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Common Sources of Pre-, Peri- and Post Surgical Site Infections (SSI) in Dogs during Clinical Students' Surgical Practice

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Authors' contributions

This work was carried out in collaboration between both authors. Author ASY designed the study, wrote the protocol, managed the literature searches and wrote the first draft of the manuscript. Author NNP performed the statistical analysis and managed the analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Surgical site infections (SSI) are important complication of Veterinary surgery. Pre, intra-, and post-surgical procedures are considered to be associated with SSI. An attempt to characterize veterinary SSI in small animal surgery practical was made. 15 dogs were grouped into 5 groups (with each group consisting of 3 dogs), in which skin-defect correction, caudectomy, cystotomy, orchidectomy, or ovariohysterectomy were performed by veterinary students under the guidance of qualified surgeons. Blood samples were obtained pre- and post-surgery. 120 swabs were taken from the following sites; students' or surgeons' hands (pre-/post-scrubbing), surgical tables, dog skin, random areas on surgical packs, kennels, and floors of surgical theatre. The microorganisms isolated were as follows; *Staphylococcus aureus, Klebsiella* spp*, Micrococcus luteus, Enterobacter spp,* and *Bacillus subtilis,* with *Klebsiella* being the highest. Leukocytosis, neutrophilia, monocytosis, increased bands, leukocytopenia, neutropenia, and lymphopenia were observed, with

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all being signs of infection. This study showed that the sources of SSI were numerous, including the followings; the dogs' skin microflora, the students' hands, surgical theater, surgical team, and the kennel. Proper scrubbing techniques should be adopted and maintained. The sterile field created should be kept and proper disinfection of the kennel should be ensured before returning the dogs after surgery.

Keywords: Students; wet-lab procedures; infections; wounds.

1. INTRODUCTION

A surgical site is any part of a patient's skin where an incision is made in order to perform surgery Sanni et al. [1]. A surgical site infection (SSI) is an infection that occurs after surgery in the part of the body particularly the site where the incision was made Sanni et al. [1], at its most basic level. SSI is an infection that is associated with a particular operative procedure and the facility in which the procedure is performed CDC [2]. It is important to clearly differentiate SSI from inflammatory processes, infection present on admission, pre-surgical evaluation and other health care associated infections. Surgical site infections are a significant source of morbidity, mortality and costs associated with small animal surgery Nelson [3]. Surgical site infections are a burden to surgeons, the clients and the health care team. SSI lead to increased health care cost as a result of additional treatment, antimicrobial administrations and extended hospital stay which can be disturbing to patients and frustrating to clients Verwilghen and Singh [4]. SSI accounts for as many as one-fourth of nosocomial infections and are the most common source of infections generally in patients Cheadle [5]. Rates of SSIs are high particularly in developing countries with resource limited settings, absence of surveillance and prevention programs, most cases in veterinary clinics are not reported either because they are treated or considered insignificant, therefore retrospective data on SSI in veterinary practice in most developing countries appears underestimated.

The sources of SSI can be endogenous including but not limited to the patient's commensally micro biota originating from body fluids, the oropharyns, the skin and possibly, excretions like urine and feces, sources of infections can also be exogenous including the surgical team, the environment where patients are kept and or surgery performed and the surgical equipment used Cheadle [5]. A number of risk factors associated with SSI have been elucidated in previous studies, this includes the patient health status and the surgical environment, length and duration of anesthesia as well as the expertise and experience of the surgeons involved. Another important factor is the scope and intensity of post-operative care provided and availability of a robust surveillance program to improve patient care Lieber et al. [6]; Mukagendaneza et al. [7]. A variety of pathogens can cause SSI. The most common and representative bacteria in dogs include; *Staphylococcus aureus, S. pseudintermedius,* Methicillin Resistant *S. aureus* (MRSA) and extended spectrum beta-lactamse-producing enterobacteriaceae (ESBL) Verwilghen and Singh [4]. SSI is considered preventable with necessary measures put in place Verwilghen and Singh [4].

This study was undertaken therefore to investigate general sources and causes of surgical site infections on animal models used during wet lab procedures for clinical veterinary students, with a wider implication and application to in and outpatients post surgery. The study will determine the efficacy of the scrub solutions used during students' wet lab procedures as well as relative pre-surgical, perioperative and postsurgical conditions predisposing to SSI. Empirical design with potential to synthesize tested and credible data has the potential to improve patient management and reduce SSI-borne mortality. Findings will possibly standardize the wet lab procedures and general surgical etiquette amongst clinical veterinary students, their clinicians and various interns in the Veterinary Teaching Hospitals across Nigeria.

