WORLD UNION OF WOUND HEALING SOCIETIES

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CONSENSUS DOCUMENT

Understanding blistering:

Causes, treatment and prevention

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All author names, following the Chair's name, are listed in alphabetical order by surname. All authors contributed equally to the development of this publication; the Chair supported with outline development and facilitated panel discussion. All authors have read and approved the final manuscript. The Global Wound Care Journal and Wounds International provided editorial support.

Foreword

The number of people living with fragile skin continues to rise as populations age, more individuals experience multiple comorbidities and increasing numbers undergo surgical procedures throughout their lives (Chudasama et al., 2021; Nepogodiev et al., 2025). As a result, global healthcare systems and the wider health workforce are facing an unprecedented challenge in managing conditions that compromise skin integrity.

Approximately 310 million people worldwide undergo a surgical procedure per year, with the associated trauma of major surgery and its potential complications, such as blistering, non-healing wounds and infections (Dobson, 2020; Nepogodiev et al., 2025). A wound of any type can negatively affect a patient's recovery after surgery due to pain, immobility, risk of infection and related complications, and potentially complex and costly interventions (Eastburn et al., 2016). It is, therefore, paramount to optimise management of these wounds and to prevent blistering to improve patient outcomes.

Blistering remains a common yet frequently overlooked complication of surgical wounds, despite its recognised association with pain, delayed healing and increased risk of infection. In clinical practice, blistering is often underreported or poorly documented, reflecting a perception that it is an unavoidable or a relatively minor consequence of surgery. This normalisation of blistering risks minimising its clinical significance and may contribute to missed opportunities for prevention and early intervention.

Lack of reporting has hindered the development of a robust evidence base to guide best practice in the prevention and management of blistering in surgical wounds. Consequently, variation persists in assessment, product selection and wound care practices, potentially exposing patients to avoidable harm. Addressing this gap requires greater clinical awareness, routine risk assessment and more consistent reporting of blistering, alongside integration of evidence-based practice in routine care to improve patient outcomes.

Healthcare professionals (HCPs) should understand how to maintain skin integrity, especially for at-risk individuals, such as those who are older and have comorbidities that may have a negative impact on skin integrity. There is a need to enhance and support clinician awareness of risk factors for blister formation and potential complications.

To achieve these objectives, this consensus document provides practical approaches to blister management. It highlights areas for further research, the importance of generating accurate prevalence and incidence data across global settings and the need for incorporating technological advances, such as artificial intelligence (AI), into care pathways and educational programmes.

Professor Karen J. Ousey, Chair

Understanding blistering

Skin blistering remains an under-recognised complication across clinical settings, reflecting a limited understanding of its underlying mechanisms, predisposing factors and potential consequences. These knowledge gaps contribute to inconsistent approaches to prevention and management, and the resulting burden on patients, caregivers, clinicians and healthcare systems is substantial and multifaceted.

This consensus document explores blisters that result specifically from mechanical trauma to the skin and underlying tissues, deliberately excluding those arising from alternative causes such as thermal injury or autoimmune pathology, which lie beyond its defined scope, although thermal injury may be present in trauma patients.

Stevens-Johnson syndrome (SJS) is also a condition that may manifest in the peri-operative period and can be misinterpreted as blistering secondary to traumatic injury or surgical intervention (Johnson et al., 2025). SJS is a rare but potentially life-threatening hypersensitivity reaction, most commonly induced by medications, and it necessitates urgent medical management. As its onset and clinical features may overlap with those of surgery-related blistering, distinguishing SJS from other skin injuries can be challenging.

This consensus document also discusses the development of fracture blisters, which arise when severe swelling and mechanical stress, following significant soft tissue trauma with an associated fracture, cause separation within the skin layers. These blisters can be subdivided into non-haemorrhagic or haemorrhagic, where haemorrhagic is indicative of a more significant soft tissue injury.

The skin

The skin is the largest organ of the human body by surface area, weighing between 2 and 4.5kg—approximately 15% of total body weight and covering approximately 2m² (Zahra, 2024). Its thickness ranges from 1 to 2mm, depending on anatomical location, and it contains structures such as hair, nails and glands (Tortora & Derrickson, 2023). The skin functions as both a physical and chemical barrier, protecting underlying tissues from mechanical injury, bacterial invasion, dehydration, ultraviolet radiation and excessive external moisture.

Structurally, it is composed of three principal layers: the epidermis, dermis and hypodermis. The outermost layer of the epidermis, the stratum corneum, prevents water loss by forming a water-impermeable barrier. Any structural defect of its integrity will result in uncontrolled water loss, such as in ruptured blisters (Ousey et al., 2016).

Periwound skin

The periwound area refers to the skin surrounding a wound, generally extending up to 4cm from the wound edge (Rippon et al., 2022). This area is essential to successful wound healing, as intact periwound skin supports epithelial migration and reduces infection risk (Haesler et al., 2025).

Disruption of the periwound as a result of the following can adversely affect healing (Rippon et al., 2022):

- Maceration
- Excoriation
- Desiccation
- Eczema/dermatitis
- Trauma (e.g. skin stripping)
- Allergic reactions
- Infection
- Blistering.

Causes of blistering

Blisters are fluid-filled lesions caused by separation between skin layers, often occurring within the periwound area, and associated with disruption of the skin barrier and imbalance in the wound environment.

Common causes of blisters include:

- **Friction and shear:** Mechanical forces between the skin and dressings or support surfaces can cause epidermal-dermal separation, resulting in blister formation (Gefen & Ousey, 2020)
- **Excess moisture (maceration):** Rippon et al. (2016) identify prolonged exposure to wound exudate as a major contributor to skin barrier breakdown, weakening the stratum corneum and increasing blister risk
- **Medical adhesive-related skin injury (MARSI):** Repeated application and removal of adhesive dressings can strip superficial skin layers, particularly in older adults or those with fragile skin, leading to blistering and skin tears
- **Pressure:** The European Pressure Ulcer Advisory Panel (EPUAP) guideline states that sustained pressure impairs perfusion and may cause blistering as an early sign of pressure-related tissue damage (EPUAP, 2025)
- **Irritant or allergic reactions:** Contact with dressing materials or topical products may provoke inflammatory responses, contributing to blister development (Nokaneng et al., 2025).

Oedema is a recognised contributor to blister formation. During the inflammatory phase following soft tissue injury, whether from trauma or surgery, oedema typically peaks between 24 and 72 hours (Tosounidis et al., 2020).

Impact on patients

Skin blistering can lead to pain and discomfort for patients, disrupting recovery from surgery, and, due to impaired skin barrier function (Stevens et al., 2019), potentially increasing the risk of surgical site infection (SSI) and non-healing wounds (Eastburn et al., 2016; Ousey, 2017; Tosounidis et al., 2020; Chernyshov et al., 2026). Patients may require repeat surgery, longer hospitalisation and prolonged treatment and recovery periods, along with the increase in associated financial and social burdens (Eastburn et al., 2016; Tosounidis et al., 2020; Chernyshov et al., 2026). Pain is associated with blistering and related inflammatory responses, affecting quality of life (QoL) for patients (Eastburn et al., 2016).

For HCPs and healthcare organisations, blistering is a costly global challenge, leading to prolonged hospitalisation, postponement of surgical procedures, the need for additional interventions, the risk of antimicrobial resistance (AMR) and potential for litigation (Eastburn et al., 2016; Tosounidis et al., 2020).

Although little direct evidence currently exists demonstrating the effect of blistering on caregivers, data from genetic blistering disorders (epidermolysis bullosa) indicate distinct physical, social and emotional impact on caregivers, especially those from a lower socioeconomic and disadvantaged background (Chogani et al., 2021).

Consensus statement: The global burden of blistering is likely underestimated and its impact on patients, caregivers, HCPs and healthcare systems remains underreported. There is a need for robust clinical studies that accurately evaluate the global blistering burden and provide guidance on effective prevention and management strategies.

