Surgical Skills for Nurses

Mini Series

Session One: Surgical Asepsis and Wound Management

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Post-operative surgical site infection is a common and potentially serious complication of surgery. The effect can range from minor, quickly resolved infections, to serious life-threatening illnesses that can be difficult and expensive to manage. Such situations are crucial for the patient and can strain relationships between surgeon and client to the limit. Approximately 5% of small animals that undergo surgery develop infection despite the measures taken to minimise contamination and use of antibiotics. Increasingly sophisticated anaesthetic protocols and surgical expertise has resulted in larger numbers of more complex procedures being performed on patients with significantly reduced ability to combat post-operative infection. This, along with the increased prevalence of resistance among populations of micro-organisms, has placed even greater emphasis on the design of and adherence to strict surgical asepsis protocols. The principle of surgical asepsis is the complete exclusion of micro-organisms from the surgical wound. However, the reality is the effective use of complementary equipment and protocols at many levels designed to reduce the level of contamination to levels that the host's defences can control.

Wound contamination

All surgical wounds become contaminated with bacteria, but not all become infected. A critical level of contamination is required before infection occurs, often quoted as approximately 10^5 organisms per gram of tissue or ml of fluid. However, this oversimplifies the situation somewhat since there are many factors involved in determining whether a level of contamination within a wound will result in infection. These factors relate to the host's resistance, the characteristics of the contaminant organism, and the interaction between host and contaminating micro-organism (i.e. the local wound environment).

Bacterial innoculum

- Number of bacteria
- Virulence
- Time since contamination

Impaired host defences

- Old age
- Poor physical condition
- Malnutrition
- Systemic disease
- Drug therapy

Local factors

- Necrotic tissue
- Haematoma
- Dead space
- Reduced blood supply
- Foreign material

Definitions

- Surgical site infections – wound infections that develop at the operative site within 30 days of surgery or within one year if implants are placed.
- Sepsis – presence of pathogens of their toxic products in the tissues of a patient
- Asepsis – absence of pathogenic microbes in living tissues
- Antiseptic – agent that either kills pathogenic micro-organisms or inhibits their growth whilst the two remain in contact. Term reserved for agents that are applied to the body.
- Disinfectant – germicidal chemical substance, that kills micro-organisms on inanimate objects
- Disinfection – removal of micro-organisms but not necessarily their spores.
- Sterilisation – complete elimination of microbial viability, including both vegetative forms of bacterial and spores. Physical and chemical means

Patient Selection

In order to assess the risks of surgical wound infection, a full evaluation of each patient for suitability for surgery should be carried out. This will guide the pre-operative preparation, the anaesthetic risks and protocol, the surgical procedure used, and influence the post-operative care of the patient. Important considerations include the patient's physical condition, the presence of concurrent disease and the presence of remote sites of infection.

Sources of Contamination

Most bacterial contamination occurs at the time of surgery. Consequently, the peri- and intra-operative phases of patient management are regarded as mainstays of aseptic technique. The main sources of contamination in surgery are:

- The patient
- Surgical equipment
- Theatre environment
- Surgical team

The Patient

The most common source of contamination is the patient's endogenous microbial flora. The skin and the hair of the animal harbour significant numbers of endogenous (normally present) and exogenous (environmental contaminant) bacteria. Common **endogenous** canine skin flora include *Staphylococcis, Micrococcus, Streptococcus, Actinobacter, Clostridium,* and *Bacillus* species as well as some Gram negative bacilli and diphtheroids. The range of **exogenous** bacterial present will of course depend on the animal's environment and will vary between patients.

Prophylactic Antibiotics

This is a different concept from treatment of infection with antibiotics. The aim is to have effective levels of a suitable antibiotic in the tissues at the time of surgery and for approximately three hours after surgery whilst the wound's fibrin seal forms. This will mean administration before induction, usually by intravenous route, and is designed to prevent the inevitable contaminants from establishing even a low level of infection. Repeat doses may be necessary depending on the length of the surgery and the antibiotic used. With appropriate use, there should be no need for post-operative courses of antibiotics for clean and clean contaminated procedures. Routine treatment of all surgical patients with a course of antibiotics is acceptance that infection is likely and therefore aseptic technique is unacceptably inadequate. Each case should be considered carefully and the many factors involved (e.g. length of surgery, implant placement, breaks in sterility, classification of cleanliness of surgery etc.) taken into account before antibiotics are dispensed.

