Postgraduate Certificate in Spinal Cord Injury Rehabilitation

Wound Prevention And Management

Pressure ulcer – a localized injury to the skin and/or underlying tissue, usually over a bony prominence, that results from prolonged pressure, or pressure combined with shear. In spinal cord injury (SCI) patients, loss of sensation and impaired mobility dramatically increase the risk. The term is often used interchangeably with “decubitus ulcer,” but the preferred clinical language is “pressure ulcer” to avoid stigma.

Stage I – the earliest visible sign of a pressure ulcer. The skin is intact but shows non-blanchable erythema, warmth, edema, or a change in texture. In darker-skinned individuals, the discoloration may appear as a purple or gray hue rather than red. Early detection at this stage is critical because the ulcer can often be reversed with pressure relief and skin care alone.

Stage II – partial-thickness loss of dermis presenting as a shallow open ulcer with a pink wound base or a closed blister (intact or ruptured). The lesion measures less than 0.5 cm in depth. Management focuses on maintaining a moist wound environment, protecting the wound from further trauma, and preventing infection.

Stage III – full-thickness loss of skin extending into the subcutaneous tissue. The wound may have undermining or tunneling, and the depth can be greater than 0.5 cm. Necrotic tissue may be present, requiring careful debridement. The surrounding skin often shows maceration or excoriation due to moisture.

Stage IV – full-thickness tissue loss with exposed bone, tendon, or muscle. The wound is at high risk for infection, including osteomyelitis, and may require surgical intervention. In SCI rehabilitation, stage IV ulcers significantly impede functional goals and increase length of stay.

Deep tissue injury (DTI) – a suspected purple or maroon localized area of non-blanchable deep tissue discoloration, or a blood-filled blister. The overlying skin may appear intact, yet the underlying tissue has suffered damage from sustained pressure and shear. DTI often precedes a pressure ulcer and warrants immediate off-loading.

Moisture-associated skin damage (MASD) – skin damage caused by prolonged exposure to moisture, such as urine, feces, sweat, or wound exudate. In SCI patients, incontinence is a common source of MASD, leading to conditions like incontinence-associated dermatitis (IAD). The management strategy emphasizes barrier creams, frequent cleansing, and absorbent products.

Shear – a force that causes the skin and underlying tissue to move in opposite directions, often occurring when a patient slides down in a chair or bed. Shear can distort blood vessels, reducing perfusion, and is a key contributor to ulcer formation.

Friction – resistance encountered when skin slides against a surface, such as when a patient is transferred from one surface to another. Friction alone may not cause tissue death, but when combined with pressure

and shear, it escalates the risk of ulcer development.

Ischemia – a reduction in blood flow that deprives tissues of oxygen and nutrients. Prolonged ischemia leads to cellular death and is the primary pathophysiologic mechanism behind pressure ulcers.

Reperfusion injury – tissue damage that occurs when blood flow returns to an area after a period of ischemia. The sudden influx of oxygen can generate free radicals, worsening cellular injury. In the context of pressure ulcer management, careful repositioning strategies aim to minimize reperfusion injury by gradually restoring perfusion.

Tissue tolerance – the capacity of a specific area of skin and underlying tissue to withstand pressure, shear, and moisture. Factors influencing tolerance include nutritional status, comorbidities, and the integrity of the vascular supply.

Braden Scale – a widely used risk assessment tool that evaluates sensory perception, moisture, activity, mobility, nutrition, and friction/shear. Scores range from 6 (high risk) to 23 (low risk). In SCI rehabilitation, the Braden Scale can be supplemented with SCI-specific considerations such as level of injury and autonomic dysreflexia.

Norton Scale – another pressure-ulcer risk assessment instrument focusing on physical condition, mental state, activity, mobility, and incontinence. While less detailed than the Braden Scale, it provides a quick snapshot of risk for patients with limited communication.