2. MATERIALS AND METHODS

2.1 Study Location and Research Animals

The study was carried out at the Veterinary Teaching Hospital, Usmanu Danfodiyo University, Sokoto, Nigeria. The institution is geographically located at the north-western part of Nigeria between latitudes 12° and 14°N and longitudes 4° and 6°E NPC [8].

Fifteen (15) apparently healthy local dogs (males and females) of mean ages 12 ± 0.3 months were purchased by combined team of the Department of Surgery and Radiology, Faculty of Veterinary Medicine; Usmanu Danfodiyo University Sokoto and clinical project students for students' wet lab procedures and graduating students research project. The surgical procedures performed on them were correction of skin defects, cystotomy, caudectomy, orchidectomy and ovariohysterectomy, representing commonest surgical cases handled in the clinic in all case loads.

2.2 Acclimation, Grouping and Collection of Pre-Surgical Samples

The animals were allowed to acclimate to their new environment. They were clinically examined for detectable abnormalities. Means of daily physical examination parameters (Temperature, Pulse and Respiratory rates) were recorded .Blood, faecal and urine samples were subjected to hematology, parasitology and urinalysis to rule out underlying infections or inflammatory conditions that might alter results.

Animals were grouped into five consisting of three dogs per group. The group corresponded with skin defects (Group 1), caudectomy (Group 2), cystotomy (Group 3), orchidectomy (Group 4) and ovariohysterectomy (Group 5). A total of 120 swab samples (i.e. swabs taken from the following sites; students' or surgeons' hands (pre-/post-scrubbing), surgical tables, dog skin, random areas on surgical packs, kennels, and floors of surgical theatre). Sixty (60) blood samples were collected from the dogs in the five different surgical groups. The blood samples were taken before and at graduated time intervals of two, four and seven days after surgery.

At the pre-surgical preparation room, blood samples were collected via the cephalic vein following the method of Gatley [9] into sample bottles containing an anticoagulant (EDTA) as well as faecal swab per rectum using a sterile swab stick (Micropoint Diagnostics Lot No: 151101), swab of shaved, cleaned but unscrubbed surgical sites and scrubbed sites were all done for all dogs and in all the groups.The swab samples were taken to the Microbiology Laboratory, Usmanu Danfodiyo University Sokoto for bacterial culture, isolation and identification of microbes to species level as described by Ruangpan and Tendencia [10]. The blood samples were taken to the Clinical Pathology Laboratory of the same university for haematological assay using standard protocols described by Lichtman et al. [11].

2.3 Premedication and Anaesthesia

The dogs were premedicated with atropine (Laborate Pharmaceuticals, India) at the dose rate of 0.02 mg/kg IM, then sedated with xylazine (Kepro, Holland) at the dose rate of 0.5 mg/kgIM; were induced and maintained with ketamine (Laborate Pharmaceuticals, India) at the dose rate of 10.0 mg/kg intravenously.

2.4 Bacterial Culture, Isolation and Identification

A total of one hundred and twenty swab samples (i.e. 24 per group; 8 per dog) were collected from the five dogs used for this research and for the five different surgical procedures (correction of skin defects, caudectomy (tail docking), cystotomy, orchidectomy in males or ovariohysterectomy in females, performed. The swab samples were taken before scrubbing and at graduated intervals of two days, four days and seven days after surgery from the surgical site. The organisms isolated from the swab samples after culture were identified based on size, shape and arrangement of colonies.

All the media used were prepared according to standard described by Cullimore [12]. All media were autoclaved and tested for sterility before use. Post inoculation, bacterial colonies were identified using Color Atlas of Diagnostic Microbiology Cullimore, [12] and confirmed using biochemical tests. First, samples were placed on nutrient agar at 30°C for 48 hours before being sub-cultured on MacConkey Agar. Resultant growth was further plated on Baird Parker agar and Eosin Methylene Blue agar (Oxoid) and incubated at 37°C for 24 hours with 5% CO_2 adjustment. Bacteria were identified in various media by morphological characteristics as reported by Kshikhundo and Itumhelo [13].

