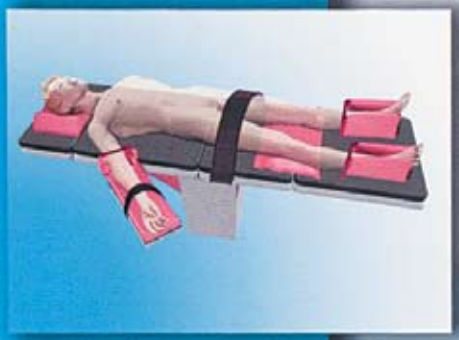
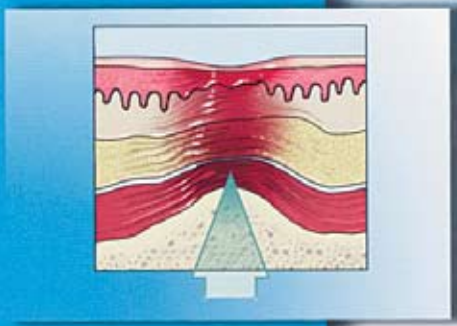


POSITIONING

a Patient Safety Initiative

Study Guide for Nurses



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POSITIONING

a Patient Safety Initiative

Study Guide for Nurses

Author
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FOREWARD

Positioning the surgical patient is an art that has its basis in science. The realm of responsibility for positioning falls primarily to the perioperative nurse. Armed with a thorough knowledge of pertinent anatomy and physiology, the nurse anticipates patient needs and nuances and prepares equipment that meets these needs. Positioning is a significant nursing action that often does not receive the emphasis that it should.

Wound care experts brilliantly describe the etiology and characteristics of pressure ulcers. But often, these descriptions are not extended to applications for surgical patients. More research by wound care and perioperative nurses that describes the potential hazards to surgical patients is sorely needed.

Between the covers of this manual, author Terri Goodman, PhD, RN has brought together what is currently known about the science and principles of patient positioning. Common surgical positions along with specific aspects of each are included. Goals related to safe patient outcomes are at the core of this work because positioning is one of the top requirements of safe surgery.

Digestion of the contents of this manual should be a requirement in the ongoing education of every perioperative nurse.

Finally, we have information that properly elevates the supreme importance of proper and exquisite patient positioning. Enjoy, read, understand, and apply!

Barbara J Gruendermann, RN, MS, PHD, FAAN, CNOR

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OVERVIEW

Correct patient positioning ranks high on the list of priorities for perioperative nurses responsible for safe surgical patient care. The educational needs include knowledge related to the potential anatomical sites for injury, pathophysiology of pressure ulcers and nerve damage, and individual patient assessment criteria related to surgical positioning planning. Positioning products and materials, and common positions used for surgical intervention are fully described. Knowledge of the potential consequences from improper and prolonged surgical positioning is critical to prevention of patient injuries; therefore, the roles anesthesia, diminished sensory perception, and prolonged immobility play in the potential for harm is reviewed. Pressure, shear, and friction are explained in depth. The AORN criteria for positioning products are presented. This independent study advocates a systems approach to positioning as related to patient safety and stresses the need for best practices in positioning techniques.

OBJECTIVES

Upon completion of this continuing education activity, the participant should be able to:

1. Describe the common patient positions important to surgical intervention.
2. Differentiate methods of tissue damage.
3. Explain the pathophysiology related to pressure ulcers originating during perioperative patient care.
4. Discuss the aspects of patient assessment that relate to potential injuries.
5. Identify the potential consequences of improper and prolonged surgical patient positioning.
6. Describe the value of a systems approach to perioperative patient positioning.
7. List critical aspects of AORN's Recommended Practices for Positioning the Patient in the Perioperative Practice Setting.

INTENDED AUDIENCE

This self-study program is intended to be used by perioperative nurses and other surgical team members who are primarily responsible for positioning of the patient in the surgical setting.

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4. Complete the review questions and compare your responses with the answers provided. If some areas are unclear, review that section of the booklet.
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SUPPORT

Grant funds and technical support provided by **ConMed Corporation.**

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INTRODUCTION

Pressure ulcers are a patient safety problem.

Patient positioning is an integral part of perioperative nursing and ranks high on the list of priorities for safe patient care. Only recently have researchers begun investigating the impact of positioning and intraoperative events on pressure ulcer development.

"There is little doubt that intraoperative events pose a pressure ulcer risk. Surgical patients have diminished sensory perception, experience prolonged immobility with unrelieved pressure, and are exposed to myriad factors that compromise tissue tolerance."[16]

In two prevalence studies, patients whose hospital stay included a surgical procedure were 90% more likely to present with an ulcer than nonsurgical patients.[65]

In April 2002, a JCAHO study of sentinel events demonstrated that postoperative complications comprised 12.2% of the 1609 events investigated.[5]

The NPUAP's* most accurate estimated prevalence rate of pressure ulcers in acute care is 15%.[29] Kemp and colleagues identified the overall incidence of pressure sore formation during operative procedures as 12%.[36]

AHCPR** placed pressure # 7 on their list of 79 evidence-based practices rated highest on prevalence and severity; pressure relief was #1 on the list of underutilized basic care practices.[9]

Approximately 23% of pressure ulcers start in surgery.[8]

Healthy People 2010 contains a goal of reducing pressure ulcers to focus the national's attention and resources on addressing this important health concern.[30,31]

Due to the delay in diagnosing pressure ulcers, the difficulty in identifying the exact time and place that they developed, and the concern for litigation, there has been, until recently, little documentation of surgery-related pressure ulcers in the medical literature in this country. [65] Previously most documentation of surgery-related pressure ulcers was found in the legal literature.[26]

Most pressure ulcers can be prevented.[10]

Emphasis on Patient Safety

Since the Institute of Medicine published To Err is Human in 1999 describing the enormous burden of medical errors in the United States,[38] public attention has been focused on patient safety. Tremendous emphasis has been placed on reducing medical errors of all kinds.

AORN has implemented a One Million Dollar Patient Safety Initiative to address patient safety issues in the perioperative setting. AORN contends that many adverse outcomes can be reduced significantly or eliminated entirely. In one study of adverse outcomes of surgery, 58% were classified as preventable.[31]

The Impact of Pressure Ulcers and Nerve Damage

Pressure ulcers can be a devastating experience for a patient - extending hospital stay, increasing recovery time, causing unnecessary pain and suffering, increasing expenses, and sometimes leaving the patient with a permanent disability. Pressure ulcers can contribute to patient mortality.

Pressure ulcers have a marked impact on the health care system as well.

- There are more than 1.5 million patients in the United States with pressure ulcers.[8,65]
- The mean length of stay in the hospital increases three to five times for a patient who develops a pressure ulcer.[1,65]
- Treatment of pressure ulcers costs the US healthcare system between $1.3 and $8.5 billion dollars.[45,30]
- There is increasing recognition that pressure ulcers are usually preventable and development of a pressure ulcer commonly represents a failure of medical or nursing care.[6]
- Pressure ulcers expose nurses, surgeons, and hospitals to significant litigation risk.[6]

Nerve injury is another potential adverse affect of positioning. Nerve injuries are more directly related to positioning errors than to managing the multitude of risk factors that predispose patients to pressure ulcer development.

In the USA, nerve injuries account for 15% of postoperative litigation claims.[58]

Clearly, patient injury related to positioning is an issue that can and should be addressed in the perioperative setting. Prevention of pressure ulcers and nerve damage is far less costly than treatment, both in terms of human suffering and financial cost.[9]

An 8-month pressure ulcer prevention study in one nursing home reported savings of more than $230,000 over treatment costs.[60]

The Answer: A Systems Approach to Positioning and Patient Safety

AORN and the Institute of Medicine emphasize that most medical errors are systems-related, and not attributable to individual negligence or misconduct. AORN proposes incorporating standardization and error-proofing to reduce medical errors in surgery,[5] an approach that has resolved many of the medication errors so widely publicized in the last several years.

> Lessons from other industries have demonstrated that system improvements can lead to reductions in error rates.

A well-developed system promotes patient safety by making it difficult to make an error. We can protect our patients from tissue and nerve damage with a positioning safety program based on best practices and best products. Reductions in adverse outcomes in excess of 50% have been seen in individual clinical settings.[17]

> Since the duration of pressure is not usually a controllable factor, minimizing the pressure intensity via the support surface will be a significant component of a patient safety program for positioning.[16]

Every operating room in the country uses a variety of approaches to positioning and a hodgepodge of positioning products. There are foam products, gel products, air-filled products, fluid-filled products, and an ample supply of sheets, towels, and blankets.

Very few of these items meet the AORN criteria for positioning devices.

Figure 1. Assortment of positioning devices used in the surgical setting

AORN believes that a culture of safety must be created, nurtured, and promoted, and that leaders must take an active role in ensuring processes to maintain and improve patient safety.[34] A culture of safety includes both consistent, comprehensive, and ongoing education and effective safety programs.[34,8] The safety program for positioning surgical patients must include best practices in positioning technique, positioning products that meet all of the established AORN criteria, and standardization to error-proof the positioning process.

> Positioning is one of the top requirements for safe surgery. The perioperative nurse should view positioning as specialized, logical, and rational knowledge that can make a distinct difference in patient outcomes.[28]

POSITIONING SAFETY PROGRAM - CHAPTER ONE

PRESSURE ULCERS

Definition

A pressure ulcer (pressure sore, bedsore, or decubitus ulcer) is an area of localized damage to the skin, muscle, and underlying tissue, usually over a bony prominence. Tissue damage is caused by unrelieved pressure, shear, and friction.

Redness (erythema) following pressure is a normal physiological response to the return of blood to the vascular bed that has been temporarily compressed. If the erythema is blanchable (whitens when pressure is applied) and the redness returns in rapidly, it indicates that compression did not destroy vessels and cell death did not occur. Blanchable erythema is not an early state of pressure ulcer development.

Pressure ulcers present as a reddened area that is often misdiagnosed as "a burn or bruise."[26,61] If the redness remains thirty minutes after pressure is relieved, enough damage may have already been done that formation of a sore is unavoidable.[35] At the time of discovery, it may be not evident that deep tissues have been destroyed.

