v. 2, n. 18, 2022

International Journal of Health Science

WOUND TREATMENT PRINCIPLES - PART TWO

Lara Bernardes Bizinoto
Postgraduate Program in Animal Health and Production in the Tropics
http://lattes.cnpq.br/9796764351091102
https://orcid.org/0000-0003-2409-629X

Fernanda de Oliveira Soares
Postgraduate Program in Animal Health and Production in the Tropics
http://lattes.cnpq.br/6136278496987143
https://orcid.org/0000-0001-7906-7897

Isabel Rodrigues Rosado
Postgraduate Program in Animal Health and Production in the Tropics; clinic: Pulo do Gato; Universidade de Uberaba
http://lattes.cnpq.br/5855259434191533
https://orcid.org/0000-0001-7819-4253

Ian Martin
Postgraduate Program in Animal Health and Production in the Tropics; Universidade de Uberaba
http://lattes.cnpq.br/4730020772591126
https://orcid.org/0000-0001-6934-8257

Endrigo Gabellini Leonel Alves
Postgraduate Program in Animal Health and Production in the Tropics; clinic:: Pulo do Gato; Universidade de Uberaba
http://lattes.cnpq.br/4550784508252779
https://orcid.org/0000-0001-8524-3949

Abstract: Wounds are defined as any interruption of the skin continuity solution, which may be to a greater or lesser extent and generate great damage to the patient if not treated correctly. Firstly, the patient must be stabilized, if necessary, and then a plan is drawn up for the adequate treatment of the lesion. After that, several procedures can and must be done to assist in the healing process, preventing the injury from worsening and minimizing healing time. The purpose of this chapter is to discuss washing techniques and decontamination solutions, debridement, culture and antimicrobial susceptibility tests, dressings, bandages and wound drainage techniques.
Keywords: Antimicrobials, dressings, debridement, drainage, wounds.

INTRODUCTION

After a tissue injury, immediate wound management is indicated, temporarily covering the affected site to avoid trauma, reduce the microbial load and avoid further contamination. Then, the general condition of the patient must be evaluated and stabilized, if necessary. (MACPHAIL, 2015).

In unstable animals, washing the wound with sterile solution or running water is recommended, followed by the application of some topical antimicrobial agent and covering with a bandage. This bandage can be left in place until the animal is more stable and it is possible for a better assessment of the wound to occur for planning a definitive treatment (HOSGOOD, 2018).

If there is no need to stabilize the patient, it is indicated to perform a wide shaving around the wound and wash it with sterile solution or running water. Then, it is suggested to collect a sample for bacterial and fungal culture, in order to obtain a more efficient therapeutic protocol. After that, antisepsis must be performed, followed by debridement to remove non-viable tissues and cellular debris, and finally, determine the best treatment plan (MACPHAIL, 2015).

Regardless of the choice of type of wound treatment, it is essential that all the steps above are followed, so that there is a better prognosis and result, and faster healing time.

WASHING TECHNIQUES AND WOUND DECONTAMINATION SOLUTIONS

One of the most important care in wound care is the removal of contaminants and the reduction of the existing microbial load in the wound bed, which negatively affects healing. This removal takes place through washing, cleaning and subsequent debridement of the wound, removing exudates, necrotic and devitalized tissues, and consequently, removing microorganisms present in these substrates (RODEHEAVER; RATLIFF, 2018).

WASHING TECHNIQUES

In contaminated and infected wounds, the bed must be washed, eliminating cellular debris, microorganisms, necrotic tissues and dirt, so that the healing process occurs efficiently. This procedure can be performed through the pressure exerted by a fluid on the wound. Among the solution options for washing, isotonic crystalloid fluids stand out, which are sterile and allow the removal of contaminants without additional injury to the wound bed and without interfering with the collection of samples for the culture and isolation of microorganisms. As alternative fluids, running water and antiseptic solutions can be mentioned (VAN HENGEL et al., 2013). The main purpose of washing is the mechanical removal of contaminants by the physical pressure exerted by the fluid on the wound bed, therefore the addition of antiseptic solutions is not recommended until samples are collected for culture and antimicrobial susceptibility testing (WILLIAMS, 1999). Although antiseptics reduce the number of bacteria in the wound bed, they hinder the isolation of contaminating microorganisms. In addition, they can damage viable tissues, as some concentrations can be cytotoxic, and have a reduced effect on already established infections (MACPHAIL, 2015).

Running water is not ideal for this procedure, since it is cytotoxic to fibroblasts due to its alkaline pH, because it is hypotonic in relation to the wound bed and because it carries the presence of some microelements in its composition that can affect the wound (WILLIAMS, 1999). However, there is no evidence that its use increases the risk of infection in the wound bed (RESENDE et al., 2015). Running water is a good alternative for non-hospital conditions where more appropriate solutions are not available.

Among the ideal solutions (isotonic crystalloids), the saline solution is the most used because it is easily found in pharmacies, offices, clinics and hospitals. It presents an osmotic pressure similar to that in body fluids, does not interfere with the wound healing process and does not cause greater tissue damage or irritation to the intact tissue (LAWRENCE, 1997).