2.5 Data Analysis

One-way analysis of variance contained in SPSS 2011 was used to compare means of the controls and test values for each group to see dispersions. Values less than 0.05 were considered statistically significant.

3. RESULTS

The haematological findings revealed marked leucocytosis in the skin defect group four days post surgery as did the caudectomy group two days post operatively. Similarly, both cystotomy and ovariohysterectomy groups presented leukocytosis from post-surgical contamination. The ovariohysterectomy group recorded marked statistically significant decrease in haemoglobin concentration indicating anaemia during and two days post surgery putatively associated with hemorrhages intra-operatively and intermittent increases and decreases were observed in the mean values of RBC and WBC. Other findings across groups were slight eosinophilia, increased band cells and neutrophilia (Table 1).

Organisms identified were *S. aureus, Klebsiella* spp., *Micrococcus luteus, Enterobacter* spp., and *Bacillus subtilis* (Tables 2 and 3). *Staphylococcus aureus, Klebsiella* spp. and *Enterobacter* spp. were the most represented contaminants before scrubbing, their source likely miscellaneous. After scrubbing, *Klebsiella* persisted from undetermined miscellaneous sources. However, other previously present contaminants before scrubbing were not detected after scrubbing. Two days after surgery and during post operative follow up, *Klebsiella, Staphylococcus aureus* and *Enterobacter* spp. were isolated as contaminants of surgical sites without any significant association to any surgical group. The organisms were distributed in all surgical groups. Four days of post-surgical management present *Staphylococcus aureus, Klebsiella* spp., *Enterococcus* spp., and same microbial panel were isolated seven days post surgery except for addition of *Micrococcus* spp. The Contaminants presented a trend of persistence before and after scrubbing with Staphyllococcus being the most persistent and represented surgical site contaminant (Table 3).

4. DISCUSSION

The decreased hematocrit (PCV and Hb) concentrations should be anticipated in most surgeries. In a comprehensive cohort study on outcome of surgical patients, Seitas et al. [14] reported marked decrease in mean hematocrit from 42.01% to 36.78% 24 hours after surgery. This is consistent with the present study as the hemoglobin concentration was significantly ($P<0.05$) decreased in the OVH group, all other groups present slightly normal values albeit on the lower margin. The low Hb concentration in our study present before surgery and two days post surgery may be related to issues with nutrition or intraoperative bleeding associated with both elective and emergency invasive surgeries. Nurses and attendants must be knowledgeable about asepsis and resist the temptation to resort to antibiotic abuse.

The marked leukocytosis recorded in the orchidectomy, cystotomy and ovariohy-sterectomy is a probable indication of systemic inflammatory response (SIR) initiated when barriers to tissues are invaded. Mahmood et al.,[15] reported similar marked leukocytosis post operatively which is a marker associated with adverse postoperative outcome. In the present study, the leukocytosis with attendant neutrophillia two days post surgery for caudectomy and orchidectomy surgical groups, as well as four days post surgery for cystotomy and skin defects surgical groups may be an independent predictor of infection-related postoperative complication. This finding becomes more plausible and convincing when considered with the microbiological findings of patients in these surgical groups. Correspondingly, *Staphylococcus aureus* and *Klebsiella* spp known to be commonly found in surgical wounds as contaminants were isolated in all the surgical groups at virtually all phases of the procedures.

The most well established strategies to reduce the impact and complication of SSIs are preventative which entails boosting host immunity while decreasing wound contamination pre, intra and post surgery Nelson [3]. Surveillance of SSI rates including feedback to the surgical team has been shown to be an effective component of SSI reduction strategy Awad [16]. This fits into the research as scrubbing proved an indispensable in decreasing intraoperative and post surgical contamination. Contaminants associated with patient's microflora: *Staphylococcus aureus, enterobacter spp,* and *Bacillus subtillis* were all destroyed during scrubbing except for *Klebsiella* that persisted intraoperatively post scrubbing.

