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RELIEVING THE PRESSURE IN PRESSURE INJURY:

Strategies for Pressure Injury Management

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Pressure injury is defined as localized damage to the skin and/or underlying tissue due to intense or prolonged pressure, or pressure combined with shear.^{1,2} Formerly referred to as "pressure ulcer," the term "pressure injury" is now preferred, as it more accurately reflects the fact that skin may remain intact in certain types of pressure injury (eg, deep tissue and less severe pressure injuries).^{2,3} Pressure injury is a common problem in the United States, affecting an estimated 2.5 million patients in acute care facilities each year.⁴ Prevalence varies by health care setting. In 2015, the estimated prevalence of pressure injury in the United States was 8.8% in acute care facilities, 28.8% in long-term acute care facilities, 11.3% in long-term care facilities, and 11% in rehabilitation facilities.⁵ Up to 28% of nursing home residents report pressure injuries.⁶

If left untreated, pressure injuries can result in significant morbidity and mortality. Infection of the pressure injury wound may occur, which in turn can lead to abscess formation, osteomyelitis, sepsis, or even death.⁷ An estimated 60,000 patients die from pressure injury-related complications each year.⁸ Chronic pressure injuries are also associated with significant pain, and have been associated with increased anxiety and/or depression, decreased social functioning, and reduced quality of life.¹ Larger or more complicated pressure injuries can lead to extended hospital or long-term acute care facility admissions, resulting in major costs to the patient and the health care system.⁷ Hospital-acquired pressure injuries account for an estimated \$26.8 billion in health care expenditures every year.⁴ In a retrospective study of hospitalized patients in the United States, pressure injury was associated with a longer median length of stay (7 days vs. 3 days), as well as higher median hospital costs (\$36,500 vs. \$17,200) and mortality rates (9.1% vs. 1.8%).⁸ Therefore, it is crucial to prevent pressure injury whenever possible, and treat it in the early stages if it occurs. This article will review the pathogenesis and clinical presentation of pressure injury, as well as best practices for prevention and appropriate methods of treatment.

Etiology and Pathogenesis of Pressure Injury

When soft tissues are subjected to intense and/or prolonged compression, tension, or shear, damage can occur.¹ Soft tissue tolerance for sustained deformations varies, depending on the characteristics of the tissue itself as well as certain patient-specific characteristics (eg, age, health status, comorbidities). Pressure injuries commonly occur over bony prominences, due to the force of the patient's body weight; however, these can also occur as the result of external pressures from a medical device or other object. The most common locations for pressure injury include the sacrum, the greater trochanters of the hip, and the heels; however, any area where there is little to no soft tissue over a bony prominence (eg, back of the head, ear, scapula, elbow, patella) can be susceptible.^{9,10} The area most at risk for a specific patient will depend on the patient's positioning.⁹

Several mechanisms contribute to the tissue damage observed in pressure injury.¹ Sustained deformation of cells, vasculature, and tissues can cause direct damage to the cells as well as trigger inflammation and subsequent edema. Pressure can also lead to

distortion of the capillary network and/or lymphatic obstruction, causing reduced blood supply, tissue hypoxia, and decreased ability to remove metabolic waste from the affected tissues.

Many risk factors for pressure injury have been identified in the literature. One of the greatest risk factors is impaired mobility.¹¹ Impaired mobility can result from a number of underlying causes, including sedation, surgery, limb fracture, restraints, spinal cord injury, and advanced dementia.^{1,11} Conditions that limit or impair perfusion, circulation, and/or tissue oxygenation can also increase a patient's risk; these conditions may include diabetes mellitus, peripheral vascular disease, and venous insufficiency. Other conditions that can increase susceptibility to pressure injury include malnutrition and decreased sensory perception (eg, peripheral neuropathy).^{11,12} Although moisture alone is not considered a direct cause of pressure injury, moisture can act synergistically with pressure, friction, and shear forces, contributing to skin breakdown and pressure injury development or worsening.⁹⁻¹¹ Therefore, patients with urinary or fecal incontinence, wound drainage, and/or excessive perspiration are also at increased risk.¹¹