The pressure indicated for adequate bed washing is between 4 to 15 psi (pounds per square inch). One of the methods used for washing is through the use of a 20 to 30 ml syringe attached to a fluid bag and equipment by a 3-way stopcock. This method entails a pressure of about 8 psi to the wound bed (WILLIAMS, 1999). Another washing method where the pressure is around 7 to 8 psi is the use of a pressure cuff at 300 mmHg over a 1 liter fluid bag (MACPHAIL, 2015). A pressure higher than 15 psi is not indicated by the possibility of causing greater injury to the wound bed, and pushing dirt and bacteria to the deeper layers of the tissues (VAN HENGEL et al., 2013).

The wound must not be rubbed during washing, either with a sponge or other material, as this action generates greater tissue damage, compromising the wound's ability to resist infections and generating a greater inflammatory response in the injured bed (MACPHAIL, 2015).

WOUND DECONTAMINATION SOLUTIONS

Decontamination solutions for wounds include topical antiseptics, which are used after washing with the main purpose of killing or inhibiting the growth of microorganisms present on the surface of the wound bed, as they are unable to penetrate deeper layers of the tissue. For a washing solution to reach deeper layers of the fabric, and act more efficiently, its concentration must be higher, which can end up causing greater damage to the fabrics (RODEHEAVER; RATLIFF, 2018). High concentrations of antiseptics have greater cytotoxic action and harm cells important for healing. They are lethal to some polymorphonuclear cells, such as neutrophils, alter blood capillaries, impairing neovascularization and decrease collagen synthesis by toxic action against fibroblasts (HOSGOOD, 2003).

Keratinocytes are also affected by the toxicity of antiseptics at high concentrations. These cells proliferate and form a protective first layer for the wound during the proliferation and epithelialization phase, and are more sensitive to topical products than the already fully stratified and keratinized epidermal layers (WILSON et al., 2005). Therefore, the indication of the use of antiseptics occurs mainly in the initial phases of the wound, to reduce the bacterial load and the chances of infection, and also helping in the removal of necrotic tissues and cellular debris. When the wound is already clean, without the presence of exudates and non-viable tissues, the use of antiseptics is contraindicated due to the direct negative effects on healthy tissues and healing (MACPHAIL, 2015). In cases where the wound does not yet present purulent exudate or devitalized tissues, the professional must evaluate the wound bed and try to determine the degree of contamination and the risk factors present. If there is a high possibility of the occurrence of bed infection, antiseptics must be used (BIANCHI, 2000).

Among the most commonly used antiseptics for cleaning and decontaminating wounds, we can mention compounds based on chlorhexidine, iodine, Dakin's liquid (0.5% sodium hypochlorite) and Tris-EDTA (ethylenediamine tetraacetic acid) (VAN HENGEL et al., 2013).

DEBRIDEMENT

Another very important factor in the management and treatment of wounds, especially those classified as contaminated and infected, is debridement. This procedure encompasses several methods and techniques with the aim of removing exudate, devitalized and necrotic tissue, cellular debris, foreign bodies and decreasing the bacterial load from the wound bed, which were not completely removed with pressure washing and wound cleaning (O 'BRIEN, 2002, AYELLO; CUDDIGAN, 2004).

The wound must be explored in its entirety, covering all the layers affected for debridement to be successful. The procedure must be performed aseptically, thus preventing any type of iatrogenic contamination (HOSGOOD, 2018). The way it will be performed is influenced by the appearance of the wound, its extent and tissue damage, amount of necrotic tissue, presence or absence of bed infection, the occurrence of sepsis, vascularization of the bed, adjacent tissues and its anatomical location (RAMUNDO; GRAY, 2008). There are six main methods of debridement: surgical, mechanical, autolytic, enzymatic, chemical and biosurgical (VAN HENGEL et al., 2013), which will be detailed below.

SURGICAL OR SHARP DEBRIDEMENT

This technique is performed with the aid of instruments such as scalpels, scissors and curettes for the removal of non-viable, devitalized and necrotic tissue that have a thicker and adherent aspect (FALABELLA, 2006). It is a procedure that requires functional anatomical knowledge of the site to be debrided and the recognition of intact tendons, nerves and blood vessels, avoiding any type of injury to these structures. But the main point that must be taken into consideration is the extent of debridement, taking care not to reach or remove large areas of viable tissue (VOWDEN; VOWDEN, 1999). This method is also indicated when large amounts of devitalized tissue need to be removed quickly, especially in cases of infected wounds or the presence of sepsis. When debridement approaches viable tissues, it can be a procedure that causes discomfort, so care with analgesia during and after the procedure must be taken into account, and depending on the severity of the injury and its extension, it must be performed within the block. surgery under general anesthesia (AYELLO; CUDDIGAN, 2004).

After surgical debridement, the wound is usually treated openly, with dressings and bandages. Third-intention treatment can be performed when the tissue appears healthy and granulation tissue grows; or it can be left to heal by second intention, with the process of epithelialization and wound contraction taking place (MACPHAIL, 2015).

MECHANICAL DEBRIDEMENT

This procedure consists of the physical removal of non-viable and necrotic tissue from the wound bed quickly (ATKIN, 2014). It is more used in extensive wounds, with a large presence of exudate, but it can also be used in smaller wounds, helping to remove cellular debris (FALABELLA, 2006).

