

## **BITES, IMPALEMENTS AND LACERATIONS – HOW TO MANAGE WOUNDS**

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Appropriate wound care provided in a timely manner can help prevent significant morbidity and mortality. The seriousness of wounds should not be underestimated and in most cases aggressive surgical treatment is indicated as soon as the patient is cardiovascularly stable.

### **FIRST AID STABILIZATION**

Evaluation of the patient should begin always with the ABC's (airway, breathing, circulation). The wound may be the obvious injury but it may be minor compared to an unseen injury such as airway disruption or pneumothorax. If the animal cannot breathe an airway will need to be established. In the case of severe oral trauma a tracheostomy may be indicated. If the patient is able to breathe adequately but there is a significant amount of hemorrhage, the clinician may need to make a decision as to whether or not to anesthetize the animal and gain control of the airway since ongoing hemorrhage could potentially lead to an airway obstruction. Once an injured patient is intubated the lungs should be auscultated bilaterally to ensure air is moving through both lung fields. The patient who arrived unconscious and not breathing may have an avulsion of the distal trachea and unless the lungs are auscultated post intubation this may not be detected. Auscultation also will allow the clinician to assess the presence of a possible pneumothorax, hemothorax or pericardial tamponade. Intravenous catheter(s) should be placed and fluids started if the patient is in shock. Analgesics are always indicated once the patient has been evaluated and resuscitation has been started.

Active bleeding from wounds will need to be controlled. Capillary oozing and most venous hemorrhage can be controlled with pressure bandages. Pressure should be applied as a temporary measure to control arterial hemorrhage but definitive control of arterial bleeding using a hemostat followed by ligation should be achieved as soon as possible.

The most important rules to follow during first aid care of wounds are to keep the wound moist and to keep it as clean as possible. All wounds should be covered as soon as possible with sterile water soluble lubricant followed by sterile gauze to prevent further contamination and injury. Gloves should be worn whenever wounds are evaluated since many wounds are contaminated but not infected when the animal enters the hospital. Many infections come from the hospital environment, both from the floors and cage surfaces, as well as the nurses' and doctor's hands. Placing sterile water-soluble lubricant in the wound helps keep it moist. This is important since desiccation impairs wound healing. Alternatively a wet dressing made from sterile gauze soaked in 0.9% saline can be applied.

If missiles are present (such as arrows, large wood splinters etc.) they should not be removed. These objects may be tamponading a vessel and premature removal may cause life-threatening hemorrhage. Missiles should only be removed under controlled surgical conditions.

If the wound is associated with a fracture then a padded bandage or temporary splint should be applied until the patient can be completely evaluated. This helps prevent further mechanical injury to the tissues from the tearing effects of bone fragments. It also helps to prevent further injury to the bone and provides comfort to the patient. Radiographs can be taken through most bandage materials; therefore, an attempt always should be made to stabilize fractures prior to taking radiographs.

### **ASSESSMENT**

Proper assessment of most wounds requires some form of analgesia at a minimum and may require general anesthesia. The injury is painful and even if the patient is stoic attention should be paid to providing adequate analgesia. Not only is pain detrimental to the overall well being of the patient but also it is detrimental to the healing process. Catecholamine release can lead to vasoconstriction and poor flow to the wound area. Initial analgesia can be provided most effectively using intravenous opioids and/or local anesthetic agents.

All wounds should be widely clipped in order to be able to assess them properly. This includes abrasions and bruises. Frequently, animals that are bitten have been impaled by both upper and lower teeth. If bite marks are seen only on one side of the limb or trunk then the other side should be shaved to search for the wound.

The type of diagnostic tests required will be dictated by the type of wound. Thoracentesis to check for air and blood should be performed in every patient that has a wound over the thoracic cavity. Radiographs are indicated in any wound that may be associated with an open fracture, joints, and thoracic or abdominal cavities. Diagnostic peritoneal lavage should be performed in cases where the wound is over the region of the abdominal cavity and it is not certain if the abdomen was penetrated or not. Laboratory tests again will be dictated by the status of the patient and the location of the wounds. Since general anesthesia is required to treat most penetrating wounds and many full thickness skin lacerations, appropriate tests should be performed to ensure the animal can tolerate anesthesia. Whenever there are concerns for significant hemorrhage (based on history), a packed cell volume and total protein always should be performed to assess for the presence of anemia and/or hypoproteinemia. Patients with extensive wounds or concerns for a coagulopathy should have coagulation parameters including platelet numbers assessed.

All penetrating wounds should be surgically explored. This is especially important in the case of bite wounds since the teeth may only have made a puncture mark in the skin but as the animal was shaken there may have been extensive tearing damage done to underlying tissues. Wounds that penetrate the abdominal cavity may have caused hollow or solid organ damage.

### **SURGICAL MANAGEMENT**

The goal of surgical management of wounds should be to explore and remove any foreign material, control hemorrhage, and remove necrotic tissue. Many wounds will require the use of general anesthesia; however, superficial wounds that do not require extensive debridement can be managed under sedation and local anesthesia.

