How to manage traumatic open wounds (Part 1)

This is the first article in a two-part series from *Erika Villedieu* of Willows Referral Centre in Solihull and focuses on the basics of wound healing, dressing types, composition and indications.

FIGURE 1: Example of a wound in the early inflammation phase with necrotic tissues and unclear cut-off line between viable and non-viable tissues.

Traumatic open wounds commonly result from road traffic accidents, animal bites or other injuries. Appropriate management is key to achieving optimal wound healing whilst minimizing complications. A good understanding of the wound healing process and of the properties of the various available dressing materials is important to guide decision making, and this will be the subject of the first part of this article. In the second part, we will look at the step-by-step management of traumatic open wounds.

Wound healing

There are three recognized phases of wound healing: the inflammation phase, the proliferation phase and the maturation phase. Although these are described below as separate phases, in practice the three phases will overlap and potentially occur simultaneously in different parts of the wound.

Inflammation phase

The inflammation phase of wound healing typically lasts for the first 3–5 days, although it can last longer in wounds with heavy contamination or severe trauma. Vasoconstriction initially occurs, followed by vasodilation and increased vascular permeability, which leads to fluid and protein loss through the wound. The predominant cell type is neutrophils, for the first 48–72 hours, followed by macrophages.

The inflammation phase is the phase of wound debridement and should progress to the proliferation phase in healthy wounds. In traumatic open wounds, the early inflammation phase is characterized by the presence of contamination, necrotic tissues and an unclear cut-off line between viable and non-viable tissues (Figure 1). The late inflammation phase is characterized by minimal contaminated or necrotic material although granulation tissue is not yet present (Figure 2).

FIGURE 2: Example of a wound in the late inflammation phase with minimal necrotic material although healthy granulation tissue is not yet present.

The early inflammation phase is the phase of maximal fluid production. This may lead to significant fluid and protein loss from the wound and consequently hypovolaemia and hypoalbuminaemia. As a result, dressing changes may need to be very frequent to keep up with fluid production. Daily dressing changes are usually required for the first few days and dressing changes usually require general anaesthesia to allow appropriate debridement. Multimodal analgesia should also be in place. To avoid hypovolaemia and hypoalbuminaemia, appropriate fluid therapy and nutritional therapy should be implemented. Placement of a feeding tube should be considered when the patient's food intake is inappropriate through voluntarily eating.

Inappropriate care during the early stages of wound healing may lead to further tissue necrosis and infection, potentially leading to a much larger wound than was initially present.

Available in the BSAVA Library: DOI: 10.22233/20412495.0723.18

Proliferative phase

The proliferative phase lasts approximately from days 4 to 12, although it can be longer in cases with delayed healing. It is characterized by the appearance of granulation tissue, which is a result of angiogenesis and collagen synthesis. The appearance of healthy granulation tissue is a hallmark of the healthy healing process. Healthy granulation tissue should look dark pink or red, be smooth and bleed easily, and be free of necrotic tissue (Figure 3). Healthy granulation tissue is also relatively resistant to infection. Once healthy granulation tissue is present throughout the wound, wound closure through primary apposition or use of a skin flap or skin graft can be considered.

FIGURE 3: Example of a wound in the proliferative phase of healing. Note the presence of healthy granulation tissue covering the wound.

During the proliferative phase, some fibroblasts in the wound bed transform into myofibroblasts and initiate wound contraction. Epithelialization also starts from the edges of the wound. Contraction and epithelialization both lead to a significant reduction in the size of the wound.

During the proliferative phase, dressing changes become faster as there is no need for debridement. There is also decreasing fluid production and dressing changes can therefore be performed less frequently, under sedation and potentially on an outpatient basis.

Maturation phase

The maturation phase starts around day 12 and can last for weeks to months. It is characterized by reorganization of the collagen network. The final scar strength is 70–80% of the original skin. If excessive mechanical stimulation (such as movement near joints) remains present during the maturation phase, this can lead to contracture formation.

