How to manage traumatic open wounds (Part 2)

In the July edition of *Companion*, *Erika Villedieu*, of Willows Referral Centre in Solihull, focused on the basics of wound healing, dressing types, composition and indications.[1] In this second article in the two-part series she focuses on the step-by-step management of traumatic open wounds.

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.

Step 1: Decontamination

As a principle, all traumatic open wounds are considered contaminated, which means that microorganisms are present at the surface of the wound. Contamination can progress to bacterial colonization, which is the replication of these microorganisms at the surface of the wound. Colonization in turn can lead to infection, which is invasion and replication of the microorganisms into the tissues of the wound.

The accepted threshold for the definition of wound infection is 10^5 colony forming units (CFU) per gram of tissue. This usually occurs 6 hours or more after injury and therefore the 'golden period' for open wound first care is <6 hours after injury. After 6 hours, there is an increased risk that colonization has occurred and that it could lead to wound infection. Wound first care should therefore not be delayed unless the patient is too unstable to undergo sedation or general anaesthesia safely and wound first care cannot be performed conscious. So long as appropriate first care is performed, definitive wound care (debridement) can be delayed until the patient is stable and a longer general anaesthetic can be tolerated.

The aim of initial wound care is to reduce microbial burden and prevent further contamination. This is achieved via the following four steps:

- Step 1 = antimicrobial treatment (broad spectrum intravenous)
- Step 2 = wound preparation
- Step 3 = irrigation/wound lavage
- Step 4 = wound protection until definitive treatment.

Antimicrobial treatment should be initiated as early as possible, using broad spectrum intravenous antibiotics, most commonly potentiated amoxicillin. Fluoroquinolones should not be used as a first line of antimicrobial treatment without prior culture and sensitivity results.

Wound preparation

The open wound should first be protected with sterile jelly before the surrounding skin is clipped. Wide skin clipping is essential and should be done similarly to any other surgical procedure, i.e. at least 10–15 cm around the entire wound. This will prevent hair from further contaminating the wound during and between dressing changes.

Skin scrubbing should be performed following standard asepsis principles: the skin is prepared with dilute chlorhexidine, respecting an appropriate contact time.

At the end of the wound preparation step (Figure 1), the wound and surrounding skin are ready for wound lavage.

Wound lavage

The aim of wound lavage is to remove gross contamination and decrease bacterial burden. This requires sufficient irrigation volume, and sterile saline is commonly used although the use of tap water or saline leads to the same rate of infection. The recommended lavage pressure is 7–8 psi, which can be achieved using a 1 litre fluid bag in a pressure sleeve, connected to a giving set (Figure 2). The use of higher pressure (i.e. large syringe with small needle) can lead to tissue damage and embedding of the bacteria into deeper tissues.

FIGURE 1: Appearance of an open wound, caused by a stick injury, after wound preparation. The area has been widely clipped and the skin has been aseptically prepared. A hanging limb positioning has been chosen to avoid cross-contamination during wound care.

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FIGURE 2: (A) Sterile saline from a bottle has been poured into a sterile kidney dish, and this will then be used with a syringe either without a needle or with a large needle. (B and C) Lavage is achieved using a fluid bag connected to a giving set, three-way-tap, syringe and large needle. This allows easy refill of the syringe from the fluid bag.

Wound lavage is typically continued until all gross contamination is removed. Any culture samples should be taken **after** wound lavage. If the culture sample is taken prior to wound lavage, then superficial contaminants will be cultured. However, post-lavage culture results in acute traumatic wounds (without signs of infection) are **not** correlated with later wound infection rates or infection species. Therefore, taking a culture sample is more useful for clinically infected wounds (i.e. a wound that is several days old with signs of infection) than for acute traumatic contaminated wounds.

Wound protection until definitive treatment

If definitive wound care (exploration and debridement) cannot be performed immediately, then the wound should be protected until such time that definitive treatment is performed. A sterile contact layer should be applied (for example, polyurethane foam) and a secure dressing should be placed to prevent further wound contamination.

Step 2: Exploration

Wound exploration should be performed in all wounds, especially wounds overlying the thoracic and abdominal cavities. Exploration sometimes requires enlarging puncture wounds to allow assessment of the deeper aspects of the wound. All the wound recesses should be checked for any communication with body cavities (Figure 3). Special care should be taken with bite wounds, as very small (puncture) skin wounds can be associated with extensive deeper tissues trauma and penetration into the thoracic or abdominal cavity.

