MANAGEMENT OF CHALLENGING WOUNDS: MOIST WOUND HEALING
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Key Points

- Wound healing is a dynamic process and an important component of open wound management is choosing the appropriate dressing and bandage
- Inappropriate dressings can impair, delay or significantly harm certain phases of healing

Most animals that have extensive wounds have also sustained life threatening injuries that require immediate attention prior to wound management. During emergency stabilization, wounds should be temporarily covered with a nonadherent bandage to prevent further contamination, hemorrhage and injury. Once the animal is properly stabilized, patients should be appropriately sedated or anesthetized for wound assessment and initial treatment. Time is of the essence when treating traumatic wounds. A wound's susceptibility to infection greatly increases after 5-6 hours from the time of injury. Therefore, when possible (if the patient is stabilized during this time frame), every attempt should be made to treat a traumatic wound within this time frame. Generally, the sooner treatment begins, the better the prognosis.

Whether a wound will be treated as an “open” wound is based on its appearance and characteristics at the time of presentation. In general, moderately to severely contaminated wounds, wounds older than 6 to 8 hours, infected wounds or those with extensive tissue loss should be treated as open wounds. Most wounds treated initially as open wounds are surgically apposed after infection and contamination have been controlled; however, some wounds with extensive tissue loss or those that are in areas that prevent primary closure (distal extremities) must be left to heal by contraction and epithelialization (healing by secondary intention).

The immediate objective of open wound management is to convert the open, contaminated wound into a surgically clean wound that can be closed or left to heal by second intention. Depending on the extent of contamination and degree of tissue loss, this process may be limited to one treatment or may require weeks of open wound management before closure or second intention healing is complete. Regardless of the type of wound, the following steps should be followed in most cases: 1) aseptic preparation of the wound, 2) aavage, and 3) debridement.

Wound debridement is the physical removal of necrotic tissue, foreign material and bacteria from a wound. Aseptic technique, gentle tissue handling, and hemostasis are essential to this phase of wound management. The presence of necrotic tissue in a wound delays or impairs healing. Necrotic tissue can also be a nidus for infection or may prevent proper control of an already established infection. The debridement phase is usually limited to the first 1-3 days after injury, but can last over a week if extensive tissue damage or infection is present. The extent of devitalized tissue usually is obvious within 48 hours of injury. In wounds that cannot be immediately closed after initial debridement, a combination of surgical debridement, autolytic debridement, enzymatic debridement, or bandage debridement can be used.

Surgical debridement is the physical removal of necrotic or irreversibly damaged tissue and foreign debris from a wound bed using a combination of sharp and blunt dissection. Although surgical debridement is a necessary component of most open wound management protocols, it should be approached with caution. This practice should be limited to grossly dead or devitalized tissue and debris and is usually only necessary in the first few days of wound
management. Surgical debridement should be delayed if the viability of wound tissue is in question. It can take several days for traumatized skin and underlying tissue to “declare” itself. If there is doubt tissue should be left in a wound until obvious signs of devitalization are present. Failure to be conservative, can lead to removal of an excessive amount of skin and underlying tissue causing a substantial delay in healing or closure. Surgical debridement should be accomplished in layers beginning at the surface of the wound and progressing to deeper tissue in controlled steps. Care must be taken to preserve tendons, ligaments, nerves, and vessels, but bone sequestra should be removed because they will impede healing and predispose the wound to infection. Surgical debridement is often followed by other methods of removing dead and devitalized tissue from the wound bed.

**Autolytic débridement** is a concept that employs the use of hydrophilic dressings to hasten the removal of dead tissue. Autolytic debridement is based on a concept known as “moist wound healing”, that refers to the provision and maintenance of optimal hydration of wound tissues to promote and accelerate wound healing. In a moist wound healing model, wound fluid is allowed to remain on the wound, keeping it warm and moist. Allowing wound fluid to remain in contact with the wound fosters autolytic debridement, a process in which endogenous enzymes selectively break down necrotic tissue, leaving healthy granulation tissue unharmed.

**Bandage débridement** refers to the use of dressings that are allowed to dry on the wound, such as “wet-to-dry” bandages or “dry-to-dry” bandages, adhere to the wound surface and pull debris from the wound when they are removed. Debridement using this method is unfortunately nonselective with the removal of healthy tissue and wound fluid in addition to necrotic tissue and debris. Although this method is still employed in veterinary medicine, recent advances (enzymatic and autolytic debridement) have replaced these types of bandages in human wound management. As these methods become more widely available in the veterinary field, the wet to dry bandage may soon become obsolete. Bandage débridement should only be used in the first few days of wound management, when obvious necrotic tissue and foreign debris reside in the wound bed. Once cleared of this contamination, the bandage technique should be replaced by other wound dressings (discussed below).