PUSH Tool – the Pressure Ulcer Scale for Healing, a validated instrument that tracks ulcer size, exudate amount, and tissue type to quantify healing progress. The tool assigns a score from 0 (healed) to 17 (worst). Regular PUSH assessments guide clinical decision-making and allow benchmarking across services.

Wound bed – the surface of the ulcer that is in direct contact with dressings and the external environment. A healthy wound bed is characterized by a moist, pink granulation tissue base, minimal necrotic tissue, and an appropriate level of exudate.

Granulation tissue – new connective tissue and microscopic blood vessels that form during the proliferative phase of wound healing. It appears red or dark pink, moist, and bumpy. Adequate granulation signals that the wound is progressing toward closure.

Epithelialization – the process by which epithelial cells migrate across the wound surface to re-establish an intact skin barrier. In pressure ulcer management, promoting epithelialization is a primary goal, often achieved with appropriate dressings that maintain a moist environment while protecting the wound from shear.

Necrosis – death of tissue, which appears black, brown, or yellowish and is often adherent to the wound base. Necrotic tissue must be removed to prevent infection and to allow granulation tissue to develop.

Eschar – a dry, leathery layer of necrotic tissue that typically forms over the surface of a stage III or IV ulcer. Eschar can impede wound assessment and may need debridement, especially if it is extensive or obstructs drainage.

Slough – a moist, yellow or white, often stringy layer of necrotic tissue that is less adherent than eschar. Slough is usually a sign of ongoing inflammation and may be removed with gentle mechanical methods or enzymatic agents.

Biofilm – a complex community of microorganisms encased in a protective extracellular matrix that adheres to wound surfaces. Biofilm formation can delay healing, increase resistance to antibiotics, and require specific strategies such as debridement and anti-biofilm dressings.

Colonization – the presence of microorganisms on a wound surface without signs of infection. Colonization is common in chronic wounds; however, high bacterial loads ($>10^5$ CFU/g) can predispose to infection.

Infection – invasion of wound tissue by pathogenic microorganisms, accompanied by clinical signs such as increased pain, erythema, warmth, edema, foul odor, or purulent discharge. In SCI patients, infection can precipitate systemic complications, including sepsis and autonomic dysreflexia.

Bacterial load – the quantity of microorganisms present in a wound, typically measured in colony-forming units (CFU). Managing bacterial load involves both local wound care and, when indicated, systemic antimicrobial therapy.

Antibiotic stewardship – a systematic approach to optimizing antibiotic use to combat resistance, minimize adverse effects, and ensure appropriate therapy. In the context of pressure ulcer management, stewardship includes obtaining cultures before initiating systemic antibiotics and limiting duration to the shortest effective course.

Systemic antibiotics – medications administered orally or intravenously that circulate throughout the body. They are indicated for wound infection when there is evidence of spreading cellulitis, osteomyelitis, or systemic signs such as fever.

Topical agents – antimicrobial or anti-inflammatory substances applied directly to the wound surface. Examples include silver-impregnated dressings, iodine solutions, and honey. Topical agents are useful for localized infection control but should not replace systemic therapy when deeper infection is present.

Negative pressure wound therapy (NPWT) – a device that applies controlled suction to the wound bed, removing exudate, reducing edema, and promoting granulation tissue formation. NPWT is especially valuable for large stage III or IV ulcers with significant depth, but careful monitoring is required to avoid pain or bleeding in patients with compromised sensation.

Hydrocolloid dressing – a semi-occlusive dressing composed of gel-forming agents that maintain a moist environment and protect the wound from external contaminants. Hydrocolloids are suitable for stage I and II ulcers with low to moderate exudate.

Foam dressing – a soft, absorbent dressing that provides cushioning and distributes pressure. It can also maintain moisture balance, making it a good choice for sacral or trochanteric ulcers where shear is a concern.

