

THE CLINICAL ISSUE

PRESSURE ULCERS IN THE SURGICAL PATIENT

OVERVIEW

Medical personnel are challenged with preventing skin injury in the perioperative environment due to prolonged periods of patient immobility, compromised circulatory function under anesthesia, and preexisting conditions of many surgical patient populations. While great strides have been made in protecting the patient from skin injury, it is an issue that still needs to be addressed. These skin injuries may result in extended hospital stay, increased medical costs and prolonged morbidity. The healthcare facility may also incur financial and legal ramifications from these injuries.^{1,2}



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IMPACT OF PRESSURE ULCERS ON THE SURGICAL PATIENT

LENGTH OF HOSPITAL STAY

The length of hospital stay varies depending upon the type of surgical procedure being performed. However, this may increase by 3.5 to 5 days on average when a pressure ulcer is present.^{3,4} In some unusual cases, the adjusted length of stay for pressure ulcers may be as high as 15.6 days.^{5,6}

COST FACTORS

Cost factors for pressure ulcer treatment have a tremendous impact on the patient and healthcare facility. The average range per incident costs \$5,000-\$60,000,^{3,5-13} depending upon the severity of the pressure ulcer and the type of treatment required. Actual cost can reach as high as \$90,000 for one incident.¹⁰

Nursing care costs and time can increase by 50% for each pressure ulcer acquired during a surgical procedure.^{10,12} Furthermore, cardiac and vascular surgery patients account for approximately 45% of

the total hospital pressure ulcer treatment costs.¹⁰

A prevalence study conducted at a large U.S. hospital provides actual numbers and not merely statistical estimates. The average length of stay for those patients acquiring pressure ulcers increased by 6.5 days and cost an additional \$12,000 for treatment.¹⁰ Unfortunately, the average reimbursement rate per patient from insurance and Medicare/Medicaid was less than \$1,600. Therefore the hospital was losing more than \$10,000 per pressure ulcer incident.¹⁰

In the United States, perioperatively acquired pressure ulcers cost \$750 million-\$1.5 billion per year on average.^{10,14}

ADDITIONAL COMPLICATIONS

Patients who have pressure ulcers may be predisposed to other complications. Those complications may include, but are not limited to: bacteremia,⁷ squamous cell carcinoma,⁷ sinus tract formation,⁷ osteomyelitis,^{7,11,15} pyarthroses,¹¹ amyloidosis,¹¹ and sepsis.^{11,15}

Patients with pressure ulcers are impacted emotionally and financially, as well as physically.^{10,11} They are subject to pain, disfigurement, additional treatment, increased hospital stay, loss of income, loss of independence and possibly even loss of life.^{4,9,11}

Surgical patients are more susceptible to developing pressure ulcers than general acute care patients. This is due to many risk factors only present in the intraoperative environment. The incidence rate (the number of new cases of disease occurring in a population during a defined time interval) for surgical patients ranges from 12-66%.^{3,9-11,15-21} On average, the prevalence rate (a percentage of a population that is affected with a particular disease at a specified time) for surgical patients is between 3.5-29%.^{10,22,23}

Furthermore, there are many opportunities for patients to develop pressure ulcers depending upon the type of procedure being performed. These specialties have differing incidence and prevalence rates. See Table 1.

LENGTH OF SURGERY

As the length and time of surgery increase, the incidence and percentage of patients with pressure ulcers also increases.⁹ See Table 2.

Due to their negative impact, it is imperative to employ best practices that will assist in preventing pressure ulcers in surgical patients. In order to do this effectively, healthcare professionals need to recognize the risk factors and mechanisms contributing to pressure ulcer formation and identify them accurately if they do occur.