Enzymatic debriding agents are infrequently used as an adjunct to wound lavage and surgical débridement in veterinary medicine. They are beneficial in patients that are poor anesthetic risks. Enzymatic agents break down necrotic tissue, liquefy coagulum and bacterial biofilm and do not damage living tissue if used properly. Local tissue irritation is a potential risk.

Once initial surgical debridement is accomplished, you must cover wound with an appropriate dressing or bandage based on the characteristics of the wound. The goal of this step in open wound management is to promote a healthy, infection-free granulation bed to allow further stages of wound healing to proceed (epithelialization and contraction or delayed primary closure). These dressings should be changed daily in the initial stages of wound management or less frequently based on the degree of contamination present, amount of exudate produced and quality of wound bed. This is a dynamic process; one dressing is not always appropriate for every stage of the healing process. Please see below for further information regarding this topic.

Once a healthy granulation bed has formed, the clinician must decide if the wound can be closed by delayed primary closure or must heal by second intention. Several methods of delayed primary closure are available. These include direct apposition of skin edges over the wound, skin grafting procedures and other skin reconstructive surgery techniques (advancement flaps, pedicle flaps etc.) If the wound is in a location that does not allow these types of reconstructive
techniques or if financial constraints exist, a wound can be left to heal by second intention. Further application of dressings and bandages will hasten this process.

Chronic open wound management refers to the long term treatment of open wounds when conventional means of immediate primary closure cannot be accomplished. Chronic wounds are generally characterized by a lack of adequate skin or granulation bed for closure. The practice of long term wound management in veterinary medicine has evolved over the past 10 years to more closely mimic techniques employed in human medicine. Newer techniques are on the horizon and include the use of growth factors, stem cells and other forms of molecular/cellular therapy to promote wound healing. This lecture will focus on the methods currently available to most clinicians in veterinary medicine.

A key component to open wound management is choosing a wound dressing and bandage that will help promote wound healing. Some of these dressings are appropriate in promoting a healthy granulation bed prior to wound closure or grafting procedures, while others are more appropriate when epithelialization and contraction become the primary goal. Wound dressings and bandages in the hands of an experienced, knowledgeable clinician can greatly enhance a wound management protocol. If used indiscriminately or inappropriately, these dressings can impair, delay or significantly harm certain phases of healing.

Moist wound healing is an old concept in chronic wound management that has just recently become popular in the veterinary wound management industry. This concept is based on the idea that healing can be optimized in a moist environment, as opposed to a dry, desiccated setting. Since the original concept was introduced to the human medical field in the 1960s, the use of dressings that keep wound tissues moist have become more widespread and have been associated with increased healing rates, improved cosmesis, reduced pain, reduced infection, and reduced overall health care costs as compared to wet to dry bandage or adherent bandaging techniques. Moist wound healing has been found to stimulate the repair phase of healing. Proliferation and activities of fibroblasts, endothelial cells, and epithelial cells are all enhanced, accelerating the formation of granulation tissue, angiogenesis, wound contraction, and epithelialization. Scientific evidence also strongly indicates that the incidence of infection is lower in wounds kept moist by an occlusive or semiocclusive dressing. Several mechanisms have been proposed to explain the anti-infection effects of the moist wound environment. First, semiocclusive dressings provide an excellent barrier against entry of exogenous bacteria into the wound. Second, moisture prevents tissue desiccation and necrosis, which serve as a culture medium for bacteria. Third, low oxygen tension in wounds covered by occlusive or semiocclusive dressings lowers the pH to levels that significantly decrease growth of many bacteria in vitro. Fourth, because moist wound healing increases angiogenesis and thus blood supply to the wound, and because wound fluid is kept in contact with the wound bed, the concentration of systemically administered antibiotic levels in the wound may be increased. Fifth, and perhaps most importantly, the warm, moist wound environment under the dressing increases viability and activity of white blood cells and their enzymes, and keeps them in the wound to fight infection.

Newer, more advanced hydrophilic nonadherent contact layers are now available to the veterinary market to facilitate a moist environment during the wound healing process. They are individually designed to meet the different demands and stages found in the phases of wound healing. It is important to remember that no single dressing will produce the optimum setting for all wounds or for all stages of wound healing. The appropriate dressing is selected based on the
phase of wound healing, amount of exudate that is being formed, type of wound, location and depth, presence/absence of an eschar, and amount of necrotic tissue, contamination or infection.

Moist wound healing is promoted by these dressings through the incorporation of hydrophilic materials into the wound bed. Hydrophilic dressings include hypertonic saline dressings, calcium alginites, polyurethane foams, hydrogels, hydrocolloids, and some topical medications. Most nonadherent, hydrophilic contact layers are highly absorbent and require infrequent bandage changes (q 1-7 days). Some veterinarians are wary of these products due to higher cost of materials, however, with fewer bandage changes (most not needing anesthesia for removal), the overall cost is comparable to more frequently changed wet-dry bandages that usually require heavy sedation or anesthesia for application and removal.

