The Preparation of the Surgical Site and the Disinfection of the Surgeon's Hands - Standards and their Implementation in a Field Setting

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Abstract

The economic and welfare impact of surgical site infections in bovine surgery should be considered and all measures of prevention applied. Bovine surgery most of the time implies a patient with high level of organic contamination, conscious and standing in a contaminated surgical theatre. All the more reason to commit to aseptic skin preparation. Time and economic considerations are often dictating the protocol and antiseptic products chosen when working in a field setting. Presently, no antiseptic or antiseptic protocol has been shown significantly better at reducing SSI rates in bovine surgery. The World Health Organization and the Centers for Disease Control and Prevention recommend the use of alcohol-based hand rubs for surgical preparation in human surgery. Despite most veterinary surgeons continue to use antiseptic soap scrubs, more studies on alcohol-based hand rubs use in veterinary surgery have appeared in the last decade showing similar efficacy. Nonetheless, not all alcohol-based products available on the market have been studied in veterinary surgery. When in a field setting, reduced preparation time, cost and water usage may be advantageous.

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The impact of surgical site infections (SSI) implies increased veterinary costs because of delayed wound healing, loss of production, prolonged hospitalization, increased use of antibiotics, possible enhanced resistance of microorganisms to antimicrobials, increased morbidity, and may result in fatal outcomes. Postoperative wound healing disorders and SSI have been reported respectively in up to 24.4% and 10.5% of clean standing flank laparotomies in cattle (1-4). Bacteria responsible for SSI may originate from the patient's skin flora, mucous membranes, or hollow viscera, or through contamination during surgery from contaminated personnel (hands of the operation team) or instruments.

Preparation of the Surgical Field

The modern concept of asepsis evolved during the 19th century with the British and American surgeons Joseph Lister and William S. Halsted. Lister introduced carbolic acid to disinfect instruments, surgical incisions, and wounds; his work led to a drastic reduction in postoperative infections. Halsted emphasized strict aseptic technique during surgical procedures by implementing the use of operating clothes, surgical site disinfection with alcohol, iodine or other disinfectants, and the use of drapes and gloves in the operating room.

The objective of the antiseptic preparation is minimizing the bioburden of cutaneous microflora on the surgical site prior to and during surgery to prevent SSI. Within 24 hours of closure, the surgical wound is resistant to microorganism entry, hence the critical time for risk of SSI development is the intraoperative period. Skin microflora can be divided in resident flora and transient flora. Pathogens causing SSI are often acquired from the patient's endogenous flora of the skin, mucous membranes, or hollow viscera. Even with appropriate antimicrobial prophylaxis, contamination of the surgical wound with greater than 10^5 microorganisms will lead to SSI and lower numbers may results in SSI in the presence of foreign material.

No evidence is available that hair removal has an impact on the incidence of SSI in human patients (5). However, this may not be true in veterinary surgery where patients have thick coats and hair removal is nearly always advised to improve contact of disinfectants with the skin. The method for hair removal should be carefully considered since the preservation of skin integrity is recognized as a crucial factor in the prevention of SSI. Shaving with razors, when compared with depilation or clipping, has been proved to cause microtrauma to the epidermis favouring therefore the growth of bacteria with SSI incidence rising from 0.6% to 5.6% (5-7). When shaving and clipping were compared prior to skin antisepsis for clean standing laparotomies in cattle, the incidence of dermatitis was 47.8% and 8.7% respectively (2). The timing of hair removal may also have an impact on frequency of SSI and clipping immediately before surgery is advised (5).

Veterinary patients, and large animals in particular, will present with higher levels of organic contamination compared to humans. Washing the surgical site prior to aseptic skin preparation is warranted to increase the efficiency of the actual aseptic step. Neutral or antiseptic soap rinsed with water should be used in this phase. Traditional skin disinfection protocols include scrubbing with brushes; however, scrubbing can create undesirable skin defects without increasing the efficacy of the procedure (8). The most important factors to consider for skin antiseptic preparation are the contact time of the active ingredient with the surgical site, and the concentration of the product.

No antiseptic or antiseptic protocol seems to be significantly better at reducing SSI than others, though, in human surgery, products containing alcohol appear to be superior to using aqueous medicated soaps (9). Aseptic preparation of the surgical site can be performed with various agents including chlorhexidine (CHX), povidone-iodine (PVI) and alcohol-based products. Each antiseptic will show different antimicrobial spectra; PVI for example is particularly active against methicillin-resistant *Staphylococcus aureus*, while CHX has shown reduced activity. When CHX and PVI, both in association with alcohol, were compared for skin preparation in bovine standing laparotomies, no difference in the frequency of SSI could be proved (1,2). Nonetheless, preparation with CHX and alcohol resulted in fewer CFUs (1,10).