A closed pressure ulcer or deep tissue injury (DTI) occurs when intense pressure causes ischemia in muscle tissue. Since skin is more tolerant of pressure, the wound begins in the deep tissues. These ulcers are not detectable initially, but deteriorate fairly rapidly as the skin tissues, normally fed by vessels from the muscle, also die. These wounds have the potential to deteriorate quickly into Stage IV wounds! They first appear blistered or bruised and can initially be confused with early stage I ulcers. Patients with these purple areas need immediate and complete pressure relief to give the tissue the most perfusion possible to attempt to reverse the ischemia.

In general, ulcers that cannot be adequately assessed because of eschar or those that are potentially DTIs should not be staged initially. There are legal implications of staging: a Stage I ulcer almost always heals with good care; a DTI initially diagnosed as a Stage I ulcer can be interpreted as worsening due to improper care, when in fact, the damage was already done. Appropriate staging requires that the bottom of the ulcer be evident.

Tissues damaged by a pressure ulcer, even when the ulcer has healed, do not regain their pre-ulcer health. Sites of previously healed pressure ulcers are at high risk for subsequent pressure ulcer development.

It is often difficult to pinpoint exactly when a pressure ulcer begins to form. Most pressure ulcers are not recognized immediately following the relief of pressure. Often hours to days pass before the ulcer is fully appreciated.

Ulcer formation is a progressive event. Pressure during the surgical experience may be the initial insult, or it may exacerbate injury that began preoperatively. Similarly, continued pressure during the postoperative period may initiate an ulcer or can exacerbate tissue damage begun in surgery. Conversely, pressure reducing/pressure relieving interventions postoperatively may inhibit the development of a potential pressure ulcer, or keep an ulcer from progressing to more serious stages.[64]

Guidelines for postoperative management usually emphasize early ambulation rather than pressure-relieving support.[12] Non ambulatory patients who spend a great deal of recovery time in a chair are at higher risk for pressure ulcer development than those who are nursed in bed.[8, 57] The outcomes of studies of pressure ulcers in surgical patients have significant implications for pressure-relief guidelines in postoperative as well as intraoperative management.

Pathophysiology of Pressure

Pressure applied to the skin causes the greatest force to be exerted deep in the tissues. The tissue next to the bone is muscle which is very intolerant of pressure and becomes ischemic easily because of its high metabolic rate. Damage occurs first to the muscle adjacent to bone, and progresses outward to the dermis and epidermis.[65] Thus, a pressure ulcer may develop in deeper tissues while the skin remains intact (a "closed' ulcer). Until late in development, a closed ulcer shows minimal superficial signs, even when the underlying damage is extensive.[67] For this reason, pressure ulcers that begin in surgery may not be discovered for hours to days following the procedure, and the seriousness of the ulcer may not be diagnosed immediately.

Prolonged exposure to high pressure, particularly over bony prominences, will almost certainly lead to ischemia and necrosis. [67] Low pressure over extended periods of time may also cause tissue damage, especially when tissue tolerance is diminished. Damage occurs first at the molecular level and is often irreversible.[26]

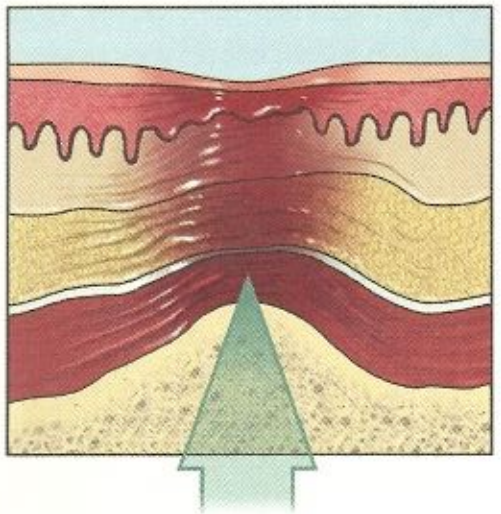

Figure 2. Internal and external compression of vessels related to pressure

Aside from extensive tissue destruction and possible permanent loss of function, sepsis is the most serious complication of pressure ulcers.[1] Other infectious complications include local infection, cellulitis, and osteomyelitis.

Common sites for pressure ulcers that develop during surgery are the heels, sacral area, trochanter, and occiput, but any part of the body upon which pressure is exerted is at risk for tissue damage. For example, in the lateral position, the upper leg, if not sufficiently padded, can exert pressure on the lower leg causing tissue damage. For each surgical position there are specific sites that are at highest risk.

Stages

In 1989, the National Pressure Ulcer Advisory Panel (NPUAP) recommended the following staging system that was adopted by the Agency for Health Care Policy and Research (AHCPR - now AHQR) Pressure Ulcer Guidelines Panels.[53]

The stages of pressure ulcers correspond to the tissue layers sustaining damage and are used for ulcer diagnosis and classification.

Stage I Defined areas of nonblanchable erythema of intact skin; the heralding of skin ulceration.

[Note: Pressure causes tissue hypoxia and capillary permeability; when the pressure is removed, there is a hyperemic reaction with vasodilatation and edema from extravasation of blood elements into the interstitial spaces. This reactive hyperemia can normally be expected to be present for one-half to three-fourths as long as the pressure occluded blood flow to the area; it should not be confused with a Stage One pressure ulcer.]

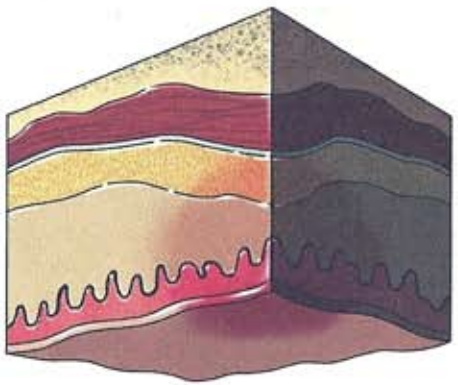

Figure 3. Stage One Pressure Ulcer

Stage I ulcers are the most difficult to identify and assess, and are frequently misdiagnosed as burns or "burn-like" lesions.

Stage II Partial thickness skin loss of epidermis and/or dermis; the ulcer is superficial and presents clinically as an abrasion, blister or shallow crater.

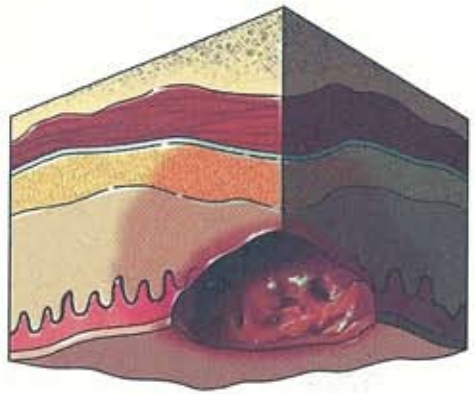

Figure 4. Stage Two Pressure Ulcer

Stage III Full-thickness skin loss involving damage or necrosis of the subcutaneous tissue that may extend down to, but not through the underlying fascia; the ulcer presents clinically as a deep crater with or without undermining of adjacent tissue.

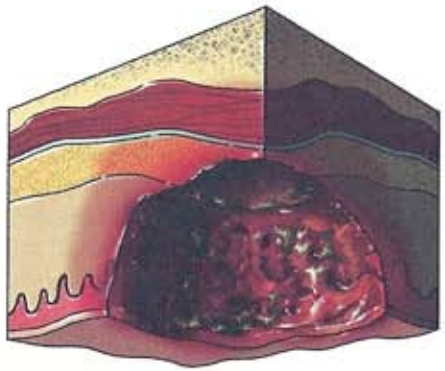

Figure 5. Stage Three Pressure Ulcer

Stage IV Full-thickness skin loss with extensive tissue destruction, tissue necrosis, or damage to muscle, bone, or supporting structures; undermining or sinus tracts may also be associated with Stage IV ulcers.

[Note: When eschar is present, accurate staging of pressure ulcers is not possible until the eschar has sloughed or the wound has been debrided.]

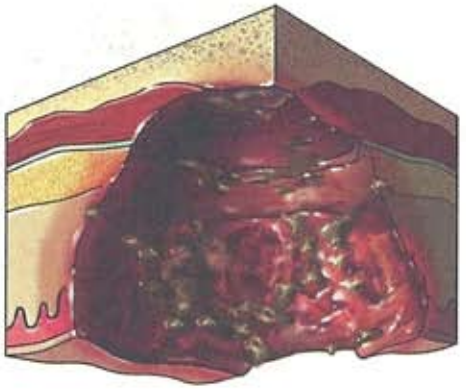

Figure 6. Stage Four Pressure Ulcer

Shear and Friction

In addition to pressure, two parallel forces - shear and friction - are commonly responsible for tissue damage during surgery.

Shear

The interface between skin and the underlying superficial fascia is interlocking and unyielding. The deeper portion of the superficial fascia is rather loose and mobile so that it slides easily in relation to the adjacent well-anchored deep fascia.[23]

When a patient is transferred, positioned, or repositioned without being lifted clear of the support surface (bed or stretcher), the patient's weight holds the skin and superficial fascia stationary against the support surface, while the deeper tissues move in the direction of the parallel force. Tissues and vessels are stretched and torn or compressed and pinched, impeding the blood supply and resulting in ischemia and tissue damage.[13]

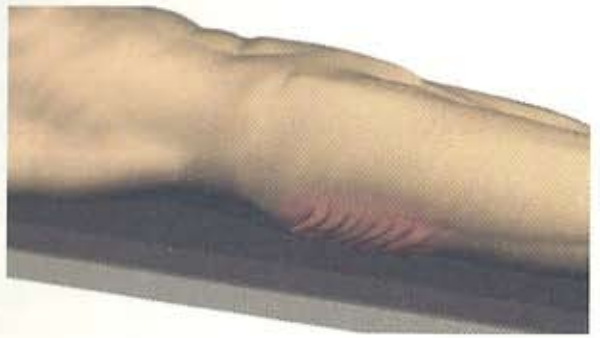

Figure 7. Illustration of tissue response to shear force

In some surgical positions, shear forces can be generated by gravity. For example, in Trendelenburg (head down/feet up), reverse Trendelenburg (feet down/head up), and Semi-Fowler's (semi-sitting), the patients lie at an angle, predisposing them to sliding up or down on the OR table. When the patient slides, there is shear stress on all parts of the body in contact with the unyielding surfaces of the procedure table and restraints.[13] For example, sacral ulcers can develop when blood vessels in the sacral area become twisted and distorted. Patients may experience combined compressive force and shear stress for the duration of a surgical procedure.