There are some methods that can be used for this procedure, such as the application of abrasive forces through a gauze on the wound bed, or the use of irrigation under pressure to the extent of the wound (O'BRIEN, 2002, HOSGOOD, 2018).

The use of abrasive methods has disadvantages as it is a non-selective process, removing healthy granulation tissue, epithelial cells and fluids containing growth factors and cytokines, causing damage to viable tissues, delaying the healing process and generating pain to the patient (VAN HENGEL et al., 2013).

The use of irrigation is a preferable method to abrasion, being quite effective and not causing much pain. This procedure directly follows the guidelines of the wound washing process, in order to apply a certain pressure to the wound bed, through saline solutions, in order to remove cellular debris and non-viable tissues (STEED, 2004). It also helps to remove adhered necrotic tissues, as it moistens their structures, facilitating removal (FALABELLA, 2006).

AUTOLYTIC DEBRIDEMENT

This procedure is performed using an occlusive dressing covering the entire wound, allowing the release of proteases by the organism itself in the injured bed with the function of liquefying non-viable and necrotic tissues (STEED, 2004). It is a natural method of debridement and the most used for the treatment of wounds, as any dressing that allows a moist environment in the bed assists in the autolytic process, allowing these enzymes to break down non-viable tissues (ATKIN, 2014).

The dressing must remain in place for about 2 to 3 days, and when removed, the wound must be washed with saline to remove all cellular debris. It is a method that must not be performed on infected wounds, and if signs of infection appear, such as the presence of purulent exudate, this method must be discontinued and preference given to faster procedures, such as surgical debridement (AYELLO; CUDDIGAN), 2004). Autolytic debridement has advantages because it is painless for the patient, is quite safe and easy to perform, with excellent results. However, as it is a slow process, it can take considerable time to obtain the desired result, and thus, end up increasing the risk of infection. It is a procedure that can be performed in order to hydrate the wound for a while, and then perform another type of debridement (VOWDEN; VOWDEN, 1999).

ENZYMATIC DEBRIDEMENT

Unlike autolytic debridement, this method is performed by the deposition of exogenous enzymes in the wound bed so that the degradation of cellular debris, non-viable tissues and removal of necrotic tissue occurs (KIRSHEN et al., 2006).

This debridement can be done on contaminated and infected wounds, and enzyme agents can be applied 1 to 2 times daily directly to non-viable tissues within the wound bed, avoiding surrounding healthy areas of skin. It is important to emphasize that large extensions of necrotic tissue must be removed prior to the start of the enzymatic treatment to facilitate the procedure (STEED, 2004, RAMUNDO; GRAY, 2008).

The most commonly used exogenous enzymes for this purpose are collagenase, papain, trypsin, fibrinolysin, chymotrypsin and deoxyribonuclease, which are usually found in ointments and creams (JOHNSTON, 1990, VAN HENGEL et al., 2013).

CHEMICAL DEBRIDEMENT

Uses the application of chemical substances to perform debridement in the wound bed. The most used substances are chlorhexidine, povidone-iodine, hydrogen peroxide and sodium hypochlorite (KRAHWINKEL; BOOTHE, 2006). In addition to the debridement function, they are used to prevent and contain wound infection (AYELLO; CUDDIGAN, 2004). Chemical debridement has the same disadvantage as the mechanical procedure, that is, it is not selective, damaging viable tissues and cells important for healing, and may irritate tissues adjacent to the wound bed. For these reasons, it is not a suitable procedure for clean wounds, but it is quite useful in contaminated and infected wounds (O'BRIEN, 2002, VAN HENGEL et al., 2013).

BIOSURGICAL OR BIOLOGICAL DEBRIDEMENT

This method consists of deposition of larvae directly on the wound bed to perform biological debridement (ATKIN, 2014). This procedure uses sterile larvae of the *Lucilia sericata* species, created specifically for biosurgery, which debride the wound by excreting proteolytic enzymes (O'BRIEN, 2002).

Through these enzymes, they remove up to 75 mg of necrotic tissue per day, clean the wound by consuming non-viable/dead tissue and bacteria present in the bed and promote the formation of granulation tissue. Therefore, they are recommended in wounds with a large amount of necrotic tissue, with the presence of infection and in cases of chronic wounds (MACPHAIL, 2015).

For the success of the technique, it is necessary to use a self-adhesive hydrocolloid dressing with an orifice in the shape and size of the wound bed, where the larvae are deposited at a density of 5-10 per cm^2 of tissue. This dressing serves to prevent the action of proteolytic enzymes on the intact tissue, the migration of larvae out of the wound bed and dehydration of the larvae. The dressing is closed and kept for 48-72 hours, and can be performed twice a week (WILLIAMS, 1999, MACPHAIL, 2015).

This therapy has the advantage of providing an accelerated debridement, however, it has a higher cost compared to other debridement alternatives, due to the sterile culture of larvae, and may not be accepted by all patients (ATKIN, 2014).