Wound healing in cats

Compared to dogs, wounds in cats have lower breaking strength during early wound healing. There is also later appearance of granulation tissue, slower infilling of the wound by granulation tissue and slower contraction and epithelialization.

Impaired wound healing

Both local and systemic factors can adversely impair wound healing, and these factors should be controlled wherever possible.

Local factors

- **Decreased wound perfusion**, if prolonged, can lead to decreased oxygen levels in the wound, which in turn prevents normal cell function. It is therefore important to maintain normal hydration and cardiac output, through intravenous fluid therapy if required, and to avoid drugs that cause vasoconstriction.
- **Fluid accumulation**, in excess, will limit wound oxygenation.
- **Presence of necrotic tissue** will also impair wound healing, prolong the inflammation phase and lead to increased fluid and protein loss, and increased risk of infection and sepsis. This highlights the importance of adequate wound debridement during dressing changes.
- **Wound infection** should be prevented if possible or recognized early and treated appropriately if it occurs. Following asepsis principles during dressing changes, and performing appropriate wound care, will help prevent infection. If wound infection is suspected, then a tissue biopsy culture sample should be obtained after wound lavage, from the deepest part of the wound.
- **Tension and movement** will delay wound healing and may encourage contracture formation. Although tension and movement are inherent to the type and location of the wound, some techniques can be employed to try and limit both, especially if surgical wound closure is eventually performed.

Systemic factors – inherent to the patient

- Some cannot be controlled, such as immune function, age, concurrent conditions.
- Some can and **should** be controlled:
  - Poor food intake, malnutrition and hypoalbuminaemia should be addressed through appropriate nutritional support and feeding tube placement if required
  - A stable cardiovascular status should be maintained through appropriate intravenous fluid therapy
  - Pain should be appropriately controlled and multimodal analgesia may be required. This should be tailored to the patient but may include a combination of opioid medication, non-steroidal anti-inflammatory medication in stable patients, paracetamol in dogs and potentially continuous rate infusions of ketamine and/or lidocaine.

Dressing contact layers and indications

Manuka honey

Manuka honey can be used during the inflammation (or debridement) phase of healing, as part of a 'non-surgical debridement' strategy. Manuka honey is not usually useful once debridement is complete, i.e. once healthy granulation tissue has appeared.

Manuka honey used for wound healing should be of medical grade. Manuka honey is hyperosmolar (due to its sugar content), which makes it bactericidal. Independently of its hyperosmolar nature, it also has antimicrobial properties through release of hydrogen peroxide and phytochemicals. Manuka honey may also help reduce inflammation.

Overall, Manuka honey is useful for contaminated wounds and wounds that require heavy debridement, as it will encourage sloughing of necrotic tissues and will reduce bacterial colonization. However, there will usually be heavy fluid production from the wound and dressing changes should therefore be performed daily or every other day at least.

Manuka honey is available in tubes (liquid form) or sheets, which are packed in a sterile fashion (Figure 4). Although a tube of Manuka honey can be used on consecutive days in the same patient, tubes should be discarded between patients. The liquid or gel form is most useful for irregular or cavitated wounds. The honey layer should be covered with a semi-occlusive dressing, such as polyurethane foam (Allevyn®) prior to finishing the dressing.

Alginates

Calcium alginates are also used during the inflammation (or debridement) phase of healing, as part of a 'non-surgical debridement' strategy. They should not be used on granulation tissue.

Calcium alginates are derived from seaweed and are very hydrophilic, thereby enhancing debridement and promoting granulation tissue formation. Calcium alginates can also be silver-impregnated, adding antibacterial properties.

Calcium alginates are available as sheets or ribbons (Figure 5); the ribbon form is useful to pack cavitated portions of the wound. Calcium alginates come in a sterile packaging and should be covered with a semi-occlusive dressing. The dry appearance is grey and fibrous (Figure 6) and alginates should be moistened prior to being placed in the wound. The alginate will progressively transform into a gel which may have a green-grey colour at the next dressing change; this is the expected appearance and should not be confused with wound infection.