Alginate dressing – a highly absorbent dressing made from seaweed-derived calcium alginate. When in

contact with wound exudate, alginate forms a gel that helps maintain a moist environment. It is ideal for heavily exuding stage III ulcers.

Silicone dressing – a gentle, non-adherent dressing that minimizes pain on removal and protects fragile granulation tissue. Silicone dressings are often used over newly formed tissue or for patients with painful wound beds.

Hydrogel dressing – a water-based dressing that provides moisture to dry wounds and helps autolysis of necrotic tissue. Hydrogel is beneficial for stage I ulcers and for debriding slough in a non-traumatic manner.

Moist wound healing – a principle that emphasizes maintaining an optimal level of moisture at the wound surface to accelerate epithelial migration, reduce pain, and lower infection risk. All modern dressings aim to achieve this balance, but clinicians must monitor for excess exudate that could macerate surrounding skin.

Debridement – the removal of devitalized tissue to promote a clean wound bed. Types include sharp (surgical), autolytic (using the body's own enzymes), enzymatic (applying proteolytic agents), and mechanical (wet-to-dry dressings). The choice depends on ulcer stage, patient tolerance, and infection status.

Sharp debridement – performed with sterile scalpels, scissors, or curettes by a qualified clinician. It provides rapid removal of necrotic tissue but may cause pain; therefore, adequate analgesia or sedation is essential, especially in patients with limited sensation.

Autolytic debridement – utilizes the body's own enzymes and moisture to liquefy necrotic tissue. Occlusive dressings such as hydrocolloids or hydrogels facilitate this process and are appropriate for patients who cannot tolerate sharp debridement.

Enzymatic debridement – applies topical proteolytic agents (e.g., collagenase) to dissolve necrotic tissue. It is useful for moderate slough when a faster removal is desired than autolysis can provide.

Mechanical debridement – involves physical forces, such as wet-to-dry gauze or low-frequency ultrasound, to dislodge necrotic tissue. Mechanical methods can be painful and may damage healthy tissue, so they are used cautiously.

Moisture balance – the equilibrium between wound exudate production and the absorptive capacity of dressings. Maintaining balance prevents both desiccation and maceration. Clinicians assess exudate volume daily and adjust dressing type accordingly.

Moisture-retentive dressing – a dressing designed to hold exudate while preserving a moist environment, such as hydrocolloid or foam. Over-use can lead to maceration; under-use can desiccate the wound bed.

Skin barrier – a protective layer applied to intact skin surrounding a wound to shield it from moisture, friction, and irritants. Common barrier products contain zinc oxide, dimethicone, or petrolatum.

Incontinence-associated dermatitis (IAD) – skin inflammation resulting from prolonged exposure to urine or feces. IAD can progress to a pressure ulcer if not promptly addressed. Management includes frequent

cleansing, barrier creams, and absorbent pads.

Pressure redistribution – strategies to spread pressure over a larger area to reduce peak forces on bony prominences. Techniques include repositioning, use of pressure-relieving cushions, and specialized mattresses.

Repositioning schedule – a systematic plan for moving a patient at regular intervals (e.g., every two hours) to alleviate pressure. In SCI patients with limited voluntary movement, caregivers must follow a strict schedule and document each turn.

Support surfaces – devices designed to minimize pressure on vulnerable areas. Categories include static mattresses, alternating pressure mattresses, low-air-loss beds, and air-fluidized beds. Selection depends on ulcer stage, patient tolerance, and resource availability.

Air-fluidized bed – a bed that suspends the patient on a fine stream of air, effectively eliminating pressure points. It is reserved for severe, refractory ulcers or for patients who cannot tolerate other surfaces.

Alternating pressure mattress – a mattress that cyclically inflates and deflates chambers to shift pressure points. It is useful for patients with stage II–III ulcers and can be adjusted for cycle length based on individual tolerance.

Low-air-loss mattress – a mattress that provides a continuous flow of air across the surface, reducing moisture buildup and helping to control temperature. It is beneficial for patients with extensive IAD or MASD.