CULTURE AND ANTIMICROBIAL SENSITIVITY TESTS

All wounds have the risk of presenting some degree of contamination or of being already infected (KRAHWINKEL; BOOTHE, 2006), which can make it difficult and even prevent the tissue to heal successfully. The development of the infection depends on the virulence and amount of microorganisms deposited in the wound, the severity of tissue trauma, the presence of dirt and foreign bodies in the wound bed, the time elapsed between the injury and its treatment, and the immunocompetence of the affected patient. (MACPHAIL, 2015). There is a correlation between the initial classification of a wound for contamination and its progression to infection. The literature describes that 0 to 6% of clean wounds, 4.5 to 9.3% of clean-contaminated wounds and 5.8 to 28.6% of contaminated wounds will become an infected wound (WILLARD; SCHULZ, 2015).

Culture and antimicrobial susceptibility testing (AST) are recommended in cases of contaminated and infected wounds, but because accurate classification of wounds is very difficult, the authors of this chapter recommend collecting specimens for culture in all cases. The results of the culture and TSA are very important for the correct choice of treatment, avoiding the occurrence of resistance and delay in healing. It is worth noting that empirical treatment with broad-spectrum antibiotics must be started until the results of culture and TSA exams are obtained (MACPHAIL, 2015).

Sample collection for culture must be performed after cleaning the wound and before decontaminating it. To be successful, the material collected must be from viable tissue, not purulent exudate or necrotic tissue. It is worth remembering that the collection procedure must be performed using aseptic techniques (BONHAM, 2009). The collection can be performed by removing a fragment (biopsy) from the wound bed or using sterile swabs, the most suitable being those that already have a culture medium for transport where the collection is inserted (BECO et al, 2013).

Biopsy is a more invasive procedure and is generally used in deeper wounds, avoiding the collection of superficial material that does not represent the focus of infection. The collection can be done with the aid of punches or other sterile surgical instruments, depending on the depth of the lesion (BECO et al., 2013).

Another way of collecting the culture is through aspiration of exudates that are below the superficial layers of the wound with a needle. This procedure must be performed within the aseptic techniques to avoid exogenous contamination (BOWLER et al., 2001).

It is important to emphasize that the examination of microbial culture and isolation (bacterial and fungal) does not present high sensitivity, that is, a negative result in the culture does not guarantee that the wound is not contaminated. For its classification, the clinical aspects of the wound, such as color, time of occurrence, presence of dirt, foreign bodies and/or exudate, must also be taken into account. The positive result in the culture also does not guarantee that it is an infected wound, it may just be a contaminated wound and not evolve to infected, depending on the quantity and virulence of the isolated microorganism and the patient's immunity (SINGH; WEESE, 2018).

ANTIMICROBIALS MOST USED IN WOUND TREATMENT

Antimicrobials can be used through systemic or topical therapy on the wound. The association of the two treatment methods can be performed in cases of contaminated wounds, in order to prevent the installation of an infection in the bed or to treat a wound with an infection already installed where only topical treatment may be ineffective (SCHULTZ et al, 2003, LIPSKY; HOEY, 2009, MACPHAIL, 2015).

The antimicrobial effect on bacteria can be variable, as it is influenced by the number of microorganisms, the patient's general condition and growth stage (age), intrinsic and extrinsic mechanisms of resistance, environmental factors and the host's immune system (DIPIRO et al, 1996). To increase the chance of successful treatment, the selection of antimicrobials for use in wounds must preferably be based on culture and sensitivity tests, avoiding the possible occurrence of bacterial resistance in the wound bed (KRAHWINKEL; BOOTHE, 2006).

Even if the right antibiotic is chosen, it must never replace any of the essential phases of wound management, particularly in relation to debridement, whether surgical, mechanical or enzymatic. That is, the use of antimicrobials must be used in conjunction with all other procedures necessary for good bed preparation and consequent healing (VAN HENGEL et al., 2013).

The most commonly used systemic antibiotics for the prevention of wound bed infection include cephalosporins, sulfamethoxazole+trimethoprim, gentamicin, ampicillin, quinolones and amoxicillin + clavulanate, always taking into account the result of culture and sensitivity tests when possible (WALDRON; ZIMMERMAN-POPE, 2003).

Ampicillin and amoxicillin are effective against a variety of gram-positive aerobic bacteria and some gram-negative and positive anaerobic bacteria. First-generation cephalosporins are effective for most gram-positive and some negative microorganisms; second-generation ones have greater action against gram-negative and anaerobic bacteria; and the third generation are effective against 90% of gram-positive bacteria. Gentamicin is effective against gram-positive and negative bacteria; quinolones and sulfa drugs also act against these organisms, but the effectiveness may vary depending on the factors already mentioned (WILLARD; SCHULZ, 2015).

Systemic antibiotic therapy is an extremely important part of the treatment of wounds, because in addition to treating it, it prevents microorganisms from spreading, infecting other distant tissues and can even cause serious systemic changes, such as the Systemic Inflammatory Response Syndrome (SIRS). However, local therapy with topical antimicrobials can be used alone in superficial and poorly contaminated wounds (SINGH; WEESE, 2018).