Certain patient populations are more likely to sustain pressure injuries. Older patients are at increased risk, in part due to age-related reductions in subcutaneous fat and capillary blood flow.¹¹ Skin changes associated with aging (eg, decreased cohesion of the dermis and epidermis, reduced sensory function) can also contribute. Very young patients (eg, neonates) may also be at increased risk due to skin immaturity and decreased dermal-epidermal cohesion. Critically ill patients are another high-risk subset; the prevalence of pressure injury in the intensive care unit has been estimated at 13.1% to 45.5%.¹ These patients frequently have multiple risk factors for pressure injury, including immobility/sedation, hemodynamic instability, and poor tissue perfusion/oxygenation. Patients receiving palliative care may similarly be at increased risk due to the organ system failure that typically occurs near the end of life.

Various tools are available to assess a patient's risk of pressure injury.¹ The most commonly used risk assessment tools are the Braden scale and the Norton scale.^{11,13} The Braden scale uses 6 criteria to evaluate risk (Table 1); Braden scale scores range from 6 to 23, with lower scores indicating a greater risk of pressure injury.¹¹ Patients with Braden scale scores less than 12 have the greatest risk. The Norton scale assesses 5 criteria (Table 2), and produces scores ranging from 5 to 20. Patients with Norton scale scores less than 14 are at highest risk for pressure injury.

Table 1. Braden scale criteria.¹¹

Score	1	2	3	4
Sensory perception	Completely limited	Very limited	Slightly limited	No impairment
Moisture	Constantly moist	Very moist	Occasionally moist	Rarely moist
Activity	Bedfast	Chairfast	Walks occasionally	Walks frequently
Mobility	Completely immobile	Very limited	Slightly limited	No limitation
Nutrition	Very poor	Probably inadequate	Adequate	Excellent
Friction and shear	Problem	Potential problem	No apparent problem	Not applicable
Interpretation of total score: 15-18, mild risk; 13-14, moderate risk; 10-12, high risk; ≤9, very high risk				

Score	1	2	3	4
Physical condition	Very bad	Poor	Fair	Good
Mental condition	Stupor	Confused	Apathetic	Alert
Activity	Bedbound	Chairbound	Walks with help	Ambulant
Mobility	Immobile	Very limited	Slightly impaired	Full
Incontinent	Urinary and fecal	Usually urinary	Occasional	None
Interpretation of total score: >18, low risk; 14-18, medium risk; 10-14, high risk; <10, very high risk				

Clinical Presentation and Staging of Pressure Injury

Pressure injury may present with localized pain and/or itching; however, impaired sensation or cognition can prevent patients from recognizing and/or reporting these symptoms.¹¹ Therefore, patients at risk for pressure injury should undergo regular skin and tissue assessments so that pressure injury can be caught and treated at an early stage.¹ Skin and tissue assessments should be comprehensive, with particular attention being paid to skin overlying bony prominences (eg, the sacrum, heels, hips, pubis, thighs, torso, and back of the head [for neonates and young children]). In obese patients, skin folds should also be examined for signs of skin maceration and pressure injury. The diagnosis of pressure injury is primarily based on visual examination of the skin.¹¹ However, when assessing the depth or extent of the injury, it is also recommended to assess the surrounding tissue for changes in sensation (eg, pain), temperature, firmness, color, and drainage upon palpation.¹⁴ Changes in these domains may indicate a more extensive injury than what is apparent from visual inspection alone. Additionally, patients should be evaluated for any signs of infection (eg, fever, leukocytosis, or wound characteristics such as tenderness, erythema of the surrounding area, swelling, warmth, exudate, or odor).¹¹

The 2016 National Pressure Injury Advisory Panel (NPIAP) Pressure Injury Staging System is used to classify and describe pressure injuries.² Pressure injuries can be classified as stage I, stage II, stage III, stage IV, unstageable, or deep tissue pressure injury (Table 3). Stage I pressure injuries are the most common type, accounting for an estimated 47%.¹³

Table 3. 2016 National Pressure Injury Advisory Panel (NPIAP) Pressure Injury Staging System.^{2,12}