Hair Removal

Hair removal is required for the majority of surgical procedures and may be carried out before anaesthesia is induced to reduce the anaesthetic duration and reduce the number of loose hairs present at surgery. However, removal of hair following induction is usually quicker and easier especially in the face of discomfort. Unfortunately all methods of hair removal will cause some degree of skin damage which will result in rapid bacterial colonisation. The incidence of post-operative surgical infection increases with the time interval between hair removal and surgery. Therefore, it is best removed immediately before surgery. Shaving is no longer recommended as it has been associated with up to a 10 fold increase in post-operative surgical infection. It minimises stubble but causes multiple small lacerations and skin erosions. Clipping is the recommended method of hair removal. Sharp blades, ample lubrication and coolants all minimise skin trauma. The blades should be cleaned between cases and sterilised if necessary. The clipped area should include 15cm each side of the proposed incision site and all sites clipped simultaneously in the case of multiple procedures. Unless directly involved in the procedure, paws should be covered with an impermeable material instead of clipping. Wounds may be covered with saline soaked gauze swabs or sterile water soluble gel to minimise hair and dander contamination during clipping.

Skin Preparation

The patient's skin cannot be completely sterilised, so the aim of preparation is to minimise the bacterial numbers whilst avoiding skin damage. Surgical scrub solutions contain both antiseptic and detergent components. The physical activity of skin preparation will loosen and remove organic debris (aided by detergent) and kill the transient or exogenous bacteria (aided by the antiseptic component). The levels of endogenous bacterial may be reduced but during the procedure they come to the surface from the skin from the follicles etc. and are a source of contamination. It is for this reason that a second antiseptic solution (water or alcohol based) should be applied to give residual surface bacterial activity. Both povidine-iodine and chlorhexidine are widely used and are generally considered to be equivocal in bacterial kill rates and incidence of postoperative wound infection. The use of either agent is justified though chlorhexidine has the advantage or prolonged residual activity, continued activity in the presence of organic matter and reduced incidence of skin reactions. It is important to note that Gram-negative bacteria (e.g. *Pseudomonas* spp) can live and multiply in some dilute antiseptic solutions so each solution should be freshly dispensed into sterile containers from concentrated stock solutions and any unused diluted preparation discarded after 48 hours.

Draping the Patient

Draping maintains asepsis by preventing contamination of the surgical field by hair and the immediate environment. The drapes should cover the entire patient and table with only the surgical site exposed. The ideal material would be easily sterilised, economical, and maintain its barrier properties. It must be securely fastened to the patient during surgery. Both reusable and disposable drapes are available.

Surgical Equipment

It is essential that all instruments, implants and equipment used in the surgical procedure are sterilised before use. There are several different methods available and the choice of method used will depend on the amount and type of equipment to be sterilised, financial considerations and available space for the equipment. Each method has its own advantages and disadvantages. Failure of sterilisation usually results from inadequate maintenance of equipment, or modification of the protocols without careful consideration.

Cleaning

Regardless of the technique to be used, gross contamination must be removed before sterilisation if it is to be effective. Cleaning items immediately postoperatively is ideal, by initially rinsing under cold water (hot water causes protein denaturisation leaving adherent residues) or soaking in detergent solution pending final cleaning. Abrasive cleaning products and ordinary soap should be avoided (this leaves behind an insoluble film). Ultrasonic cleaning devices are very useful, cleaning by a process of microcavitation.

Steam Sterilising. (autoclaves)

Sterilisation with saturated steam under pressure is the most dependable and widely used method of microbial destruction. Steam penetrates each pack and porous article, giving up heat as it condenses. It depends on direct contact and so items impenetrable by the steam are unsuitable for this method as are heat sensitive items. Air present in the steriliser will reduce the penetration of the steam and limit the condensation as well as the attainment of the high temperature necessary. Modern steam sterilisers differ principally in the mechanism by which air is excluded during the procedure.

- Pack preparation – items are packed according to their intended use and arranged to allow full steam penetration. Complex items should be disassembled and locking mechanisms should be open. Dishes should be placed in the chamber in rows so they are parallel to the flow of the steam. Care should be taken to avoid overloading and blocking of the inlet and exhaust valves.
- Autoclave operation – it is generally agreed that 13 minutes at 120°C is a safe minimum standard to destroy most resistant microbes. Emergency sterilisation is carried out at 131°C for three minutes. The cycle times will be longer to account for heat up and dry times.