During procedures such as total hip or total knee replacement, the patient's limb is manipulated aggressively. This movement can create both friction and shear forces.

Friction

Friction is the result of two parallel surfaces rubbing against one another. Friction injuries are abrasions, tears, or blisters caused when the skin rubs against a support surface, linens, or restraints. Friction damage can be superficial or extend to deeper tissues , depending on the extent and duration of the friction.

While friction is commonly associated with superficial injuries, it may contribute to more extensive injury by decreasing the amount of external pressure required to produce a pressure ulcer.[9] Friction damage is also common during transfer and position changes.

Capillary Interface Pressure

Capillary interface pressure represents the pressure limit at which the capillary remains open and blood flow is maintained.[40] In 1930, Landis determined that the end capillary arterial pressure averaged 32mm Hg (mercury). Pressures above 32 mm Hg, therefore, would compress the vessels, resulting in tissue ischemia.

32 mm Hg is frequently thought to be a benchmark for the effectiveness of support surfaces. Unfortunately, interface capillary pressures can vary widely among individuals Even more challenging, pressures vary among the vessels of a single

individual's body. In some areas and for short periods of time, capillary blood flow can be sustained at pressures higher than 32 mm Hg. In other circumstances, however, pressures much lower than 32 mm Hg can occlude blood flow causing ischemia and venous engorgement.

Internal pressure from bony prominence may be much higher than the external pressure on the skin, causing distortion and blanching of the capillary beds and a discrete area of acute ischemia in the deeper tissues. Thus a relatively low surface interface pressure may be associated with extensive deep tissue destruction.[13]

Pressures as low as 11mm Hg can occlude blood flow in compromised patients.[56]

POSITIONING SAFETY PROGRAM - CHAPTER 2

RISK FACTORS

The most important risk factor for pressure ulcer is immobility.[34] Surgery requires that all patients be immobilized, either partially or completely for the length of the procedure. The duration of immobility is even longer when adding the amount of time preoperatively and postoperatively that the patient will be immobile. Even healthy patients can be immobile for hours before the procedure, and hours to days afterward.[64] Immobility, coupled with the additional extrinsic and intrinsic risk factors, places surgical patients at high risk for the development of pressure ulcers.

IMMOBILITY + PRESSURE + TIME = TISSUE DAMAGE

Time/Pressure Relationship

Prolonged, uninterrupted mechanical loading of the tissue results in breakdown of the tissue.[5,10,39,63] Localized low pressure maintained for long periods can be as traumatic as localized high pressure for a short period of time.[63] Hence, a combination of time and pressure put tissue at risk.

Under normal conditions, increasing pressure results in pain or discomfort, and individuals respond by altering their position, thereby relieving the pressure. Factors inherent in surgery prevent the individual from responding to the body's signals. This makes the surgical patient a candidate for tissue damage.

The majority of studies concur that the potential for tissue damage due to localized pressure increases markedly with procedures lasting more than 2 to 21/2 hours. More than 50% of surgical procedures last at least this long.

Procedure tables are designed for utility, not comfort. In one study with healthy subjects, the conventional procedure table mattress (2" thick foam covered with black, laminated vinyl fabric) produced a pressure of 66 mg Hg., much higher than the mean capillary interface pressure of 32 mg Hg. Special foam and gel mattress overlays improved pressure readings, but no overlay reduced pressure to 32mg Hg. Linens (e.g., towels, blankets, sheets) placed over the surface increased pressure intensities by almost 44 mg Hg.[56]

Time

The length of an operative procedure significantly affects the risk of pressure ulcer development. A 1989 study by Campbell demonstrated that pressure sampling on the sacral area of healthy patients was 35% higher after 2.5 hours.[17] In a study by Hoshowsky and Schramm, time on the OR table greater than 2.5 hours was the single independent variable predictive of skin changes. Procedures lasting from 2.5 to 4 hours double the risk of skin changes and pressure sore formation; procedures lasting four hours or more triple the risk of skin changes and quadruple the risk of pressure sore development.[56, 65] For this reason, patients on procedure tables must be protected from pressure effectively for an extended period of time.

Type of Surgical Procedure

Although vascular, orthopedic (especially for fractures), and neurosurgical procedures are considered the highest risk procedures for pressure ulcer development, any surgical procedure that lasts more than two hours or involves sustained pressure over bony prominences places the patient at risk.

Anesthesia

> Immobility is the prime extrinsic factor in ulcer development.[23]

Two important risk factors for tissue and nerve damage common to all surgical patients are immobility and altered level of consciousness. Anesthesia both immobilizes the patient and depresses his level of consciousness. Anesthetized patients are unable to recognize or respond to body signals of increasing pressure.

Anesthesia has many more implications for increasing a patient's risk of suffering tissue damage during surgery. Hypotension increases tissue deformability and reduces blood flow. Anesthetic agents and blood loss frequently result in hypotension.

Anesthetic agents

- Disrupt normal vasodilatation and constriction, reducing perfusion to bony prominences and elevated or dependent limbs.[28]
- Obliterate protective muscular and vasomotor mechanisms, increasing pressure over bony prominences.[6,28] Muscle relaxants reduce the "milking" action of normal muscle tone that aids in venous return. [27]
- Interfere with physiologic adaptive mechanisms; therefore, the stresses of positioning cannot be automatically compensated. [28]
- Depress the immune system for a period of time following surgery.[67]

Patients experience a certain degree of immobility and sensory changes as a result of postoperative analgesia.[67]

Heat

Heat raises the tissue's metabolic rate and increases the need for cellular oxygen and nutrients, and the rate of byproduct removal. Conversely, if an area is too cold, the cells will automatically produce less energy. In either instance, cells are not able to function efficiently and are, therefore, prone to damage. [22] Even a small rise in temperature (1°C.) can increase metabolic activity and oxygen demand by 10 per cent.[63] In combination with pressure that diminishes blood flow, heat can significantly increase the potential for tissue damage.

Investigations have identified many pressure ulcers associated with the use of warming devices. [26] In one study by Campbell & Stuart, 75% of postoperative pressure ulcer patients were on a warming blanket intraoperatively, and in another by Kokate, tissue damage increased significantly as skin temperature increased, even when pressure and time remained constant.[6]

Heat also increases the amount of sweating, particularly if ventilation is inadequate.[22]

Moisture

Potential exposure to moisture during surgery includes prep solutions, irrigation, perspiration, and possibly incontinence. Moisture macerates tissue and reduces its resilience to external forces and reduces the tensile strength of the skin resulting in breakdown. Excessive sweating or moisture between the skin and support surface increases the risk of ulceration as friction forces are increased in the presence of moisture.[63] Pooling of prep solutions may change the pH of the patient's skin and remove protective oils, making the skin more susceptible to pressure insult.[45]

Massage

Historically, massaging the skin over bony prominences postoperatively was thought to prevent pressure ulcer formation. Evidence suggests that such massage may be harmful.

Studies by Ek in 1985 and Olson in 1989 found that subjects experienced a significant decrease in skin temperature in massaged areas, suggesting that circulation was not improved and the blood supply to the massaged areas may have been compromised.[25,58] Dyson in 1978 also documented deleterious effects of massage. His study found a 38% reduction in the incidence of pressure ulcers in non-massaged over massaged patients. On postmortem biopsies, massaged tissue appeared macerated and degenerated, where non-massaged tissue showed no evidence of tissue tearing.[23]

Intrinsic (Patient) Factors

Many characteristics of patients themselves affect their ability to tolerate pressure.

Age

Many studies have implicated age as an important predictive factor in the incidence of pressure sore development. The increased prevalence of pressure ulcers with age is due to the increase in vascular and neurological changes, not to age itself.[13]

With advancing years, there is thinning of the dermis and flattening of the dermal-epidermal junction, leading to wrinkling and tearing of the skin. Loss of elasticity, increased skin permeability, and alterations in the skin's barrier function create the potential for irritant reactions.[45]

As age increases, there is a greater likelihood for reduced capillary skin perfusion and collagen regeneration, both of which are essential for wound healing. Elderly patients have less elastic, smaller, more calcified blood vessels, diminishing normal blood flow to the tissues. Poor skin turgor and prolonged capillary refill are also risk factors for pressure ulcer formation in the elderly.[45]

Study results related to age:

- Kemp identified age as one of three critical determinants that contribute intraoperatively to alterations in skin integrity.[36]
- Campbell associated age over 50 with increased incidence of pressure sore development.[17]
- Hoshowsky and Schramm identified "age over 40" as a predictive factor in pressure sore formation. In their study, risk for developing pressure ulcers doubled after age 40, and tripled after age. [70,33]
- In another study, patients from 60-69 had a 2.5-fold greater likelihood of developing pressure ulcers compared to patients under 60, and the likelihood for patients 70 and older increased to 5.3-fold.[59]

The number of people age 60 and older is growing at a faster rate than the population as a whole.[41] Pressure ulcers are common in countries like the United States and Britain with large populations of chronically disabled and elderly patients.[13] In Singapore's Ministry of Health study, 78% of the patents who developed pressure ulcers were over 60 years old.[51]

Age is also a factor in a patient's ability to heal. Allman identified an increase in mortality among pressure ulcer patients who were elderly.[1]

Pediatric patients

Neonatal and pediatric patients with low birth weights, immature skin, fragile immune systems, and poor nutritional status are at high risk for tissue damage.

Weight

Overweight

- Obese patients put more weight on their bony prominences.[45]
- Morbid obesity complicates positioning and may require significant restraint to maintain the patient's position on the relatively small operating table.
- Surface friction increases with heavier patients and increases the risk of friction injuries.[62]

Underweight

- Thin patients have less subcutaneous tissue to cushion bony prominences.

