

PRESSURE ULCER PREVENTION: ADVANCED PATIENT MONITORING TECHNOLOGY FOR REPOSITIONING MANAGEMENT

KEY POINTS

- Pressure ulcers (PUs) remain a significant patient safety concern that affects an estimated 3 million patients per year with associated U.S. health care costs of approximately \$11 billion.
- Hospital-acquired advanced-stage PUs are “never events” that are not subject to Medicare reimbursement.
- Despite evidence supporting the importance of rigorous patient assessment and monitoring to reduce the incidence of PUs, compliance with prevention protocols remains suboptimal.
- Implementation of advanced patient monitoring technologies can enhance patient-turning protocols, aid in protocol compliance, and reduce the incidence of PUs.
- Implementation of PU-prevention strategies is highly cost-effective and improves patient safety.

BACKGROUND

According to the National Pressure Ulcer Advisory Panel and the European Pressure Ulcer Advisory Panel (NPUAP-EPUAP), pressure ulcers are defined as a “localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear.”¹ PUs develop when compression of the capillaries supplying the skin and subcutaneous tissue results in reduced tissue perfusion. In addition to this pressure-induced regional hypoxia, reperfusion injury, localized lymphatic system impairments, and mechanical injury are also believed to contribute to tissue necrosis and PU formation.² Clinically, PU severity is graded based on the extent and depth of tissue involvement. (See Table 1.)

INCIDENCE AND BURDEN

Unfortunately, while considered mostly preventable events, PUs remain a major health problem in U.S. health care facilities, affecting an estimated 3 million patients per year with approximately 60,000 patient deaths per year attributed to PU complications.³⁻⁵ Furthermore, despite advances in patient monitoring and care, there has been disappointing progress in reducing the occurrence of these events. In fact, the Healthcare Cost and Utilization Project (HCUP) reported a 63% increase in PUs from 1993 to 2003, while the total number of hospitalizations during this time increased by only 11%.⁶ Similarly, PUs were noted in 503,300 hospital stays in 2006, representing an 80% increase compared to 1993.⁷ Given an aging population in combination with increasingly fragmented care and nursing shortages, the incidence of PUs is likely to continue to increase.⁸

In the Eighth Annual HealthGrades Patient Safety in American Hospitals Study, which reviewed records from approximately 5,000 hospitals from 2007 to 2009, PUs were the second most common patient safety indicator (PSI), with an incidence rate of 26.6 per 1,000 at-risk hospitalizations.⁹ Together, the four PSIs of death among surgical inpatients with serious treatable complications, PUs, postoperative respiratory failure, and postoperative sepsis accounted for 68.5% of all patient safety events.⁹ Despite comprehensive training, education, and newer prevention and treatment techniques, PU formation continues to be especially problematic in acute care settings such as intensive care units (ICUs). A review of the ICU literature from 2000 to 2005 showed a PU incidence of 3.8% to 12.4%.¹⁰ In the International Pressure Ulcer Prevalence Survey in 2009, facility-acquired PU prevalence rates were highest in the medical ICU at 12.1%.¹¹ PUs are also costly events, with an estimated charge per stay of more than \$70,000 for a full thickness ulcer and an estimated \$11 billion spent annually on PU treatment in the United States.^{7,12,13}

