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Comparative clinical effectiveness of preoperative skin antiseptic preparations of chlorhexidine gluconate and povidone iodine for preventing surgical site infections in dogs

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ABSTRACT

Contamination of surgical sites often resulting from inadequate surgical site preparation and poor asepsis is a common cause of surgical site infection (SSI) and postoperative complications. Standard practice ensuring preoperative skin disinfection helps to prevent the incidence of SSI. The choice of antiseptic therefore poses a serious counterbalance for the surgeon. This study was carried out to determine whether skin asepsis immediately prior to surgical site incision will reduce skin microbial burden that may potentiate the incidence of SSI and to compare the clinical effectiveness of chlorhexidine gluconate B.P 0.3%W/V, Cetrimide B.P 3.05 W/V (CG + Cetrimide) against povidone iodine 10% (PI) in pre-surgical skin preparation and asepsis in dogs. A total of 15 dogs were used for the study. Both side of each dog was used for the study, right side for CG + Certrimide and left side for PI; (n = 30). Aseptic agents' chlorhexidine gluconate 0.3% and Cetrimide 3.0% and povidine iodine 10% were used as pre surgical scrub solutions prior to surgery. Swab samples were evaluated before scrubbing, 0, 30, 60 and 90 min after scrubbing. Percent reductions of bacterial colony forming units were determined for all site scrub techniques. Mixed-design ANOVA results revealed significant difference ($P < 0.05$) within groups and no significant difference ($P > 0.05$) in the disinfectant effects between groups treated with CG + Cetrimide and povidone iodine respectively across the various time periods. Changes in the mean bacteria count were observed to be equivalent using CG + Cetrimide and povidone iodine. It was concluded that there was no significant difference between CG + Cetrimide and PI in preoperative surgical skin preparations.

1. Introduction

Surgical site incision which is a common practice in invasive surgery, creates breaks in the integrity of the skin and subcutaneous tissues. This process does not only interfere with the physical defensive barriers of the patient; it also allow entry, contamination, multiplication and proliferation of infecting microorganisms. Inherently there is an accompanied risk of surgical site infection (SSI). Devastating outcomes culminating in post-surgical complications can be the result of infection of surgical sites by contaminating organisms due to poor surgical sites preparation or a total lack of surgical sepsis prior to surgery. Efficient and effective pre-surgical preparatory protocols and guidelines, with adequate infection control practices are essential for prevention of SSIs [1]. Inadequate surgical site disinfection and cleansing have been found to contribute not only to infections of surgical incision wounds, but also post-surgical infections, contamination of body cavities, tissues and organs and post-surgical complications such as osteomyelitis [2].

Specific infection prevention measures applied in surgery include a strict and well designed and implemented surgical asepsis protocol; which include the surgical environment, personal protective equipment such as surgical kits, gowns and scrubs, essential hand disinfection and adequate hygiene, proper sterilization and decontamination of anesthetic machines, adequate and proper use of peri-operative antimicrobial agents, and proper surgical site disinfection and management pre- and post-operatively [3]. In order to prevent nosocomial infections, the operative site should be prepared following standard, strictly adhered to aseptic rules without undermining preparatory surgical and post-operative clinical protocols [4]. Although it is impossible to sterilize skin without impairing its natural protective function and

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interfering with wound healing, good and efficient pre-operative skin preparation reduces the risks of surgical site infection [5]. The surgeon must bear in mind that instruments and surgical devices to be used will contact the skin and subcutaneous tissues of the animal and they must be appropriately and adequately sterilized to reduce and eliminate post-operative infections resulting from contaminated equipment. The surgical site (skin) should be washed thoroughly before scrubbing with appropriate antiseptic. The type and nature of antiseptic solution applied for scrubbing and preparation of the surgical site becomes a matter of choice for the surgeon. Scrubbing should be done thoroughly and adequately; taking care not to contaminate already prepared sites. While making sure the sites are free of debris and rinsed with alcohol or sterile water for at least three times or until site is free of visible debris. Most often antiseptic solution is painted onto the surgical site and allowed to dry [5].

The majority of post-surgical infections result from contamination of the surgical site with resident microorganisms from the patient skin [6]. Therefore, decontamination of the surgical site and prevention of contamination from other areas is the best means of preventing post-surgical infections. Studies have compared the efficacy of different types of antiseptic solutions used in the preoperative disinfection of surgical sites for the control of surgical site infections without considering the effect of preoperative skin asepsis [7,8]. Even though pre-operative management of the surgical site is very essential for successful surgical outcomes, there has been very little research in this area in veterinary surgery.