FIGURE 4: Tube of Manuka honey. Note the mention of 'medical grade' Manuka honey.

FIGURE 5: Calcium alginate in sheets. Note the sterile packaging.

FIGURE 6: Calcium alginate sheet. The typical appearance is of a greyish fibrous material. The alginate sheet or ribbon should be moistened prior to being placed in the wound.

Wet-to-dry dressings

Wet-to-dry dressings are composed of wet gauze placed in contact with the wound as a primary layer, followed by dry gauze. Wet-to-dry dressings used to be popular for the debridement phase of wound healing. However, the gauze primary layer tends to stick to the wound bed and risks removing healthy tissue at the same time as necrotic tissue. For that reason, wet-to-dry dressings have fallen out of favour and are no longer considered part of optimal wound therapy due to the indiscriminate nature of the debridement they provide.

Maggots

Specific maggots that can be used for the inflammatory (debridement) phase of wound healing are from the *Lucilia sericata* species. They provide

discriminate debridement as they only feed on necrotic tissues, but they can cause damage to healthy skin and they therefore need to be confined to the wound, potentially using a specific dressing. They remain much less commonly used than other methods of non-surgical debridement.

Negative-pressure wound therapy

Negative-pressure wound therapy (NPWT) consists of applying continuous (most often) or intermittent subatmospheric pressure to the wound itself, usually during the inflammatory phase of wound healing. The negative-pressure applied is usually around -125 mmHg. The contact layer consists of a coarse, open-cell foam (black) or finer foam (white, for skin grafts) held in place with an adhesive layer that creates an air-tight seal. The foam is then connected to the vacuum unit (Figure 7).

> “Calcium alginates are also used during the inflammation (or debridement) phase of healing, as part of a ‘non-surgical debridement’ strategy.”

NPWT has many purported benefits: it improves wound perfusion, reduces oedema, stimulates granulation tissue formation, removes exudate and decreases bacterial colonization. However, it requires some specialized equipment and training to apply and monitor the dressing. It also requires being able to create an air-tight seal around the wound, which may be very challenging in some body areas, such as near orifices.

Polyurethane foam (Allevyn®)

Polyurethane foam (Allevyn®) is a semi-occlusive and hydrophilic dressing with very good absorptive capacities. As such, it facilitates debridement, maintains a moist wound environment and promotes granulation tissue formation. It can also be silver-impregnated, adding antibacterial properties useful for heavily contaminated or infected wounds.
Polyurethane foam is a versatile contact layer that can be used during the inflammation (debridement) and proliferative phases of healing.

Polyurethane foam is available in multiple sizes and can be cut to size (Figure 8A). Polyurethane foam has an external side – usually pink (Figure 8B) and an absorbent side – usually white or cream (Figure 8C); care should be taken to place the appropriate side (white side) against the wound. The dressing should be changed before the polyurethane foam becomes saturated.

Minimally absorbent semi-occlusive dressings (Melolin®)

Melolin® is a semi-occlusive dressing with minimal absorptive capacities. It is useful to protect a mature wound but is not appropriate for exudative wounds. A such, it should only be used in the late proliferative or repair phases of healing.

Melolin® is available in multiple sizes and can be cut to size (Figure 9A). The ‘shiny’ face should be placed against the wound (Figures 9 B and C).

