

Surgical Site Infections: Prevention is better than cure

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Surgical site infections are costly to veterinary practices in terms of time, resources and reputation. It is easy to blame wound infections on poor owner compliance with postoperative instructions or on the behaviour of the patient chewing or licking at the wound, rolling in dirt or swimming in cattle troughs but, although these things do not help, the fact is that normal skin flora is the major cause of postoperative infections in 'clean' surgical wounds. (1, 2)

Wound infections result in increased patient discomfort and morbidity, longer hospitalisation, take up the valuable time of veterinary staff and often involve the use of extra sedation or anaesthetic drugs, antibiotics, antiinflammatories, dressings and bandages in order to clean them up. These things are sometimes given away cheaply or for no cost to the owner because we feel guilty. Clients may perceive the veterinarian involved as careless or unsanitary and such events can result in the loss of their business and negative publicity to all their friends.

It is not possible to completely sterilise the skin of a patient. Even the best skin prep technique will not reduce the resident bacterial count to zero. (3) The idea is to get the microbial count low enough for the patient's immune system to prevent them reaching the numbers required to cause an infection. Bacteria continue to multiply throughout the surgical procedure and longer surgery and anaesthetic times have been associated with more frequent surgical site infections. (13) Veterinary surgeons can improve on this by adding an impervious drape, especially if that drape adheres to the skin up to the incision's edge. This provides a physical barrier to microbial wound invasion. Lastly, the use of effectively sterilised instruments and implants and scrupulous sterile technique augments the chances of avoiding iatrogenic wound infection. Veterinary surgery has come a long way from the surgeons of the 19th century who prided themselves on never changing their gowns; the bloodier the better. They used the same

sponges and instruments for every patient, rinsed in between surgeries only if you were lucky. (4) Surgical patients had very low expectations back then and wound infection rates were between 70 and 90%. Society today is not as forgiving!

There is a large amount of variation in surgical patient prep techniques. The preference of each veterinarian differs according to when and where they were trained, price and availability of skin prep products, individual perceptions about effectiveness or safety and, most importantly, the outcomes of personal experience. Most of the commonly used patient skin preps are suitable for their purpose in terms of meeting the minimum criteria for immediate and persistent antimicrobial activity. (1,5). Hence there is no one correct method. However, different products compare differently on issues affecting their application, cost effectiveness and performance when exposed to factors like bleeding, exudate, saline irrigation and dirt as well as when used prior to procedures involving heat such as electrocautery.

Preoperative skin preparation

1. **Hair removal.** Most veterinary patients are hairy, woolly or furry and this is associated with a significant microbial load as well as physically obstructing access to the surgical site. At least some degree of hair removal is indicated for most surgical procedures. Dirt and other debris adhering to the coat will increase microbial populations even more, as well as impairing the action of some antiseptic agents. (6)

In human surgery, patients are sometimes asked to shower the night or the morning before surgery with a chlorhexidine based soap or body wash. This is a recommendation veterinarians could consider implementing, at least for dog owners. Bathing, particularly with chlorhexidine based shampoo, the day prior to surgery would allow time for the coat to be dry at surgery time and would provide a useful head start to removing dirt and other organic material as well as reducing skin microbial loads. The use of an effective external parasite

control with a residual action that covers the surgical and recovery period is another aspect that should be discussed with owners prior to their pet's surgery. Fleas walking over the surgical site are not sterile!

Even though hair removal is necessary, damaging the surface of the skin is undesirable. An intact superficial epithelial layer is the skin's most important line of defence against microbial contamination. Aggressive clipping or shaving can create microscopic (or macroscopic) cuts and abrasions to the epidermis which allow bacterial invasion. (3) As microbial numbers multiply logarithmically over time, it is not recommended to clip a patient any significant duration of time prior to surgery. (3, 7) This should only be done immediately prior to the procedure using disinfected, sharp electric or battery powered clipper blades and gentle technique whenever possible. A small amount of stubble is preferable to a scraped and damaged skin surface (5,8). Hand held razors and scalpel blades are associated with significantly greater skin damage than electric clippers and many studies have linked their use to increased wound infection rates (5, 8, 9, 10)