Table 1. Incidence and Prevalence by Specialty^{3,8-10,12,15,18,19}

Specialty	Incidence Rate	Prevalence Rate
Cardiac	17-29.5%	7%
Vascular	9.8-17.3%	
Spinal/Abdominal	36%	
Orthopedic	15-20.6%	6.5%
Elderly Orthopedic	66%	
General/Thoracic	27.7%	7%
Head & Neck		10%
Neurologic		5.2%

Table 2. Prevalence Rate Based on Length of Surgery^{3,4,18,28}

Length of Surgery	Prevalence Rate
3-4 hrs	5.8%-6.0%
4-5 hrs	8.9%
5-6 hrs	9.9%
>6 hrs	9.9%
>7 hrs	13.2%

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RISK FACTORS FOR THE DEVELOPMENT OF PRESSURE ULCERS

Approximately 95% of all pressure ulcers are preventable IF early risk assessment is performed and appropriate interventions are implemented.¹³

There are a substantial number of risk factors for developing pressure ulcers perioperatively. Many studies have attempted to identify the most accurate risk indicators for pressure ulcer development in the surgical patient. See Table 3.

Table 3. Risk Factors for Pressure Ulcers in the Surgical Patient

Preoperative Risk Factors	Intraoperative Risk Factors	Intraoperative Risk Factors
<ul style="list-style-type: none"> Advanced age^{4,9,12,13,15,19,25-27} Smoking^{19,26} Nutritional status^{4,9,12,13,15,17,19,25-27} <ul style="list-style-type: none"> Low preoperative serum albumin^{4,9,16,17,26} Low serum protein^{4,19,26} Decreased lymphocyte count⁴ Impaired lymphatic drainage¹⁹ Mid-arm circumference (Decreased muscle mass)⁴ Triceps skin fold⁴ Weight (Obesity)^{4,9,17,19,26,27} Low Body Mass Index (BMI)²⁸ Dehydration^{9,19,25} Changes in soft tissue structure¹⁹ Comorbidities^{4,9,19,26,27} <ul style="list-style-type: none"> Diabetes mellitus^{4,9,16,19,25} Preoperative hypertension⁴ Respiratory disease⁴ Vascular disease^{4,9,19,25} Anemia^{12,19} Neurological disease²⁵ Heart disease¹⁹ Low preoperative hematocrit and hemoglobin^{4,16,26} Immobility or impaired mobility^{9,12,13,15,19} Hypotensive episodes 	<ul style="list-style-type: none"> Patient morbidity⁹ Type of surgical procedure^{17,22} Hypothermia²⁶ <ul style="list-style-type: none"> Patients remaining in a hypothermic condition Use of heat/heating/warming blankets^{4,19,25,27} toward the maintenance of normothermia^{9,15} Anesthesia and anesthetic agents (sedatives, hypnotics, anesthetics, muscle relaxers, vasodilators)^{4,19,25,27} Hemodynamics^{4,26} <ul style="list-style-type: none"> Hypotensive episodes Lower arterial pressure^{4,26} Altered perfusion⁴ Extracorporeal circulation^{4,25,26} Blood loss²⁶ Low systemic blood pressure^{15,19} Decreased peripheral blood flow¹⁵ Time spent on operating room table undergoing surgical procedures^{4,9,19,27} Body positioning during surgery^{4,9} Skin friction and/or shear^{9,12,15,19,26} Intensity (>32 mm Hg)^{4,12,19} and duration of the applied pressure²⁸ Moisture^{9,15,17,19,26,27}/incontinence^{9,12,15}/excess pooled skin prep solution⁴ Impaired sensory perception/sensory loss^{9,12,15} 	<ul style="list-style-type: none"> Time required to return to preoperative body temperature (normothermia)^{4,16} Patient positioning^{7,10,16} Activity level/Mobility¹⁶ Pressure on surgical area¹⁰ Frequency of skin cleansing¹⁶ Elevation of head of bed¹⁶ Environmental Risk Factors (e.g., humidity)¹⁶

MECHANISMS CONTRIBUTING TO THE FORMATION OF PRESSURE ULCERS

Pressure ulcers have multiple causes. Their development and severity may be affected by vascular occlusion, ischemia and/or pressure intensity. Pressure ulcers develop when sustained mechanical occlusion of the vascular network occurs. Extended periods of uninterrupted pressure and shear occlude blood and lymphatic circulation, causing deficient tissue nutrition and a buildup of waste products due to ischemia. Blood vessels collapse and thrombose if the pressure is not relieved over time.