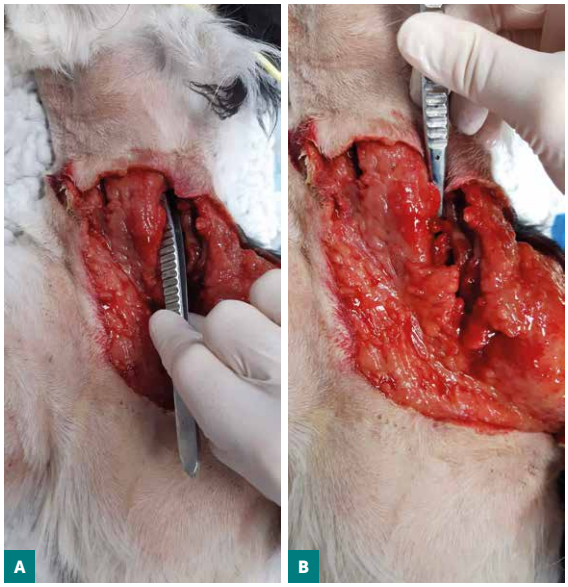

FIGURE 3: Example of a cervical wound secondary to a stick injury. The wound has many crevasses and recesses which are explored with thumb forceps. (A) One of the recesses was found to communicate with the oral cavity at the level of the initial stick injury.

Step 3: Debridement

Wound debridement techniques can be broadly separated in two categories: surgical debridement and non-surgical debridement. The aim of wound debridement is to remove all non-viable tissues from the wound bed to allow wound progression to granulation tissue formation. This is usually achieved over several dressing changes.

Surgical debridement is usually performed with a scalpel blade and aseptic technique:

- This can be either 'tangential' where necrotic tissues are progressively removed working from the superficial areas to the deeper areas of the wound, or 'en bloc' where the entire wound area is removed and then closed. 'En bloc' debridement is usually reserved for small wounds in areas allowing primary closure
- Surgical debridement is preferred if there is a clear delineation between viable and non-viable tissues. It is faster than non-surgical debridement, but it also risks removing healthy tissues if overzealous debridement is performed (Figure 4).

Non-surgical debridement is the use of dressings to achieve and promote wound debridement. These dressings have been detailed in the previous article[1] and include:

- Dressings maintaining a moist wound environment: honey, alginates, polyurethane foam[1]
- Negative pressure wound therapy
- Wet-to-dry dressings
- Maggots.

Non-surgical debridement may be more time-consuming but carries less risk of damage to viable tissues, and it is therefore preferred if there is an unclear delineation between viable and non-viable tissues. It is also preferrable in the proximity of critical structures.

Honey, alginates or negative pressure wound therapy (VAC) are preferred in the early inflammation phase, when there is marked exudation from the wound. Polyurethane foam (Allevyn) is appropriate for late inflammation (mild to moderate exudation). As previously mentioned, wet-to-dry dressings are now not considered to be gold-standard due to the indiscriminate nature of the debridement they provide.

Figures 5 and 6 provide summaries of recommended dressings.

FIGURE 4: (A) Tangential surgical debridement performed on a necrotic wound. (B) Although there are still some necrotic areas present after surgical debridement, these would be difficult to fully resect without damaging viable tissues. In this case, surgical debridement still achieved faster wound progression than would have been achieved with non-surgical debridement alone.

> "Non-surgical debridement may be more time-consuming but carries less risk of damage to viable tissues."

Step 4: Bandaging

Padded dressing

The standard padded dressing is composed of:

- The wound contact layer of choice (honey, alginate, polyurethane foam, etc.)
- The padded layer (Sofban® or equivalent)
- The conforming bandage layer
- The self-adhesive layer (Vetwrap® or equivalent).

General rules for placement of a padded dressing are as follows:

- Avoid excessive tension and apply the layers with even tension. A very narrow dressing layer (especially of conforming bandage or self-adhesive layer) will lead to higher tension within the dressing which could lead to complications
- Start the dressing distally and finish proximally, for all layers
- Overlap each turn by 50%

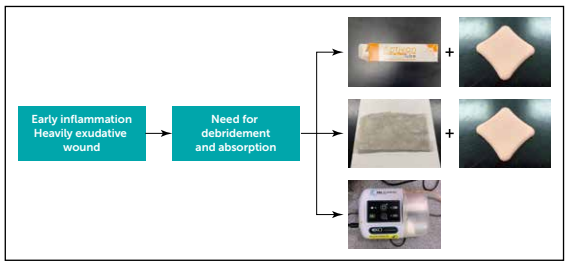

FIGURE 5: Summary of recommended dressings for the early inflammation phase.