Shear reduction – methods to limit shear forces, such as using slide sheets during transfers, ensuring proper wheelchair positioning, and employing cushions that conform to the shape of the buttocks.

Wheelchair cushion – a pressure-relieving device placed on the seat of a wheelchair. Cushions may be made of foam, gel, air, or hybrid materials. Proper fit and regular inspection are essential to prevent cushion breakdown and ulcer formation.

Seating analysis – an assessment of the patient's posture, weight distribution, and pressure points while seated. It informs cushion selection, backrest angle, and foot support. In SCI rehabilitation, seating analysis is integral to functional mobility training.

Risk assessment – a comprehensive evaluation that identifies factors predisposing a patient to pressure ulcer development. It includes clinical scales, skin inspection, nutritional appraisal, and comorbidity review. The output guides prevention interventions.

Autonomic dysreflexia – a potentially life-threatening hypertensive crisis triggered by noxious stimuli below the level of injury, such as a painful ulcer. Awareness of this condition is crucial; any sudden increase in blood pressure during wound care should prompt immediate evaluation and management.

Nutritional support – interventions aimed at optimizing the patient's dietary intake to promote wound healing. Key components include adequate protein, calories, vitamins, and minerals.

Protein intake – essential for collagen synthesis, immune function, and tissue repair. Recommendations for patients with pressure ulcers range from 1.2 to 1.5 g/kg body weight per day.

Vitamin C – a cofactor in collagen formation and antioxidant defense. A daily intake of 500–1000 mg is often advised for patients with active ulceration.

Zinc – supports DNA synthesis and immune response. Supplementation of 30 mg elemental zinc per day may be considered when dietary intake is insufficient.

Albumin – a serum protein that reflects overall nutritional status. Low albumin (Hemoglobin – the oxygen-carrying component of blood. Adequate tissue oxygenation is necessary for healing; a target hemoglobin of >10 g/dL is often set for patients with stage III–IV ulcers.

Diabetes mellitus – a chronic condition that impairs microvascular circulation and immune function, increasing ulcer risk and slowing healing. Tight glycemic control (HbA1c Smoking – nicotine causes vasoconstriction and reduces oxygen delivery to tissues. Smoking cessation counseling is a mandatory component of pressure ulcer prevention programs.

Edema management – techniques to reduce swelling that can exacerbate pressure and shear. Strategies include limb elevation, compression therapy, and gentle range-of-motion exercises.

Lymphedema – accumulation of lymphatic fluid, often seen in lower-extremity injuries. Manual lymphatic drainage and compression garments may be employed, but care must be taken not to create additional pressure points.

Compression therapy – use of elastic or inelastic bandages to improve venous return and reduce edema. Compression is contraindicated in arterial insufficiency, which must be ruled out before application.

Vascular assessment – evaluation of arterial blood flow to determine suitability for compression or to identify ischemic contributors to ulceration. Common tools include the ankle-brachial index (ABI) and Doppler ultrasound.

Ankle-brachial index – a ratio of systolic blood pressure at the ankle to that in the arm. Values Doppler ultrasound – an imaging modality that assesses blood flow velocity and can locate arterial stenosis. It is valuable for planning surgical debridement or flap reconstruction.

Tissue viability – the capacity of skin and underlying structures to maintain integrity under stress. Assessment includes visual inspection, palpation, and, when indicated, tissue oxygen tension measurement.

Wound measurement – the process of recording length, width, and depth to monitor healing. Accurate measurement is essential for tracking progress and for reimbursement documentation.

Perimeter tracing – a method where a transparent sheet is placed over the wound, and the outline is drawn to calculate area. This technique is especially useful for irregularly shaped ulcers.

Digital photography – standardized photographs taken with a ruler or calibrated grid for visual

documentation. Consistent lighting, angle, and distance are critical for reliable comparison over time.