Topical therapy must assist in the healing process by protecting the wound from the occurrence of infections, mechanical injuries and providing a microenvironment favorable to the natural processes of tissue repair. It is noteworthy that most drugs have no effect on devitalized tissue or in the presence of hematomas and clots, and therefore, the wound must be cleaned and debrided for topical therapy to be effective. It is also worth remembering that if the lesion is already infected and with suppuration, the benefits of the topical antimicrobial are small (VAN HENGEL et al., 2013, MACPHAIL, 2015).

The most commonly used topical antibiotics are triple antibiotic ointment (bacitracin, neomycin, polymyxin), silver sulfadiazine, nitrofurazone, gentamicin, cefazolin, and mafenide. Triple ointment is broad spectrum, being efficient in combating several bacteria that commonly colonize superficial wounds, however, it is more competent in preventing infections than treating them (MACPHAIL, 2015).

Silver sulfadiazine is efficient against most gram-negative and gram-positive bacteria and fungi, commonly used for burns, in addition to acting as an antimicrobial barrier, penetrating necrotic tissue and improving epithelialization. Nitrofurazone has broad-spectrum antibacterial activity and hydrophilic action, helping to drain exudates, but has the disadvantage of delaying wound epithelialization (KRAHWINKEL; BOOTHE, 2006, MACPHAIL, 2015).

Gentamicin is effective against gram-negative bacteria and Staphylococcus spp., and its use in solutions is preferable to ointment or creams. The isotonic solution helps in the speed of epithelialization and contraction of the wound, when compared to the use of creams and ointments. Unlike gentamicin, cefazolin is effective against gram-positive and some gram-negative bacteria (SWAIM, 1990, VAN HENGEL et al., 2013).

Mafenide is an antimicrobial compound available in the form of a spray, having a broad spectrum against several gram-negative and gram-positive bacteria, including some anaerobic species, and therefore, it is used mainly in extremely contaminated wounds (MACPHAIL, 2015).

Once the wound has healthy granulation tissue, antibiotic therapy can be stopped, whether topical or systemic, as the mechanical barrier provided by the granulation tissue, together with the blood supply of new vessels, allows the wound to be resistant to damage. infections (WALDRON; ZIMMERMAN-POPE, 2003).

BANDAGES, DRESSINGS AND WOUND PROTECTION TECHNIQUES

Dressings are materials applied directly in contact with the wound, in order to aid healing, and bandages are used externally to the dressings, in order to secure them around the wound and provide additional mechanical protection. al., 2013). Bandages help wound healing by protecting it from the external environment, absorbing exudates, eliminating dead space, and applying or relieving the pressure exerted on the wound. In addition, it retains topical medications, helps control pain, restricts or allows safe movement, and ultimately immobilizes, stabilizes, and supports structures adjacent to the wound.

The bandages are divided into three well-defined layers: the first layer, usually composed of a dressing that has been in direct contact with the lesion; the second layer is padded, with the function of exerting pressure and/or absorbing liquids from the wound; and the third layer, with a protection function (WILLIAMS, 1999).

The first layer composed of the dressing can be adherent or non-adherent. The adherent dressing is usually made with gauze in direct contact with the wound, with the aim of generating a mechanical debridement of the bed. Exudates, necrotic tissue, and cellular debris will settle on the gauze, and when the dressing is changed, all of this material is removed along with it. It is a procedure that can be painful, removing not only the dead tissue, but also causing damage to viable tissues and various cells responsible for healing (MILLER, 2003).

Non-adherents are used when there is already healthy granulation tissue in the bed, not harming healing. Dressings can still be classified as occlusive, semi-occlusive and non-occlusive: the first is waterproof, used for wounds with little exudate; the second allows a certain amount of the fluid to escape to the absorption layer; and the third allows all the fluid to reach the absorptive layer, with gauze as an example (VAN HENGEL et al., 2013).

Occlusive and semi-occlusive dressings are preferable in decontaminated wounds, as both are able to keep the wound environment moist, bringing benefits to healing and not causing pain with their removal. Among them we can mention foams, hydrogels, hydrocolloids and alginates (DHIVYA et al., 2015). The dressing is chosen based on the type of wound, its depth, location and extent, the degree of infection and the amount of exudate produced (GHOMI et al., 2019). The first layer of the bandage consists of serving as a last barrier between the wound and external contaminants, absorbing exudates or transferring them to the second layer and keeping the environment moist, assisting in autolytic debridement, granulation tissue formation, epithelialization and wound contraction (CAMPBELL, 2018).

The second or intermediate layer is absorptive and its function is to remove liquids expelled by the wound, whether blood or exudates, as well as cellular debris and bacteria, from the dressing and the wound. In addition to the absorption function, it also protects and fixes the first layer that is in contact with the wound, protects from seroma formation by promoting a medium compression around the wound and still provides greater comfort to the patient (DEVEY et al., 2017).). It is important that this second layer has good capillarity and is thick enough, being able to use more than one layer to collect all the fluid and keep it away from the dressing and the wound (WILLIAMS, 1999). One of the most used materials for this second level is cotton, but it is important that it does not come into contact with the wound surface, and it may be difficult to remove it later (MILLER, 2003).