Classification	Description
Stage I	Intact skin with localized, nonblanchable erythema. May be difficult to identify on darkly pigmented skin, as blanching may not be visible; however, color, temperature, or firmness of the skin may differ from that of adjacent tissue, and the area may be painful.
Stage II	Partial-thickness skin loss with exposed dermis. Wound bed will appear viable, pink or red, and moist, with no visible adipose tissue and no signs of granulation tissue, slough, or eschar. May also present as intact or ruptured serum-filled blisters.
Stage III	Full-thickness skin loss, with visible adipose tissue in the ulcer. Granulation tissue and rolled wound edges often present; slough and/or eschar may be visible.
Stage IV	Full-thickness skin and tissue loss and exposed or directly palpable fascia, muscle, tendon, ligament, cartilage, or bone. Rolled edges, undermining, and tunneling often occur, and slough and/or eschar may be visible.
Unstageable	Full-thickness skin and tissue loss, but full extent of tissue damage cannot be determined due to slough and eschar.
Deep tissue pressure injury	Localized area of persistent, nonblanchable deep red, maroon, or purple discoloration; may also present as epidermal separation revealing a dark wound bed or blood blister. Skin may be intact or broken; pain and temperature change may precede skin discoloration.

Pressure Injury Prevention

It is important to initiate appropriate preventive measures in patients who are at risk for pressure injury; this generally involves addressing any modifiable patient-specific risk factors and minimizing episodes of prolonged pressure on any given area.¹⁵ Patients who are bedbound or chairbound should be repositioned or turned at scheduled intervals, and padding should be placed at pressure points as appropriate.^{15,16} The appropriate frequency of repositioning will depend on the patient's condition and ability to self-reposition, but for most hospitalized patients, turning and repositioning every 2 hours while in bed and every hour while seated is reasonable.⁹ Patients in the intensive care unit may require more frequent repositioning (eg, every hour), and patients in specialty beds (eg, air-fluidized beds) may only need repositioning every 4 hours. Support surfaces and heel suspension devices may be useful adjunctive measures to redistribute pressure throughout the body and decrease pressure on vulnerable areas.¹⁶ Support surfaces may include static devices (eg, air, foam, gel, or water overlays or mattresses) or dynamic devices (eg, alternating or low-air-loss mattresses, air-fluidized beds).⁹ Static devices are generally more appropriate for patients at low risk of pressure injury, while alternating or low-air-loss mattresses are ideal for patients who have a moderate to high risk or existing stage III or IV pressure injuries. Air-fluidized beds, which contain silicone-coated beads that liquefy when air is pumped through the bed, are useful for very high-risk patients and patients who have nonhealing or numerous truncal full-thickness pressure injuries.

Prophylactic dressings can also be used to help minimize risk, particularly for pressure injury to the sacrum or heel.^{16,17} Depending on type, a dressing may assist in reducing friction, shear, and pressure, as well as modifying skin moisture (eg, by absorbing sweat or protecting the area from external moisture).¹⁷ The NPIAP recommends a soft, multi-layered silicone foam dressing for skin protection in patients at risk.¹ Prophylactic dressings should be considered for patients with current or planned immobility, loss of sensation that reduces spontaneous movement, reduced or restricted mobility, atypical movement (eg, due to agitation or dementia), a medical device in place, or scarring from a previous pressure injury.¹⁷ For patients with incontinence, other skin barriers (eg, creams, ointments, pastes, film-forming skin protectants) should also be used as needed to protect skin from excess moisture.¹⁶

Since malnutrition can increase risk for pressure injury, nutritional interventions may also be important.¹ Nutritional status should be assessed at baseline, and an individualized nutrition care plan should be implemented for patients who are malnourished or at risk of malnutrition. Adult patients who are malnourished or at risk of malnutrition should generally be offered a minimum of 30 to 35 kcal/kg body weight per day, as well as 1.25 to 1.5 g of protein/kg body weight per day and 1 mL fluid per kcal per day.¹⁶