Documentation – the systematic recording of wound assessments, interventions, and outcomes. Thorough documentation supports continuity of care, legal protection, and quality improvement initiatives.

Interdisciplinary team – the collaborative group of professionals involved in wound prevention and management. Core members include nurses, physicians, physiotherapists, occupational therapists, dietitians, and wound-care specialists.

Physiotherapist – contributes to pressure redistribution through mobility training, gait analysis, and strengthening of trunk muscles to improve sitting balance.

Occupational therapist – focuses on wheelchair fitting, seating analysis, and adaptive equipment to reduce shear and improve independence in daily activities.

Dietitian – assesses nutritional status, designs individualized meal plans, and monitors supplementation to ensure optimal substrates for healing.

Nurse – performs routine skin inspections, applies dressings, educates patients on self-care, and coordinates interdisciplinary communication.

Physician – oversees medical management, orders investigations, prescribes systemic antibiotics, and determines need for surgical intervention.

Wound care specialist – provides expert guidance on advanced dressings, debridement techniques, and complex wound management algorithms.

Rehabilitation goals – functional targets that integrate wound care, such as achieving safe transfers, independent wheelchair propulsion, and participation in community activities without ulcer recurrence.

Patient education – teaching patients and caregivers about risk factors, skin inspection techniques, and the importance of adherence to pressure-relief schedules. Education is tailored to cognitive ability and cultural background.

Self-management – the patient's active involvement in daily skin checks, repositioning, and dressing changes when appropriate. Empowering patients improves adherence and reduces hospital readmissions.

Adherence – the extent to which patients follow prescribed preventive measures. Barriers to adherence may include fatigue, limited caregiver support, or lack of understanding.

Barriers – challenges that impede effective wound prevention, such as limited access to specialized mattresses, financial constraints, or environmental factors like high humidity.

Cultural considerations – respect for beliefs and practices that influence wound care, such as preferences for natural remedies, modesty concerns during examinations, or dietary restrictions.

Legal and ethical issues – responsibilities include obtaining informed consent for invasive procedures,

respecting patient autonomy, and reporting adverse events. Documentation must reflect these obligations.

Informed consent – a process where the patient (or legal representative) receives comprehensive information about the proposed intervention, its risks, benefits, and alternatives, and voluntarily agrees to proceed.

Documentation standards – guidelines set by professional bodies (e.g., Royal College of Nursing) that dictate the content, timeliness, and confidentiality of wound records.

Pressure ulcer pathway – a structured algorithm that outlines steps from risk assessment through prevention, early detection, treatment, and follow-up. Pathways improve consistency of care and facilitate audit.

Early detection – the practice of routine skin inspections at least once per shift, focusing on high-risk sites such as the sacrum, trochanters, heels, and ischial tuberosities. Early detection allows intervention at stage I, often avoiding progression.

Case study example – a 35-year-old male with T6 complete SCI presents with a new stage II ulcer on the left ischial tuberosity. Risk assessment reveals a Braden score of 12, poor nutrition (albumin 2.9 g/dL), and frequent incontinence. The interdisciplinary plan includes repositioning every two hours, a pressure-relieving air-filled cushion, a hydrocolloid dressing, protein supplementation to 1.4 g/kg, and weekly wound measurement using perimeter tracing. After three weeks, the ulcer regresses to stage I, demonstrating the impact of coordinated intervention.

Practical application of debridement – in a patient with a stage III ulcer containing thick slough, the clinician first applies an enzymatic debriding agent (collagenase) for five days, monitoring for pain and infection. When slough reduces, sharp debridement is performed under local anesthesia to remove residual necrotic tissue, followed by application of an alginate dressing to manage exudate. This staged approach minimizes patient discomfort while preparing the wound bed for granulation.

Challenge of biofilm – biofilm often persists despite standard antimicrobial dressings. Advanced strategies include using NPWT with silver-impregnated foam, coupled with periodic mechanical debridement to disrupt the matrix. Studies indicate that combining these modalities can reduce bacterial load and accelerate healing in chronic SCI-related ulcers.