Wound dressings refer to the primary contact layer used for open wound management that promote and control wound healing. Bandages refer to the secondary or outer layers that help hold the wound dressings in place and provide ancillary support in the process of wound healing. There is unlikely one type of wound dressing and bandage that provides the ideal environment for all types of wounds. An ideal wound dressing/bandage will perform the following: 1) remove exudates and toxic components, 2) maintain high humidity at the wound-dressing interface, 3) allow gaseous exchange, 4) provide thermal insulation, 5) relieve pain, 6) protect from secondary infection, 7) protect from particulate or toxic contaminants, and 8) is easy and painless to remove.

The primary contact layer is in direct contact with the wound and is more commonly referred to as the “dressing.” Depending upon the situation, the primary contact layer is used for manual or autolytic debridement, to deliver topical medication, absorb wound exudate, promote moist wound healing and granulation tissue formation and to accelerate epithelialization and contraction. Contact layer dressings can further divided into adherent or nonadherent, and occlusive or semiocclusive.

Two types of adherent dressings are the ‘dry-to-dry” and “wet-to-dry”. These contact layers are no longer recommended unless a wound is severely contaminated, infected or in need of aggressive bandage debridement. The disadvantages of a dry adherent contact layer are that they can be painful to remove, can cause a desiccated wound environment and employ a method of non-selective debridement (removing healthy tissue and wound fluid along with necrotic debris). Before the advent of newer products, a dry adherent contact layer was chosen when a wound had loose necrotic tissue, foreign material or a large amount of low-viscosity exudate. Sterile wide-mesh gauze is most commonly used for these dressings. In this setting, the dry gauze absorbs excessive exudates, dries and then adheres to necrotic tissue and debris. With removal, the necrotic tissue, debris and healthy tissue are removed. A “wet-to-dry” contact layer is no longer recommended unless a wound is severely contaminated, infected or in need of aggressive bandage debridement. The “wet to dry” bandage is most commonly used when the wound surface has excessive necrotic tissue, foreign debris, or a high-viscosity exudate. Sterile, wide-mesh gauze moistened with saline is used with an intermediate layer of dry absorbent gauze. The sterile saline dilutes the exudates and is absorbed by the intermediate layer of the bandage. As the moistened gauze dries, necrotic tissue and foreign material adhere to the gauze as it dried and then is removed along with the bandage. Potential disadvantages this type of bandage are pain and healthy tissue damage during bandage changes, tissue maceration, bandage strike through and the promotion of dry wound environment.

Nonadherent contact layers are commonly employed in veterinary wound management. Most nonadherent contact layer dressings retain moisture to promote granulation tissue
formation, epithelialization, wound contraction and prevent wound dehydration. These dressings do not “seal” the wound and therefore allow excess fluid to drain, preventing harmful tissue damage, bacterial proliferation and skin maceration. Examples of these products are petrolatum impregnated gauze (Adaptic) and Telfa Pads.

Moist wound healing dressings are also nonadherent products and are sometimes referred to as occlusive or semi-occlusive dressings, advanced dressings, or modern dressings. Individual dressing types are diverse in both their physical composition and appearance. A recent issue of a wound care products buyer’s guide lists more than 400 individual advanced wound dressings including 25 alginites, 55 foams, 50 hydrocolloids, 51 hydrogels, and 24 transparent films. Semiocclusive dressings are the most common nonadherent moist wound healing products used. These include various forms of calcium alginites, foams, hydrocolloids and some hydrogels. These types of dressings require less frequent bandage changes, are painless to remove, strongly promote autolytic debridement, as well as hasten the repair phases of healing. Selection of the primary contact layer used for moist wound healing is based on factors such as wound size, shape, and location, amount and type of exudate formed, need for autolytic debridement, percent coverage with granulation tissue +/- epithelial cells, and presence or absence of infection. The ideal dressing should maintain a moist environment, eliminate dead space, cause no harm to the wound or surrounding skin, provide thermal insulation, and act as a barrier to bacteria. Another type of nonadherent contact layer is an occlusive dressing. Occlusive dressings are virtually impermeable to air and therefore have the potential to exacerbate bacterial contamination, tissue maceration and fluid accumulation. These dressings should only be used on healthy wounds with minimal exudation during the repair phase (granulation, epithelialization and contraction) of healing. Occlusive dressings are beneficial in an environment that is in need of epithelialization and collagen synthesis. They require less frequent changes than other types of bandages. Examples of occlusive nonadherent contact layers include polyurethane films, hydrogels, and hydrophilic beads, flakes, powders, and pastes. These products are contradicted in infected wounds.