Pressure Injury Treatment

Goals of pressure injury treatment must be individualized according to patient values.¹ Common objectives include preventing/treating infection, managing pain, and achieving complete wound healing.^{1,11} If complete healing is not possible, other goals may include reducing pressure injury size,

enhancing quality of life, and limiting wound impact (eg, reducing exudate and odor).¹

Previously discussed prevention measures are used in patients with existing pressure injuries to prevent worsening or development of new injuries.^{16,18} Local wound care measures should also be implemented to keep the wound clean and create an environment that supports wound healing.¹ Pressure injuries and the surrounding skin should generally be cleansed with potable water or normal saline, although antimicrobial cleansing solutions such as povidone iodine or sodium hypochlorite may be used when infection is suspected or confirmed. These antimicrobial cleansing solutions should be avoided in non-infected wounds, as they can kill granulation tissue and impair wound healing.¹¹ Sharp, enzymatic, biological, mechanical, or autolytic debridement should be performed to decrease bacterial burden and remove any suspected/confirmed biofilm and necrotic or devitalized tissue from the wound.^{1,18} Maintenance debridement should continue until the wound bed is free of devitalized tissue and covered with granulation tissue.¹

Wound dressings are selected based on the goals of care and clinical characteristics of the specific pressure injury (eg, presence of infection or exudate, volume of exudate, location of the wound, size/shape).^{1,15} Wound dressings should be able to absorb any wound exudate, minimize friction or shearing, and protect the tissue surrounding the ulcer.^{1,18} For nonischemic wounds, it is best to maintain a moist environment to promote wound healing.¹⁸ Transparent film dressings and foam dressings can be used to protect stage I pressure injuries where the skin remains intact.¹⁵ Hydrocolloid, hydrogel, or polymeric membrane dressings can all be appropriate choices for patients with non-infected stage II pressure injuries, with the choice of specific dressing dependent upon the clinical condition of the injury.¹ For patients with non-infected stage III or IV pressure injuries and minimal exudate, hydrogel dressings are appropriate, whereas patients with moderate exudate should receive more absorbent calcium alginate dressings. Foam dressings are appropriate for patients with stage II or greater pressure injuries and moderate to heavy exudate. For patients with nonhealing pressure injuries, collagen matrix dressings can also be considered to improve wound healing.

Additional therapies that may encourage wound healing in patients who do not respond to conventional therapy include negative pressure, topical growth factors, and biophysical therapies.¹ Negative pressure wound therapy creates a vacuum in the wound bed, which is thought to encourage the healing of chronic wounds.¹⁵ This approach can be considered as adjunctive therapy for patients with stage III or IV pressure injuries.^{1,18} Growth factors (platelet-rich plasma and recombinant platelet-derived growth factor) have been shown to promote healing when applied to pressure injury wounds and can be considered for patients with higher-stage pressure injuries refractory to conventional therapy. Biophysical therapies, such as pulsed current electrical stimulation and ultrasound therapy, can also be used as adjunctive therapies for patients with stage III and IV pressure injuries. Pulsed current electrical stimulation may be helpful for patients with recalcitrant stage II pressure injuries as well.

Wound infection and biofilm formation are common complications of pressure injury; the presence of microorganisms in

the wound can lead to chronic inflammation, delayed healing, and/or systemic infections.¹ Therefore, prevention and treatment of infection and biofilm formation is a vital component of pressure injury management. Local wound infection may be indicated by delayed healing, discoloration or friability of granulation tissue, pocketing at the wound base, foul odor, wound breakdown, or increased pain, even in the absence of classic signs of infection.^{1,18} In pressure injuries with delayed healing, topical antimicrobial agents (eg, silver-containing cream, cadexomer iodine gel) can help to control the microbial burden and promote healing. Patients with signs and symptoms of systemic infection should receive appropriate systemic antibiotics.¹ Empiric antibiotic therapy that provides broad-spectrum coverage for aerobic Gram-negative rods, Gram-positive cocci, and anaerobic bacteria should be used until culture results are available.¹¹ If osteomyelitis is suspected, a bone biopsy should be performed to confirm the diagnosis, and appropriate treatment (including debridement and systemic antibiotics) should be initiated.¹⁸

