-98. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3848666/. Accessed September 14, 2015.

49. Beckett AE. Are we doing enough to prevent patient injury caused by positioning for surgery? *J Periop Pract.* 2010;20(1):26-29.

50. Chitlik A. Safe positioning for robotic-assisted laparoscopic prostatectomy. *AORN J*. 2011;94(1):37-45.

51. Chitlik A. Safe positioning for robotic-assisted laparoscopic prostatectomy. *AORN J*. 2011;94(1):37-45.

52. Walton-Geer P. Prevention of pressure ulcers in the surgical patient. *AORN J*. 2009;89(3):538-548.

53. Association of periOperative Registered Nurses. Guideline for positioning the patient. In: *Guidelines for Perioperative Practice.* 2015 ed. Denver, CO: AORN, Inc; 2015:578.

54. Association of periOperative Registered Nurses. Guideline for positioning the patient. In: *Guidelines for Perioperative Practice.* 2015 ed. Denver, CO: AORN, Inc; 2015:578.