The third layer has the function of fixing and keeping the other two layers in place, in addition to protecting against contamination from the external environment and physical abrasions. It is important to be careful to assess whether the second layer is not saturated with exudate, which can end up affecting the third layer, causing it to lose its protective function as it allows the access of bacteria from the external environment through regions contaminated by the fluid. The materials used in this layer can be elastic or inelastic, adherent or adhesive, porous or waterproof (MILLER, 2003, DEVEY et al., 2017, CAMPBELL, 2018).

DRAINAGE TECHNIQUES

In the treatment of wounds, the abolition of dead space is one of the essential steps to obtain a good result, avoiding the accumulation of liquids that hinder the complete healing of the wound. This dead space can be eliminated through sutures, compressive bandages and the use of surgical drains, and the association between techniques can, and must, be used in some more severe cases (BABIES, 1999).

The most efficient way of draining a wound is by treating it openly, by second intention. Some wounds allow the approach by first or third intention, but with uncertainties about the degree of contamination and about the occlusion of the dead space, in which cases the use of drains is indicated. The most common causes of these uncertain wounds are bites, lacerations, avulsions or extensive skin separations (MACPHAIL, 2015). Other indications for the use of drains are in cases of lesions with accumulation of fluid, whether seroma, blood or exudates, which cannot be removed only in the first drainage; when the wound cannot be completely debrided, which may lead to the production of undesirable fluids; or when the wound is in an advanced degree of contamination or infection, with the production of large amounts of exudate. The drains will eliminate dead space and fluid accumulation, reducing the chances of infection, when it is not already installed, and accelerating the healing process (BABIES, 1999).

Drainage techniques can be used on all types of wounds, from clean and clean-contaminated to contaminated and infected. However, it is important to emphasize that the elective treatment for infected wounds is carried out using the technique of second or third intention. In cases of clean and clean-contaminated wounds, systemic antibiotics can be used to reduce the chances of ascending infections (DOUGHERTY; SIMMONS, 1992). Drains do not act as a substitute for incorrect wound management or for avoiding a possible surgical procedure. Its use will have no result if the wound does not previously receive a successful washing, cleaning and debridement (MILLER, 2003). The use and inadequate management of drains can lead to ascending contamination by microorganisms from the external environment, so their placement and management must be done through aseptic techniques. Some care must be taken when choosing to use drains. The drain exit must not coincide with the suture line, so as not to predispose to dehiscence and compromise healing, therefore, another incision must be performed beside or close to the suture line for its exit. If the drain is passive, its outlet must be at the lowest point in the affected area to ensure all gravity drainage (MILLER, 2003).

Drains can be divided into passive open or active closed. The former depend on gravity, on the different pressure gradients exerted on the wound or on the movements performed by the animal for the wound to drain, and are usually open, draining the exudate directly into the dressing. Active closed drains are more efficient as they drain fluids continuously through a negative pressure exerted by a closed mechanism capable of producing a vacuum in the drainage system (CAMPBELL, 2018).

PASSIVE DRAINS

They are generally more flexible than active drains and act as a function of gravity, constantly draining fluids to the external environment. One of its main functions is to establish a path of least resistance for the exit of the fluid that is formed by the wound, especially in cases where the fluid is very viscous, and which could present difficulty in being drained by active drains. 1992). They are more economical when compared to active drains, and generate less possibility of injury or trauma to adjacent tissues because they are more flexible. It is mainly indicated in wounds that produce less exudate, since they have an open drainage mechanism and would be unfeasible in cases of very high volumes, due to the need for several dressing changes. They must be installed in the ventral part of the wound, to facilitate drainage, and are not indicated for wounds located in the head or back, since the action of gravity can be difficult in these cases (CARNE, 2011).

The most used passive drain is the Penrose drain, characterized by a type of soft and flexible rubber. When applied to the wound, a dressing composed of gauze and bandages must be placed on its ventral end to absorb the expelled fluids and also to decrease the possibility of ascending infection. The volume of drained fluid can usually be estimated by weighing the gauze and bandages before and after dressing change (DURAI et al., 2009). Not only the Penrose drain, but all passive drains must be protected with absorbent pads, and these must be changed daily to monitor the amount of fluid expelled and signs of inflammation or infection. Dressing changes must be performed aseptically, with gloves and sterile materials, and before applying the new dressing. The skin around the wound must be cleaned and subjected to antisepsis. Sterile fluids or emollients can be used to facilitate the removal of the dressing if it is very adhered to the wound (CARNE, 2011).

ACTIVE DRAINS

The drainage mechanism works by sucking fluids from a tube inserted into the wound, by different pressure gradients exerted by the vacuum created in the system, into a closed reservoir. This reservoir can be compressive, that is, it expands as it is completely occupied by fluids, or it can be rigid, already established in a defined shape and size (HALFACREE et al., 2009). They are generally more expensive than passive drains, but more efficient, as the risk of drain occlusion is lower due to the constant negative pressure and because they allow the drainage of large amounts of fluid with minimal need for dressing changes. This fact compensates for the higher price, because if a cheaper passive drain were used in a wound with a high production of exudates, the cost of dressings would be too much (CARNE, 2011). Active drains also have the possibility of measuring the amount of fluid expelled by the wound, as they are kept in a container until disposal and cleaning takes place. And this also helps in controlling ascending infections, as they remain closed throughout the drainage (MAKAMA; AMEH, 2008).