Nutrition

Studies have intimated that malnourished patients are at higher risk for tissue damage; inadequate dietary intake can result in impaired skin integrity.[62]

A low albumin level (normal range: 3.5-4.5 mg/dl) is an indicator of low levels of protein in the blood. Patients with albumin levels below 3.0 are considered at risk. [6,7] Low serum protein is accompanied by tissue edema from poor capillary bed venous return. This results in slow nutrient and oxygen transport accompanies low serum protein, decreasing the tissue's tolerance for pressure and therefore increases the risk of pressure ulcer development.

However, nutrition has been identified more as a predictor of difficulty in healing than of developing pressure ulcers. It has been demonstrated that malnourished patients sustain more severe ulcers and have greater difficulty in healing.[18,46]

> It is possible that the correlation between impaired nutritional status and ulcer development is based on the fact that impaired nutritional status accompanies more serious health problems.[6]

Hypovolemia

Hypovolemia resulting from being NPO for a period of time before surgery and from intraoperative blood loss increases the risk of poor perfusion and ischemia and reduces the amount and quality of nourishment delivered to the tissues.[67] In a patient with flaccid tissues due to dehydration and loss of capillary tone, pressure resulting from an internal bony prominence may be proportionally much higher than pressure on the skin. In this case, a relatively low interface pressure may result in minimal superficial damage with extensive deep tissue destruction.[13]

Extracorporeal Circulation

Some studies have suggested that extracorporeal circulation is a risk factor for tissue damage.[6,33] In other studies, extracorporeal circulation times were not identified as a risk factor.[59,44]

Comorbidities

Critically ill patients are at high risk for pressure ulcer development; even low pressures may cause extensive tissue necrosis.[13] In addition to the physical problems that may predispose them to tissue damage, all of their physical coping and healing resources are diminished. In one study, days in bed and days without nourishment were independent predictors of pressure ulcer development.[24]

Several studies have demonstrated that diseases which limit mobility, sensation, blood supply, or oxygenation of tissues are directly associated with pressure ulcer development.[11,58]

Diabetes mellitus places an individual at significant risk because of vascular deficiencies, neuropathies, and impaired healing. Diabetes also significantly increases the risk of infection. When blood glucose levels are over 200, effectiveness of white blood cells is significantly impaired.

> Diabetic foot sores are almost all a result of neuropathy and pressure.[13]

The preoperative assessment of surgical patients should identify the following co-morbid conditions as risk factors:

Infection: Infection increases metabolic rate and the higher oxygen demand endangers ischemic tissue.

Orthopedic: Orthopedic patients often experience immobility before and after surgery, exposing them to the single greatest extrinsic risk factor for pressure ulcer development. Orthopedic patients with fractures appear to be at greater risk than patients admitted of elective orthopedic procedures.[9] The fracture patient on prolonged bed rest frequently develops sacral/coccyx and heel ulcers. It is not unusual for pressure and friction damage to occur under casts.

Neurologic: Neuropathy that affects sensation and the appreciation of pressure pain is an important predisposing factor to the development of pressure ulcers.[13] Neurologic disorders may also involve immobility. These patients have a high probability of early tissue damage that could be exacerbated during the surgical procedure.

Diabetes Mellitus: vascular disease and neuropathies; impaired healing.

Vascular: Patients with vascular/circulatory insufficiencies are predisposed to tissue damage as a result of decreased tissue oxygenation and nutrition.

Smoking: Smoking causes chronic vasoconstriction and increases the potential both for pressure ulcer development and for impaired healing.

Assessment of Risk Factors

The AHCPR Guidelines suggest that risk predictor tools improve the ability of practitioners to predict who will or will not develop pressure ulcers, and recommend that risk prediction be an integral part of pressure ulcer prevention programs. The NPUAP recommends that an ideal assessment tool should have a good predictive value, have high sensitivity and specificity, and be easy to use.[53]

Although no tool can predict pressure ulcer development with 100% accuracy, there are several risk assessment tools available. Unfortunately, none of the available tools were developed specifically for surgical patients. The Braden Scale was designed and primarily tested in long term care.

The Braden Scale[14] and Norton Scale[55] have been tested extensively. Several studies have found that the Braden Scale is the more psychometrically sound evaluation tool, has the best balance of sensitivity and specificity, and has good reliability and better predictive validity than the other available scales.[10,41]

Although similar, the Braden and Norton scales measure slightly different parameters, specifically factors commonly seen in the long-term care patients. Both scales measure mobility/activity level, sensory perception, and moisture, but the Braden Scale includes nutritional status and potential for exposure to friction and shear. The Gosnell Scale, developed by Davina Gosnell in 1973 in the context of research, is a modification of the Norton Scale with additional descriptors to aid in rating risk factors and incorporating nutrition.[27]

The scores on the Braden and Norton scales have an inverse relationship. A high Braden Score indicates low risk; a high Norton Score indicates high risk. For acute care patients, a score of 14 on both the Braden and Norton scales indicate a patient at risk. However, on the Braden scale, risk increases as the score decreases; on the Norton Scale, risk increases as the score increases.[45]

Although they are psychometrically sound evaluation tools, both scales have limited usefulness when used alone to predict ulcer development. The pressure risk assessment scores derived 48-72 hours after admission are more predictive than those done on admission. No tool by itself is more effective than clinical judgment.

BRADEN RISK ASSESSMENT				
	Evaluation Score			
Criteria	1. Completely Limited	2. Very Limited	3. Slightly Limited	4. No Impairment
Sensory Perception				
Moisture				
Activity				
Mobility				
Nutrition				
Friction and Sheer				

Score Evaluation:

1. A score of 14 places a critical care patient (including a surgical patient) at risk for pressure ulcer development
2. Risk increases as score decreases
3. The LOWER the Braden Score, the higher the pressure ulcers risk

Figure 8. The Braden Scale for Pressure Ulcer Risk Assessment

NORTON RISK ASSESSMENT				
Criteria	Evaluation Score			
	1	2	3	4
Physical Condition	Good	Fair	Poor	Very Bad
Mental Condition	Alert	Apathetic	Confused	Stupor
Activity	Ambulant	Walk/help	Chairbound	Bedridden
Mobility	Full	Slightly	Limited	Very Limited Immobile
Incontinence	Not	Occasional	Usually (urine)	Doubly

Score Evaluation:

1. A score of 14 places a critical care patient (including a surgical patient) at risk for pressure ulcer development
2. Risk increases as score increases
3. The HIGHER the Norton Score, the higher the pressure ulcers risk

Figure 9. The Norton Scale for Pressure Ulcer Risk Assessment

Preoperative Assessment

The potential for developing pressure ulcers can be difficult to predict because many patients who experience adverse outcomes of positioning are not those considered to be at risk.[6]

Preoperative experiences and postoperative expectations are important factors in determining risk. For instance, normally healthy, younger patients whose mobility has been impaired by illness or accident are at high risk for developing pressure damage, especially if they will remain immobile for a period of time following surgery.

The incidence of pressure ulcers increases with severity of illness and length of hospitalization.[67]

Under certain circumstances, pressure alone will result in tissue damage, even in healthy viable tissue. Pressure synergistically combines with other factors to increase the chance for pressure ulcer development. The more diligent the assessment is in identifying factors that predispose to pressure ulcer development, the better prepared clinicians will be to protect the patient.

General Considerations

From the patient and the chart, gather as much information as possible that will impact positioning decisions. Ask the patient to share anything specific that might affect positioning, such as the results of previous injury or accident, or past experience with pressure damage. Scores from risk assessments done on the unit can be important indicators.

As a rule, the patient is the best judge of his own comfort level. While the patient is awake, do as much of the positioning as possible. For instance, the awake patient can let you know if an arm position is uncomfortable, or if lying flat causes back strain.

POSITIONING CONSIDERATIONS

Nerve damage/Neurapraxia

Hyperextension (stretching) or compression of nerves during positioning or during the surgical procedure can result in nerve damage. Intraoperative nerve injuries are due to a neurapraxia, a focal lesion resulting in loss of conduction along a nerve without axon degeneration. Neurapraxias are usually followed by a complete recovery, but some intraoperative nerve injuries can produce lasting disability.[68] Maintaining body parts in anatomical alignment and padding them adequately reduces the potential for nerve injury.

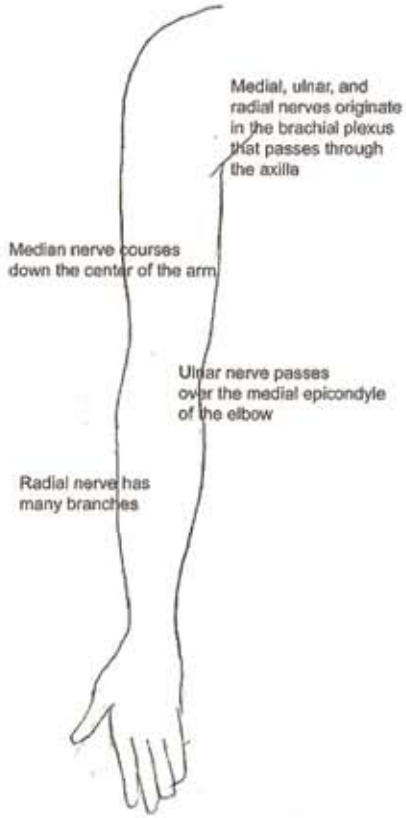

Figure 10. Medial, ulnar, and radial nerves of the arm

Types Of Intraoperative Nerve Injuries And Their Origins

Brachial Plexus

- Hyperextending the neck
- Hyperextending the arm
- Compression of the axilla
- Palm down arm position

Ulnar nerve

- Palm down arm position
- Compression against humerus by OR table
- Elbow compression

Median Nerve

- Compression against humerus by OR table
- Elbow compression

Radial nerve

- Compression against humerus by OR table

Common peroneal nerve

- Improper positioning and padding of the knees and legs

Unique situations such as

- Patients with pressure palsies[32]
- Medial cutaneous branch of the femoral nerve in lithotomy position[54]