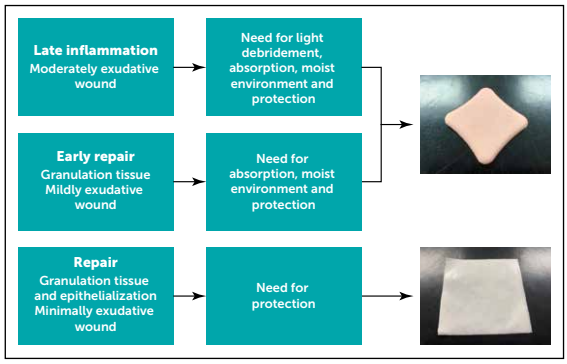

FIGURE 6: Summary of recommended dressings for the late inflammation, repair and maturation phases.

- Add cotton roll between the toes and pads (including the dew claws)
- Do not pad over bony prominences or fragile areas. Padding will actually increase pressure on these areas, which is counterproductive. To relieve pressure on a given area, a doughnut is shaped out of padded dressing material (Sofban®) and is placed over the area of concern, therefore preventing pressure in the centre of the doughnut and redistributing pressure to the surrounding areas
- The dressing can be augmented with stirrups or overlay tape strips for added security, especially in areas like the proximal limbs or the torso.

Tie-over dressing

To place a tie-over dressing, the following steps are taken:

- **Step 1**: suture loops are placed in the skin surrounding the wound, at regular intervals, with 2-0 or 3-0 Ethilon® (Figures 7 and 8). The loops should be placed in healthy skin approximately 1–2 cm from the wound edge. These are used to thread the nylon tape at the end of the dressing change
- **Step 2**: the contact layer is applied (honey or alginate covered with polyurethane foam, or polyurethane foam alone). For added security, slits can sometimes be cut in the polyurethane foam so that the suture loops fit in the slits (Figure 9)
- **Step 3**: dry sterile swabs, either small gauze swabs or laparotomy swabs, are added for bulk so that they cover all of the contact layers and create a 'raised' dressing
- **Step 4**: nylon tape is threaded through the suture loops in a criss-cross fashion above the sterile swabs, and even tension is applied prior to tying the nylon tape to secure the dressing (Figure 10).

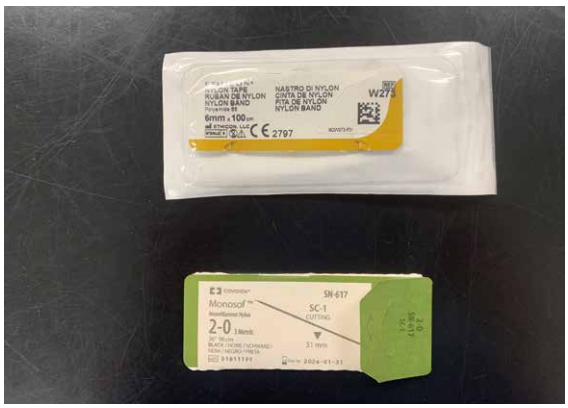

FIGURE 7: Nylon tape (top) and Ethilon® (bottom) used for placement of a tie-over dressing.

FIGURE 8: Suture loops are placed in the skin with 2-0 or 3-0 Ethilon®, at regular intervals around the wound, approximately 1–2 cm from the wound edge.

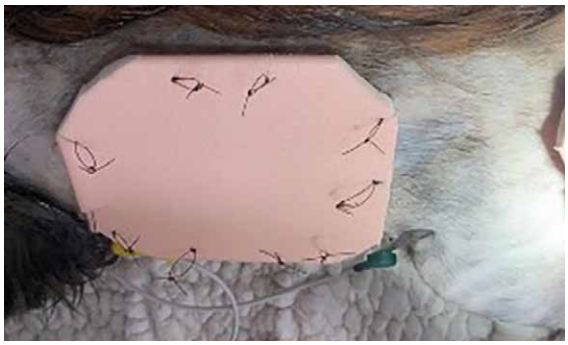

FIGURE 9: The contact layer is placed on the wound. In this case, the suture loops have been fitted through slits in the polyurethane foam.