Moist Heat (boiling): Boiling cannot be guaranteed to kill all micro-organisms and their spores as the maximum temperature attained is 100°C. Therefore is should not be considered as a means of sterilisation.

Dry Heat: Dry heat kills micro-organisms by causing oxidative destruction of bacterial protoplasm. Equipment suitable for this method is restricted to those not easily damaged by the conditions. Hot air ovens have largely been superseded by autoclaves.

Irradiation: Gamma radiation is the most effective, and enables a measured dose to be administered easily. Many pre-packaged items (e.g. needles, syringes) are sterilised in this way.

Ethylene Oxide: Ethylene oxide inactivates cellular DNA and prevents cell reproduction. It is capable of destroying all known bacteria, spores and the larger viruses but it is toxic, irritant to tissue and flammable unless mixed with carbon dioxide. The only system available in the UK operates at room temperature and takes 12 hours, it is suitable for many items but its use is limited by the size of the sterilising chamber, its toxicity and the time needed. There are strict health and safety regulations regarding its use.

Cold Sterilisation - This refers to the soaking of items in disinfectant solutions ad should be considered really as disinfection although some manufacturers guarantee sterilisation after 24 hours. Occasionally used for endoscopes and other items unsuitable for steam sterilisation, this method should not be used for items that may be introduced beneath the surface of the body.

Gas Plasma - Hydrogen peroxide gas plasma sterilisation results in rapid inactivation of a broad spectrum of micro-organisms and removal of harmful residues. It takes approximately one hour and requires no aeration. There are no reported toxic emissions or residues. Specialist equipment is required.

Theatre Environment

The design, construction and layout of the operating theatre, as well as room protocols will affect how readily the principles of aseptic technique can be applied.

Design

It is important to minimise traffic through the operating room both in terms of personnel and patients. Only patients undergoing surgery should enter the room, having been previously anaesthetised and prepared for surgery. The room should have good access but be away from the main thoroughfares in the practice with only essential, correctly attired personnel being allowed entry. The room must not be used for other purposes. The room should be of suitable size for the surgical team and equipment but small enough to facilitate regular thorough cleaning and discourage storage of redundant equipment. The air should flow from the area of least contamination towards other areas. Therefore the operating room should be at mid positive pressure with at least 25 air changes per hour if the air is re-circulated or 15 if it is vented to the outside. Fan heaters should be avoided since they cause dust and air movement. The floors and walls should be light coloured, non-staining, seamless and impervious with coved corners to facilitate thorough cleaning. Furniture should be minimal, and what there is should be ideally simple construction stainless steel and glass. A pass through port from the preparation room is extremely useful as it minimises traffic.

Scheduling of Procedures

Surgeries should be ordered from the cleanest to those with the potential for contamination being performed last. A surgical list should allow any occurrences of sepsis to be traced. Dirty procedures (e.g. dentals) should be performed in a separate room allocated for such procedures.

Maintenance and cleaning

This is essential if high standards of asepsis are to be achieved. Before commencing the surgical list each day the surfaces should be damp dusted (not dry dusted as this merely moves the dust) with a dilute disinfectant solution. Between cases the table, equipment, and floor if soiled, should be thoroughly cleaned and disinfected. All surfaces should be scrubbed and cleaned with disinfectant. Each week there should be a thorough cleaning session when all equipment is removed from the room and all walls, ceilings etc. scrubbed with a disinfectant solution that also has detergent properties which will remove organic debris and is active against a ranged of contaminants, including *Pseudomonas* spp. All equipment should receive similar meticulous cleaning. Operating room cleaning utensils should remain exclusive to this room and be stored separately, away from the sterile area.

The Surgical Team

Preparation of the surgical team is aimed at minimizing contamination through the shedding of particulate matter (including micro-organisms).

Scrub suits: An occlusive barrier to micro-organisms, these garments should not be worn outside the operating theatre or for procedures where contamination is possible if further surgery is planned.

Surgical head covers: These are the most useful item as hair represents a primary source of contamination from the surgical team. Hoods are preferable to caps and the item chosen must cover the occipital and temporal regions.

Shoes: The wearing of designated theatre shoes appears to be no more effective at reducing bacterial contamination than properly fitting covers over outdoor shoes. Uncovered outdoor shoes should not be worn in the operating theatre.