Table 1. Pressure Ulcer Classification

<p>Suspected deep-tissue injury</p> <ul style="list-style-type: none"> ▪ Purple or maroon localized area of discolored, intact skin or blood-filled blister caused by damage to underlying soft tissue from pressure or shear. ▪ The discoloration may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler compared with adjacent tissue. 	<p>Category/Stage III: Full thickness skin loss</p> <ul style="list-style-type: none"> ▪ Full thickness tissue loss. ▪ Subcutaneous fat may be visible, but bone, tendon, or muscle isn't exposed. ▪ Slough may be present, but doesn't obscure the depth of tissue loss. ▪ Could include undermining and tunneling. ▪ The depth of a Category/Stage III pressure ulcer varies by anatomical location. ▪ The bridge of the nose, ear, occiput, and malleolus don't have (adipose) subcutaneous tissue. Category/Stage III ulcers can be shallow. ▪ In contrast, areas of significant adiposity can develop extremely deep Category/Stage III pressure ulcers. ▪ Bone/tendon isn't visible or directly palpable.
<p>Category/Stage I: Non-blanchable erythema</p> <ul style="list-style-type: none"> ▪ Intact skin with non-blanchable redness of a localized area usually over a bony prominence. ▪ Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area. ▪ The area may be painful, firm, soft, warmer, or cooler, as compared to adjacent tissue. ▪ Category I may be difficult to detect in individuals with dark skin tones. ▪ May indicate "at risk" persons. 	<p>Category/Stage IV: Full thickness tissue loss</p> <ul style="list-style-type: none"> ▪ Full thickness tissue loss with exposed bone, tendon or muscle. ▪ Slough or eschar may be present. Often includes undermining and tunneling. ▪ The depth of a Category/Stage IV pressure ulcer varies by anatomical location. ▪ The bridge of the nose, ear, occiput, and malleolus don't have (adipose) subcutaneous tissue. These ulcers can be shallow. ▪ Category/Stage IV ulcers can extend into muscle and/or supporting structures (e.g., fascia, tendon, or joint capsule), making osteomyelitis or osteitis likely. ▪ Exposed bone/muscle is visible or directly palpable.
<p>Category/Stage II: Partial thickness</p> <ul style="list-style-type: none"> ▪ Partial thickness loss of dermis presenting as a shallow, open ulcer with a red-pink wound bed, without slough. ▪ May also present as an intact or open/ruptured, serum-filled, or sero-sanguinous filled blister. ▪ Presents as a shiny or dry shallow ulcer without slough or bruising (indicates deep tissue injury). ▪ This category should not be used to describe skin tears, tape burns, incontinence-associated dermatitis, maceration, or excoriation. 	<p>Unstageable</p> <p>Full-thickness tissue loss with the base of the ulcer covered by slough (yellow, tan, gray, green, or brown) or eschar (tan, brown, or black) in the wound bed.</p>

Modified from the National Pressure Ulcer Advisory Panel, 2009.¹

RISK FACTORS

The risk factors for PU development are complex and multifactorial, with more than 100 individual factors identified in the literature. In general, it's believed that any factor that results in functional impairment of the microcirculation along with factors that affect tissue integrity and elasticity can contribute to the development of PUs. Selected risk factors are described below in Table 2.

Table 2. Risk Factors for Pressure Ulcer Development

Age. The skin of older patients tends to be more fragile, thinner, less elastic, and drier than the skin of younger adults.
Lack of sensory perception. Spinal cord injuries, neurological disorders, and other conditions can result in a loss of sensation and reduce the patient's ability to sense an ulcer or feel the need to move.
Weight loss. The loss of a significant amount of fat and muscle results in less cushioning between bones and a bed or a wheelchair.
Poor nutrition and hydration. Sufficient fluids, calories, protein, vitamins, and minerals are needed to maintain healthy skin and prevent the breakdown of tissues.
Excess moisture or dryness. Moist skin due to sweat or lack of bladder control can increase the risk of PUs along with increased friction between the skin and clothing or bedding. Very dry skin can also increase friction.
Bowel incontinence. Bacteria can cause serious local infections and lead to life-threatening infections.
Medical conditions affecting blood flow. Health problems that can affect blood flow, such as diabetes and vascular disease, have increased risk of tissue damage.
Smoking. Smoking reduces blood flow and limits the amount of oxygen in the blood. Smokers tend to develop wounds that are more severe and heal more slowly.
Limited alertness. Reduced mental awareness due to disease, trauma, or medications may result in the inability to take the actions needed to prevent or care for pressure sores.
Muscle spasms. Frequent muscle spasms or other involuntary muscle movement may increase the risk of pressure sores from frequent friction and shearing.

As these diverse risk factors suggest, PUs can occur in a wide range of patients and in all parts of the hospital. PUs can develop in as little as two to six hours, indicating that early and continuous monitoring of at-risk patients is of critical importance.⁸ (See below for current monitoring technology.) It is also important to note that PU development is an insidious process. The initial injury typically begins in the deeper layers of tissue and then progresses toward the surface. By the time injury is visible, the deeper damage is already more advanced.² With this in mind, effective PU care bundles require vigilant risk assessment combined with aggressive prevention strategies.