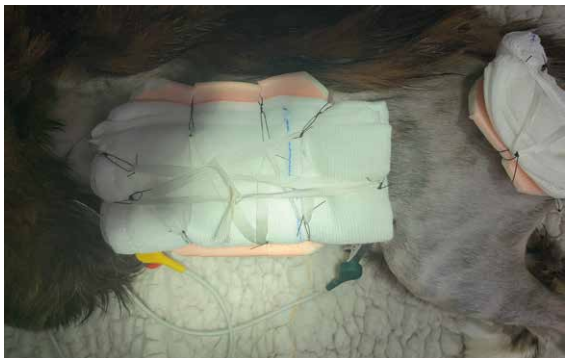

FIGURE 10: Sterile laparotomy swabs are placed on top of the contact layer. The nylon tape (white) is then threaded through the suture loops in a criss-cross fashion above the swabs to secure the dressing.

Downstaging

Once healthy granulation tissue is present and a lighter dressing is appropriate, mainly for wound protection, the tie-over dressing can be easily downstaged to only polyurethane foam, either held in place with nylon tape (as above) or by suturing the polyurethane foam to the suture loops. This is useful in areas where holding the polyurethane foam in place with tape is not possible.

Step 5: Ongoing care and wound closure

The frequency of dressing changes will depend on the stage of the wound and the level of wound discharge. Dressing changes usually need to be performed daily during the early inflammation phase, when there is marked exudation. They can then be performed every other day once fluid production has decreased, usually once debridement is complete. Once granulation tissue is present, then dressing changes can be performed every 3–4 days.

Similarly, dressing changes usually need to be performed under general anaesthesia during the debridement phase, as debridement of the wound tends to be a painful procedure. Sedation is usually sufficient for dressing changes during the proliferation phase (after debridement is complete), and conscious dressing changes may even be possible in amenable patients once granulation tissue is present.

Once wound healing is progressing as expected, options for wound closure can be considered. These include delayed primary closure, secondary closure or second intention healing.

Delayed primary closure is the closure of a traumatic wound days after the initial injury, but before the apparition of granulation tissue. This requires the wound to be healthy, free of infection and necrotic tissues, and therefore may be reserved for wounds that are initially minimally contaminated.

Secondary closure is the closure of a traumatic wound after the apparition of healthy granulation tissue, therefore after an extended period of open wound management. Waiting until the apparition of healthy