Definitions

Blisters are a cutaneous disorder that occur due to a disruption in the structure of the skin. They may present as:

Haemorrhagic: This type of blister forms when damage to the dermal blood vessels allows blood to accumulate within the blister cavity. They may develop following mechanical trauma, friction, burns or infection

Non-haemorrhagic: This type of blister forms without vascular injury and does not contain blood, instead filling with serous fluid

Fracture blister: This type of blister may arise as a complication of fractures, particularly in anatomical regions where the skin is closely adherent to underlying bone and there is minimal subcutaneous cushioning (Uebbing et al., 2011). Their appearance can resemble that of a superficial partial-thickness (second-degree) burn. Fracture-associated blisters typically develop in response to substantial local soft tissue trauma and most commonly appear within approximately 6–72 hours following the initial injury

Infected: This type of blister occurs when microbial contamination leads to secondary infection, typically presenting with erythema, increased swelling and exudate.

Confusion in defining blisters often leads to variations in reporting and treatment outcomes. The literature predominantly characterises blisters as accumulations of fluid within the superficial layers of the skin. Terminology, such as blisters, vesicles and bullae, is frequently applied interchangeably. Smaller superficial lesions may be classified as vesicles, whereas larger lesions may be described as blisters (Fitzpatrick et al., 2018). When seeking a formal definition, the ScienceDirect dictionary describes blisters as 'fluid-filled lesions on the skin' (ScienceDirect, 2026).

The British Medical Journal (BMJ, 2025) divides blisters into two types based on their size, stating:

- 'Vesicles are circumscribed, fluid-filled epidermal elevations <1 cm in diameter'
- 'Bullae (originating from the Latin word "bulla", meaning "balloon") are blisters >1 cm in diameter containing serous or seropurulent fluid' (BMJ, 2025).

The BMJ definition does not specify the skin layer involved in blister formation, although it implies that the epidermis is involved to some extent.

The clearest definition of blisters may be provided by the National Library of Medicine (NLM), which defines blisters as: 'Visible accumulations of fluid within or beneath the epidermis' (NLM, 2026).

Consensus statement: The following definition of blistering should be adopted for blisters that occur due to traumatic injury and surgery: 'Blisters are visible accumulations of fluid within or beneath the epidermis and, for treatment purposes, can be divided into small (<1 cm^2) or large (>1 cm^2)'.

Prevalence and incidence

Recent data indicate variable prevalence and incidence of blisters across global healthcare settings [Table 1]. These prevalence estimates are derived largely from studies using older dressing technologies and, therefore, may not be representative of contemporary protocols and materials. As a result, these data may not reflect improvements in clinical practice over time.

Post-surgery blisters are likely a combination of post-surgery trauma and skin damage due to surgical dressings containing strong adhesive; there is a need to educate HCPs on dressings associated with increased blistering risk.

Table 1. Blister prevalence and incidence.		
Blisters associated with traumatic injury	In studies summarised by Tosounidis et al (2020): • In hospitalised patients: 2.9% of 1,468 fractures resulted in a blister • In patients suffering with an isolated or multiple lower-extremity trauma: 7.2% developed a blister.	
Post-surgery blisters	• Cole et al (2020) reported post-operative blistering in 15% of all patients who underwent a spinal surgery • Clarke et al (2009) reported blister formation in 19.5% of >1000 hip and knee arthroplasties in a single orthopaedic unit in the UK.	
	Wound dressings containing strong adhesives	• Polatsch et al (2004) reported dressing tape-associated blistering in >20% of patients who underwent hip surgery • Cosker et al (2005) reported dressing-dependent blistering in 6% to 24% of patients after knee or hip surgery.
	Negative pressure wound therapy (NPWT)	• Howell et al (2011) reported that >60% of patients developed a blister after NPWT use on knee incisions • Ruhstaller et al (2017) reported that the risk of blistering in obese women receiving an NPWT dressing after a caesarean section may be up to four times higher than conventional dressings, but these patients are likely to have existing risk factors necessitating NPWT use • In a study of patients undergoing knee or hip revision surgery, a lower blistering rate was noted in the group receiving NPWT versus a standard dressing (Giannini et al., 2018): 88% versus 70% ($p<0.05$) • In a meta-analysis assessing the impact of closed-incision NPWT (ciNPWT) on wound complications after total joint arthroplasty, the rate of blistering was 12 times higher in patients receiving ciNPWT, despite an overall reduction of decreased SSIs and hospital stay duration (Ailaney et al., 2021).

Consensus statement: A historical bias persists in blistering prevalence and incidence data, as much of the evidence is based on older dressing technologies and does not reflect current care pathways or modern dressing technologies and materials.

The absence of a clear, standardised definition continues to prevent accurate assessment and reporting of blistering, contributing to wide variability in published prevalence and incidence figures. Current evidence also fails to differentiate between post-operative blisters attributable to surgical factors and those arising from dressings or other external contributors.

A clear and standardised definition of blistering is needed to support accurate, consistent and inclusive documentation across patient populations. Establishing such a definition would provide a foundation for reliable clinical assessment and communication. Once this has been achieved, robust clinical research will be required to address current gaps in prevalence and

incidence data, enabling a more precise understanding of blistering patterns and associated complications.

There is also a lack of evidence and educational materials representing a range of skin tones. The majority of information focusses on light skin and differences in presentation across skin tones may mean identification of blistering in dark skin is overlooked.

Consensus statement: The lack of representation of diverse skin tones in wound care education drives care inequities and poorer outcomes for patients with dark skin tones (Johnson et al., 2024). Wound care education must include recognition of wound presentations, including blistering, across a range of skin tones.

Consensus statement: HCPs should recognise that variability in blistering incidence and prevalence data is influenced by both underreporting and inconsistent documentation (Ousey et al., 2025).

Consensus statement: There is a need for standardised assessment, documentation and reporting practices to improve the consistency and quality of global data on blistering.

Pathophysiology

This consensus document focusses specifically on the mechanisms of blister formation resulting from traumatic injury to skin and tissue (e.g. physical accidents or dressings with strong adhesives) or surgery.

Traumatic injuries or surgical incisions can disrupt the integrity of the skin and the underlying tissues. Blister formation serves a protective function in this context, acting to cushion the damaged area and create a microenvironment that supports tissue repair (Diaz & Giudice, 2000; NLM, 2026). Three distinct phases of blister formation have been described; each can occur in sequence or simultaneously (Bork, 1978):

1. Loosening of the structure: Diminished cohesion of epidermal cells or decreased adhesion of epidermis to the corneum
2. Discontinuity: Cleft formation between the keratocytes or in the different levels of the junction zone
3. Fluid accumulation.

Although molecular mechanisms remain under investigation, it is hypothesised that separation of the dermal-epidermal junction occurs due to the differing structural and strain-bearing properties of these two skin layers (O'Halloran et al., 2025). Trauma to the skin results in increased tissue permeability and oedema, as well damage to the lymphatic and venous systems (Riedel et al., 2024). Resulting inflammation and hydrostatic forces then fill with fluid the gap created by the separated and damaged dermal-epidermal layer, leading to blister formation (O'Halloran et al., 2025). Figure 1 shows the structure of a blister located at the dermal-epidermal junction; Figures 2 and 3 show hydrostatic pressure due to oedema and examples of different blister types, respectively.

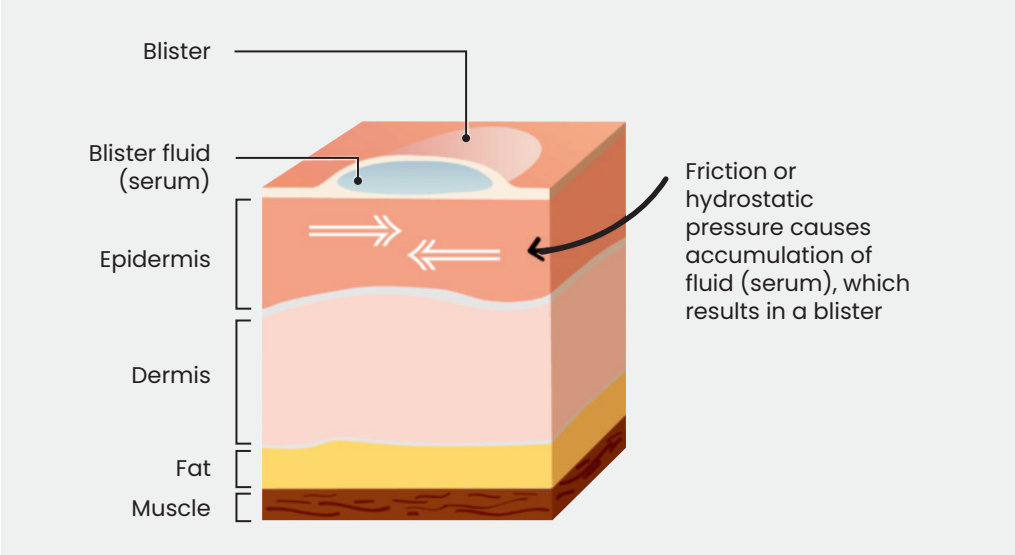


Figure 1. The mechanism of blister formation due to friction or hydrostatic pressure.