Face masks**:** Face masks do reduce the level of environmental contamination since droplets shed are directed to the sides and bottom of the mask. Indeed, during quiet talking and breathing there is little of no emission of bacterial laden particles. However, masks do protect the wound from droplets of saliva expelled during talking. Those that pass through the pores are of a size that does not readily fall into the wound. Masks will also tend to reduce unnecessary chatter in the operating room.

Scrubbing up: Similarly to patient preparation, scrubbing is aimed at the mechanical removal of gross organic debris and transient flora and killing the resident population of bacteria. No single technique has been found to be superior; therefore one method should be selected and strictly followed. Present opinion recommends a technique of approximately five minutes duration for the first case or following contamination, and three minutes for subsequent cases. The hands should always remain higher than the elbows, with particular attention paid to nails, cuts and abrasions. Storing brushes in antiseptic solution will allow some bacteria to multiply freely and become transferred to the patient by the surgeon and so this practice must be avoided by using either autoclaved or sterile disposable brushes instead.

Gloves: Gloves may be considered a sterile barrier and should be worn to reduce contamination still further. Closed gloving technique is preferred. Studies have shown that most gloves develop minor perforations by the end of the procedure though with good routine skin preparation this does not increase the likelihood of wound contamination. Double gloving is recommended for orthopaedic cases.

Gowns: Gowns also represent a sterile barrier between surgical team and patient. Gloves should cover the elasticated cuff of the gown.

Surgical technique

The technical skills of the surgeon are also important in reducing the potential for infection. By the close observation of Halstead’s principles of atraumatic, aseptic surgery, tissue contamination and injury are minimised. This will result in the preservation of vascularity, tissue oxygenation and enhancement of wound healing. The elimination of dead space will also significantly reduce the infection rate, as well as the placement of minimal numbers of finest appropriate gauge sutures. It is important to minimise the length of surgery as far as possible since for every hour of surgery, the infection rate is approximately doubled.

Post-Operative Patient Care

The principles of asepsis should be carried through into the post-operative period with regard to sterile dressing changes and the maintenance of catheters and drains. Reduced attention to detail at this stage may reduce the benefits of the measures taken pre- and intra-operatively to avoid contamination. The potential for contamination with nosocomial infection has been found to be directly related to the length of stay in the hospital environment and the number of procedures (from catheter placement to radiography) that the patient undergoes.

Summary

In combination with aseptic operating technique, the principles and protocols outlined in this article should allow the highest standards of surgical asepsis to be sought and maintained. Whilst adaptations to accommodate facilities available, operator preference and economics are often necessary, the pursuit of excellence must be continued since failure to observe these principles may have disastrous consequences on the outcome of surgery.

INITIAL WOUND MANAGEMENT; LAVAGE AND DEBRIDE

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A basic knowledge of the phases of wound healing gives clinical team members an idea of what to expect in terms of speed of healing, and a basis on which to make wound management decisions. The continuous process is commonly described as having four phases:

- Inflammatory phase *(From days 0-5)*: haemorrhage, then haemostasis, followed by vasodilation and increased vascular permeability
- Debridement phase *(From day 0):* migration of leukocytes , removing cellular debris, phagocytosing and killing bacteria
- Repair (or proliferative) phase *(From days 3 or 5 to 4 weeks):* fibroblasts proliferate, synthesising collagen, angiogenesis and the formation of granulation tissue. Epithelialisation and wound contracture.
- Remodelling (or maturation) phase *(From day 20 to years):* wound contraction and remodelling of collagen fibres.

We expect acute wounds to heal over a ‘normal’ period of time as such management focuses not on accelerating the process, but on removing any impediments or deterrents to normal healing. In doing so we hope to prevent delays or complications in healing, and prevent acute wounds becoming chronic wounds.

Common impediments to healing include; excessive bacterial population, the presence of necrotic tissue, seromas and haematomas, poor blood supply, and mechanical damage to tissue during surgery. Impediments such as these prolong the ‘Debridement phase’ of healing, and delay the onset of the ‘Repair phase’.

Preventing Further Wound Contamination

Wounds should be covered with a sterile dressing as soon as possible after entering the clinic. Once issues affecting the major organ systems have been addressed, attention can turn to controlling contamination of the wound.

At this stage the patient may not be a suitable candidate for general anaesthesia, and a combination of adequate analgesia, sedation, local anaesthetic techniques and restraint may be required to allow intervention. Bearing in mind that the aim is to prevent further contamination, and reduce that which is present, aseptic technique should be used throughout, with involved staff wearing sterile gloves, and preferably hat, mask and gowns.