Once occlusion of the blood flow has occurred, ulceration continues the process. When tissues have been compressed for prolonged time periods, tissue damage continues to occur even after the pressure is relieved. Studies suggest an inverse relationship between pressure intensity and duration (time) of pressure in pressure ulcer development.⁷ Therefore, tissue damage can be produced by low pressures over an extended period of time or high pressures for shorter periods of time.^{4,10,12,15,23,25,29}

It is important to note that the patient's tolerance to pressure during surgical procedures can be affected by factors that may cause changes in metabolism and circulation such as anesthesia, surgical trauma, patient age, and other preexisting conditions.³⁰ As a result, the patient's own body weight upon bony prominences is directly capable of creating injury situations.

Figure 1 provides a visual illustration of the pressure ulcer development cycle.

Pressure ulcers which originate during the perioperative environment may appear within as little as a few hours postoperatively. However, the majority typically present one to three days postoperatively.^{4,10,26} These surgically-associated late onset pressure ulcers are often mischaracterized as energy-related "burns".³¹ Gendron stated that "it is precisely the lack of recognition of their [pressure ulcers'] true nature that has guaranteed their continuance."³²

Additional situational factors that augment the risk of pressure ulcer development in the perioperative setting have been identified. They include shear, pressure, temperature and time as discussed below.

- The presence of shear may decrease the time that tissue can remain under pressure before ischemia occurs.
- The sustained high pressure from specific patient positions and/or various devices such as use of supports and straps, pneumatic tourniquets, and unyielding electrode adhesives for an extended time (>2-3 hrs) may shorten the time to pressure ulcer development.^{1,2}
- Elevated tissue temperatures increase the oxygen consumption rate of the local cells, thereby shortening the time to death from ischemia.
- The severity of the ulcer is determined by the length of time pressure is applied to any given location. The probability of developing a pressure ulcer increases with the duration and intensity of the pressure and shearing force acting upon the tissue during surgery.³³ See Figure 2.

Figure 1. The Pressure Ulcer Development Cycle

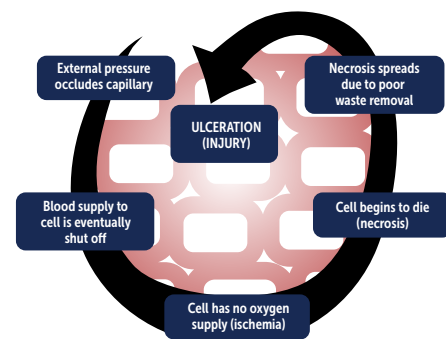
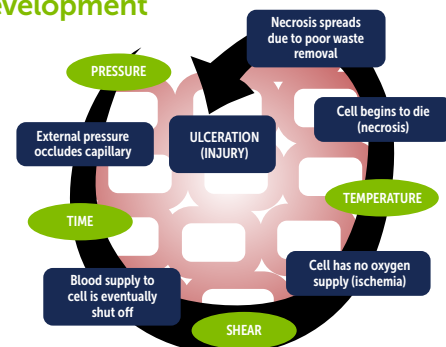


Figure 2. The Accelerated Cycle of Pressure Ulcer Development



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PRESSURE ULCER IDENTIFICATION

Pressure ulcers which have frequently been identified in long term care environments are also referred to as pressure injuries, bedsores, decubitus ulcers, trophic ulcers³⁴ or ischemic ulcers.⁷ They are defined as complex lesions of the skin and underlying structures which tend to develop when excessive pressure, shear, or friction is applied to soft tissue for an extended period of time. They are characterized by disintegration or tissue necrosis³² and frequently develop during serious illness and trauma, including surgery. They vary considerably in size and severity⁸ and are often described as unexplained “burn-like” lesions or inaccurately labeled as “burns”.^{9,22,29,30}