Even if active drains have a lower contamination rate, care must be taken during their maintenance. The use of sterile gloves must be recommended for the evaluation of the place where the drain is inserted, in search of possible irritations or infections, during the change of the occlusive dressing, which must remain in the drain outlet region, and for the emptying of the drain. reservoir. The constant checking of the drain must be carried out, since the suction can be interrupted due to the loss of vacuum caused by the entry of air into the reservoir (CARNE, 2011).

FINAL CONSIDERATIONS

Several procedures must be performed, most of the time together, to always obtain the best prognosis and result regarding the treatment of tissue injuries.

The use of washing techniques and decontamination solutions, debridement, culture and sensitivity tests to antimicrobials, bandages, dressings and drains show us several possibilities for the most appropriate management of the wound, always looking for the best treatment plan and with the greatest speed. in healing.

REFERENCES

ATKIN, L. Understanding methods of wound debridement. **British Journal of Nursing**, v.23, n.12, p.10–15, 2014.

AYELLO, E. A.; CUDDIGAN, J. E. Debridement: controlling the necrotic/cellular burden. **Advances in Skin and Wound Care,** v.17, n.2, p.66–75, 2004.

BABIES, S. J. Surgical drains. *In*: FOWLER, D.; WILLIAMS, J. M. **BSAVA Manual of Canine and Feline Wound Management and Reconstruction**. British Small Animal Veterinary Association, 1999, p.47-55.

BECO, L.; GUAGUÈRE, E.; MÉNDEZ, C. L.; NOLI, C.; NUTTAL, T.; VROOM, M. Suggested guidelines for using systemic antimicrobials in bacterial skin infections: part 1 - diagnosis based on clinical presentation, cytology and culture. **Veterinary Record**, v.172, n.3, p.72–78, 2013.

BIANCHI, J. The cleansing of superficial traumatic wounds. **British Journal of Nursing**, v.9, n.19, p.28–38, 2000.

BONHAM, P. A. Swab Cultures for Diagnosing Wound Infections. **Journal of Wound, Ostomy and Continence Nursing,** v.36, n.4, p.389–395, 2009.

BOWLER, P. G.; DUERDEN, B. I.; ARMSTRONG, D. G. Wound Microbiology and Associated Approaches to Wound Management. **Clinical Microbiology Reviews**, v.14, n.2, p.244–269, 2001.

CAMPBELL, B. G. Bandages and drains. *In:* JOHNSTON, S. A.; TOBIAS, K. M. **Veterinary Surgery Small Animal.** 2 ed. Elsevier, 2018, p.791-818.

CARNE, H. How to manage wound drains. **The Veterinary Nurse**, v.2, n.9, p.540–543, 2011.

DEVEY, J. J.; LINKLATER, A.; KIRBY, R. Wounds and bandages. *In*: KIRBY, R.; LINKLATER, A. **Monitoring and Intervention for the Critically Ill Small Animal: The Rule of 20**. John Wiley & Sons, Inc, 2017, p.373-388.

DHIVYA, S.; PADMA, V. V.; SANTHINI, E. Wound dressings – a review. **BioMedicine**, v.5, n.4, p.24-28, 2015.

DIPIRO, J. T.; EDMISTON, C. E.; BOHNEN, J. M. A. Pharmacodynamics of antimicrobial therapy in surgery. **The American Journal of Surgery**, v.171, n.6, p.615–622, 1996.

DOUGHERTY, S. H.; SIMMONS, R. L. The biology and practice of surgical drains part I. **Current Problems in Surgery**, v.29, n.8, p.567–623, 1992.

DOUGHERTY, S. H.; SIMMONS, R. L. The biology and practice of surgical drains part II. **Current Problems in Surgery**, v.29, n.9, p.643–730, 1992.

DURAI, R.; MOWNAH, A.; PHILIP, C. H. N. Use of Drains in Surgery: A Review. **Journal of Perioperative Practice**, v.19, n.6, p.180–186, 2009.

FALABELLA, A. F. Debridement and wound bed preparation. **Dermatologic Therapy**, v.19, n.6, p.317–325, 2006.

GHOMI, E. R.; KHALILI, S.; KHORASANI, S. N.; NEISIANY, R. E.; RAMAKRISHNA, S. Wound dressings: Current advances and future directions. **Journal of Applied Polymer Science**, p.1-12, 2019.

HALFACREE, Z. J.; WILSON, A. M.; BAINES, S. J. Evaluation of in vitro performance of suction drains. **American Journal of Veterinary Research**, v.70, n.2, p.283–289, 2009.

HOSGOOD, G. Wound repair and specific tissue response to injury. *In*: SLATTER, D. **Textbook of Small Animal Surgery**. 3 ed. v. 1. Saunders, 2003, p.91-111.

HOSGOOD, G. Open wounds. *In:* JOHNSTON, S. A.; TOBIAS, K. M. **Veterinary Surgery Small Animal.** 2 ed. Elsevier, 2018, p.3810-3839.