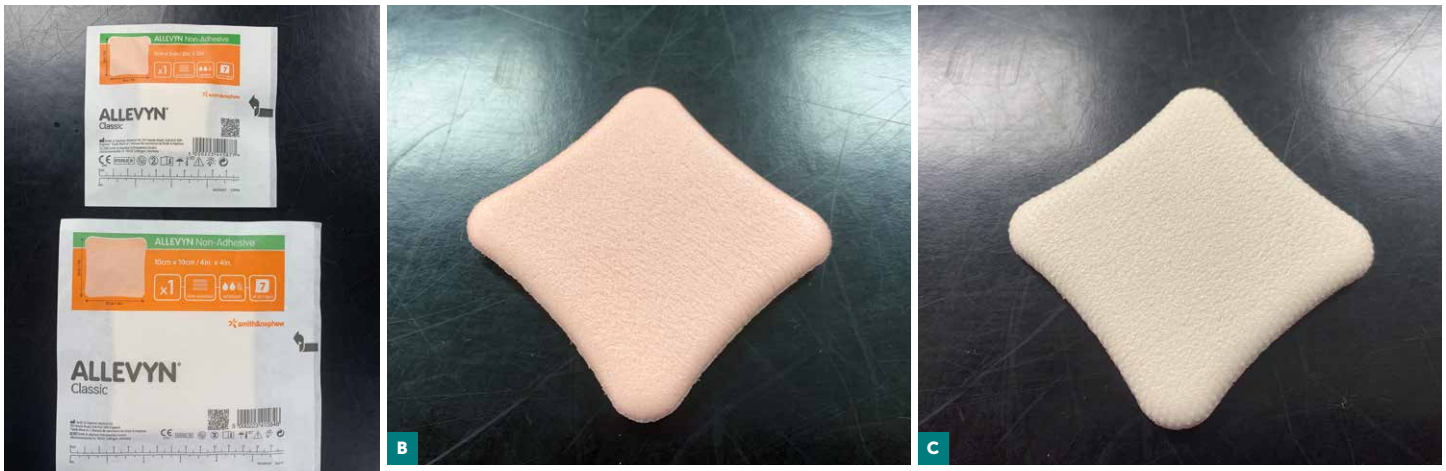
How to secure the dressing

Once the contact layer has been chosen, it needs to be secured until the next dressing change. This is most commonly achieved with either a standard padded dressing or a tie-over dressing.

Padded dressing

In a standard padded dressing (Figure 10), three layers are present on top of the wound contact layer:

FIGURE 7: (A and B) Negative pressure wound therapy dressing application with black foam contact layer, adhesive and suction tubing. (C) The vaccuum unit.



FIGURES 8: Polyurethane foam in different sizes. (A) Note the sterile packaging. (B) External pink side of the polyurethane foam. (C) The absorbent white side of the polyurethane foam to be placed against the wound.