2. **Preparation of the patient's skin.** In New Zealand, the most commonly used veterinary skin prep solutions contain either chlorhexidine gluconate or an iodophore. These are either prepared immediately prior to use by dilution with water or come as ready to use or dilutable alcohol based combinations. Alcohols work to destroy microbes by denaturing their proteins (6). Their immediate antimicrobial action is very rapid; faster than both aqueous chlorhexidine and aqueous iodophores working in isolation. But alone they are unsuitable as a surgical skin prep because they lack any significant residual action. (5, 6, 11). They are also ineffective in the presence of dirt and organic debris. Alcohols at 65%-95% concentrations have very good invitro activity against a broad range of gram positive and gram negative bacteria including multidrug-resistant strains such as MRSA. They are effective against M. tuberculosis and some fungi as well as some viruses. (6).

The alcohols are best used in combination protocols with chlorhexidine or iodophores as they speed up the onset of microbial destruction and improve their gram negative bacterial spectrum of activity. In addition, they are excellent at removing soap residues (which irritate open wounds) and the dirt trapped within the lipid surface layers of the skin. They also have significantly improved drying properties when compared to aqueous solutions. (6). They have a very low allergenic potential although they can be slightly drying to the skin surface with repeated use. Isopropyl alcohol is worse than ethanol in this respect. (6)

The spectrum of activity of chlorhexidine and the iodophores are roughly similar. They both are effective against a wide range of vegetative bacteria (although some gram negative bacilli are resistant). They also destroy yeasts, fungi and some viruses. (6) Chlorhexidine is ineffective against mycobacteria whereas iodine is effective. These spectrums target most significant resident skin flora. They both have an acceptably quick immediate onset of action with chlorhexidine being slightly quicker than povidone iodine but slower than the alcohols. (1,6). They also have acceptable residual action but chlorhexidine is significantly more persistent than povidone iodine. Some of the newer polymerised iodophores have greater residual activity than both povidone iodine and chlorhexidine.(1).

Chlorhexidine is a cationic surfactant and it works by disruption of the cell membrane. Cationic surfactants are easily inactivated by being mixed with other chemicals. Certain detergents are incompatible and it cannot be mixed directly with iodine. However, if used in a protocol involving alternate aqueous chlorhexidine then alcohol applications which are allowed to dry before finishing with an iodophore spray, effectiveness will be maintained due to the separated applications. (1) Not all chlorhexidine products are created equal. There are varying grades with some being gentler on skin than others.

Also, higher concentrations tend to be more irritant to the skin. (6) It is not uncommon to see low grade skin reactions to chlorhexidine such as dryness or redness. This is likely to be a contact irritation and could be reduced if a lower concentration or a more skin friendly grade of chlorhexidine is used. Chlorhexidine is not suitable as a prep in the eye or periocular region as it causes corneal damage. It must be flushed out thoroughly in the case of accidental contact. It is also not recommended for use in the ear as it can cause deafness in contact with the inner ear and it is unsafe to use in contact with brain tissue or the meninges(6).

Iodophores work by oxidation and free iodine substitution of amino acids and unsaturated fatty acids within microorganisms. This leads to impaired protein synthesis and damage to the cell membrane.(6) Combining iodine with various polymers can increase its solubility, reduce skin irritation and promote sustained iodine release properties and therefore persistence of action. Povidone iodine is perhaps the best known of the iodophores. It has the disadvantage of being inactivated by blood and exudate and its duration of action is impaired by irrigation with saline. Iodine povacrylex is a polymer that overcomes these disadvantages and also helps improve drape adhesion which can reduce wound infection rates. (1). Prolonged skin contact can cause irritation in some individuals and this appears to be worse with higher concentrations. It is more commonly associated with contact skin irritation than chlorhexidine (11) Iodine's yellow brown colour clearly shows the prepped area of the skin, which some surgeons find reassuring. Once the colour is no longer visible, iodophores are generally no longer effective (6). Optical preparations containing povidone iodine are available for surgery in the periocular field.

Non-lint producing gauze swabs are preferable to cottonwool for the application of surgical skin prep solutions because cotton wool is prone to leaving fibres on the skin. These are associated with the transfer of skin

microbes into surgical wounds. (3)

Whatever patient skin prep protocol is preferred, it is important that the skin is allowed to air dry before draping and surgery commences. Any pooled prep solution should be removed by 'wicking' it up with sterile gauze swabs. The faster drying properties of an alcohol based product, at least for the final part of the prep, are advantageous in a busy practice situation where time is of the essence. Draping onto a wet surface, especially with cloth drapes, will allow immediate strike through of all viable skin microbes, counteracting the physical protection afforded by the drape. Another key reason to ensure alcohol based preps are allowed to dry is that they are otherwise flammable. A recent case study in the literature described the use of electrocautery before the alcohol based prep had dried on a human surgical patient resulting in skin burns, severe pain and permanent scarring. (13).