Pain associated with pressure injuries can be constant and/or severe, so patients with pressure injury often place a high priority on pain management.¹ Nonpharmacologic pain management strategies (eg, position changes, distraction, warmth applications, relaxation techniques) should be implemented first-line or as adjunctive treatment. Pharmacologic treatments for pain are also commonly used, and may include topical and/or systemic therapies. Topical analgesics used to treat pressure injury pain include opioids, anti-inflammatory drugs, and local anesthetics. These interventions may be most effective when applied 20 to 30 minutes prior to wound care or other activities associated with

pressure injury pain. Systemic options for pain management include acetaminophen, nonsteroidal anti-inflammatory drugs (eg, ibuprofen), and/or opioids. Scheduled administration of analgesics (rather than as-needed dosing) is recommended for optimal pain control.

Alocane Plus is a topical ointment containing 4% lidocaine (a topical analgesic) and 0.13% benzalkonium chloride (a topical antiseptic), along with other ingredients such as aloe and tocopherol acetate (vitamin E).¹⁹ This product may be useful for treating pain and preventing infection in early-stage pressure injuries. In an observational study, topical lidocaine was associated with significant reductions in pain intensity in patients with a variety of painful wounds, including pressure injury.²⁰ An additional retrospective study found that topical application of 4% lidocaine was safe and effective for reducing pain during debridement of digital ulcers secondary to systemic sclerosis.²¹ Benzalkonium chloride has been shown to decrease bacterial biofilm burden in *in vitro* studies and murine wound models.²² Therefore, it may be useful to prevent infection or biofilm formation in patients with pressure injury. The “inactive” ingredients aloe and vitamin E have additional properties that may be beneficial to wound healing.

A clinician described successful use of Alocane Plus in two elderly patients with painful leg wounds likely caused by venous stasis. Both patients experienced atypical pain despite treatment with topical lidocaine, cellulose mesh dressing, and light compression. Following initiation of Alocane Plus, both patients experienced greater pain reduction as well as improvement in wound beds (Figure 1).

Monitoring and Follow-Up

After pressure injury treatment is initiated, it is important to monitor the wound to make sure that it is healing appropriately.¹¹ Pressure injury wounds should be reassessed on a weekly basis at minimum.¹ If no signs of healing are observed within 2 weeks despite the implementation of appropriate wound care, pressure redistribution, and nutrition, the plan of care should be re-evaluated. Validated tools are available to assess wound healing progress in pressure injury. One commonly used tool is the Pressure Ulcer Scale for Healing (PUSH), which assesses the dimensions of the pressure injury, the amount of exudate, and the presence of various tissue types in the wound to generate an overall total healing score.^{1,9,11} Another commonly used tool is the Bates-Jensen Wound Assessment Tool (BWAT), which uses 13 wound characteristics to generate a score.^{1,9} With both tools, a lower score indicates a greater degree of healing.⁹

Conclusion

Pressure injury is a common problem that can lead to significant morbidity and mortality. In order to prevent serious consequences, it is important to identify patients who are at-risk and implement appropriate preventive measures. If pressure injury occurs, timely treatment is essential to prevent worsening and associated negative health consequences. Wound care measures and frequent repositioning are mainstays of pressure injury care, along with interventions to prevent infection and manage pain. Alocane Plus can be a useful tool in the management of early-stage pressure injuries, with active ingredients that help to reduce wound pain and prevent wound infection.

Figure 1. Venous stasis wounds before and after treatment with Alocane Plus.



Before

After

Length of Application	Size of Injury and Reduction
Start 12/07/20	13 cm x 6 cm x 1 cm (78.0 cm ³)
Stop 01/01/21	9 cm x 6 cm x 0.6 cm (32.4 cm ³)
26 Day Duration	45.6 cm ³ Size Reduction or 42%

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Case Count	48	12
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ICD-10-Wound	Z48.00	Z48.00
ICD-10-Pressure Injury	L89-	L89-
ICD-10-Radiation Dermatitis	L58-	L58-
ICD-10-Venous Stasis Ulcer	I87.319	I87.319



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