Surgical practices in a field setting are often influenced by economic and time considerations. Despite, the standard rules of asepsis and skin preoperative preparation must be respected as surgical procedures are occurring in a contaminated surgical theatre, with the patient conscious, moving and defecating. When a 7-minute CHX preoperative skin preparation protocol using sterile one-use material was compared to an abbreviated 4-minute protocol using nonsterile reusable material, no

difference was found in CFUs reduction or SSI rate (3). While use of hydroalcoholic hand antiseptics could be tempting, these products are not adequate for patient's preparation as emollients in the formulations may interfere with proper wound healing.

Surgeon's Hands Disinfection

The first proof that hand disinfection could prevent infection was provided by a Hungarian doctor in 1847, Ignaz Semmelweis. After observing that women whose babies were delivered by students and physicians, who were also conducting autopsies, were more likely to develop fever and die compared to those treated by midwives, he imposed a new rule mandating chlorhine hand disinfection between each patient. The rate of deaths in the maternity unit fell dramatically and remained low thereafter. Unfortunately, Semmelweis encountered great difficulties in convincing colleagues of the benefit of this procedure and it was not until the 1980's that the Centers for Disease Control and Prevention (CDC) identified hand hygiene as an important way to prevent infection and published formal written guidelines.

The aim of surgical hand disinfection is to reduce the amount of superficial microbial flora on the hands, wrists, and forearms to reduce the risk of SSI via the hands of the operation team. The hands are carrying $4x10^4$ to $5x10^6$ bacteria and fungi per cm^2 and those of health care workers may become persistently colonized with pathogenic flora (e.g., *Staphylococcus aureus*). Veterinary patients are likely to have higher bacterial counts on their body surface than human patients, thus veterinary surgeons may carry higher contamination loads on their hands compared to their human counterparts.

Hand washing with soap and water has a clear, but limited and short effect on microbes' reduction. Surgical hand disinfection with antiseptic-containing preparation, reduces transient and permanent skin flora, therefore reducing the contamination of the surgical wound through any possible hole of the surgical gloves. In fact, a significant correlation has been reported between glove perforation and SSI in human surgery (11), as up to 10^6 bacteria may pass through tiny undetected holes during the period of surgery (12). The rates of glove perforation in veterinary medicine are similar to those in human surgery with at least one glove perforation per surgery in up to 66% of surgical procedures and only 25% of glove perforations detected intraoperatively by the wearer (13-15). Well-performed preoperative hand disinfection inhibits bacteria proliferation on the skin under the gloves and thus reduces contamination of the surgical wound through perforated gloves.

The World Health Organization (WHO) and the CDC recommend the use of alcohol-based products or antiseptic soaps for surgical hand preparation. Alcohol-based hand rubs appear to be at least as effective as antiseptic soaps, while preparation time, cost and water usage are reduced. A survey on surgical hand disinfection practices conducted among veterinary surgeons showed that 80% of respondents still use antiseptic soaps with most preferring chlorhexidine gluconate (16). The reason behind why surgical scrub with antiseptic soap is traditionally preferred in veterinary surgery may reside in the fact that veterinary surgeons, particularly those dealing with larger species, will have soiled hands before surgery. When compared, both chlorhexidine and povidone-iodine antiseptic soaps used in a 5-minute surgical scrub provided adequate reduction of bacterial colonization for 120 minutes after scrubbing, regardless the amount of contamination before hand disinfection (17).

Hand scrubbing may however damage the stratum corneum of the skin and may change the skin flora, resulting in more frequent colonization by staphylococci and gram negative bacilli. WHO and CDC promote alcohol-based hand rubs containing emollients and other skin conditioner as it may be more beneficial than antiseptic soap scrubs. Multiple alcohol-based gels or rubs with or without additional active agents are available on the market. These products vary according on the alcohol contained (ethanol, isopropanol, and n-propanol) as well as their concentration, with n-propanol seeming to be more effective against the resident bacterial flora. A alcohol-based product (Sterillium®) when compared to chlorhexidine and povidone-iodine antiseptic soaps, showed a better sustained, and immediate and sustained effect respectively (18). Another alcohol-based product containing 1% chlorhexidine (Avagard®) showed equivalent efficacy for preoperative hand antisepsis compared to the traditional chlorhexidine 4% scrub (19-21). A recent study emphasized the need of a standardized protocol to improve the efficacy of alcohol-based hand rubbing (22).

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