Draping

Cloth drapes are still commonly used in veterinary practice due to ease of re-sterilisation, reusability and low cost. They are not ideal for the job of providing an impenetrable physical barrier between the skin and the surgical site because they allow the transfer of moisture and accompanying bacteria from above and below the drape. They also tend to gape and move around on the surgical site which is associated with significantly increased wound infection rates when compared to adhering waterproof drape materials. (3) In one study, drape movement was associated with a six times higher surgical infection rate. (12)

Impervious sterile surgical drapes are effective at preventing micro-organisms entering a surgically created wound because these micro-organisms cannot move by themselves. Microbes travel by only three different methods. The most significant is in association with fluid (strike through). The second method is by direct contact of surrounding skin by the surgeon's gloves,

materials or instruments and the third is on dust and debris such as lint particles either in the air or left during the prep procedure. Multiple layers of disposable impervious drapes are used routinely in human and specialist hospitals. Commonly, the drape closest to the skin is an adhering type to minimise microbial transfer through direct contact.

Summary

Preventing surgical site infections is much cheaper than treating them. It is impossible to completely sterilise skin and resident skin microbes will start to multiply again during the surgical procedure. Gentle clipping of hair from the surgical site is far superior to shaving because microscopic epidermal damage provides an unprotected site for bacterial infection. Chlorhexidine and iodophore based skin prep protocols are both effective. The addition of alcohols improves these regimes through physical and chemical methods but alcohol alone is not enough. The use of adherent impervious drapes provides the best prevention against microbial strike through during the surgical procedure.

References

- 1 3M Sterile Surfaces Resource Guide. Feb 2010.
- 2 Cole and Bernard, "Relationship of skin carriage to postoperative Staphylococcal wound infection." *Surgical Forum* 15 (1964).
- 3 Anderson Manz, Ellen; Gardner, Debbie; Millard, Maret. "Clipping, Prepping and Draping for Surgical Procedures." *Managing Infection Control* Aug 2006 pp. 84-97.
- 4 Manley, Y. B. "Surgical scrubbing, then and now." *JORRI* 1980: 1 (1) pp28-31.
- 5 Centers for Disease Control. Guideline for Prevention of Surgical Site Infections. 1999. Available at: <http://www.cdc.gov/ncidod/dhqp/plg/surgicalsites.html>
- 6 Centers for Disease Control and Prevention. Guideline for Hand Hygiene in Health-

care Settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR 2002;51(No.RR-16)

7 Brown, D. C., Conzemius, M. G., Shofer, F., Swann, H. "Epidemiological evaluation of postoperative wound infections in dogs and cats." *JAVMA* 1997 May1;210(9):1302-6

8 "Sacred Cows: Hair Clipping Superior to Preoperative Shave" *OR Manager* 1990: 6(2):2

9 AORN Recommended Practices and Guidelines. Denver Colo: AORN Inc 2005:443-446

10 Surgical Site Infections. APIC Infection Control and Applied Epidemiology Principles and Practice. St Louis, Mo: Mosby Year Book; 1996:11-1.

11 3M Infection Prevention Newsletter Vol 2. Available at <http://multimedia.3m.com/mws/mediawebserver?333333SQa783cMj3wMj33jmYPuFiiiiH->

12 Alexander, J. W., Aerni, S., Plettner, J.P., 1985. "Development of a safe and effective one minute preoperative skin preparation" *Arch Surg* 120:1357-1361

13 Marwah, S. "Spirit induced cautery burns: an unusual iatrogenic injury" *The Internet Journal of Surgery* 2010 Vol 22, No 2.

13 Nicholson, M., Beal M., Shofer F., Brown D.C. " Epidemiological evaluation of postoperative wound infection in clean-contaminated wounds: A retrospective study of 239 dogs and cats" *Vet Surg* 2002 Nov-Dec 31(6): 577-81