Figure 2. Example of hydrostatic pressure due to oedema after surgery; image shows the anterior approach immediately after wound closure; note the white colour of the skin, reflecting high hydrostatic pressure and hypoperfusion (image courtesy of Daniel Chaverri).

Figure 3. Examples of blistering. **A**, blisters around a surgical wound after ankle fracture surgery; **B-C**, blisters after a high-energy trauma in the context of an ankle fracture; the patient was surgically treated with an external fixator for damage control; **D**, blistering after a surgical wound; **E-G**, medical adhesive-related skin injury (MARSI) at various stages of healing; **H**, haemorrhagic blister after a tibial plateau fracture (images courtesy of Daniel Chaverri, Sara Carvalhal and Chris Edelman).

Aetiology

Blisters may present as either a primary or secondary response to cutaneous or subcutaneous trauma or inflammation (Ousey et al., 2025). As a primary event, blistering can arise following direct injury to the skin, including burns, mechanical trauma or surgical procedures. Alternatively, blisters may develop secondary to underlying physiological or pathological processes, such as autoimmune conditions or infectious diseases (Ousey et al., 2025).

Table 2 lists blistering aetiology based on trauma versus underlying physiological disorders (Fitzpatrick et al., 2018; Frantz et al., 2021; Gupta et al., 2021; King et al., 2020; Lumbers, 2018; Manoharan et al., 2016; Tosounidis et al., 2020; Velozo et al., 2025; Welsh, 2009).

Table 2. Aetiology of blistering.

Cause of blistering	Examples	Details
Skin trauma*	Traumatic injury to the soft tissue structure or closed fracture	• Commonly affected areas: ankle; hindfoot; proximal tibia (due to swelling and soft tissue inflammation in ankle fractures).
	Surgery (e.g. cardiac, orthopaedic, vascular, spinal, cosmetic) • Pre-operative • Intra-operative • Post-operative.	• *Pre-operative*: inappropriate patient repositioning techniques leading to tissue trauma; blisters associated with trauma in patients who also require surgical intervention, resulting in further damage to the soft tissues • *Intra-operative*: trauma to the skin (e.g. blistering developing during prolonged surgery duration; inappropriate handling or repositioning of patient leading to friction or pressure on skin; due to adhesives used for surgical implements); tourniquet-induced ischaemia, and the resultant repurfusion injury to the lower limb, may increase inflammation and tissue/skin damage • *Post-operative*: around the surgical incision/injection site; medical adhesive-related trauma to the skin (e.g. irritation due to using conventional dressings with acrylic adhesive, NPWT or allergy to adhesives); poor dressing application technique (e.g. stretching a dressing).
	Inappropriately applied or removed wound dressings	Commonly affected areas: Periwound and along the edge of the dressing.
	Medical adhesive-related skin injury (MARSI)	Skin damage due to adhesive products or devices (e.g. dressings, stoma products or electrodes).
	Friction	Commonly affected areas: feet and other areas exposed to friction forces, such as over a joint (i.e. knee or elbow).

Table 2. Aetiology of blistering. (Continued)

Cause of blistering	Examples	Details
Physiological disorders or conditions*	Autoimmune • SJS • Pemphigus vulgaris.	• SJS is a rare condition in which an immune reaction to irritants leads to detachment of the epidermis and blister formation at the dermal-epidermal junction. These blisters typically appear across multiple body sites, a feature that helps distinguish them from blisters caused by traumatic injury or surgery, which result in localised blisters. This syndrome may also present in patients undergoing surgery if they develop an adverse reaction (e.g. allergic reaction to surgical sprays or glues, and other chemicals or medications used during the peri-operative period) • Pemphigus vulgaris is a rare chronic immune disorder, which causes blistering primarily inside the mouth/throat, and may affect other parts of the body.

*Second- or third-degree burns (chemical-, radiation-, thermal- or frost-related) may also cause blistering, as can infections (e.g. chickenpox, shingles, cold sores, impetigo) and allergic reactions. However, a discussion of these blistering types is beyond the scope of this consensus document.

Prevention of blistering

To optimise patient care, HCPs should recognise the risk factors for blistering and proactively implement preventive strategies.

At-risk populations

The following factors should be considered when assessing the skin, as they increase the risk of blistering:

High-energy trauma

People with lower-limb trauma or severe upper-limb trauma, such as a fracture, are predisposed to blistering, often called 'trauma blistering' (O'Halloran et al., 2025). This type of blistering is more common in people with lower-limb trauma (e.g. tibial plateau fractures, or fractures involving distal tibia, ankle or pilon). When a fracture is the underlying cause, these blisters are referred to as 'fracture blisters'.

The blistering occurs due to thin skin structure and limited tissue-based protection in areas such as the ankle, knee, elbow and wrist, as well as the adipose and soft tissue structure being prone to significant tissue damage (O'Halloran et al., 2025).

Compromised skin integrity

Skin integrity refers to 'intact, unbroken and healthy skin' (Blackburn et al., 2024). A loss of skin integrity disrupts the structure and function of the dermis and epidermis, and may occur due to extrinsic (e.g. trauma) or intrinsic factors (e.g. ageing, malnutrition, diabetes and vascular diseases). This can make affected skin prone to blistering and skin tears.

Box 1 lists factors that may increase skin fragility and, therefore, the risk of blistering (Atkin, 2014; Has & Bruckner-Tuderman, 2014; Bruckner-Tuderman, 2020; Khoury et al., 2021; Blackburn et al., 2024; O'Halloran et al., 2025; Xia et al., 2025).

Box 1. Factors and conditions that may increase skin fragility and susceptibility to blistering.

- Peripheral vascular disease
- Peripheral oedema
- Lymphoedema
- Infections (e.g. cellulitis)
- Malnutrition
- Diabetes
- End-stage renal disease
- Smoking
- Alcoholism
- Mechanical or physical damage to the skin
- Frailty
- A history of genetic skin fragility disorders
- Autoimmune blistering disorders (e.g. pemphigus vulgaris)
- A history of bullous drug reactions.

Consensus statement: Any compromise to skin integrity in a patient should be considered a risk factor for blister development. This is particularly important for surgical interventions undertaken in at-risk populations, such as patients receiving ankle, hip and knee arthroplasty, vascular surgery or open heart surgery.

Emergency versus elective surgery

Surgical intervention constitutes a controlled form of tissue trauma, and evidence suggests that blister incidence may differ between elective and emergency procedures (O'Halloran et al., 2025). Blisters can occur following elective foot and ankle surgery even in the absence of intraoperative complications and/or fractures (O'Halloran et al., 2025).

In patients who have undergone a traumatic injury that requires emergency surgery, blisters may present before emergency surgery, typically reflecting more severe underlying soft tissue injury (Tosounidis et al, 2020). These blisters may signal an increased likelihood of further post-operative blistering, necessitating early preventive measures.

Blister-related risk factors can be more effectively anticipated and mitigated in elective procedures, whereas emergency cases require more comprehensive assessment to minimise blister formation.

Consensus statement: Post-operative blisters may be exacerbated by wound dressings applied to the incision, compounding skin and tissue damage and increasing blister incidence.

Consensus statement: A standardised scoring system for fracture- and trauma-related blister risk assessment is needed to support HCPs in prevention and management planning.