Managing incontinence-associated dermatitis – for a patient with frequent urinary leakage, a barrier cream containing zinc oxide is applied after each toileting episode, followed by a breathable, absorbent pad. The caregiver is trained to perform skin cleansing with a pH-balanced cleanser, avoiding harsh soaps that can further damage the epidermis. Regular skin checks ensure early identification of any erythema, allowing prompt intervention before an ulcer develops.

Effect of autonomic dysreflexia on wound care – during a dressing change for a sacral ulcer, the patient experiences a sudden spike in blood pressure (200/110 mmHg) and severe headache. Recognizing this as autonomic dysreflexia, the clinician immediately stops the procedure, places the patient in a supine position, and administers a rapid-acting antihypertensive (e.g., nifedipine). Once the blood pressure

stabilizes, the dressing change is resumed with careful monitoring. This scenario underscores the need for vigilance when performing wound procedures below the level of injury.

Nutrition monitoring example – a 48-year-old female with a stage IV heel ulcer is found to have a serum albumin of 2.8 g/dL and a BMI of 18 kg/m². The dietitian initiates a high-protein oral supplement (30 g protein per serving) and adds a multivitamin containing 500 mg of vitamin C, 30 mg of zinc, and 400 µg of folic acid. Weekly labs show albumin rising to 3.2 g/dL and the ulcer size decreasing by 20 % over a month, illustrating the direct impact of nutrition on wound healing.

Pressure redistribution technology – the use of an alternating pressure mattress with a 15-minute cycle can reduce peak pressure by up to 30 % compared with a static foam mattress. For a patient with a stage III ulcer, switching to this mattress resulted in faster granulation tissue formation, as measured by PUSH scores decreasing from 12 to 6 over six weeks.

Assessment of tissue viability using transcutaneous oxygen measurement ($TcPO_2$) – in a patient with suspected arterial insufficiency, $TcPO_2$ values below 30 mmHg at the ulcer margin indicated compromised perfusion, prompting a vascular referral. After revascularization, $TcPO_2$ improved to 55 mmHg, and the ulcer began to heal, highlighting the importance of objective perfusion assessment.

Legal scenario illustration – a caregiver fails to reposition a bedridden SCI patient for 8 hours, resulting in a stage IV ulcer and subsequent sepsis. The family files a negligence claim. Documentation shows that the care plan stipulated a two-hour repositioning schedule, but the caregiver's notes were incomplete. This case emphasizes the necessity for accurate, timely documentation and adherence to established protocols.

Interdisciplinary communication tool – a shared electronic wound-tracking platform allows the nurse to upload daily wound measurements, the dietitian to note nutritional changes, and the physician to prescribe antibiotics. Alerts are generated when PUSH scores worsen, prompting a team review. This integrated approach enhances coordination and reduces duplication of effort.

Cost-effectiveness consideration – while high-tech support surfaces such as air-fluidized beds are expensive, studies have shown that preventing a single stage IV ulcer can offset the cost of the equipment within a year. Decision-makers must weigh upfront investment against long-term savings and patient quality-of-life outcomes.

Future direction: regenerative medicine – emerging therapies such as autologous skin substitutes, platelet-rich plasma, and stem-cell-infused scaffolds hold promise for accelerating closure of complex pressure ulcers in SCI patients. Ongoing clinical trials are evaluating safety, efficacy, and integration with standard wound-care protocols.

Key take-away for learners – mastering wound prevention and management in spinal cord injury rehabilitation requires an integrated understanding of pathophysiology, risk assessment, evidence-based dressing selection, nutritional optimization, and collaborative practice. By applying these concepts consistently, clinicians can reduce ulcer incidence, promote faster healing, and support the broader goals of independence and community participation for individuals living with spinal cord injury.