Initially the wound should be packed, so that during the clipping of hair, further contamination is not introduced into the wound bed. This can be achieved with: a water soluble lubricant gel (KY jelly), a hydrocolloid gel, with sterile saline soaked swabs, or a combination of gel and swabs.

The area surrounding the wound is clipped, ensuring the clipper blades are sharp, clean, and have no missing teeth; this minimises the chance of causing tissue trauma.

Care should be taken to ensure the wound margins are not traumatised with the clippers; the hair here can be removed with scissors that have been wetted with sterile saline, so that the hair sticks to the blades and doesn't fall into the wound. The swabs are removed from the wound, or the gel is wiped out with sterile swabs. The skin surrounding the wound is then prepared using standard aseptic preparation with a suitable antiseptic,(eg chlorhexidine) at appropriate dilution, working from the wound outwards, taking care not to get antiseptic on the wound itself (concentrations of antiseptics suitable for aseptic skin preparation are cytotoxic to exposed tissue).

Wound Lavage

Aims of wound Lavage; The aim of wound lavage (or irrigation) is to remove loose foreign material and necrotic tissue from the wound, whilst diluting the bacterial contamination present. In so doing, lavage aims to remove impediments to wound healing, and reduce the risk of infection.
As with a lot of areas in the human and veterinary medical world, the decision making behind how an individual clinician performs wound lavage is often based on a mixture of scientific reasoning, tradition and habit. The ideal lavage technique and pressures required for optimal results are still unclear in human literature.
Variations exist in the technique employed for lavage, and in the choice of lavage fluid used. However, some factors are agreed on:

- The greater the volume of lavage fluid, the less the risk of infection
- The more contaminated the wound, the greater the volume of fluid required
- Warmed fluids are more comfortable than room temperature fluids
- The earlier the wound is lavaged, the better the removal of bacteria

Performing Wound Lavage: Lavage fluids are generally administered as a controlled jet directed over the wound surface. The pressure at which the fluid is applied is crucial to achieve the goal of removing impediments to healing; pressures need to be sufficient to dislodge debris and loose tissue, and overcome adhesive forces of bacteria, but excessive pressure will drive bacteria and debris deeper into the wound, and open up previously uncontaminated tissue planes. Pressures of 8-12 psi (pounds per square inch) are strong enough to overcome adhesive forces of bacteria. Pressures greater than 15 psi may cause wound trauma and drive bacteria deeper into wounds. Pressures lower than 4 psi are insufficient to remove surface contamination and bacteria. High pressure lavage is associated with increased risk of complications in open fractures.
In a practical situation correct pressures can be achieved with a 20 or 30 ml syringe, and a 19G needle or intravenous cannula; this provides an output pressure range of 11-31 psi, but the pressure of the jet that reaches the wound is probably about 8 PSI. The syringe can be rapidly refilled by incorporating a 3-way tap and a giving set attached to a bag of lavage fluids. An alternative technique which achieves similar pressures is to connect a fluid bag to a giving set with a 19g IV cannula on the end, and squeeze the fluid bag with a pressure cuff or pressure bag inflated to 400mg Hg.

The stream of lavage fluid should be directed at 45 degrees to the wound bed to maximise dislodgement of debris.

Lavage Fluid Selection and Volume: In human medicine suggestions exist for the volume of lavage fluid deemed necessary based on the size of the presenting wound; volumes of 50-100ml per centimetre of laceration or per square centimetre of wound. In veterinary texts suggestions are made regarding the minimum volume per wound; 500ml. Required volumes are likely to be higher in our patients due to an increased risk of contamination from hair, environment and patient interference. As mentioned previously, the greater the amount of contamination, the greater the volume of lavage required.

Controversies exist in the choice of lavage solution, and whether antiseptics should be added to the solution. Solutions need to be non-toxic to tissues, reduce the number of microorganisms, not cause sensitivity reactions and be widely available and cost effective.

Whereas normal saline is used extensively in human wound lavage, and is seen as the ‘standard’ solution, most veterinary texts recommend Hartmann’s solution (Lactated Ringers) as the wound lavage solution of choice. Whilst both normal saline and Hartmanns are isotonic, and evidence suggests lavage should be carried out with a fluid that has similar osmotic pressure to that found in living cells, recent human literature has looked at the use of ordinary drinking water as an alternative lavage solution for acute wounds. Drinking water has the advantage of being readily available and cheap. A study on contaminated musculoskeletal animal wound models showed identical reduction in bacterial counts following lavage with identical volumes of normal saline and drinking water, even in open fractures. Studies in humans have shown no difference in infection rates or healing rates when comparing normal saline to drinking water in the lavage of acute wounds.