Surgical site

Certain surgical locations are associated with an increased risk of blistering, partly due to the thin coverage of soft tissues (Sinha et al., 2022). These include cardiac, vascular, ankle, lower limb, obstetric (e.g. caesarean section) and spinal surgeries. Patients undergoing cardiac and vascular surgery often share risk factors, such as poor circulation, cardiovascular diseases and diabetes, that may increase blister and SSI risk (Sinha et al., 2022).

Dressing type and application

Although demonstrating effectiveness in promoting the wound healing trajectory in hip/knee arthroplasty-related incisions, NPWT is associated with a higher risk of blistering in patients undergoing total joint surgery (Kuo et al., 2021). In a meta-analysis of 21 studies involving 7,293 patients undergoing total joint arthroplasty, Kuo et al (2021) compared 12 dressing types, including NPWT. The highest incidence of blistering was associated with NPWT, with significantly greater odds of blister formation compared with gauze dressings (odds ratio, 9.3; 95% confidence interval, 3.5-24.8). Kuo et al (2021) reported an overall lower rate of prosthetic joint infection with NPWT; this suggests that NPWT may be a preferable option for certain patient populations (e.g. those at high risk of infection). Further investigations are needed to determine whether the risk of blistering is associated with NPWT application technique- and/or patient-related factors.

In joint replacement orthopaedic surgery, application of adhesive dressings may increase friction and yield a shear force over the joint area. In a study of four dressing types applied on total knee replacement (TKR) incisions, traditional adhesive dressings showed inadequate extensibility during normal knee flexion (Dillon et al., 2007). In contrast, the hydrocolloid and two different types of occlusive film dressings demonstrated a higher and adequate level of extensibility. Therefore, it is important to consider the type of dressing used on TKR wounds to reduce the risk of blistering.

Pre-blistering signs

There is limited evidence describing the clinical signs that precede blister formation. Box 2 outlines potential pre-blistering signs that HCPs should be aware of when assessing patients at risk of blister development. Clinical studies are required to understand potential pre-blistering symptoms, especially in at-risk populations.

Box 2. Potential pre-blistering signs.

- Skin stress: Stretched, damaged skin with an appearance of oedema
- Colour change to the skin: A range of colour changes may be noticeable, depending on the baseline skin colour of the patient
- Pain.

Preventive approaches

For patients undergoing surgery, especially elective procedures, pre-surgical optimisation offers an opportunity to implement measures that may prevent blistering and improve outcomes.

The Enhanced Recovery After Surgery (ERAS) framework has become a central component of post-operative care in elective procedures (Slim & Theissen, 2020). Its primary aim is to reduce the physiological stress response to surgery and promote faster recovery (Melnyk et al., 2011; Kaye et al., 2019). Although no direct evidence currently exists, adhering to and implementing ERAS protocols may indirectly help reduce the risk of blistering after surgery, especially when used alongside dressings with adhesives designed to minimise adhesive-related skin damage (e.g. soft silicone dressings). Further research is needed to assess the impact of atraumatic dressing on peri-operative blistering, especially within ERAS protocols developed for different elective surgical procedures (Sandy-Hodgetts & Wainwright, 2024).

Consensus statement: Adoption of ERAS protocols, alongside the use of dressings designed to minimise adhesive-related skin damage, may contribute to reducing post-operative blister formation. Further research is required to determine the specific impact of ERAS protocols on peri-operative blistering in elective surgery. There is a need to consider the inclusion of incision care in ERAS protocols.

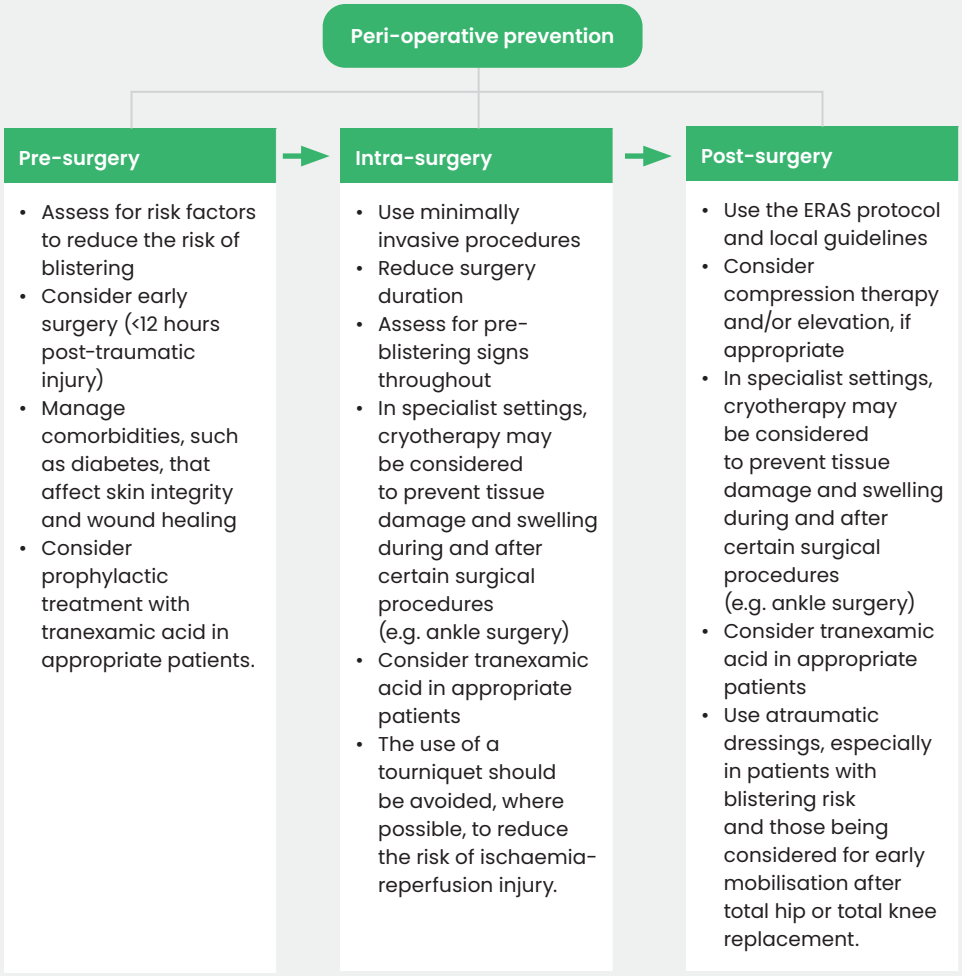
Figure 4 depicts the preventive measures recommended at each stage of surgery to reduce the risk of blister formation (Ker et al., 2013; Kuint et al., 2020; Tosounidis et al., 2020).

Avoiding skin irritants

In post-operative patients, it is important to minimise exposure to irritants and substances that may cause cutaneous trauma. Hypersensitivity reactions to surgical glues are relatively common, and some individuals may develop local allergic responses. Acrylic-based wound dressings and skin adhesive sprays can further increase mechanical stress on the epidermis, thereby compounding tissue damage and elevating the risk of blister formation (Dillon et al., 2007; Kuo et al., 2021; Barton et al., 2024).

Consensus statement: The choice of wound dressing or adhesive plays an important role in managing the risk of post-operative blisters. There is a need to examine the effects of post-operative glues, sprays, wound dressings and other peri-operative skin irritants on skin integrity, given the range of products to which patients are exposed throughout the surgical pathway. Dressings with adhesives known to cause blisters should be avoided.

Figure 4. Blister prevention measures at each surgery stage.



Appropriate NPWT application

Although standard NPWT has been associated with an increased risk of blistering, Zhang et al (2021) demonstrated that a modified NPWT technique can reduce linear blister formation while supporting improved healing and reduced infection risk. In a randomised clinical trial (RCT) comparing conventional NPWT with a modified NPWT dressing in patients with Gustilo type II and III open fractures (n=53), the modified approach resulted in a significantly lower incidence of NPWT-related blistering.

NPWT, with correct application technique, remains a good option for patients with significant comorbidities and high risk of non-healing wounds. In high-risk patients with closed surgical wounds, multilayer dressing-based NPWT devices should be considered. For open wounds with secondary intention to heal, foam dressing-based conventional NPWT is preferred. See **Figure 5** for examples of how to select NPWT dressings based on these wound types.