Pressure points

The circulation surrounding bony prominences is superficial and easily obstructed by pressure. Body weight is not evenly distributed, and in each of the standard positions, the bony prominences and surrounding tissues that are in contact with a firm surface are the sites at highest risk for tissue damage. Pressure ulcers are more likely to form at a point where the bone is close to the skin. Once formed, pressure ulcers can take months to heal, can be painful, can complicate existing health problems, and in some cases, can be life threatening.[35]

A review of the literature shows that about 80% of pressure ulcers occur in four anatomical locations: [63]

- Sacrum
- Ischium
- Trochanter
- Heel

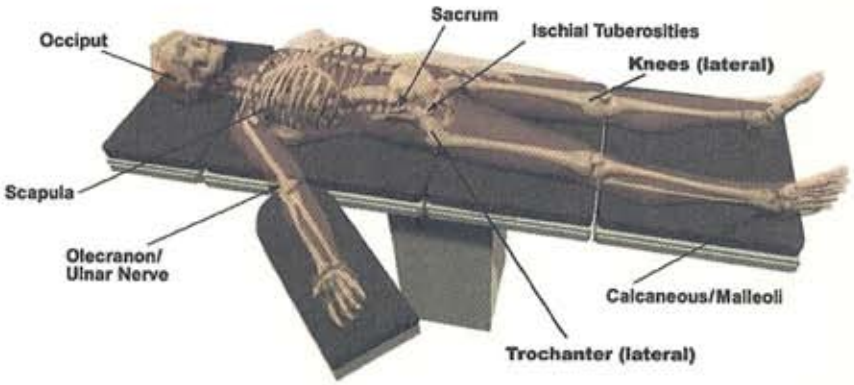

Figure 11. Pressure points

Any tissue that sustains high pressures, or significant pressures for a length of time is at risk for tissue damage. In each surgical position, identify and protect the anatomical sites that are supporting the weight of the patient. Consider also pressure from the surgical team or from instruments or equipment.

Alopecia

Many cases of occipital alopecia (localized hair loss at the back of the head) have been reported, particularly following long cardiovascular, head and neck, or neurosurgical procedures with the patient in the supine position.[23]

If the patient remains intubated or immobile following surgery, pressure on the occiput is prolonged and occipital alopecia even more likely. In some cases, occipital pressure has caused blistering of the scalp and significant tissue damage in addition to hair loss. If the tissue damage is extensive, the alopecia can be permanent. Even when alopecia from pressure is a transient phenomenon, it is a cosmetic disaster to the patient.

Surgical Positions

There are five fundamental positions used for surgical procedures: supine, sitting, lithotomy, prone, and lateral. Each of these positions has a variety of modifications, and each presents specific challenges for preventing patient injury.

Supine

With its many variations, the supine, or dorsal recumbent position, is the most common position for surgical procedures and is thought to result in more pressure ulcers than other surgical position.[26] The supine position places the patient on his back with the cervical, thoracic, and lumbar vertebrae in a straight, horizontal line. The legs are extended. A safety strap is placed at the waist or across the upper thighs. Both arms can be extended on armboards, placed at the patient's side, or positioned separately.

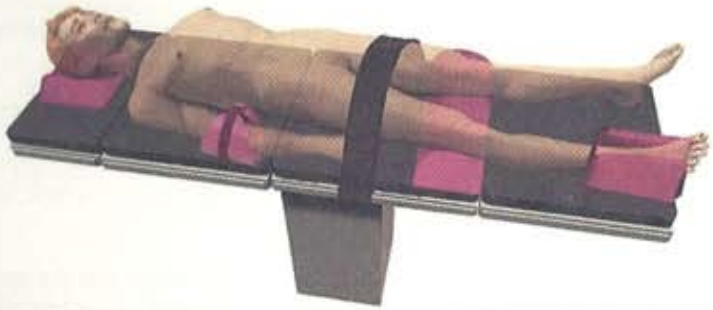

Figure 12. Supine Positiion

The bony prominences that bear the majority of the patient's weight in the supine position are the occiput, the scapulae, the olecranon process of the elbow, the sacrum, the ischial tuberosities, and the calcaneous (heel). These areas are subject to the highest pressures and are the sites with the greatest potential for tissue damage in this position. The heels are most vulnerable, with a substantially higher interface pressure when compared to other bony prominences. AHRQ suggests raising heels completely off of the support surface, and avoiding the use of donut-type devices.[9]

The nerves at highest risk for injury in the supine position are the brachial plexus, the median nerve, and the ulnar nerve related to arm positioning, and peroneal and tibial nerves related to leg positioning. Vessel damage can also result from faulty positioning.

- Arm extension less than 90° from the torso will protect the brachial plexus from traction, stretching, and pressure.
  - This will also protect the subclavian and axillary vessels from being stretched under the coracoid processes of the scapula or compressed and occluded between the clavicle and the first rib.

- Hyperabduction of the arm can stretch or compress the subclavian and axillary vessels. It is possible to completely occlude the radial pulse, resulting in arterial thrombosis.[28]

- Padding the elbow carefully, and positioning the arm with palms up on the armboard or with the palm nestled against the patient's thigh will protect the ulnar nerve from compression as it passes through the humeral notch at the elbow.
  - The palms-up position on an armboard will also relieve pressure on the brachial plexus.
  - Keeping the arm and elbow from resting directly on the OR bed will prevent compression of the medium, ulnar, and radial against the edge of the OR bed.
  - Be sure that fingers are not pinched between positioners or personnel and the mattress.
- Keeping the legs parallel and uncrossed and padding below the knees and heels will protect the peroneal and tibial nerves.
- Extreme rotation of the head, especially during operations on the neck, can cause occlusion and thrombosis of the vertebral artery.
- Relaxation of the paraspinous muscles during anesthesia flattens the normal lumbar curve and puts tension on the interlumbar and lumbosacral ligaments. The resulting backache can be prevented by using a support device to maintain the normal curvature of the spine.

Sitting (Semi-sitting; Semi-Fowler's; Lawnchair)

The same bony prominences are at risk in the sitting position as in the supine position. However, in the sitting position, body weight is distributed unequally with the greatest pressure on the sacral area. Adequate support of the legs and feet is essential to prevent the patient from sliding down on the table which greatly increases the potential for injury from pressure, friction, and shear, especially in the sacral area.

The potential for hypotension increases due to vasodilatation by anesthesia and pooling of blood in the lower extremities, which increases the risk of pressure damage. Slight elevation of the thighs and compression stockings, bandages, or devices can prevent untoward changes in blood pressure.

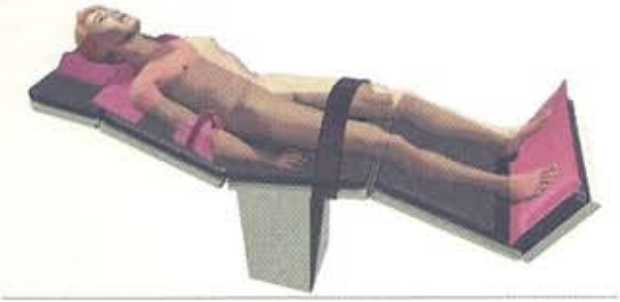

Figure 13. Semi-sitting (Semi-Fowler's) (Lawnchair) Position

Lithotomy

Lithotomy is a supine position with the legs placed in stirrups, used most commonly for vaginal and genitourinary procedures. It is an unnatural position anatomically and has greater potential for nerve, muscle, fascial, and circulatory injury.

The sites at risk for pressure damage in the upper body remain the same as in the supine and sitting positions. The buttocks are at the edge of the OR table, requiring a great deal of thigh flexion. Rotating the pelvis when the legs are lifted flattens the lumbosacral curve, with increased pressure on sacrum and buttocks, predisposing the patient to backache and strain and pressure damage.

Lifting the legs simultaneously and slowly is important to avoid hip dislocation, problems with back and leg musculature and nerves, and unnecessary changes in blood pressure. Raising the legs may catch tissue in folds which could remain compressed throughout the surgical procedure. Following the procedure, the legs must be lowered simultaneously and slowly to avoid possible hypotension.

Figure 14. Lithotomy Position

The legs can be supported by ankle straps, boot stirrups (molded footpieces), or special leg holders. Each type of support requires careful positioning and padding to prevent direct compression of extremity compartments and increased compartment pressure, decreased extremity perfusion, and possible vessel occlusion from excessive joint flexion or direct pressure.

Stirrups must not compress the popliteal fossa (vessel and nerve compression), the fibular head at the lateral knee (peroneal nerve damage), or the inner calf (saphenous nerve). Stirrups placed too high predispose the patient to sciatic symptoms and sacroiliac discomfort. Placing stirrups too low results in pressure and pain in the thigh and calf muscles. Thighs spread too far apart causes adductor strain.

Prone

In the prone position, the patient is lying face-down. Although there are many variations of this position (e.g. jackknife, knee-chest, etc), each requires the same principles for protecting the patient. The forehead, ears, and cheeks are subject to pressure damage, as are the the shoulder, the clavicle, iliac crest, patella, and toes.

In the prone position the female breasts and male genitalia must also be protected.

There is the additional positioning challenge of having to turn the patient after induction. Anesthesia is induced with the patient supine, so none of the positioning can be done with the patient awake and helpful. Turning the patient safely requires additional personnel. The patient must be "log-rolled" (turned as a unit without twisting or abnormal movements of body parts) onto chest rolls or special positioning devices that lift the patient's torso to allow for lung excursion and prevention of circulatory compression. The positioners onto which the patient is turned must be secured in place. Turning is done slowly to compensate for hemodynamic changes.

Figure 15. Prone Position

The arms must be rotated carefully into position either onto armboards or onto the OR table. Arms must not hang over the side of the OR bed; pressure can cause tissue damage as well as trauma to the ulnar and median nerves.

A headrest keeps the patient's neck in alignment with the spinal column, preventing hyperextension and brachial plexus injury. It protects the eyes from corneal abrasion and conjunctival edema as well as the ears, cheeks, and forehead from tissue damage due to pressure.

> Horseshoe headrests should be avoided as they have been implicated in severe eye injuries in the prone position.[3] Unless very well padded, horseshoe headrests create very high pressures.

Proper head positioning relieves pressure on jugular veins, preventing increased intracranial pressure and cervical venous distention that might lead to increased bleeding during surgery.