The addition of antiseptics to lavage fluid can have cytotoxic effects on important cells involved in healing, such as keratinocytes and fibroblasts. Hydrogen peroxide and povidone-iodeine reduce proliferation and migration of fibroblasts in a dose dependant fashion. Chlorhexadine and silver-containing antiseptics also reduce proliferation at high concentrations , but at lower concentrations they may actually enhance epithelial growth. If chlorhexadine is used in a wound, it should be used at low concentrations (a solution of 0.05%); used at this dilution chlorhexadine causes no significant difference in wound contraction or epithelialisation compared to sterile saline or Hartmanns in dogs whilst achieving 100% bacterial kill rates against *Staphylococcus Intermedius* , a common skin commensal bacteria.

The addition of antiseptics is often used in infected wounds; the aim of lavage is to reduce bacterial levels to a where the immune system can prevent critical colonisation or infection. The use of an antiseptic in the lavage fluid may lower residual bacterial counts by killing as well as diluting.

Addition of antibiotics to lavage solution is not recommended. Antibiotics may cause sensitivity reaction in the patient, they are unlikely to maintain effective local levels for a suitable length of time, they are costly, and the promotion of resistance is a concern.

Soap or surfactants are commonly used in lavage of open fractures in human patients, where their use has been shown to reduce the complication rate compared to lavage with normal saline. Soaps have lipophillic components which block bacterial cell adhesion in a wound, so assisting their removal. Soaps may also be of use in chronic wounds where they are more effective at removing adherent denatured proteins, such as dry fibrin and blood compared to saline or Hartmanns.

The benefits of wound lavage in removing impediments to healing in the wound environment are without question, as is the idea that the greater the volume of fluid used, the greater the benefits. Well established techniques exist to enable delivery of lavage fluids at the correct pressure, using equipment that is readily available in veterinary practice. What is less clear is the choice of solution used in lavage, whether to add antiseptics or surfactants, and whether different wound types require different solutions. The majority of veterinary clinicians will use isotonic crystalloids as their lavage solution of choice, current trends in human medicine in the use of drinking tap water and surfactants may impact on the veterinary world in the future.

Wound Debridement

Debridement is defined at the removal of damaged tissue or foreign objects from a wound. Necrotic tissue will delay wound healing and increase the risk of wound breakdown by acting as a nidus for infection. Necrotic tissue also slows wound healing by obstructing re-epithelialisation and wound contraction

Surgical Debridement: Devitalised tissue is cut from the wound, allowing rapid and effective removal of tissue as well as thorough wound exploration and assessment of underlying vital structures. Debridement should be treated as any other surgical procedure; strict aseptic technique should be used to prevent introducing further bacterial contamination into the wound, therefore the area is draped, and the clinician gowned and gloved.

In areas where there is adequate normal tissue to allow closure afterwards, the whole affected tissue can be excised with a border of healthy tissue- in a similar fashion to removing a tumour with healthy margins in all planes. This is termed ‘en-bloc’ debridement, ideal areas for this technique are the trunk, or proximal limbs where there is plenty of available skin to close the deficit. The wound is usually packed with surgical swabs and sutured closed prior to excision.

More commonly when debriding a wound, devitalised tissue is removed gradually in layers, allowing conservation of tissue where possible, this may be important in areas such as the lower limbs and feet where there is inadequate skin to allow en-bloc debridement. Superficial tissue is removed first, followed by debridement of deeper tissues. As debridement progresses, instruments can be changed, or disinfected and rinsed to prevent contaminating areas that areas that have already been debrided.

Assessing which tissue is non-viable and should be removed is not as straightforward as it sounds. In areas of non-vital tissue (ie skin, muscle, fat), one option is to cut tissue back until it bleeds, on the understanding haemorrhaging tissue is healthy tissue. Certain factors can affect the degree of bleeding from cut tissues, such as systemic or local vasoconstriction, tissue temperature and coagulation defects, therefore this more aggressive approach could result in removing viable tissue.