While NPWT can improve overall surgical outcomes in appropriate patients, further research is needed to understand which NPWT dressings are most effective while minimising the risk of blistering.

Consensus statement: Further investigation into selective and modified therapeutic approaches is required for patients with significant comorbidities who are at heightened risk of post-operative complications.

Figure 5. Examples of how to select NPWT dressings based on wound type.

A, a surgical wound after hip replacement; **B,** application of multilayer dressing-based NPWT; **C**, necrosis in a surgical wound after distal femur and patella fracture surgery; **D,** debridement of necrotic tissue; **E,** wound after debridement; **F,** application of foam dressing-based NPWT.

Appropriate dressing type and application

A dressing should maintain an optimal healing environment without causing blistering. This is best achieved by using dressings designed to minimise adhesive-related skin damage, which are flexible and easy to apply and remove. In patients with fragile skin, soft silicone dressings should be used due to a reduced risk of blistering and improved cost-effectiveness (Ousey et al., 2025).

Effective surgical incision management aims to minimise the risk of wound-associated complications, limit wound disruption, prevent microbial entry and optimise patient comfort. Post-surgical dressings containing silicone adhesives have demonstrated significantly better performance over conventional dressings, and are favoured by patients and HCPs (Bredow et al., 2018; Beele et al., 2020). In an RCT including 209 patients receiving primary knee or hip

endoprosthesis or a primary spinal surgery, no blisters were recorded in the group receiving absorbent, silicone-coated versus adhesive dressings; the frequency of dressing changes was significantly lower ($p<0.001$) with silicone-coated dressings (Bredow et al., 2018). In an RCT of a silicone-coated absorbent dressing versus a dressing containing hydrocolloid and hydrofibre coated with waterproof polyurethane ($n=103$), patients undergoing elective primary knee or hip arthroplasty experienced significantly better outcomes when the silicone-coated absorbent dressing was used, due to its effective management of exudate and blood, minimisation of pain and improved comfort; HCPs also reported a higher level of satisfaction with the silicone-coated absorbent dressing (Beele et al., 2020).

Flexible dressings may also reduce the risk of blistering by reducing shear forces on the skin (Ousey et al., 2025). The incidence of post-surgical blistering can be minimised by applying dressings without tension (i.e. flexible dressings), limiting the frequency of dressing changes and removing dressings gently to avoid additional skin trauma and improve patient comfort and HCP satisfaction (Bredow et al., 2015; Bredow et al., 2018). See **Box 3** for the potential advantages associated with atraumatic dressings in blistering prevention.

Box 3. Advantages of atraumatic dressings in blistering prevention.

- Prevention of patient harm through reduced pain and risk of complications
- Improved patient engagement due to easier, pain-free application and removal
- Potential long term cost-savings through reduced blister formation and improved outcomes
- Reduced costs, as adhesive removal materials are no longer required.

Consensus statement: Dressings should be selected to reduce the risk of infection while also minimising harm from MARSI. Further clinical studies are needed to identify the most appropriate dressing options for different surgical procedures and patient risk profiles.

A lack of elasticity in post-surgical dressings has been shown to increase the risk of blistering in patients undergoing several different types of procedures, such as TKR, total hip replacements, hip hemi-arthroplasty, dynamic hip screw and tibial and femoral nailing (Cosker et al., 2005). Cosker et al (2005) showed that elastic dressings can reduce blistering even in patients with fragile skin.

Stretching a dressing over an incision may also apply a higher amount of friction force to the periwound skin in moveable areas (e.g. over a joint), resulting in blistering. Correct application of post-surgical wound dressings is crucial to prevent blistering. Stretching a dressing, particularly an adhesive one, should be avoided, as it can cause significant damage to the periwound area, leading to blister formation (Sanusi, 2011).

A consensus of >100 surgeons and surgical experts identified the characteristics of an 'ideal' dressing for surgical wounds (Morgan-Jones, 2025). HCPs should be aware of these characteristics:

- Flexible and comfortable, so as not to impede the patient's movement or cause damage to the skin
- Fixes well to the skin on application, even after skin disinfection
- Absorbent and able to manage exudate
- Skin-protective (minimises the risk of blistering or irritation; not excessively adhesive)
- Waterproof, providing a good seal/barrier and allowing the patient to engage in personal hygiene activities
- Eliminates 'dead space' between the wound bed and dressing.

A dressing with these characteristics can help protect surgical wounds, promote healing and reduce skin damage, including blistering.

Box 4 outlines the correct approach to dressing application, minimising skin trauma and blistering risk.

Consensus statement: The incidence of blistering associated with wound dressings demonstrates considerable variability (Ousey et al., 2025), with incidence influenced by the specific dressing materials and technologies employed. There is a need to address the lack of recent, high-quality, standardised data describing the prevalence and incidence of different blister types associated with dressings commonly used across global healthcare settings.

Consensus statement: Based on current evidence, silicone adhesives have been clinically demonstrated to be the recommended choice of dressing for reducing blister formation (Bredow et al., 2018; Beele et al., 2020; Ousey et al., 2025).

Box 4. Appropriate dressing application and change techniques.

- Select correct dressing size and shape as per wound location, size and patient needs
- Use sterile or aseptic technique during dressing application and removal, and minimise exposure time while changing the dressing
- Apply dressings only to dry skin to ensure adequate adhesion, using an atraumatic approach
- Change dressings only when clinically indicated.

Scan the QR codes to view videos demonstrating appropriate dressing application techniques (videos courtesy of Chris Edelman).

Application of a soft silicone foam dressing on a surgical wound

Application of a portable, single-use NPWT dressing on a surgical wound

Barrier film

Further research is needed to determine the effect of applying a barrier film beneath post-operative adhesive dressings to reduce friction-related skin injury and blister formation. In a study of 185 patients undergoing spinal surgery, Cole et al (2020) found no difference in skin injury incidence between dressings used with and without a barrier film.

Prophylactic corticosteroids

Recent evidence shows that corticosteroids reduce systemic inflammation and loss of microcirculation that may otherwise lead to severe post-operative complications (Bain et al., 2023). These improved outcomes have been noted across both emergency and elective surgery procedures, including knee, abdominal and cardiac surgery. Across the studies summarised by Bain et al (2023), differing doses of corticosteroids have been reported, requiring careful consideration by HCPs when choosing the correct dose to avoid the risks associated with steroid treatment.

Corticosteroid therapy may be considered during the peri-operative period for major surgical procedures; however, further research is required to understand its impact on patients at risk of peri-operative or trauma-related blistering. Current evidence is insufficient to guide HCPs in selecting and administering steroid regimens safely and appropriately for individual patient needs.

Structured skincare

Maintenance of skin integrity and prevention of skin blistering are essential to reduce the risk of wound infection and resulting use of antimicrobial agents. Throughout the peri-operative period, prevention of skin damage should be an integral part of routine care, particularly for patients with fragile skin. Post-operatively and when removing any type of dressing, consideration must be given to reducing MARSI.

MARSI may present as a combination of adhesive-induced injuries, including epidermal stripping, tension-related trauma, dermatitis and blister formation (Savine, 2024), all of which can significantly impair healing and increase susceptibility to infection. Reducing MARSI risk requires a structured, evidence-based prevention programme and consistent skincare regimen that incorporates appropriate emollients to maintain epidermal hydration, support barrier function, and enhance overall skin resilience.

Timing of blister appearance

Understanding the pattern of blister development can inform subsequent clinical decision-making. Blisters generally form within hours of cutaneous irritation or injury, and healing may require 3–6 weeks, depending on factors such as severity and anatomical location. Blisters occurring in high-friction areas, such as the foot, will take longer to heal, with healing further compromised in the presence of impaired vascular supply.

Anatomical regions with a higher incidence of fracture-related blistering, particularly those of the lower limb, tend to have relatively thin skin and limited subcutaneous tissue, leaving the underlying soft structures more vulnerable to blister formation following significant trauma.

In some orthopaedic trauma cases, surgery may need to be delayed if fracture blisters develop at the injury site. These blisters may appear 6–72 hours post-fracture, often within the same period required to stabilise the patient, and may increase the risk of infection and complicate surgical planning (Tosounidis et al., 2020). However, current evidence is insufficient, highlighting the need for scientific studies to understand the approximate timeframe in which a blister may develop.