Knees are slightly flexed to prevent back strain, and knees, ankles, and feet must padded to alleviate direct pressure The feet should be positioned to avoid plantar flexion.

Lateral

The patient is placed in the lateral, or side-lying position after anesthesia induction in the supine position. Pressure points in the lateral position include the ear, scapula, acromion process, iliac crest, greater trochanter, lateral knee, malleolus, and toes. There is also potential for damage to the brachial plexus, peroneal, tibial, and sural nerves.

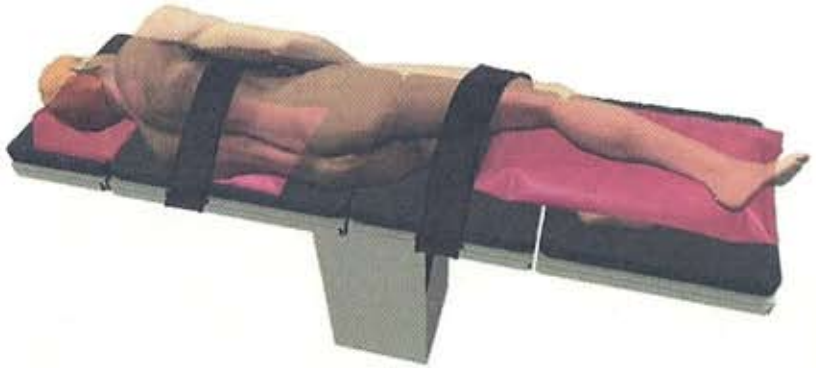

Figure 16. Lateral Position

An effective headrest maintains the alignment of the cervical vertebrae with the spinal column, preventing hyperextension and brachial plexus injury. The headrest also protects the ear, cheek, and temporal area from excessive pressure.

The torso must be stabilized to prevent movement or position change during surgery. The lower arm is positioned slightly forward to prevent pressure on the brachial plexus. In any position, the arm must be protected from hyperextension and from pressure on soft tissue or bony prominence.

The lower shoulder and deltoid must be padded. Axillary rolls are discouraged, but a pad placed beneath the scapula (upper chest) relieves pressure on the arm and allows greater chest movement with respiration.

The bottom leg is flexed to provide stability and padding between the legs lifts the weight of the top leg off the lower one and prevents pressure on soft tissues and bony prominences. The trochanter requires adequate padding as it supports a significant portion of the patient's weight.

If a "beanbag" device is used, diligent observation and effective protection are required to prevent pressure, shear, and friction forces from damaging tissue.

POSITIONING SAFETY PROGRAM - CHAPTER 4

MATERIALS

Since there is little control over surgical position and length of the procedure, a significant variable in the effectiveness of the positioning process is the quality of the positioning products used.

The purpose of any positioning device is to support the patient anatomically and reduce trauma to the tissue over bony prominences An effective positioner will reduce the internal pressure and shear at the bone/tissue interface of bony prominences and preserve circulation to both skin and underlying tissues.

Positioning devices must also be stable and conform to the patient's body to distribute body support forces evenly regardless of patient position or external forces during the surgical procedure.

OR Table Mattress

The OR table support surface (mattress or pad mattress) is the most consistent and important positioning device in all interface pressure studies.

Studies demonstrate that interface pressures for the standard 2-inch mattress are consistently high and do not sufficiently reduce pressure or prevent skin changes.[13,33,42,46] This, however, does not mean that a properly configured OR table mattress has to be more than 2-inches in height.

The material used for the OR table mattress cover also has an impact on the prevention of pressure ulcers.[45] The traditional firm vinyl covering negates some of the pressure-reducing effect of the foam, and has a greater hammock effect.[13] This tough outer cover further reduces the cushioning potential of the mattress and can result in increased pressure and shearing forces.[20] Softer and more pliable covers can provide improved pressure reduction. Cover material, however, must be durable, impervious to moisture and microorganisms, and easily cleaned.

Kemp et. al. found that a 4-inch deep solid foam mattress significantly reduced the incidence of pressure ulcers compared to a 4-inch convoluted foam ("eggcrate") overlay.[37] Convoluted foam was initially developed for sound chambers and has only 50% of the foam content of a solid overlay of the same thickness.

Studies comparing the standard OR bed mattress with different types of overlays, found that a viscoelastic overlay was more effective than either foam or gel.[33] First used in the space program, viscoelastic acts somewhat like a fluid with being a fluid, slowly returning to its original shape after it is compressed and released.

Linens

Linens (sheets, towels, blankets) are frequently used in positioning patients. Linen can actually increase pressure, and increase the potential for friction and shear injury. Positioning devices devised from rolled towels, sheets, or blankets create both high and inconsistent pressures, and while they may stabilize the patient for the surgical procedure, they may contribute to tissue injury rather than provide protection from pressure, friction, and shear.

Ring Cushions ("Donuts")

Donut-shaped devices (rings or ring cushions) are known to cause venous congestion and edema in wheelchair-bound patients and when used to support a significant amount of weight.

Although there are few research studies specifically targeting ring cushions, wound care professionals agree with Crewe's 1987 study that ring cushions ("donuts") are more likely to cause pressure ulcers than to prevent them." [19] When ring cushions are used support high pressure areas (sitting, supporting the heels, head, etc), the vertical pressure in a ring around the supported area causes a high shearing force through the tissue much as a "cookie cutter" cuts through dough, collapsing blood vessels, creating edema, and promoting cell death.

Perioperative teaching resources recommend using "donuts" cautiously and avoiding them on lengthy procedures.[50]

When used as a headrest, ring cushions create greater pressures on the inner circumference of the ring, which can lead to venous congestion, edema and occipital alopecia. The weight of the head is more evenly distributed on a pillow or a contoured headrest as the high forces are spread more evenly over a greater area, thus reducing concentrated loading or pressure.

Evacuatable Devices ("Beanbags")

An evacuatable device or "beanbag" is sometimes used to maintain the patient in a lateral position. The device is an impervious, pliant pillow filled with tiny plastic beads. When the device is molded to the patient's contours and air is evacuated, the beads are forced together and, in effect, the pillow becomes a rigid mass, holding the patient in place.[49]

When using this type of device, it is essential to insure that skin is not wrinkled or folded inside the device, and that no tissue becomes pinched in folds of the pillow as air is evacuated. Any tissue compression will remain unrelieved for the duration of the surgical procedure. Any padding used between the patient and the device must be kept free from wrinkling as well.

While the device is supporting the patient, any movement of the patient within the device creates the probability of friction and shear injury. This device has the potential for exerting significant pressure on tissues and sustaining the pressure as long as the device is inflated.

Science of Positioning Materials

The science of support surface evaluation is still at an early stage.[63] Much of the equipment available for the prevention of pressure ulcers has not been reliably evaluated.[46]

> Properly interpreted testing devices and results can provide a scientific basis for making selections of effective positioning products.

A majority of investigators use average or mean tissue interface pressure as the basis for comparing products, but average interface pressure is a highly abstracted and dubious value, even for static surfaces.[63] "Average" or widely dispersed pressure readings do not provide sufficient information to describe the tissue loading at any particular point and cannot be used in isolation to infer the internal stresses and strains on the tissue.

Localized high interface pressure readings suggest high levels of tissue distortion that can lead to capillary occlusion and disruption of the lymphatic system.[63] Experimental data has demonstrated higher pressures at the bone and soft tissue interface when compared to interface pressure values at the skin. This would indicate that surface pressure readings that seem within capillary tolerance, might actually be high enough internally to promote tissue damage.

Characteristics of support materials

Ideal positioning product characteristics for use in the operating room include stability, firmness, pressure reduction, and the ability to control the distribution of pressure without "bottoming out." "Bottoming out" means that the support material has been fully compressed by the weight of the patient or body part and is virtually solid, no longer acting as a springy cushion to relieve pressure.

Stability is necessary to maintain the patient's position during the surgical procedure. Pressure relieving/reducing products such as air- or water-filled mattresses, and surfaces that move sequentially to relieve pressure are used effectively on the units, but do not stabilize the patient sufficiently for surgery.

Materials used for OR positioners

Positioning products most commonly used in the operating room are made from:

- foam
- fiber (linen)
- gel

Each of the materials used to construct positioning aids has advantages and disadvantages.

Foam

Foam is used throughout the hospital in numerous patient-related products. Foam is polyurethane, generally in the form of polyester or polyether made from oil-based chemical compounds, either with holes (open celled) or without holes (closed celled). The number and size of cells within the material help to determine firmness or density.

Foam is lightweight and fashions easily into a variety of shapes and contours. The density of foam can be adjusted to produce different levels of support. The strength of foam is attributed to the chemical make-up of the components and the various combinations within a product. Strength of material is directly related to cell structure. Soft foams have flexible cell structures and are of low strength.

The firmness of foam is best understood as a measure of its springiness. Soft materials do a good job of relieving pressure, but they bottom out quickly. Effective positioners must attain a balance between softness and depth of the material.

Foam products can be covered with a variety of different materials, all of which affect the interface pressure of the foam. Cleaning methods will be dependent upon the cover material and construction. Disposable foam products are not generally encased in covers.

Foam must be monitored to insure that it springs back to its original shape when pressure is released. Eventually all foams age and lose their effectiveness. Over time the cells will collapse, the foam will harden, and no longer spring back to its initial shape.

Linens

Bath blankets, towels, sheets, and pillowcases are used in the positioning of patients in every surgical suite. Only recently has it been demonstrated that linens do not provide a good platform for pressure control. In addition, they interfere with the effectiveness of support devices they cover.

Coarseness of the material contributes to abrasion of the skin which can be a precursor to underlying tissue death. Linen is fluid-absorbing and does not protect the skin from moisture damage. Linen wrinkles easily and wrinkles increase pressure on tissues. Layers of linen can also promote an increase in patient temperature.

Gel

Gel products are made from oil-based chemical compounds (polymers), called viscous polymers, a material that exhibits properties of both liquids and solids. The polymer is sealed in a durable membrane. The product is firm and quite heavy, but provides a degree of buoyancy dependent upon the chemical makeup of the gel and the membrane covering on the product.