The wound should be widely clipped and surgically prepped. This is very important since the extensive nature of the trauma can be easily underestimated based on external visualization.

### **Wound Irrigation**

Wound and body cavity irrigation form an important part of any surgical procedures. "Dilution is the solution to pollution." Sterile isotonic solutions are preferred for irrigation. Tap water has been used to irrigate wounds without complication; however, tap water is not ideal due to its hypotonicity. In large wounds effective irrigation with sterile isotonic solutions may be cost prohibitive, in which case irrigation with tap water may be appropriate. Antibiotics should not be added to irrigation fluids since this may lead to bacterial resistance (see below) and extreme care should be exercised when adding disinfectants to irrigation fluids. Body cavities should be irrigated with sterile isotonic fluid only. Irrigation can be provided using mechanical lavage systems designed for wound irrigation or using a 35 ml syringe and an 18- to 19-gauge needle. Pressure generated by the irrigator ideally should not exceed 7-9 PSI although some commercial irrigators generate 15 PSI which appears to be safe. Irrigation should not be done blindly or up into holes since this may force infection or foreign material further into the wound or potentially into healthy tissues. This can actually make the wound worse.

### **Hemostasis**

Hemostasis generally is achieved by direct pressure, suturing of wounds (compression of vessels), electrosurgery, ligation of vessels, vascular clips, omental packing, use of superglue, use of hemostatic agents or removal of the organ that may be bleeding. There are numerous products available for hemostasis many of which are based on gelatin, fibrin, bovine thrombin, seaweed and a variety of other natural products that have hemostatic qualities.

Electrosurgery is indispensable for rapid and efficient control of hemorrhage in critically ill or injured patients who are predisposed to being anemic and have coagulopathies. It causes heat-induced protein denaturation and tissue coagulation and can be used to control hemorrhage from arteries up to 1 mm and veins up to 2 mm in diameter. Monopolar electrosurgery passes a current between the electrode through the patient to a ground plate. It requires a dry field as opposed to bipolar electrosurgery where the current passes between 2 electrodes. Thermal damage is a potential side effect of monopolar electrosurgery and to a lesser extent with bipolar electrosurgery that can lead to ischemia and delayed healing.

### **Wound Exploration**

The skin should be incised in order to be able to visualize and assess the entire wound. Most mistakes in wound care are made from a lack of knowledge about the extent of the trauma because the wound was not adequately explored. Foreign material should be removed as it is encountered. Tissues should be debrided back to bleeding edges whenever possible using sharp dissection. This is especially important with fat and muscle. Bone and ligament should be removed if the surgeon is certain it is non viable but if there is any doubt

the tissue should remain since removal may interfere with subsequent function of the affected area. Skin edges of wounds should be debrided using sharp dissection back to bleeding edges unless this might cause problems with wound closure. Scissors generally should not be used since they may cause crushing of the tissue, which can compromise circulation to the wound edges and cause problems with healing.

### **Wound Closure**

Wounds should be irrigated again prior to closing the skin to remove any additional foreign material and blood. The presence of blood provides an ideal medium for bacterial proliferation. If there is any doubt about viability of tissues the wound should not be closed initially. Instead wet-to-dry dressings should be placed and the wound should be reevaluated on a daily basis. Daily debridement should be performed as necessary until the health of the tissues is assured.

Infected wounds generally should not be closed but should be allowed to heal by second intention. Alternatively the wound can be left open until it is certain that the infection is resolved and then closed at a later date.

The amount of suture left in wounds should be minimized. Fine monofilament suture should be used in the repair of most wounds. Braided suture should be avoided in potentially infected wounds. Skin sutures should not be placed tightly since again this may compromise circulation. Wounds should not be closed under tension since this will compromise wound healing. Skin can either be mobilized by undermining of healthy tissues or grafting should be used as needed.

### **Closing Dead Space**

Dead space can only be closed effectively using active suction drains or bandages. Both drains and bandages will help enhance wound healing and prevent seroma formation. Sutures can be used to approximate tissues but cannot close dead space. Using sutures to "close dead space" should be avoided since it can create compartmentalization and the amount of foreign material (suture) left in the wound is increased.

### **DRAINS**

Two types of drains exist – passive and active. Passive drains such as Penrose drains allow wound exudate to drain by gravity or overflow. The most serious complication associated with Penrose drains is the risk of ascending infection and ideally Penrose drains should be covered with a sterile dressing. Active drains remove wound fluids by application of negative pressure. Fenestrated drains are attached to a suction bulb that is primed by removal of air. These are available commercially in sizes ranging from 4 to 20 Fr. A small suction drain can be made using a butterfly catheter and a vacutainer tube. The end of the butterfly catheter is cut off and multiple holes are made in the catheter. The drain is placed in the wound and the needle end is inserted into a vacutainer tube. Similarly a suction device can be made from a 12 or 20 cc syringe. The syringe is attached to a fenestrated butterfly or other catheter or tube that has been inserted in the wound. The plunger is pulled back about 50-75% of the way (until the desired level of negative pressure is achieved) and an 18 or 20 ga needle is placed through the plunger to hold it at that level. The hub of the needle rests on one side of the barrel of the syringe and the tip of the needle rests on the opposite side to prevent the plunger from sliding back into the barrel. The tip of the needle should be cut off or taped to prevent inadvertent injury from the needle.