While burns result from contact with energy sources, pressure ulcers are a result of localized unrelieved pressure exacerbated by factors such as compression, shear, friction, and moisture.¹⁵ Circumstances under which pressure exceeds circulatory pressure is typically defined as 32 mm Hg. The result is sub-dermal cell damage normally seen at or around bony prominences which propagate outward to the surface. These may present within hours following the surgical procedure or as long as seven days after the injury has occurred.^{3,9,16,17} Conversely, burns are tissue injuries that initiate directly

at the skin surface, are visible immediately at the end of the surgical procedure and penetrate as they advance.²

PRESSURE ULCER CLASSIFICATION

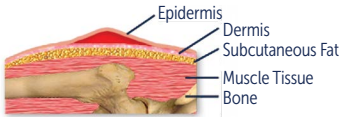
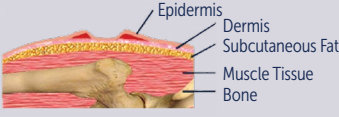
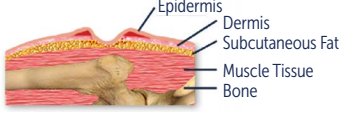

A common method which medical personnel use to determine the severity and treatment requirements for pressure ulcers is to classify the ulcer according to grading or staging systems based on the degree of tissue destruction. The stage is determined on initial assessment by noting the deepest layer of tissue involved. Table 4 describes a four-stage classification system, developed by the National Pressure Ulcer Advisory Council (NPUAC), is used to define pressure ulcers.³⁵

PROMINENT LOCATIONS OF PRESSURE ULCERS

Pressure ulcers are most prevalent in tissues overlying the patient’s bony prominences.¹³ In fact, over 95% of all pressure ulcers develop over bony prominences on the lower half of the body.^{4,29} The most prevalent locations for pressure ulcers in frequency of occurrence are illustrated in Figure 3 (on page 7).

Additional locations for pressure ulcer formation include the anterior chest.³⁵ In the prone position, pressure ulcers frequently develop on the forehead, cheek, female breasts, male genitalia, ankles and toes.³⁶

Table 4. Ulcer Staging Criteria Summary

Ulcer Stage	Criteria
Stage I 	Non-blanchable erythema of intact skin; the heralding lesion of skin ulceration. May also include changes in skin color, skin temperature, skin stiffness and/or sensation (pain).
Stage II 	Partial thickness skin loss involving epidermis and/or dermis. The ulcer is superficial and presents clinically as an abrasion, blister or shallow crater.
Stage III 	Full thickness skin loss involving damage or necrosis of subcutaneous tissue; may extend down to but not through underlying fascia. Presents clinically as a deep crater with or without undermining of adjacent tissue.
Stage IV 	Full thickness skin loss with extensive destruction, tissue necrosis or damage to muscle, bone and/or supporting structures, e.g., tendon, joint capsule.

In order to protect patients, identifying the cause(s) of pressure ulcers has become a necessity. Once identified, preventative measures can be implemented and may help reduce future occurrences.

BURN DIFFERENTIATION

Pressure ulcers and burns may both occur in the intraoperative environment and are often difficult for clinicians to differentiate upon post-injury inspection; however, they differ in several ways. A burn is a skin lesion caused by direct contact with thermal, chemical, electrical sources or radioactive agents that exceeds the skin’s tolerance for that energy.^{32,36} A distinguishing characteristic of this type of injury is that it typically presents much earlier after the insult than a pressure ulcer.³⁷

BURN CLASSIFICATION

Burn injuries have three primary classification levels: 1st, 2nd, and 3rd degree burns. These classification levels are based primarily on the skin layers affected by the burn. The skin layers include the epidermis, the thin, outermost layer; the dermis, which provides strength, support, blood and oxygen to the skin; and the hypodermis or subcutaneous layer, located beneath the dermis, which provides blood supply to the dermis for regeneration.