Where removing viable tissue is an issue, due to the requirement to preserve as much tissue as possible, a more conservative approach is taken. A line of demarcation between dark (or very light) tissue and normal coloured tissue is a good indicator of non-viable tissue. Where there is doubt over an area it can be left and re-evaluated at the next assessment, when a line of demarcation may have developed, this is sometimes termed ‘staged’ debridement.

Surgical debridement is often followed by the use of dressings to achieve mechanical debridement. This is especially the case where a single surgical debridement is not sufficient to produce a wound bed suitable for closure. A common technique is to assess and surgically debride the wound daily, whilst using dressings in between procedures to mechanically debride the wound.

Mechanical debridement: Wet-to-dry dressings have been used for decades in humans and they are a very useful tool in wound management in veterinary practice. Their effectiveness relies on the adherence of the dressing to the wound bed, which on removal lifts the debris and necrotic tissue that becomes trapped in the mesh of the dressing.

The application of wet-to-dry dressings is straightforward, and involves readily available materials. A sterile gauze swab is wetted with sterile saline and placed in contact with the wound bed, this is then protected by a standard secondary and tertiary bandage layers. The moisture from the swab dilutes the exudates in the wound, which is absorbed into the secondary layer, and the swab dries and adheres to the wound surface. The dressing needs to be changed daily, before any strike-through is noted, any delay leads to delay in healing and an increased risk of infection.
Wet-to-dry dressings are very useful, cost effective, and easy to apply; but if applied incorrectly can delay healing.

A recent advancement in mechanical debridement is the use of monofilament polyester debridement pads (Debrisoft; Activa Healthcare). These single use pads are moistened, and then wiped across the surface of acute of chronic wounds; exudate and necrotic tissue are removed and held within the fibres. The use of these pads is now recommended as 'best practice' within human healthcare in the UK, for community management of acute and chronic wounds.

Autolytic Debridement: Autolytic debridement is a selective debridement brought about by release of the patients own proteolytic enzymes (eg collagenase, elastase) and the activation of phagocytes. These enzymes soften and breakdown necrotic tissue, and are mostly produced by leucocytes. This is a natural process that occurs in all wounds, but its action can be enhanced by using products that promote and maintain an ideal moist wound-environment that promotes the activity of leucocytes and macrophages. The moist environment also promotes the swelling of necrotic tissue, which loosens them from the wound bed.

Records of the use in honey extend back more than 4000 years. Honey is a supersaturated sugar solution containing 30% glucose, 40% fructose, 5% sucrose and 20% water as well as other substances such as amino acids, vitamins, minerals and enzymes. For wound management honey is available in tubes, or in impregnated dressings.

Honey promotes autolytic debridement, whilst having antimicrobial effectiveness. Honey osmotically draws fluid from the surrounding tissues, this reduces wound oedema and increases exudates which both promote autolytic debridement . Antimicrobial activity is likely to be due to a number of factors; osmotic dehydration of bacteria, low pH (3-4.5), release of small amounts of hydrogen peroxide or methyglyoxal. Honey should not be used in dry wounds, where its osmotic effect would further dry out wounds.

Hydrosurgery: Hydrosurgical units emit a very high pressure stream of saline that cuts tissues. The Versajet (Smith & Nephew) is the most commonly used unit in human hospitals, where they are used for debridement of acute wounds, chronic ulcers, and burns. These units should not be confused with 'water-piks' that deliver a stream perpendicular to the wound, and are used for pulsatile lavage. In a Versajet the stream crosses a window in the hand-piece, and is orientated parallel to the wound bed, allowing tissue to be 'shaved' off; the saline passes into an evacuation collector. The Versajet not only cuts with the saline stream, but the stream creates a vaccum ('Venturi' effect) that evacuates the ablated tissue and debris along with the saline, leaving a clean wound bed. The speed of the stream is controlled on the console.

Human reports suggest that Versajet is equally, if not more effective than conventional surgical debridement, by causing less damage to viable tissue. Other perceived advantages include shorter surgical time, shorter hospital stays, and less risk of injury or aerosol contamination compared to surgical debridement with lavage. Experimental data based on equine tissue, demonstrates superior reduction in bacteria numbers compared to sharp debridement with lavage

During the process of debridement, it is important to keep inspecting and re-evaluating the wound. As soon as the clinician is confidant than contamination and necrotic tissue has been reduced to a level where phagocytosis can deal with the remaining impediments to healing, wound closure can be considered. It is often more cost effective to reconstruct a wound at this point, rather than a prolonged period of second intention healing which can rapidly run up a large bill with repeated dressings and sedations.