Because gel is heavy, gel positioning products that are small, like heel and elbow protectors, are more practical than large products like mattress overlays. Sometimes gel is combined with foam for a lighter product.

Perspiration can be a problem for patients as gel and the sturdy membrane cover are non-breathing materials. The viscous polymer reacts slowly to changes in temperature, retaining heat or cold for longer periods of time than other positioning materials.

A gel pad of sufficient depth will protect from lateral motions quite well. It provides good shock absorption when encased is a sturdy membrane, but has not demonstrated the ability to provide controlled pressure relief. Gel support materials have fallen into disuse for wheelchair patients because of tissue breakdown.

The surface of gel products is smooth and easy to clean. Some manufacturers caution against using alcohol-based or undiluted cleaning products as they may discolor or harden the product's outer skin. Soaking the product over a long period of time might weaken the outer membrane.

Positioning aids fashioned in the surgical setting

In nearly every surgical setting, you will find positioning devices custom-fashioned "on site" from rolled or folded linens, anesthesia tubing covered with gauze, and other creative approaches to positioning. Sometimes rolled linens are taped and/or dampened to hold their shape. In nearly all cases, they stabilize the patient while creating very high pressures.

Textiles, tape, and gauze coverings are rough materials and promote friction injuries. These fashioned devices are not fluid resistant and therefore promote cross-contamination if used for more than one patient. Additionally, making the devices is time-consuming and costly, considering manpower, material purchase, and processing expenses.

Product finishes

A foam or gel positioning product will be encased in a cover that is heat-sealed, stitched, dipped, or sprayed. The method of construction has important implications for patient safety.

Heat sealed

Heat-sealing positioner covers provide a fluid-proof barrier, protecting the patient from cross-contamination. The flat edge produced by the process of heat sealing should be soft to avoid scratching the skin.

Stitched or sewn

Sewn products are usually non disposable and intended for use with many patients. Each stitch creates a small hole in the cover that permits penetration by fluid and microorganisms, altering the quality of the cushioning material and putting the patients at risk for cross-contamination.

Stitched products occasionally have corded seams which create a small roll of material around the positioning product. This ridge of raised material will create an area of increased pressure if the patient lies directly on the seam.

Dipped

The dipping process is used in applications where the covered surface is irregular, such as ring positioners. In some cases, the carrier for the plastic may be toxic, and the toxicity may remain in the material after curing. Manufacturers of dipped products should produce proof of acceptable contamination levels in the finished product.

Sprayed

Spray finishes are a variation of the dipped products. Spraying required less materials and space for curing and drying. Durability is a function of the coating chemistry and the thickness of the application. Chemical components used for spraying may dissipate after curing, but some remnants remain in the surface coat. Manufacturers of sprayed products should produce proof of acceptable contamination levels in the finished product.

AORN Criteria for Positioning Products

AORN in Recommended Practices for Positioning the Patient in the Perioperative Practice Setting[4] has defined minimum criteria for positioning devices.

1. Availability in a variety of appropriate sizes and shapes

   Each patient presents with a different set of positioning challenges based on his physiognomy, medical history, and the surgical procedure scheduled. To position each patient safely and effectively, positioning devices that address all of the patient's needs must be readily available.

   An appropriate assortment of procedure-specific positioning products should be readily accessible for positioning each surgical patient to avoid the necessity of using something inferior in the interest of time and urgency, or wasting time looking for an appropriate positioner.

2. Durable material and design

   Positioning products used in surgery, even non-disposable products, must be puncture-resistant and fluid-resistant. If disposable products are reused, they must be returned to "as new" condition for subsequent patients. Covering disposable foam with linen decreases the pressure-reducing properties of the product and does not prohibit the transmission of microorganisms.

   Durability is a much greater issue with non-disposable products. With each subsequent use, the product must provide the same level of support and protection. Durability is one determiner of the lifespan of a product and is a factor is assessing the cost effectiveness of an investment.

3. Ability to maintain normal capillary interface pressure

All positioning devices should perform three functions effectively: absorb compressive forces, redistribute pressure, and prevent excessive stretching.[50]

The science of support surface evaluation is still at an early stage. Interface pressure measurement is the most commonly used quantitative technique.[63] Testing methods are not consistent; and interpretation of testing results can be difficult and misleading.

An average pressure measurement does not provide sufficient information to fully describe pressure loading at a particular point on the body surface and can't be used in isolation of internal stresses and strains in the tissues. It is more valuable to know the specific pressure measurements at the locations where the actual pressures were measured.

"Average interface pressure" is a highly abstracted and dubious value, even for static surfaces, as it relies on the exact number and placement of sensors.[63]

Areas of pinpoint high pressure are more damaging than high pressure areas covering a larger diameter. For example, a two-inch diameter area of high pressure will cause less tissue damage than a half-inch diameter area due to the larger blood supply around the site.

A pressure reading represents the average pressure under the sensor; therefore, the smaller the diameter of the sensor, the more accurate the peak pressure reading. Coarse high mean interface pressure readings, however, do suggest high levels of tissue distortion that can lead to capillary occlusion and disruption of the lymphatic system.[63] Query the results of any testing system about the smallest point of peak pressure measurement.

4. Resistance to moisture and microorganisms

Positioners should be impervious to moisture which can serve as a breeding ground for microorganisms a become a source for contamination and infection. Any positioning product used for more than one patient should be impervious to fluids and microorganisms to protect the patient from potential infection.

Uncovered foam tends to "wick up" moisture. If uncovered foam is reused, it should be returned to "as new" condition before being used for subsequent patients. Sewn products allow penetration of moisture through the myriad pinholes in the cover. Over time, the interior contents can become quite disreputable.

Some products are made with antimicrobial additives. The efficacy of antimicrobials diminish over time. It is wise to examine clinical studies of these products to assess the efficacy of the antimicrobial and the length of time it remains effective.

The cover material of a positioning device should be gentle to the skin and not cause the patient to perspire or to "stick" to the material. Excessive sweating or moisture between the skin and a support surface increases the risk of pressure ulceration as friction and shear forces are increased in the presence of moisture.

Positioning devices should be normothermic, promoting neither an elevation or reduction of the patient's body temperature.

5. Radiolucency

Positioning products must not interfere with intraoperative radiography or fluoroscopy.

6. Fire resistance

Positioning devices used in the operating room should be fire resistant. It is also important that a positioning device be able to tolerate heat sources such as lasers and electrosurgical pencils without deteriorating in a manner that would harm the patient. For example:

- Nylon melts and can cause a serious burn.
- Some materials produce toxic products of combustion

7. Nonallergenic to the patient

Materials used in positioning products must be hypoallergenic and latex-free.

8. Ease of Use

Ideal positioning products are lightweight and easy to carry and manage, come in a wide variety of shapes and sizes, and are easy to store.

Positioners should remain stationary when placed in position (e.g. round chest rolls can roll off the OR table as the patient is being turned, and products with slippery covers are a challenge to keep in place).

9. Easily cleaned/disinfected if not disposable

Non-disposable positioning products should be able to be cleaned effectively and quickly with any standard disinfectant. The material should not be adversely affected (stained, damaged) by blood or body fluids, povidone iodine, or any type of standard cleaning agent. Any product that can not be adequately cleaned has the potential for harboring microorganisms and inhibiting infection control. A disposable product, if used for more than one patient must meet the same standards of cleanliness of new products.

The surface of gel products is smooth and easy to clean. Some manufacturers caution against using alcohol-based or undiluted cleaning products as they may discolor or harden the product's outer skin. Soaking the product over a long period of time might weaken the outer membrane.

An ideal product can be immersed, if necessary, for thorough cleaning. Stitched products cannot be immersed because of the countless pinholes that allow liquid to penetrate the cover and saturate the filling. Uncovered foam must be allowed to dry thoroughly if saturated.

10. Easily stored, handled, and retrieved

Positioning products should be manageable in weight and size. Large positioning devices, such as mattress pads can be unwieldy, but are usually stored on the operating room table. Gel products are comparatively heavy and the large devices such as mattress overlays, can be prohibitively heavy, difficult to handle, and a challenge to store.

An area in each room or in the immediate vicinity of several rooms dedicated to an assortment of positioners is a good idea. A cart with an ample assortment of positioning devices that remains in the room or can be easily transported from room to room would be ideal.

11. Cost effectiveness

> Just as there are costs associated with treating pressure ulcers, there are costs associated with preventing them.[35]

After ascertaining that a positioning product, disposable or reusable, meets all the basic AORN criteria, the remaining considerations include convenience and cost.

The price of a product is the most obvious financial consideration, but cost includes other factors, sometimes called "hidden costs": order processing, storage, ease of handling, maintenance, disposal, and replacement. Deriving an accurate figure for comparison shopping requires identifying all of the costs associated with using a product.

Another hidden cost is the expense associated with adverse outcomes when a product does not perform effectively.

> Inappropriate selection of positioning devices not only wastes capital resources, but it can also be detrimental to the patient.[62]

POSITIONING SAFETY PROGRAM - CHAPTER 5

POSITIONING SYSTEM FOR PATIENT SAFETY

Positioning patients for surgical procedures is a key patient safety concern in the operating room. A 1999 study published in the AORN Journal concludes that a standardized set of guidelines needs to be developed to delineate the best padding options for surgical procedures.[18]

Based upon recommendations from the Institute of Medicine and AORN, an error-proof system is the most effective way to prevent adverse outcomes of intraoperative positioning. A system includes:

- **EDUCATION** for practitioners to insure that guidelines are understood and implemented
- **BEST PRACTICE** positioning guidelines for each surgical position
- A comprehensive, integrated **SYSTEM OF POSITIONING AIDS** that provide adequate pressure reduction/relief for all surgical patients

Education

- Nurses will identify the physiology that places certain anatomical sites at risk for damage from pressure, friction, and shear in each surgical position.
- Nurses will recognize the multitude of factors that put individual patients at risk for tissue and nerve damage

Best Practice

- Positioning techniques for all patients will comply with established principles of protection from nerve damage and tissue trauma from pressure, shear, and friction.

There are many excellent perioperative nursing texts that can be used to establish best practices for each surgical position.