The primary goal of pre-surgical site decontamination and asepsis is the elimination of possible pathogens and reduction of possible invasion and colonization of surgical wounds by opportunistic organism without however compromising the animals' innate immunity [9]. Since a majority of surgical site infections are results of incision and are also localized to areas around the incision; optimal skin decontamination and asepsis prior to surgery most often results in a significant clinical benefit [10]. The choice of antiseptic solution often times creates an equipoise.

Knowledge of the efficacy of antiseptic solutions is important in making a final choice. The aim of this study however was to determine whether skin asepsis immediately prior to surgical site incision will reduce skin microbial burden and to compare the clinical effectiveness of chlorhexidine gluconate + Cetrimide (CG + Cetrmide) against povidone iodine (PI) for pre-surgical skin preparation and surgical asepsis in dogs.

2. Material and methods

2.1. Ethical approval

Ethical approval for the research and sample size was obtained from the State Veterinary Services Department Committee on Animal Use and Care (DT/VSDCAUC) before the commencement of the study.

2.2. Animals

Fifteen (15) adult dogs (6 males and 9 females) with average body weights of 18 kg ± 2SEM were used for the study.

2.3. Experimental design

Both sides of each dog were used for the study, right side for CG + Certrimide and left side for PI. Aseptic agents used were chlorhexidine gluconate 0.3% + Cetrimide 3% (Purit®, Saro Lifecare Ltd., Nigeria) and povidone iodine 10% (Wosan ® Solution, Jawa International Ltd, Nigeria). All experimental animals were housed in the state veterinary clinic and surgery kennels, Agbor, Delta State, Nigeria.

The experimental animals were maintained on a standard diet once daily with water *ad libitum*. The animals were stabilized for two weeks during which complete physical examinations were performed. All animals were taken to the surgery preparation area, anesthesia was applied with 1.1 mg/kg xylazine hydrochloride (VMD, Belgium) and 10 mg/kg ketamine hydrochloride (RotexMedica, Germany) intramuscularly after premedication with 0.04 mg/kg atropine sulphate (Hubei Tianyao Pharm. Co., China). Anesthesia was maintained with 10 mg/kg ketamine hydrochloride (RotexMedica, Germany) intravenously. Area of skin on both sides of 15 adult dogs were clipped with a sterilized electric clipper and sterile surgical blades; a very liberal area of both sides of each animal was clipped and clean shaved for surgery. A pre-surgical skin preparation was then performed to remove as much dirt and bacterial flora as possible. The clean shaved areas on both sides of the 15 adult anesthetized dogs were scrubbed using 0.3% chlorhexidine gluconate + 3% Cetrimide (CG + Cetrimide) on the right side and 10% povidone iodine (PI) on the left side from mid-line of the abdominal region of prepared sites for 5 min respectively. The scrubbing was performed in a circular manner starting at the proposed incision site and progressing circularly towards the periphery using cotton wool and sponges.

Swab samples ($n = 150$) were taken from the prepared sites at both sides, right side with CG + Cetrimide and the left side with PI ($n = 30$). Swab samples were evaluated before scrubbing, immediately after scrubbing, 30, 60 and 90 min after scrubbing. Sterile saline solution was prepared for serial dilution of the samples taken. A ten-fold serial dilution of each sample was made and 1 mL each of the serially diluted samples was spread plated on nutrient agar plates as described by Carter and Cole [11]. Plates were incubated for 3–5 days at 37 °C for optimum bacterial growth. Bacterial colonies were counted, and colony forming unit of each plate was calculated based on the dilution factor used. Plates having between 30 and 200 colonies were considered, while those with fewer than 30 and above 200 were excluded from the study. Bacterial colony forming units (CFU) were calculated for all site scrubbed and sampled.

2.4. Statistical analysis

The repeated measures ANOVA was used to determine any significant reduction in mean bacteria count using CG + Cetrimide and povidone iodine respectively over various time points. The bacteria colony count was used to estimate the disinfectant properties of each disinfectant at time 0, 30 min, 60 min and 90 min respectively. Assumption of sphericity of data source was checked using the Mauchley's test. Greenhouse-Geisser adjustment was reported where Mauchley's test of sphericity was significant. Main effects were compared with Bonferroni adjustment.

3. Results

The estimated marginal mean bacteria counts before and after application of both disinfectants are shown in Fig. 1 and Table 1. A repeated measures ANOVA with a Greenhouse-Geisser correction determined that the mean bacteria count differed significantly between time points, $F(1, 18) = 59.567$, $P < 0.001$ (Table 2). We concluded that the use of CG + Cetrimide and povidone-iodine causes a significant reduction in mean bacteria count following application and this reduction was significant at the various time points in the study. The reduction in mean bacteria count at 90 min was observed to be more with the use of CG + Cetrimide (722 ± 151) than with povidone-iodine (981 ± 151). However, the difference in the mean bacteria count following the choice of disinfectants was not statistically significant.