PATIENT RISK ASSESSMENT

The thorough assessment of a patient's relative risk for the development of PUs requires a number of key steps, including: the careful examination of a patient's skin to identify any existing PU, the identification and evaluation of a patient's risk factors for the development of PUs, and a careful review of the patient's records to identify any prior history of PUs.³ Based on the above risk factors, scoring systems have been developed over the past 50 years in an attempt to classify a patient's likelihood of developing PUs. The first of these systems was the Norton Scale, which was developed in 1962. This 5 to 20 point scale grades patients according to physical condition, mental condition, activity level, mobility level, and incontinence, with ratings of <9 for very high risk, 10–13 for high risk, 14–17 for medium risk, and >18 for low risk.³ Similarly, the more recently developed Braden Scale incorporates the risk factors of sensory perception, skin moisture, patient activity, patient mobility, and patient nutrition, along with potential friction and shear problems, into a 6 to 23 point scoring system to allow for the classification of patients into the categories of mild risk (score 15–18), moderate risk (13–14), high risk (10–12), and severe risk (≤ 9).^{3,16}

PREVENTION AND TREATMENT

PUs typically form over bony prominences, with the back, buttocks, heels, and elbows of patients considered to be especially vulnerable regions.¹⁶ As mentioned above, the development of a PU is a progressive event that often begins in the deeper tissue before there are any visible signs of injury.² Thus, the development of more advanced PUs in a hospital setting can indicate a breakdown of patient safety protocols and PU prevention guidelines. Given this etiology, Stage III and IV PUs are now considered "never events" that are not subject to Medicare reimbursement.¹⁷ With

Modified from ^{14,15}

the enormous health care burden of PUs, all appropriate resources and monitoring technologies should be employed to minimize/prevent the development of PUs in hospitalized patients. Unfortunately, while most institutions recognize the importance of PU prevention and care protocols, the real-world adherence to these protocols can be suboptimal.¹⁸ Given current evidence, using appropriate support surfaces,

frequent repositioning of the patient, optimizing nutritional status, and moisturizing sacral skin should be considered appropriate strategies to prevent PUs.¹⁷ More specifically, the Institute for Healthcare Improvement (IHI) has suggested six essential steps for PU prevention.¹⁷ (See Table 3.) Of these components, patient-turning protocols and effectiveness are described below in more detail.

Table 3. Sample Strategies for PU Prevention

<p>Conduct a pressure ulcer assessment for all patients on admission</p> <ul style="list-style-type: none"> ▪ Assess skin for existing pressure ulcers. ▪ Perform a risk assessment to determine risk for ulcer development. ▪ Patients with a PU on admission or a history of PUs are at risk for developing more pressure ulcers. ▪ Use a validated pressure ulcer risk assessment tool such as the Braden Scale (http://www.bradenscale.com). 	<p>Manage moisture</p> <ul style="list-style-type: none"> ▪ Clean the patient’s skin at routine intervals and any time there is incontinence. ▪ Watch for excessive moisture caused by incontinence, perspiration, or wound drainage. ▪ Dry skin is also susceptible to breakdown. If the patient’s skin is dry and fragile, apply moisturizers and skin protectors. ▪ Provide appropriate undergarments or products that wick moisture away from the skin, clean soiled skin promptly, and apply a topical moisture barrier to protect the skin and prevent skin breakdown.
<p>Reassess risk for all patients daily</p> <ul style="list-style-type: none"> ▪ Risk profiles can change daily due to changes in patient acuity, clinical condition, or complexity of care. ▪ Use a standard, validated reassessment tool and include it on the assessment forms. ▪ Keep all members of the health care team informed on risk status. ▪ Keep all levels of staff educated about pressure ulcer risk factors and the process for implementing prevention strategies. ▪ The use of visual clues, such as stickers in the patient’s medical record or color markings on the patient’s ID band, can help remind staff that the patient is at risk for pressure ulcers. 	<p>Minimize pressure</p> <ul style="list-style-type: none"> ▪ Most patients should be turned or repositioned every two hours, but those with very fragile skin or little subcutaneous tissue may need to be repositioned more frequently. ▪ Use alerts and cues to remind staff to turn the patient. ▪ To protect skin during turning, use lift devices or draw sheets, heel and elbow protectors, or sleeves and stockings. ▪ Keep the head of the bed at 30 degrees or less (unless contraindicated) to reduce pressure, friction, and shearing forces on the sacrum. ▪ Use pillows and cushions to help position patients. Specialty pressure-relieving support surfaces, such as mattresses, should be used when appropriate.
<p>Inspect skin daily</p> <ul style="list-style-type: none"> ▪ Inspect the patient’s skin when assisting the patient to a chair or during bathing, for example. ▪ Pay particular attention to sacrum, back, buttocks, heels, and elbows. ▪ Protect the skin from injury due to moisture from incontinence and also from excessive dryness. 	<p>Optimize nutrition and hydration</p> <ul style="list-style-type: none"> ▪ Document the patient’s nutritional intake and notify staff if intake is inadequate. ▪ Use nutritional supplements as needed. ▪ Monitor hydration status and offer water (if appropriate) whenever patient is repositioned.