Drain suction bulbs, syringes, or vacutainers are changed as necessary – usually 2-4 times per day. Drains are left in place until they are no longer functional or until they are no longer needed. Drainage will slow down within 72 hours in most wounds. If a large amount of dead space was created the drains may need to stay in place for up to 5-14 days.

### **BANDAGES**

Bandages are designed to protect the wound and encourage wound healing. They can also provide support to underlying tissues and help improve patient comfort and mobility. Contaminated or infected wounds should have wet-to-dry dressings placed until the wound is clean. When wet-to-dry bandages are removed they will help mechanically debride remaining foreign material and necrotic tissue. These dressings should be compromised of wide-meshed gauze, which will entrap particulate matter, soaked in 0.9% saline.

Nonadherent dressings should be used in acute wounds that do not require further debridement, are not draining large amounts of fluids, or in wounds that are starting to heal. These can be purchased commercially and also can be made from gauze impregnated with petrolatum or petrolatum-based antibiotic ointments that has been autoclaved.

The intermediate layer of the bandage is designed to absorb wound fluids. The thickness of this layer depends on the wound itself. It is important to make it thick enough to avoid "strike-through" of wound fluids in between bandage changes. The outer layer should secure the other bandage layers and should protect the wound from external contamination from urine, feces and other fluids that could soak into the dressing. The outer layer is usually some form of tape – either elastic or surgical. It is important that this layer be placed securely enough to prevent slippage of the bandage but not too tightly so as to compromise circulation to the underlying tissues.

Large wounds may require excessive amounts of bandaging material. In these cases sterile towels can be used to cover the wounds. If wounds are superficial but need protection, application of a broad-spectrum antibiotic ointment to the wounds followed by towels may be all that is needed. Towels can also be used to hold inner layers of a bandage in place. Alternatively surgical paper drape material can be used as an outer layer. Both towel and surgical drape material can be secured using tape or safety pins.

### **ALTERNATIVE WOUND MANAGEMENT OPTIONS**

There are a wide variety of alternatives available for wound care and more are being developed on an ongoing basis.

#### **Sugar and Honey**

Recently attention has been brought to the use of wound remedies that have been used for centuries – sugar and honey. Both of these topical treatments appear to have applications in veterinary medicine for treating wounds. Sugar and honey both have wound healing properties that include attraction of macrophages into the wound and reduction of edema and inflammation. In addition honey generates low levels of hydrogen peroxide and is acidic – both of which enhance bacterial killing.

Sugar can be used to treat degloving injuries, infected wounds, burns, and any skin injury where primary closure is not possible. The wound should be debrided and then a large volume of sugar is placed in the wound to ensure the osmolarity remains high enough within the wound to kill the bacteria. Approximately 1 cm of sugar is placed in the wound which is then covered with an absorbent dressing and a bandage. The bandage is changed once to twice daily. If there is no sugar in the wound when the dressing is changed then more sugar should be used in the wound.

Honey can be used to treat the same kinds of wounds as sugar. The wound is irrigated and debrided and then unpasteurized honey is placed in the wound. Strips of bandage material can be soaked in the honey prior to placing on the wound, or alternatively the honey can be placed in the wound and then covered with large amounts of absorbent bandage material.

#### **Hyperbaric Oxygen**

Hyperbaric oxygen chambers provide oxygen at high pressures (1.5 times atmospheric pressure), which increases the amount of dissolved oxygen into the blood. Hyperbaric medicine has been shown to be very effective at improving wound healing and may be a useful modality of the future.

### **ANTIBIOTICS**

Antibiotic therapy is indicated in infected wounds. Initially broad-spectrum antibiotics should be used pending culture results. The use of antibiotics in non-infected wounds is controversial. The use of broad-spectrum perioperative antibiotics is appropriate for most wounds.

Silver sulfadiazine is used clinically to treat gram negative infections, especially resistant ones. It has broad spectrum activity and is particularly effective against *Pseudomonas aeruginosa*. The silver interferes with DNA replication and causes cell wall damage to the bacteria. Resistance is unusual.

### **COMPLICATIONS**

Many animals that present to veterinary hospitals have wounds that are dirty and contaminated but not infected. Many wound infections are nosocomial and can come from the nurse and doctor's hands. Secondary problems with wound healing and patient morbidity may relate to inappropriate wound handling during the initial stages. Most problems with sepsis from wounds come from inadequate debridement of necrotic tissue. The presence of the necrotic tissue leads to a persistent inflammatory response, which can be overwhelming and can ultimately cause patient death.