Best Products

- The facility will provide a standardized system of quality positioning products with sufficient variety to accommodate the positioning needs of all patients
- Nurses will utilize positioning devices that provide the greatest degree of support and pressure reduction/relief for their patients.

Since the patient's position is determined by the surgical procedure, and there is little control over the duration of the patient's immobility, the key factor in providing protection is the quality of the positioning devices used to protect the patient from pressure, friction, and shear forces.

Developing the patient safety initiative

The development of a positioning system should be multidisciplinary, involving the clinicians and clinical areas from which your surgical patients arrive, and those who will care for your patients postoperatively.

The development of any system follows the nursing process. Document the process as well as the outcomes.

JCAHO has targeted patient safety as a significant commitment for health care facilities. As part of a facility's JCAHO review, documentation of the development of a safety program to reduce adverse outcomes of positioning and associated patient outcomes represents an important contribution to quality assurance and supports the JCAHO patient safety standard.

Assessment

- Explore current science, research, best practices, and best products.
- Identify current practices in your facility, opportunities for improvement, and challenges for change.
- Evaluate what statistical and anecdotal information is available on adverse outcomes of positioning in your facility.

Planning

- Create protocols for patient management in each surgical position.
- Evaluate available positioning products; select a system of products that will meet all of your patients' needs.
- Plan education for your clinical staff.
- Plan the implementation process.
- Create an evaluation plan for the newly implemented procedures and products

Implementation

- Consider implementing changes incrementally, beginning with the most common positions and clinical areas with the greatest potential for success.
- Document the process as well as the outcomes

Evaluation

- Use written evaluations as well as anecdotal reports
- Implement revisions indicated through the evaluation process

EDUCATION + BEST PRACTICES + BEST PRODUCTS

⬇

EFFECTIVE POSITIONING SYSTEM FOR PATIENT SAFETY

GLOSSARY

Alopecia

Hair loss. Alopecia due to pressure on the occiput during surgery is usually transient.

"Bottom out"

Support material has been fully compressed and is virtually solid, no longer acting as a spring to relieve pressure.

Capillary Interface Pressure

Highest pressure at which the capillary can remain open and sustain blood flow. Typically considered 32 mm Hg, but varies significantly among individuals and among different anatomical sites in a single individual.

Dampening

The ability to absorb impact loads without "bottoming out".

Density

The ratio of weight to volume of a substance, measured in pounds per cubic foot. Density contributes to firmness, feel, and strength of material.

Dynamic Support Surface

Pressure-reducing device that is designed to cyclically change its support characteristics (e.g. alternating air mattress; mechanical seats that change shape to redistribute pressure). Inappropriate for surgical positioning as they don't provide stability.

Edema

Excessive fluid in cells and interstitial spaces.

Foam

Polyurethane (polyester or polyether) made from oil-based chemical compounds, either with holes (open celled) or without holes (closed celled); lightweight; manufactured in a wide variety of densities.

Friction

Force created when two surfaces rub against one another.

Gel

Viscous polymer with characteristics of both liquid and solid. Provides a degree of buoyancy dependent upon the chemical makeup of the gel and the membrane covering on the product.

Hyperemia

Redness and warmth of the skin due to an increase in blood in the immediate area; caused by local relaxation of arterioles or obstruction of the outflow of blood.

Indentation Load Deflection (ILD)
Also called Indentation Force Deflection (IFD)

A measure for degree of firmness Pounds necessary to compress 4-inch thick foam 25% using 50 square in "indentor".

Interface pressure

Pressure measurement at the common boundary of two surfaces.

Interstitial space

Space between cells within and between tissues, excluding body cavities. Edema represents excessive fluid in cells and in interstitial spaces.

Necrosis

Localized tissue death that occurs in groups of cells in response to disease or injury.

Overlay

A pad placed over a support surface to reduce pressure on the patient.

Neurapraxia

Usual type of nerve damage from positioning error: a focal lesion resulting in loss of conduction along a nerve without axon degeneration; usually followed by a complete recovery, but can produce lasting disability

Resilience	Ability to recover shape following compression.
Sentinel Event	A sentinel event is an unexpected occurrence involving death or serious physical or psychological injury, or the risk thereof. Serious injury specifically includes loss of limb or function. The phrase, "or the risk thereof" includes any process variation for which a recurrence would carry a significant chance of a serious adverse outcome. (JCAHO)
Shear	Parallel force created when the surface layer of tissue remains stationary on a surface and the underlying tissues move, thereby stretching or crimping vessels and nerves.
Stiffness	Measure of softness.
Viscoelastic or "memory" foam	Foam that slowly returns to its original shape after it is compressed and released (seems to have a "memory"). Initially developed for the astronaut couches to allow them to conform to a variety of body shapes and sizes and reduce concentrated loads at launch. Viscoelastic foam acts like a fluid without being a fluid.

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REVIEW QUESTIONS

Multiple choice. Please choose the word or phrase that best completes the following statements. Circle correct answer.

1. Which of the following statements is NOT TRUE?
   a. 32mg Hg is the "classic" pressure beyond which capillaries are thought to occlude.
   b. Average interface pressure is an excellent measure of the effectiveness of a positioning device.
   c. Interface pressure is the pressure exerted at the point of contact between two surfaces.
   d. The pressure at which capillaries occlude varies widely among individuals.

2. Which of the following statements is TRUE?
   a. Product coverings that are stitched allow penetration of fluids and microorganisms.
   b. Foam is a lightweight and versatile material for positioning products.
   c. Heat sealed covers provide a fluid-resistant barrier for positioning products.
   d. All of the above.

3. Which of the following is a risk assessment tool for critical care patients?
   a. Braden Scale.
   b. Norton Scale.
   c. Gosnell Scale.
   d. None of the above.

4. Which of the following statements is NOT TRUE?
   a. Deep tissue injury is caused by intense pressure at the bone/tissue interface.
   b. Deep tissue injury may not be immediately apparent; initially the skin may just appear reddened or blistered.
   c. Deep tissue injury is a serious tissue insult and is immediately apparent.
   d. Deep tissue injury results from ischemia in the tissues adjacent to the bone.

5. The three most important risk factors for pressure ulcer development in surgical patients are
   a. Immobility; age; time
   b. Pressure; time; age
   c. Immobility; pressure; time
   d. Age; pressure; immobility

6. Damage to tissues resulting from rubbing against a surface is
   a. Shear damage
   b. Pressure damage
   c. Capillary interface pressure
   d. Friction damage

7. Which of the following statements about pressure damage is true:
   a. damage can be greater at the bone/tissue interface that at the skin surface
   b. pressure damage heals readily
   c. damage from pressure may not be immediately apparent
   d. pressure damage is categorized into stages

8. Which of the following statements about shear is NOT true.
   a. Shear damage requires pressure over a bony prominence
   b. Shear damage results from crimping or tearing of tissue and vessels as tissues are forces in opposite directions from one another
   c. Shear damage can occur if patients slide up or down on the operating table intraoperatively
   d. Shear combines with pressure to cause tissue damage during surgical positioning.

9. The nerves at greatest risk during surgical positioning are
   a. Median; femoral; brachial plexus; popliteal
   b. Radial; median; ulnar; phrenic
   c. Brachial plexus; ulnar; femoral; phrenic
   d. Median; ulnar; popliteal; brachial plexus

10. A systems approach to a safety program includes
   a. Education
   b. Optimal practice
   c. Effective products
   d. All of the above

11. Which of the following statements is true:
   a. All surgical patients are at risk for development of pressure ulcers during the procedure.
   b. Risk for developing pressure ulcers escalates with procedures over two hours.
   c. Friction and shear are much less problematic than pressure.
   d. Stage II ulcers usually deteriorate to Stage IV.

12. AORN criteria for effective positioning devices include do not include
   a. Fireproof
   b. Antibacterial
   c. Fluid-resistant
   d. Radiolucent

13. A patient who is repositioned during surgery is susceptible to injury from
   a. Shear
   b. Friction
   c. Pressure
   d. All of the above

14. Which of the following statements is true.
    a. Blanchable erythema is a normal reaction to pressure
    b. Non blanchable erythema is a sign of a Stage II pressure ulcer
    c. Color returns to blanchable erythema within two minutes
    d. Rubbing an area of erythema increases circulation and promotes healing.

15. Heat has been identified as a factor in the development of pressure ulcers. Heat
    a. Causes the body to react poorly to anesthetic agent producing untoward reactions.
    b. Raises the tissue's metabolic rate and increases the need for cellular oxygen and nutrients, and the rate of byproduct removal.
    c. Damages the internal components of the cells causing tissue breakdown.
    d. Tissues that are hot are more susceptible to shear and friction injuries.

16. Extrinsic factors affecting the risk for development of pressure ulcers include:
    a. Age, weight, length of procedure
    b. Length of procedure, position, age
    c. Position, type of procedure, length of procedure
    d. Type of procedure, age, weight

17. Adverse outcomes of positioning include
    a. Pressure damage
    b. Neurapraxia
    c. Alopecia
    d. All of the above

18. Ring positioning devices ("donuts")
    a. Cause high shearing forces when used to support high pressure areas
    b. Should not be used on lengthy procedures
    c. Should not be used for supporting the occiput
    d. All of the above

19. Which of the following statements are true
    a. Pressure ulcers identified following a surgical procedure are the result of poor positioning techniques.
    b. Pressure during a surgical procedure may exacerbate tissue breakdown begun before surgery.
    c. Areas of pressure damage identified postoperatively began during the surgical procedure.
    d. Pressure ulcers discovered five days postoperatively could not have begun during the surgical procedure.

20. Which of the following statements is true.
    a. The lithotomy procedure has the highest incidence of pressure ulcer development
    b. Cardiovascular patient almost always develop pressure ulcers.
    c. Vascular, neurological, and cardiovascular patients are at higher risk for pressure ulcer development.
    d. Good positioning techniques for high risk patients can prevent pressure ulcers.

ANSWER KEY:

1. B
2. D
3. D
4. C
5. C
6. D
7. B
8. A
9. D
10. D
11. B
12. A
13. D
14. A
15. B
16. C
17. D
18. D
19. B
20. C