Modified from ^{17,19}

PATIENT TURNING AND NURSING COMPLIANCE

While frequent patient turning is considered crucial for reducing pressure hot spots and the risk of PU formation, surprisingly little research has been published related to optimal turning protocols. The first nursing study was an observational analysis by Norton et al that divided older adults into three turning treatment groups (every two to three hours, every four hours, or turned two to four times/day). For this older adult population, patients turned every two to three hours had fewer ulcers, leading to the widespread adoption of patient turning every two hours as standard practice.^{8,20}

Additional resources on PU development and prevention, including recommendations on patient monitoring and turning protocols

- The Agency for Healthcare Research and Quality (www.ahrq.gov)
- The American National Pressure Ulcer Advisory Panel (www.npuap.org)
- The European Pressure Ulcer Advisory Panel (www.epuap.org)
- The Institute for Healthcare Improvement (www.ihl.org)
- The Wound Ostomy & Continence Nurses Society (www.wocn.org)

Unfortunately, studies have shown that despite the widespread adoption of patient-turning protocols, these standards are often not actually achieved on the patient care floor. One survey study investigating body positioning in intensive care patients found that of 74 patients observed, 49% were not repositioned for more than two hours. In fact, only 2.7% of these patients had a demonstrated change in body position every two hours.¹⁸ In this survey, 80% to 90% of respondents recognized the benefits of turning every two hours, but only 57% of respondents believed that this goal was achieved in their ICUs.¹⁸ While most turning protocols recommend turning patients at least every two hours, a recent systematic review failed to identify an optimal turning/repositioning strategy.⁵

Given that the cost of treating an advanced PU can exceed \$70,000, it is not surprising that several studies have indicated a fairly rapid return on investment for the implementation of rigorous patient monitoring and turning protocols. Overall, patient assessment, monitoring, and turning are relatively inexpensive compared to the potential cost of treatment. In a study by Padula et al, the average cost of PU prevention was estimated at \$54 per patient per day, with an overall reduction in average cost of care per patient of \$1,200.¹³ In 2002, Lyder et al evaluated two long-term care facilities with 260 combined beds using retrospective and prospective data to evaluate the effect of implementing a PU care bundle.²¹ Retrospective data showed a combined, cumulative, five-month PU incidence of 43% in the two facilities. Implementation of the comprehensive PU prevention program resulted in an 87% decrease in PU incidence in one facility and a 76% decrease in another facility. In this analysis, the average monthly cost of prevention for a high-risk resident was \$520 (plus a one-time cost of \$277 for mattress and chair overlays). More than half (\$277) of these monthly costs were related to labor; the most expensive item cost was for support surfaces.²¹ In a recent study by Slight et al, the implementation of a continuous patient monitoring system resulted in projected cost savings of up to \$9,089,000 (\$2,228,000 annualized) with \$1,201,000 (\$294,000 annualized) of these savings due to reduced PU development.²² In this analysis, the hospital was seen to break even on the monitoring investment in 0.5 to 0.75 years.²²

CONCLUSIONS

The development of PUs in any monitored-care situation should be considered to be a preventable event. There are well-established patient care guidelines designed to identify at-risk patients, evaluate current skin conditions and patient history, monitor patient activity/pressure, and promote frequent patient turning to reduce prolonged pressure hot spots. Studies have indicated that careful, consistent, and rigorous implementation of comprehensive PU care bundles can effectively reduce the incidence of these events, improving patient safety and reducing cost of care. In light of the demonstrated costs and patient safety burden of PUs, failure to adopt and implement PU prevention strategies employing the latest protocols and monitoring technology is not a viable option.