Consensus statement: Skincare bundles help to prevent skin injuries, including skin tears and blistering. There is a need to develop and evaluate focussed skincare bundles specifically for patients at increased risk of post-operative blisters.

Principles of blister management

Current evidence on blister prevention and management is sparse. HCPs involved in the care of post-surgical patients (and patients who have experienced significant trauma) should understand and implement the following major principles of blister management:

1. Remove the irritant (e.g. adhesive dressings, tight clothing)
2. Promote undisturbed wound healing
3. Do not de-roof the blister; it can increase the risk of infection
4. Document and re-evaluate regularly
5. Use dressings that are clinically demonstrated to minimise the risk of post-operative complications including blister formation
6. If there are clinical signs of infection, antimicrobial treatment should be initiated (see **Box 5** for clinical signs of infection in a blister). Follow local antimicrobial and AMR guidelines. Do not use prophylactic fusidic acid, as it can increase the risk of AMR
7. Manage pain to ensure patient comfort and prevent further irritation of the blister site.

Blister management is a complex process, especially for patients who are older, have fragile skin, oedema and/or comorbidities, or those with limited mobility or poor nutritional status.

To support effective education of HCPs, management considerations for each category of blister are presented separately. In practice, however, an individual patient may present with multiple blisters spanning different categories. Each blister requires individual assessment, with management decisions guided by the overall clinical picture.

Box 5. Clinical signs of infection in a blister.

- Pus in the blister
- Surrounding erythema
- Warm skin.

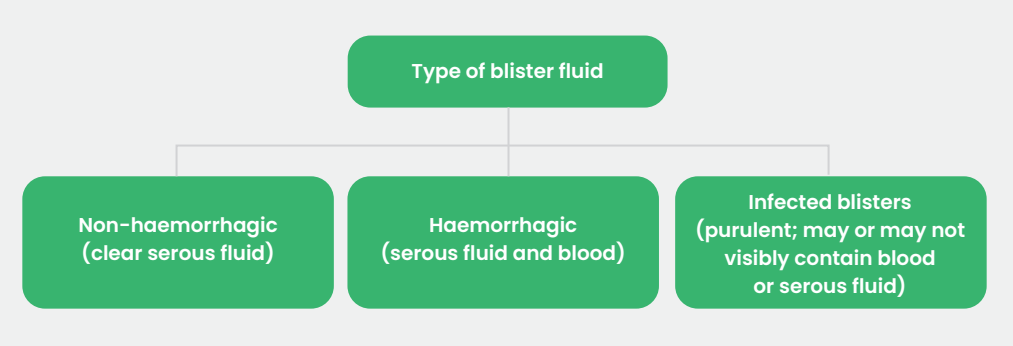
Types of blister fluid

Blisters may contain clear serous fluid, blood or purulent material [Figure 6], depending on the degree of underlying tissue injury and the presence or absence of secondary infection (National Health Service inform, 2024)

It is important to differentiate haemorrhagic, non-haemorrhagic and infected blisters because each type reflects differing degrees of underlying tissue injury, carries distinct surgical considerations and requires tailored management strategies.

In a retrospective review of post traumatic orthopaedic fracture blisters, Strebel et al (2020) found that approximately 10% of aspirated blisters were colonised with microorganisms and 57% of these colonised lesions were haemorrhagic. SSIs were also observed in patients whose blister fluid cultures were sterile, demonstrating the limitations of using blister fluid characteristics alone to predict SSI risk.

Figure 6. Types of blister fluid.



For patients requiring operative intervention after trauma, making an incision through or adjacent to a haemorrhagic blister, but not a non-haemorrhagic blister, is recognised as a significant predictor of increased post-operative infection risk (Tosounidis et al., 2020).

Comorbidities

Evidence indicates that patients with systemic comorbidities may be more vulnerable to soft tissue complications. In a cohort of 45 individuals with fracture blisters, Strauss et al (2006) reported an 11% incidence of blister-related soft tissue complications; two patients required repeat surgery, and both had diabetes mellitus. In a study of 1,119 patients with lower extremity fractures, approximately 11% had fracture blisters; among these patients, body mass index (BMI) and Elixhauser Comorbidity Index (ECI) were found to be risk factors for fracture blisters (Wang et al., 2024).

Recent data indicate that, in addition to post-surgical complications, comorbidities (e.g. diabetes and high BMI) may also be associated with immune system dysregulation in patients after surgical injury, further impacting recovery (Bain et al., 2023; Rich et al., 2024).

Collectively, these findings indicate that the presence of blisters, particularly haemorrhagic blisters, not only contribute to delays in post-trauma surgical management but may also be associated with an elevated risk of post-operative complications. This risk may be further amplified in patients with underlying comorbidities such as diabetes.

Consensus statement: There is a need to undertake robust clinical studies to evaluate post-surgical complications, such as infections and the need for repeat surgery, in trauma patients presenting with serous versus haemorrhaging blisters with and without systemic comorbidities.

Categorisation and management

Currently, no global classification system for blistering exists. There is a need for a standardised blister classification system that:

- Encompasses all trauma- and surgery-related blister types, which can be used in global clinical settings
- Is easy-to-use for all care staff and HCPs
- Can be integrated into electronic health record (EHR) systems.

Figure 7 presents a proposed conceptual framework for blisters arising from trauma or during the peri-operative period. This system is not based on the structural layers damaged during the formation of a blister, although the increasing severity of a blister may indicate a higher extent of underlying damage to the skin. The aim of this conceptual framework is to provide practical considerations to HCPs, so they can assess the patient's risk and intervene with evidence-based blister management approaches.

This framework is not a validated system and further studies are required to develop a global blistering classification guideline.

Figure 7. A conceptual framework system, dividing blisters into two categories based on the extent of tissue and skin damage and patient risk.

Increasing risk of complications

Catergory 1:	**Catergory 2:** Arise due to traumatic injury or surgery	
	2a:	2b:
Damage to the skin caused by friction, for example, inappropriate wound dressing choice, excessive movement of dressing on patient repositioning or movement, inppropriate application or removal of dressings.	• Due to skin damage in the epidermal or dermal tissue; may also involve blood vessels • Blister may contain clear serous fluid; if blood vessels are involved, may contain haemoserous fluid (i.e. a combination of serous fluid and blood).	• Intection is present • Purulent discharge will be thick and milky in appearence.

Blisters in both categories have the potential to develop into a non-healing wound if risk factors are present.

A patient may present with one or more of these blister catergories at the same time and should be treated as a complex patient.

Consensus statement: There is a need to develop and validate a classification system for blisters that emerge from trauma or in the peri-operative period. A validated classification system can help standardise blistering prevention, management and reporting, as well as facilitate collection of reliable data to assess the prevalence and incidence of blistering.

Managing blisters

Category 1 blisters

For this category, the cause of blistering should be addressed promptly. Atraumatic dressings should be used and correct application and removal techniques employed (see page 17 for videos demonstrating correct dressing application and removal techniques).

The blister should be assessed routinely for symptoms of non-healing and/or infection, especially in patients with risk factors and fragile skin (see **Table 1**, page 7, for a list of factors that may increase skin fragility and risk of infection). When a blister shows signs of impaired or stalled healing, referral to an appropriate wound care specialist is advisable and a non-healing wound management pathway should be initiated. Ongoing, structured reassessment is essential to detect early indicators of infection and enable prompt intervention.

To reduce the risk of non-healing wounds and infection occurring, it is important to address any comorbidities that may impair skin integrity. Depending on the patient's individual risk profile, relevant members of the multidisciplinary team (MDT); e.g. podiatrists, endocrinologists, and other specialist services) should be informed so that coordinated management can be provided.

All HCPs should also be aware of safe patient handling, transferring and repositioning techniques to avoid shear forces on skin; for example, patient should be 'lifted' and not 'dragged' when being transferred between surfaces (Nokaneng et al, 2025).

Category 2 blisters

Arising due to traumatic injury or surgery, these blisters may vary in size and appearance, making their management a complex decision-making process that depends on various factors. Blisters containing serous and haemoserous fluid can also coexist in an injured area (Tosounidis et al., 2020).