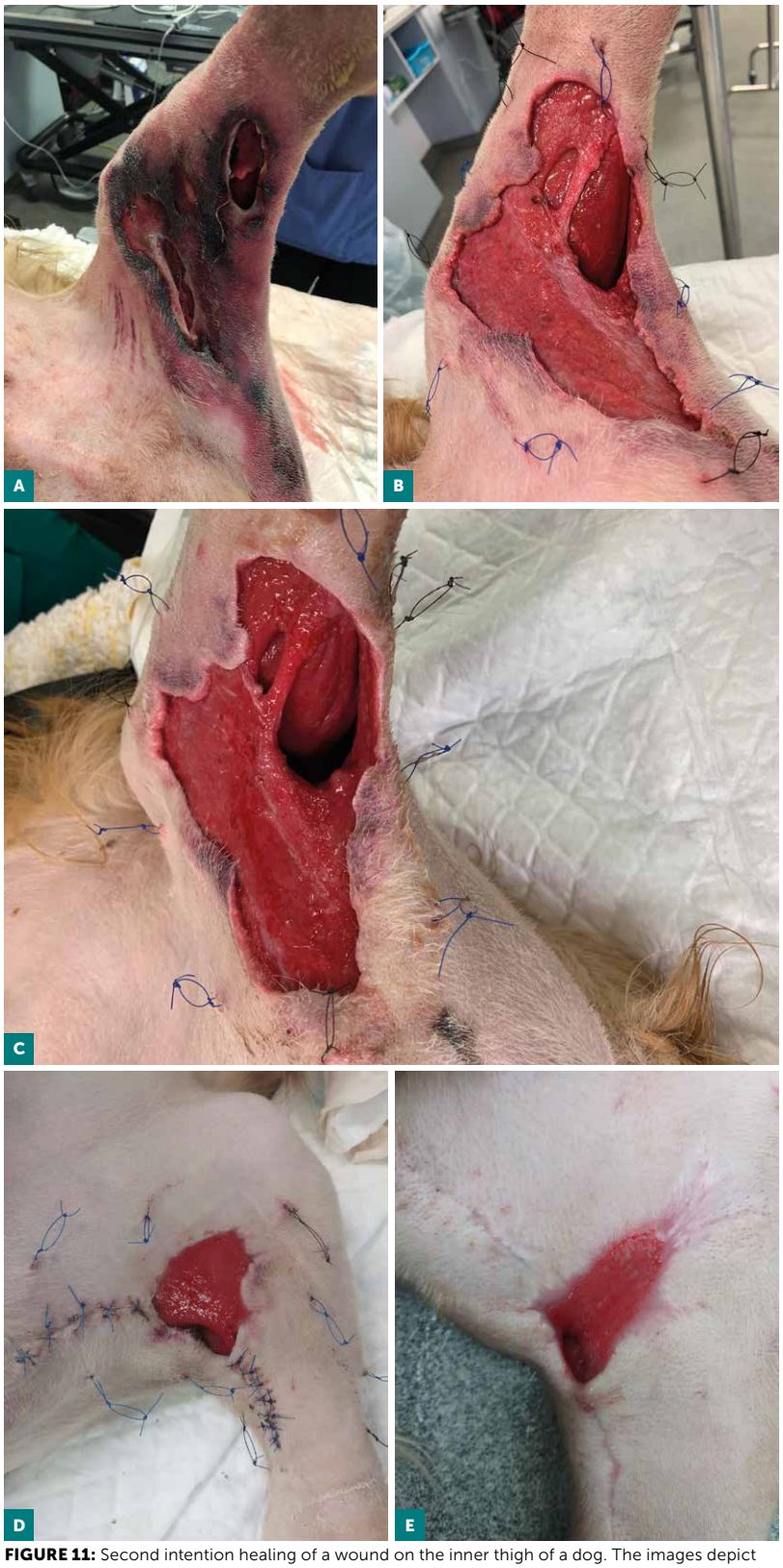

FIGURE 11: Second intention healing of a wound on the inner thigh of a dog. The images depict the appearance of the wound (A) at Day 0, (B) Day 4, (C) Day 7, (D) Day 14 and (E) Day 33. Note that partial closure of the wound was performed between Day 7 and Day 14 to speed up the healing process, but complete wound closure was not possible. At Day 33, the wound is around half the size of Day 14 and is epithelializing nicely, although complete healing will likely take another 3–4 weeks.

granulation tissue ensures that the wound bed is healthy, well vascularized and free of infection.

Secondary closure can involve primary apposition or the use of skin flaps or skin grafts. The bed of granulation tissue can be excised prior to closure, or the granulation tissue can be scraped to remove the most superficial layer. This is to remove any superficial contaminants, and to prevent the formation of an indolent pocket within the closed wound.

Second intention healing is the healing of a wound by the processes of contraction and epithelialization, until complete wound healing has occurred. Although it is the simplest form of wound healing and does not require surgical intervention, it can take many weeks for an open wound to completely heal, and dressing changes may have to be continued during that time (Figure 11). The costs associated with sedation events and dressing changes can sometimes be higher than the cost of surgical intervention to close the wound. Furthermore, some wounds may never progress to complete healing, and some wounds may heal with a contracture leading to impaired mobility. As such, the advantages and disadvantages of second intention healing must be weighed against those of more expedient options such as secondary wound closure.

Summary of the general steps of wound care

Figure 12 summarizes the steps of wound care as outlined in this article. These steps can be applied to all acute open wounds and should be followed in all cases. With appropriate care, most acute open wounds will proceed to complete healing given enough time. Failure of the wound to heal appropriately should raise questions about the wound management technique, the presence of infection and the overall patient health (see section on Impaired Wound Healing in Part 1 of this two-part series).[1]

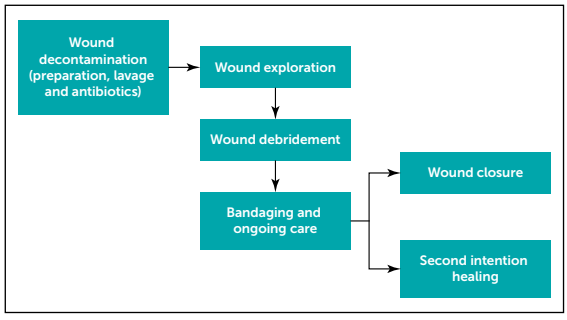

FIGURE 12: Summary of the steps of wound care as outlined in this article.

Chronic non-healing wounds pose a different challenge and their management is not detailed here. However, the key to managing chronic non-healing wounds lies in identifying the main reason for the failure to heal, and these reasons have been detailed in the Impaired Wound Healing section.[1]

Reflect on your reading

1. What is the advantage of non-surgical debridement?
2. Which dressings/contact layers are appropriate in the early inflammation phase?
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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