1. European Pressure Ulcer Advisory Panel and National Pressure Ulcer Advisory Panel. Prevention and treatment of pressure ulcers: quick reference guide. Washington DC: National Pressure Ulcer Advisory Panel; 2009.
2. Kottner J, Balzer K, Dassen T, Heinze S. Pressure ulcers: a critical review of definitions and classifications. *Ostomy Wound Manage*. 2009;55(9):22-29.
3. Berlowitz D, Lukas C, Parker V, et al. Preventing pressure ulcers in hospitals: A toolkit for improving quality of care. April 2011. AHRQ. <http://www.ahrq.gov/professionals/systems/long-term-care/resources/pressure-ulcers/pressureulcertoolkit/index.html>.
4. Lyder CH. Pressure ulcer prevention and management. *JAMA*. 2003;289(2):223-226.
5. Reddy M, Gill SS, Rochon PA. Preventing pressure ulcers: a systematic review. *JAMA*. 2006;296(8):974-984.
6. Russo CA, Elixhauser A. Hospitalizations related to pressure sores, 2003. HCUP. <http://www.hcup-us.ahrq.gov/reports/statbriefs/sb3.pdf>. Published April 2006.
7. Russo A, Steiner C, Spector W. Hospitalizations related to pressure ulcers among adults 18 years and older, 2006. HCUP. <http://www.hcup-us.ahrq.gov/reports/statbriefs/sb64.pdf>. Published December 2008.
8. Lyder CH, Ayello EA. Pressure Ulcers: A Patient Safety Issue. In: Hughes RG, ed. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville, MD: Agency for Healthcare Research and Quality (US); 2008.
9. Reed K, May R. HealthGrades Patient Safety in American Hospitals Study. March 2011. Healthgrades. <https://www.hospitals.healthgrades.com/CPM/assets/File/HealthGradesPatientSafetyInAmericanHospitalsStudy2011.pdf>. Published March 2011.
10. Shahin ES, Dassen T, Halfens RJ. Pressure ulcer prevalence and incidence in intensive care patients: a literature review. *Nurs Crit Care*. 2008;13(2):71-79.
11. VanGilder C, Amlung S, Harrison P, Meyer S. Results of the 2008-2009 international pressure ulcer prevalence survey and a 3-year, acute care, unit-specific analysis. *Ostomy Wound Manage*. 2009;55(11):39-45.
12. Gordon MD, Gottschlich MM, Helvig EI, Marvin JA, Richard RL. Review of evidenced-based practice for the prevention of pressure sores in burn patients. *J Burn Care Rehabil*. 2004;25(5):388-410.
13. Padula WV, Mishra MK, Makic MB, Sullivan PW. Improving the quality of pressure ulcer care with prevention: a cost-effectiveness analysis. *Med Care*. 2011;49(4):385-392.
14. Mayo Clinic staff. Bedsore (pressure sore). Mayo Clinic. <http://www.mayoclinic.org/diseases-conditions/bedsores/basics/risk-factors/con-20030848>. Published December 2014.
15. Bluestein D, Javaheri A. Pressure ulcers: prevention, evaluation, and management. *Am Fam Physician*. 2008;78(10):1186-1194.
16. Bergstrom N, Braden BJ, Laguzza A, Holman V. The Braden scale for predicting pressure sore risk. *Nurs Res*. 1987;36(4):205-210.
17. Ayello EA, Lyder CH. A new era of pressure ulcer accountability in acute care. *Adv Skin Wound Care*. 2008;21(3):134-140.
18. Krishnagopalan S, Johnson EW, Low LL, Kaufman LJ. Body positioning of intensive care patients: clinical practice versus standards. *Crit Care Med*. 2002;30(11):2588-2592.
19. How-to guide: Prevent pressure ulcers. Institute for Healthcare Improvement. <http://www.ihl.org/resources/Pages/Tools/HowtoGuidePreventPressureUlcers.aspx>.
20. Norton D, McLaren R, Exton-Smith A. *An investigation of geriatric nurse problems in hospitals*. Edinburgh UK: Churchill Livingstone; 1975.
21. Lyder CH, Shannon R, Empleo-Frazier O, McGehee D, White C. A comprehensive program to prevent pressure ulcers in long-term care: exploring costs and outcomes. *Ostomy Wound Manage*. 2002;48(4):52-62.
22. Slight SP, Franz C, Olugbile M, Brown HV, Bates DW, Zimlichman E. The return on investment of implementing a continuous monitoring system in general medical-surgical units. *Crit Care Med*. 2014;42(8):1862-8. doi: 10.1097/CCM.0000000000000340.

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