***Category 2a*:**

- Use atraumatic dressings, with correct application and removal techniques (see page 17 for videos demonstrating dressing application and removal techniques)
- Manage comorbidities and routinely reassess for symptoms of non-healing and/or infection.

Some data indicate that compression therapy with spica wraps versus taping may reduce blistering in patients undergoing hip surgery (Hahn et al., 1999; Koval et al., 2007). It may be hypothesised that reduction in oedema through compression therapy may lead to reduction in blistering, as noted in patients with erysipelas with massive lower leg oedema (Dissemond et al., 2023). However, there is a need to investigate the impact of compression on blistering in post-surgery patient populations (Christensen et al., 2021).

***Category 2b*:**

For infected blisters, timely infection control measures should be taken, following local guidelines. In addition, the following recommendations should be implemented to reduce the risk of further blistering and associated complications:

- Use atraumatic dressings, with correct application and removal techniques (see page 17 for videos demonstrating correct dressing application and removal techniques)
- Consider appropriate antimicrobial dressings
- Employ an MDT approach to manage any comorbidities (e.g. diabetes, obesity) that may have an adverse effect on the wound healing trajectory (Flores et al., 2019; Wang et al., 2022).

Managing the risk of infection

Infected blisters may lead to deep tissue infection, which can become a serious and rapidly progressing emergency requiring immediate medical intervention (Runer et al., 2021).

It is crucial that HCPs are familiar with their local escalation pathways for a suspected deep tissue infection. Local antimicrobial treatment guidelines should be followed in accordance with AMR recommendations.

All HCPs and care staff must also be able to recognise the signs of sepsis outlined in **Box 6** (The UK Sepsis Trust, 2026).

Box 6. Identifying SEPSIS.

Seek medical help urgently if a patient presents with any of these signs:

S Slurred speech or confusion
E Extreme shivering or muscle pain
P Passing no urine in a day
S Severe breathlessness
I It feels like you are going to die
S Skin mottled or discoloured.

Consensus statement: Blister fluid should always be considered contaminated with microbes, so infection should be suspected and infection control procedures followed.

Pain management

Inadequate pain management in people with blistering can lead to discomfort, reduced QoL and reduced engagement with care. Using appropriate atraumatic dressings can help support pain management as the blister begins to heal.

Patients and their caregivers should receive appropriate support and medication in line with local guidelines, and pain management should be delivered within an MDT to ensure comprehensive care.

Improving education

Blisters can be prevented with appropriate and timely care and should not be accepted as an inevitability. To enable timely identification and intervention, education around blistering needs to be improved.

HCPs

HCPs should receive appropriate education and skills on preventing and managing blistering, tailored for their clinical setting.

Blistering prevention and management differs between specialities and should be aimed at the MDT, including:

- Emergency first-responders
- Accident and emergency units
- Primary care HCPs
- Surgeons
- Intensive care and high-dependency units
- Specialist burn and wound care clinics
- Physiotherapists
- Wound, ostomy and continence nurses
- Tissue viability nurses.

Consensus statement: All HCPs, irrespective of clinical setting, should receive structured training in blister prevention and management. Education programmes must include guidance on selecting appropriate dressings, the correct application and removal of adhesive products, and an understanding of blistering risks associated with different dressing materials.

The following topics should be included in all educational materials aimed at HCP training:

- Assessment for skin fragility
- Blistering identification
- Complications if not treated promptly
- Importance of patient risk assessment and prevention strategies
- Awareness of blistering types and associated complications, and their impact on treatment choices, SSI risk and the need to practice antimicrobial stewardship (AMS)
- Patient diversity (e.g. diverse skin tones and their impact on skin assessment)
- Associated clinical concepts, such as inflammation versus infection in a blister
- Potential long-term impact of inadequate blistering prevention and management for patients, caregivers and healthcare systems (e.g. QoL and cost).

Consensus statement: Appropriate channels must be used to disseminate HCP education. Digital formats (e.g. podcasts and webinars) may offer wider reach, whereas care staff (such as those working in long-term care settings) may benefit from printed materials.

Patients and caregivers

Patients and carers who are involved in their own wound care should also receive appropriate education on the correct application and removal of dressings. Ensuring they are equipped with the necessary knowledge and skills helps minimise the risk of skin trauma, including MARSI, and supports safer ongoing management at home.

Patients and caregivers may consider blistering a minor skin injury. Some may not actively seek treatment and advice from their local care services unless a severe complication occurs (e.g. infection or a blister becoming a non-healing wound). In patients with dark skin tones, the

initial stages of blistering may be missed, putting individuals at higher risk of complications. Blistering and its associated complications are likely to occur in patients with comorbidities and fragile skin, which also increase the risk of infections and non-healing wounds. Therefore, there is a need to improve patient and caregiver awareness in preventing and managing blistering for those with comorbid conditions.

The following recommendations should be considered in preparing patient and caregivers education materials:

- Preferably use printed materials
- Simplify the message
- Emphasise the importance of 'prevention versus cure' in at-risk patients
- Provide clear guidance on when and how to seek help.

Box 7 outlines advice for patients and caregivers.

Box 7. What can I do now as a patient or caregiver?

- Understand the risk of blistering: If you have been asked to change your own dressing, learn how to apply and remove the dressing provided
- Upon each dressing application or removal, check your skin regularly for signs of distress, such as redness, itching or pain. These are clues that skin damage may have occurred
- Communicate with your HCP and alert them to any pain, itching, stretched or damaged-looking skin
- Speak up about changes: Tell your healthcare provider if you notice changes, such as new soreness, itching or skin damage, or if a blister has developed.

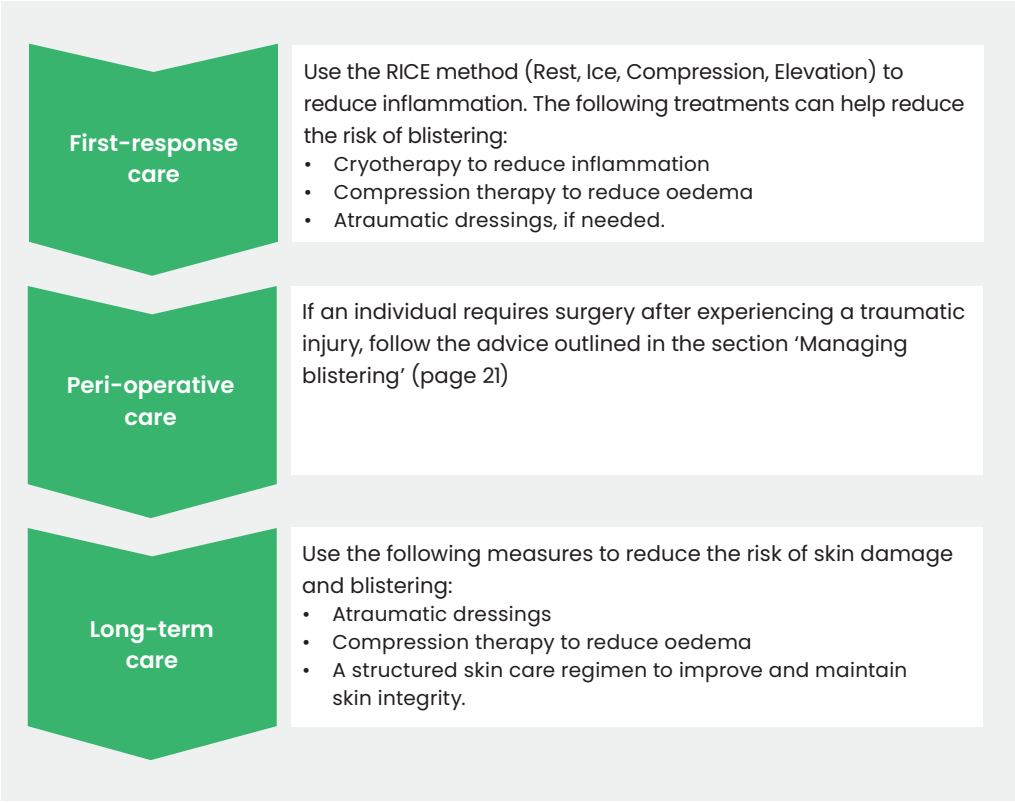
Importance of MDT collaboration

Blistering can complicate or delay surgery, resulting in poor patient outcomes and increasing costly interventions such as prolonged inpatient stays and additional antimicrobial use. Multidisciplinary care throughout the patient journey is crucial to reduce complications for people who have suffered a traumatic injury or those with a surgical incision. All HCPs, commencing with the first responders, should be aware of the risk of blistering and equipped with appropriate preventive measures.