CAUSES OF BURNS

There are several causes for patient burns within the intraoperative environment. Burns have been found to occur due to contact with various types of energy sources. Chemical, electrical, or thermal sources are the primary causes.

Table 5 describes differences between thermal burns and intraoperatively-acquired pressure ulcers.

Figure 3. Most Prominent Pressure Ulcer Locations by Frequency of Occurrence

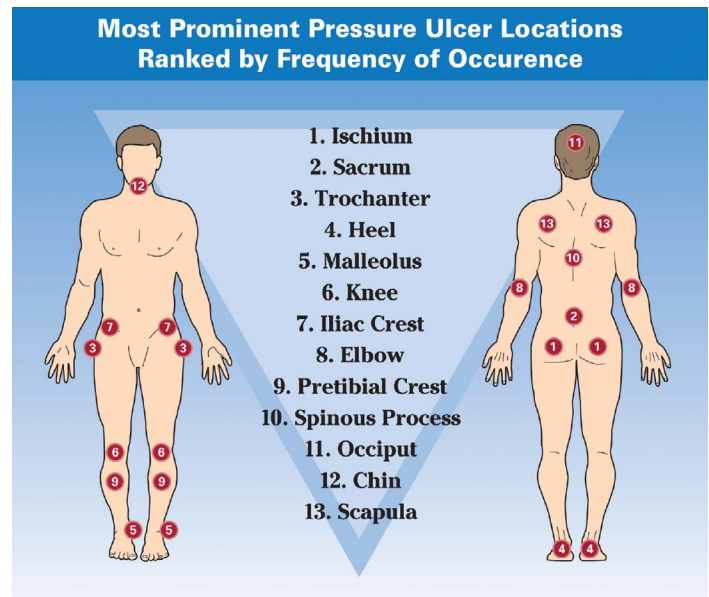


Table 5. Burn and Pressure Ulcer Differentiation†

	Burn (Thermal) 1 st and 2 nd degree burns (Superficial)	Pressure Ulcer (Intraoperatively-Acquired)
Physical Appearance	Presents as a painful reddening of the skin (appearance of sunburn), swelling (erythema) and blanchable redness; blistering (in 2 nd degree)	Stage I: Defined areas of persistent, non-blanchable redness Stage II: Abrasion, blister or shallow crater
Time of Observation	Immediately or soon after event (<24 hours)	One to 3 days postoperatively
Pain	Moderate to severe	Stage I: None to mild Stage II: Mild to moderate
Requires	Thermal source in contact with skin above the temperature/time threshold	Pressure (possible exacerbated by other risk factors) of sufficient intensity to cause tissue ischemia, for a sufficient length of time to cause tissue necrosis
Risks	Direct contact with thermal source	Patient position, positioning devices, negativity, heat, cachectic or obese body types, and/or presence of disease, medications or surgical event that could reduce tissue perfusion

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BEST PRACTICES FOR PREVENTING PRESSURE ULCERS

In order to prevent pressure ulcers in the surgical patient, healthcare professionals should develop and employ education and communication initiatives in addition to thorough patient assessments.

EDUCATION AND COMMUNICATION INITIATIVES

"Heightened awareness and education may be an effective intervention, which alone can positively influence prevention."⁴

- Develop a facility plan for monitoring the incidence of pressure ulcers acquired perioperatively.¹⁰
- Provide frequent education and training to healthcare professionals in appropriate areas.²⁶
- Develop a "Surgical Care Plan" or an individual (patient-centered) care plan for continuity of care and improved communication between the operating room and other patient care units.^{10,13,38,39}

PATIENT ASSESSMENT STRATEGIES

Strategies to prevent pressure ulcers in surgical patients should begin upon admission¹¹ and be carried on throughout the hospital stay.¹¹ Patients should be reassessed at regular intervals, particularly after a surgical procedure.^{11,13} Patient assessment strategies can be divided into 3 phases: preoperative, intraoperative and postoperative. The following is a listing of strategies grouped by phase.