JOHNSTON, D. E. Care of Accidental Wounds. **Veterinary Clinics of North America: Small Animal Practice**, v.20, n.1, p.27–46, 1990.

KIRSHEN, C.; WOO, K.; AYELLO, E. A.; SIBBALD, R. G. Debridement: a vital component of wound bed preparation. **Advances in Skin and Wound Care**, v.19, n.9, p.506–517, 2006.

KRAHWINKEL, D. J.; BOOTHE, H. W. Topical and Systemic Medications for Wounds. **Veterinary Clinics of North America: Small Animal Practice**, v.36, n.4, p.739–757, 2006.

LAWRENCE, J. C. Wound irrigation. **Journal of Wound Care**, v.6, n.1, p.23–26, 1997.

LIPSKY, B. A.; HOEY, C. Topical Antimicrobial Therapy for Treating Chronic Wounds. **Clinical Infectious Diseases**, v.49, n.10, p.1541–1549, 2009.

MACPHAIL, C. M. Cirurgia do Sistema Tegumentar. *In:* FOSSUM, T. W. **Cirurgia de Pequenos Animais**. 4 ed. Elsevier Editora Ltda, 2015, p.546-596.

MAKAMA, J. G.; AMEH, E. A. Surgical Drains: What the Resident Needs To Know. **Nigerian Journal of Medicine**, v.17, n.3, p.244-250, 2008.

MILLER, C. W. Bandages and drains. *In*: SLATTER, D. **Textbook of Small Animal Surgery**. 3 ed. v. 1. Saunders, 2003, p.244-249.

O'BRIEN, M. Exploring methods of wound debridement. **British Journal of Community Nursing**, v.7, n.3, p.10–18, 2002.

RAMUNDO, J.; GRAY, M. Enzymatic Wound Debridement. Journal of Wound, **Ostomy and Continence Nursing**, v.35, n.3, p.273–280, 2008.

RESENDE, M. M. C.; ROCHA, C. A.; CORRÊA, N. F. M.; VEIGA, R. R. G.; PASSOS, S. J. F.; NOVO, N. F.; JULIANO, Y.; DAMASCENO, C. A. V. Tap water versus sterile saline solution in the colonisation of skin wounds. **International Wound Journal**, v.13, n.4, p.526–530, 2015.

RODEHEAVER, G. T.; RATLIFF, C. R. Wound cleansing, wound irrigation, wound disinfection. *In*: KRASNER, D. L; VAN RIJSWIJK, L. **Chronic Wound Care: The Essentials**. Malvern, 2018, p.47–62.

SCHULTZ, G. S.; SIBBALD, R. G.; FALANGA, V.; AYELLO, E. A.; DOWSETT, C.; HARDING, K.; ROMANELLI, M.; STACEY, M. C.; VANSCHEIDT, W. Wound bed preparation: a systematic approach to wound management. **Wound Repair and Regeneration**, v.11, n.2, p.1–28, 2003.

SINGH, A.; WEESE, J. S. Wound Infections and Antimicrobial Use. *In:* JOHNSTON, S. A.; TOBIAS, K. M. **Veterinary Surgery Small Animal.** 2 ed. Elsevier, 2018, p.530-548.

STEED, D. L. Debridement. **The American Journal of Surgery**, v.187, n.5, p.71–74, 2004.

SWAIM, S. F. Bandages and Topical Agents. **Veterinary Clinics of North America: Small Animal Practice**, v.20, n.1, p.47–65, 1990.

VAN HENGEL, T.; TER HAAR, G.; KIRPENSTEIJN, J. Wound management: a new protocol for dogs and cats. *In:* KIRPENSTEIJN, G.; TER HAAR, G. **Reconstructive Surgery and Wound Management of the Dog and Cat**. Manson Publishing Ltd, 2013, p.21-48.

VOWDEN, K. R.; VOWDEN, P. Wound debridement, Part 1: non-sharp techniques. **Journal of Wound Care**, v.8, n.5, p.237–240, 1999.

VOWDEN, K. R.; VOWDEN, P. Wound debridement, Part 2: sharp techniques. **Journal of Wound Care**, v.8, n.6, p.291–294, 1999.

WALDRON, D. R.; ZIMMERMAN-POPE, N. Superficial skin wounds. *In*: SLATTER, D. **Textbook of Small Animal Surgery**. 3 ed. v. 1. Saunders, 2003, p.284-298.

WILLARD, M. D.; SCHULZ, K. S. Infecções Cirúrgicas e Seleção dos Antibióticos. *In*: FOSSUM, T. W. **Cirurgia de Pequenos Animais**. 4 ed. Elsevier Editora Ltda, 2015, p.269-294.

WILLIAMS, J. M. Open wound management. *In*: FOWLER, D.; WILLIAMS, J. M. **BSAVA Manual of Canine and Feline Wound Management and Reconstruction**. British Small Animal Veterinary Association, 1999, p.37-47.

WILSON, J. R.; MILLS, J. G.; PRATHER, I. D.; DIMITRIJEVICH, S. D. A Toxicity Index of Skin and Wound Cleansers Used on In Vitro Fibroblasts and Keratinocytes. **Advances in Skin & Wound Care**, v.18, n.7, p.373–378, 2005.