Figure 8 recommends steps to reduce the risk of blistering at each stage of patient care (Wang & Ni, 2021).

Consensus statement: Each clinical setting should establish its own setting-specific protocols for prevention and management of blistering related to trauma or during the peri-operative period.

Figure 8. Interventions to reduce the risk of blistering in post-surgery patients or those with traumatic injury.



Recommendations for clinical studies

In a recent scoping review, Ousey et al. (2025) reported that the current evidence on blistering risks, prevention and management strategies is both limited and outdated. Most of the available studies focused on post-operative hip and knee patients, with smaller bodies of evidence relating to obstetric populations, trauma cases and general surgical patients.

Consensus statement: Robust, large scale and multidisciplinary studies are required for surgery and trauma-related blistering to develop standardised categorisation, prevention and management guidelines across global healthcare settings.

Prevention and risk management

Dressings

Several studies have highlighted the role of dressings in reducing the risk of blistering following traumatic injury or surgery (Ousey et al., 2025). Atraumatic dressings are generally recommended to minimise the risk of blistering.

However, there is a need to investigate how dressing structure, stretch, positioning and application techniques impact the risk of blistering throughout the peri-operative period, as well as immediately following a traumatic injury.

NPWT

NPWT has demonstrated benefits in wound healing and infection prevention (Zeng et al., 2026). Zhang et al. (2021) reported that modifying the geometry of foam-based NPWT dressings significantly reduced linear blistering at the dressing edge, a complication attributed to mechanical imbalance and friction at the dressing-skin interface.

While effective in open wound management, where these systems promote contraction and fluid removal, closed surgical incisions require a different mechanical strategy focussed on stabilisation and tension offloading. In response to this, multilayer closed-incision NPWT dressing systems have been developed to distribute forces more evenly across the incision and surrounding tissue, rather than relying on contractile effects at the dressing edge.

Therefore, NPWT outcomes may depend not only on application technique, but also on dressing architecture and its interaction with the surrounding tissue environment (see **Figure 5**, page 16, for examples of how to select NPWT dressings based on wound type).

Corticosteroids

Optimal management of the immune and inflammatory responses to injury, as well as microcirculatory function, is a key area for future research aimed at reducing the risk of traumatic injury- or surgery-related blistering (Riedel et al., 2024).

There is a need to assess the role that corticosteroids can play in both elective and emergency surgeries. Future studies should focus on:

- Adaptive or multi-stage trials to investigate optimum dosing (low, moderate and high) in appropriate patient populations
- Optimal timing of corticosteroid administration
- Microcirculatory care bundles aimed at reducing the risk of blistering.

Trauma-related and peri-operative complications

Globally, the volume of surgical procedures continues to rise (Nepogodiev et al., 2025). As populations age and the prevalence of comorbidities increases, the number of surgeries associated with a heightened risk of post-operative blistering, such as spinal procedures and joint arthroplasty, is also expected to grow (Ousey et al., 2025). In the United States alone, it is projected that an average individual will undergo approximately three inpatient and two outpatient surgical procedures over the course of their lifetime (Vierra et al., 2024).

Currently, there is a lack of evidence on appropriate prevention and management of blisters in people undergoing surgery with or without a preceding traumatic injury (Tosounidis et al., 2020). Furthermore, there is no consistent or recent evidence supporting the use of prophylactic antibiotics for preventing or managing blisters and associated surgical and SSI-related complications. Investigations addressing these gaps are essential to develop evidence-based guidelines.

Patient QoL

Blistering can cause significant distress and morbidity for patients, affecting their daily activities and long term recovery. Given the current lack of robust evidence on the prevalence and incidence of blistering, it remains difficult to fully assess the impact of blistering on patients and their caregivers. There is a clear need for QoL research in individuals with blistering to better understand the overall burden, associated pain, complications, and the effect on daily activities for both patients and caregivers.

Certain interventions, such as NPWT and atraumatic dressings, have demonstrated improved outcomes for patients with wounds and those undergoing specific surgical procedures. However, current evidence is insufficient to provide definitive recommendations regarding their long-term cost-effectiveness relative to the QoL benefits they offer.

There is a need to evaluate the impact of potential interventions aimed at reducing and managing blistering, ensuring alignment with patient and healthcare system priorities for value-based, patient-centred care.

AI-led MDT care

AI is an emerging solution to the healthcare challenges encountered by patients with complex multifactorial disorders, including non-healing wounds. Evidence indicates that AI can support multiple dimensions of wound care, from diagnosis and treatment to HCP education and workflow optimisation in an MDT environment (Rippon et al., 2024).

AI tools offer an opportunity to enhance patient outcomes and improve healthcare system efficiency in the prevention and management of blistering. They can support the early identification of at-risk populations, enable focused interventions and have the potential to strengthen MDT coordination. These technologies can also help ensure patients receive timely, collaborative MDT care. The following AI-driven decision-making and training tools have the potential to improve blistering management and prevention, especially when integrated into EHRs:

- Investigating the impact of new treatments (e.g. modelling the effect of corticosteroids on immune and inflammatory responses)
- Assessment and risk stratification using patient- and injury-related data (such as the extent of tissue damage, type of surgery, comorbidities)
- Standardised data recording and reporting
- Decision-support tools to improve patient-centric prevention and management
- Auditing tools to monitor protocol implementation and patient adherence
- Health-economic and outcomes research (HEOR) tools to assess the impact of interventions and build a business case
- AI-assisted training modules
- Patient and caregiver education to deliver tailored content in a timely manner.

Conclusions

There is a growing need to recognise post-surgical complications, including blistering, as a potential global health concern (Dobson, 2020; Ousey et al., 2025). An evidence gap persists in this area of wound care, contributing to ongoing uncertainty regarding the definition of blistering and creating challenges for assessment and reporting.

This consensus document provides a preliminary definition and proposes a conceptual framework for future studies on blister categorisation. Further research is needed to explain blister pathophysiology, refine classification systems and inform effective prevention strategies, while also considering the impact of blistering on patient outcomes. Although atraumatic dressings are recommended to reduce blister risk, robust evidence is still required to identify dressing choices that support optimal overall wound management.

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Appendix 1: Glossary

Aspiration	The process of removing or draining blister fluid to promote healing and reduce the risk of infection; compared to de-roofing, blister aspiration may be less painful for the patient
Blistering	Visible accumulations of fluid within or beneath the epidermis, and can be divided into small (<1cm²) or large (>1cm²) for treatment purposes
Bullae	A type of fluid-filled blisters, >5 mm in size
De-roofing	The process of removing the top layer of the blister (i.e. the blister roof) to drain fluid, reduce debris, promote healing and cell growth and reduce the risk of infection; compared to aspiration, de-roofing a blister may be more painful for the patient
Enhanced Recovery After Surgery (ERAS) protocols	Evidence-based peri-operative care protocols designed to reduce surgical stress and complications, and improve patient recovery
Gustilo types I-III open fractures	A classification to divide soft-tissue damage in open fractures into three classes: • Type I: wound ≤1cm, minimal contamination or muscle damage • Type II: wound 1-10cm, moderate soft tissue injury • Type III: wounds >10cm, severe injuries characterised by extensive soft tissue damage
Incidence	Indicates the proportion of the population studied that develops a given medical condition over a specified time period
MARSI (Medical-Adhesive-Related Skin Injury)	Erythema and skin abnormalities that last for at least 30 minutes after removal of a medical adhesive
Prevalence	Refers to the total number of individuals in a population who have a medical condition at a specific point in time
Retractors	Surgical instruments used to hold tissues or organs to improve exposure and access to the surgical area
Vesicles	A type of fluid-filled blisters, <5mm in size

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