PREOPERATIVE STRATEGIES

- **Collect information on devices to be used during surgery** (for follow-up investigation if required).^{1,2} This information may include: type and location of positioning and/ or padding devices;⁴⁰ manufacturer;^{1,2} lot numbers;^{1,2} settings used during the procedures, if applicable; expiration (or "use before") dates of prep solutions, electrodes, and electrode gels;^{1,2} models;^{1,2} hospital control numbers;^{1,2} and serial numbers of equipment.^{1,2}
- **Identify patients at risk**^{9,26,27} by completing an initial risk assessment.^{9,41} By identifying all contributing factors, measures can be taken to reduce or prevent pressure ulcers.¹²
- **Maximize nutritional status.**³⁹
- **Develop a normothermia strategy to be employed** in order to monitor and maintain body temperature as close to normothermia as possible.⁴⁰
- **Minimize skin exposure to moisture** so that all dependent skin surfaces will remain dry during the surgical procedure.¹⁷
- **Assess and modify increased pressure situations** (e.g., when seated or lying down).³⁹
- **Reduce or eliminate friction and shear.**^{16,17,39}
- **Avoid massaging over bony prominences**¹⁶ or areas that have been damaged by pressure.¹⁰

INTRAOPERATIVE STRATEGIES

- **Protect and position patient properly.**
- **Protect pressure-sensitive areas** when placing a patient in a prone, supine, or lateral position.^{9,13}
- **Ensure adequate peripheral perfusion** in pressure areas.²⁵
- **Minimize skin exposure to moisture intraoperatively.**⁹
- **Smooth out all sheets, pads, and other materials beneath the patient** while on the operating room table.

- **Consider additional criteria if patient temperature regulators are used** (i.e. hypo/hyperthermia unit operation)³⁶ such as thermostat settings,²¹ heat exposure temperature (both direct and indirect), temperature probe placement,²¹ system and patient temperature monitoring²¹ and patient pressure maintenance (especially on bony prominences).¹⁰

POSTOPERATIVE STRATEGIES

- **Consider removing adhesive and gel interfaces** from the skin immediately following the surgical procedure.
- **Record any observed changes or abnormalities.**¹
- **Mobilize early** after the surgical procedure.⁸
- **Position patients** to prevent them from lying directly on their trochanters.¹⁶
- **Reposition patients** who are confined to bed at least once every two hours.^{7,16}
- **Provide complete and total relief of pressure** for the injured area postoperatively.¹⁰
- **Consider placing the patient on a pressure relieving device** if any of the following criteria are met:²¹ >40 years of age;²¹ on operating room table longer than 2.5 hrs;²¹ or has vascular disease (e.g., diabetes).²¹
- **Select pressure relief systems that reduce pressure at the interface between the underlying supporting surface** (e.g., dynamic alternating pressure support systems).⁷
- **Use positioning devices** to prevent contact with bony prominences.¹⁶
- **Cleanse skin** at the time of soiling and at routine intervals.
- **Maintain the head of the bed** at the lowest degree of elevation (30° laterally inclined)¹² consistent with the patient's medical conditions.¹⁶
- **Minimize the environmental risk factors** such as low humidity (i.e., less than 40%).

CONCLUSION

Pressure ulcers in the surgical patient occur all too frequently. As they are one of the more common skin injuries, medical personnel should understand the impact pressure ulcers have on the surgical patient, recognize the importance of accurate identification, and follow appropriate strategies to prevent them from occurring. Through careful planning and implementation of best practices, pressure ulcers in the surgical patient can be eliminated.

ACCREDITED EDUCATION ON THIS TOPIC:

A CE accredited, in-depth study guide on this topic is available through your Halyard Health Sales Representative.

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