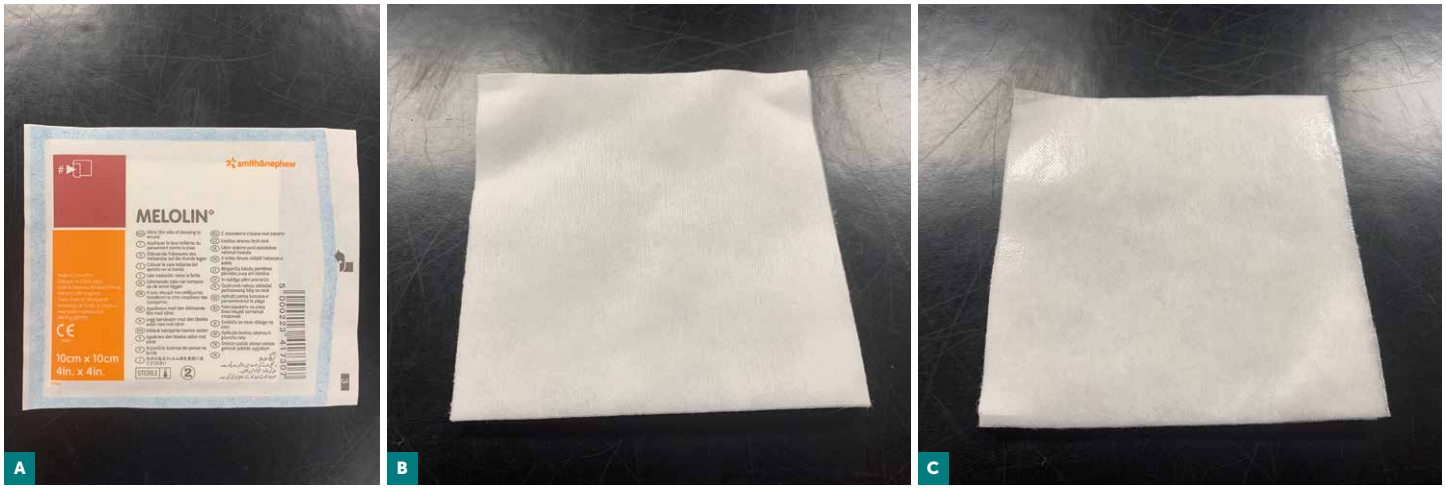


FIGURE 9: (A) Melolin® in sterile packaging. (B) Melolin® external 'matt' side and (C) The 'shiny' wound-side of the dressing.

FIGURE 10: Illustration of a standard padded dressing on a forelimb. In this case, the dressing is used to maintain a negative-pressure dressing on an elbow wound, hence the tubing at the proximal end of the dressing. Note that the toes have been included in the dressing.

- **Padded layer** (Sofban®); this layer provides some absorptive capacity, adds bulk to the dressing and protects intact skin
- **Conforming bandage layer**; this is an elastic layer that adds security to the dressing and allows some pressure to be applied. In turn, this layer can be easily over-tightened leading to dressing complications
- **Self-adhesive layer** (Vetwrap®); this layer is self-adhesive and secures the dressing. Care should be taken not to stretch the material when applying it, as this can result in excessive tension and bandage-related injuries.

The padded dressing can be augmented with stirrups or overlay tape strips to add security and prevent slippage. Stirrups are secured to the skin and to the outer surface of the padded layer. Overlay tape strips are applied at the top of the dressing (for a limb dressing) or

at the edge of the dressing (for an abdominal or torso dressing), to adhere both to the skin and to the outer dressing layer.

Standard padded dressings are fast and easy to perform, the materials are readily available and it is the ideal type of dressing for limbs. A figure-of-eight version is also a good option to bandage the chest. However, padded dressings are at risk of slipping and at risk of overtightening, potentially leading to very serious bandage-related injuries. Padded dressings are also very difficult or impossible to place in certain body areas.

Tie-over dressing

Tie-over dressings (Figure 11) are composed of the wound contact layer covered with sterile gauze swabs, which are held in place by 'nylon tape' (umbilical tape) threaded through suture loops placed in the skin surrounding the wound. Placement of this type of dressing will be detailed further in the second part of this article.

FIGURE 11: Tie-over dressing in place. Note the polyurethane foam contact layer, the suture loops through the skin, the sterile laparotomy swabs and nylon tape passed through the suture loops.

Tie-over dressings are extremely versatile as they can take any shape or size and can be applied to nearly any area of the body, including on the head and near orifices. They are less likely to slip than padded dressings and overtightening is not a concern.

Disadvantages include having to place suture loops through the skin, which makes the first dressing placement more time-consuming, and the need to familiarize oneself with this more unusual type of dressing. Large amounts of gauze swabs may be required at each dressing change, although laparotomy swabs can also be used to add bulk to large tie-over dressings. C

Reflect on your reading

1. Which dressing type(s) would you consider appropriate for a wound over the neck and ear region?
2. If you were concerned about infection on an open wound, how would you obtain a culture sample?
3. Which antimicrobials are appropriate for first-line use in acute traumatic open wounds?
4. Which steps should you follow when presented with an acute traumatic open wound?

Answers available online in the BSAVA Library.

About the author

Erika originally graduated from France and completed her residency training at Willows Referral Centre in Solihull. She became a Diplomate of the European College of Veterinary Surgeons in 2022 and is currently working at Willows as part of the Soft Tissue Service.

References and further reading are available at **www.bsavalibrary.com** and in *e-Companion*.

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