A survey performed amongst human surgeons reported 63% did not comply with the current recommended guideline on pre-operative bathing, hair removal, antimicrobial prophylaxis, and intraoperative skin preparations as well as continuous scrubbing Davis et al. [17]. Similar unsatisfactory compliance was reported (Davis et al. [17] amongst surgeons in a recent comprehensive survey amongst small animal surgeons and clinicians which reported that

Table 1. Haematological indices for various common surgical procedures in small animals

	Groups		PCV (%)	Hb (g/dl)	RBC ((10^6/mm^3)	WBC (×10^3/mm^3)	N (×10^3/mm^3)	L (×10^3/mm^3)	M (×10^3/mm^3)	E (×10^3/mm^3)	B (×10^3/mm^3)	Ba (×10^3/mm^3)
Skin Defect	1	DA	34±0.20	12±0.80	5.34±0.20	10.50±0.20	7.98±0.07	1.89±0.80	0.32±0.06	0.32±0.30	0.00	0.00±0.00
		DB	30±0.30	10±0.20	4.51±0.40	15.95±0.80	13.24±0.40	1.60±0.30	0.48±0.40	0.00±0.00	0.00	0.64±0.50
		DC	28±0.06	9±0.30	3.18±0.20	60.78±0.40	46.80±0.06	2.43±0.10	4.25±0.20	0.00±0.00	0.00	7.29±0.10
		DD	31±0.08	10±0.70	4.89±0.10	10.85±0.30	4.12±0.08	4.56±0.50	1.19±0.07	0.11±0.40	0.00	0.87±0.40
Caudectomy	2	DA	37±0.06	12±.20	4.49±0.40	20.10±0.20	12.46±0.30	4.62±0.30	1.41±0.30	0.60±0.60	0.00	1.01±0.80
		DB	22±0.23	7±0.05	5.08±0.70	21.90±0.70	17.08±0.60	3.94±0.40	0.22±0.70	0.00±0.00	0.00	0.66±0.30
		DC	33±0.07	11±0.06	2.82±0.20	13.10±0.40	8.65±0.30	4.06±0.40	0.13±0.25	0.13±0.80	0.00	0.13±0.40
		DD	33±0.10	11±0.20	4.29±0.10	9.23±0.80	3.88±0.20	4.98±0.50	0.37±0.30	0.00±0.00	0.00	0.00±0.00
Cystotomy	3	DA	39±0.55	13±0.10	5.93±0.30	21.90±0.20	18.40±0.20	0.44±0.20	0.88±0.70	0.00±0.00	0.00	2.19±0.40
		DB	24±0.40	8±0.06	3.79±0.20	17.60±0.60	11.62±0.10	4.75±0.40	0.88±0.30	0.00±0.00	0.00	0.35±0.50
		DC	23±1.06	8±0.70	3.36±0.30	22.85±0.50	17.14±0.20	4.57±0.70	0.69±0.20	0.23±0.20	0.00	0.23±0.20
		DD	25±0.06	8±0.20	4.18±0.30	7.25±0.40	4.71±0.10	1.81±0.30	0.36±0.60	0.00±0.05	0.00	0.36±0.40
OCH	4	DA	33±0.07	11±0.10	4.65±0.80	13.85±0.01	9.97±0.20	3.05±0.50	0.14±0.40	0.14±0.50	0.00	0.55±0.60
		DB	30±0.24	10±0.10	4.18±0.30	27.93±0.30	20.95±0.10	4.47±0.20	0.84±0.05	0.00±0.00	0.00	1.68±0.07
		DC	30±0.06	10±0.40	4.73±0.10	12.50±0.06	7.75±0.40	1.25±0.40	0.75±0.70	0.00±0.00	0.00	2.75±0.60
		DD	28±0.08	9±0.60	4.70±0.20	2.95±0.30	1.06±0.30	1.53±0.60	0.18±0.30	0.00±0.00	0.00	0.18±0.40
OVH	5	DA	38±0.21	13±0.01[a]	5.30±0.10	8.88±0.10	3.37±0.30	4.88±0.30	0.27±0.60	0.00±0.00	0.00	0.36±0.20
		DB	34±0.05	11±0.03[a]	5.14±0.40	1.30±0.40	0.30±0.80	0.78±0.30	0.22±0.40	0.00±0.00	0.00	0.00±0.40
		DC	35±0.05	12±0.10	4.29±0.05	18.75±0.30	9.38±0.10	6.75±0.20	0.56±0.60	0.19±0.50	0.00	1.88±0.10
		DD	34±0.10	11±0.07	5.31±0.01	15.85±0.09	9.83±0.10	4.12±0.70	0.48±0.80	0.48±0.60	0.00	0.95±0.20
	Ref. Values		**36-55**	**12-18**	**5.4-8.5**	**6-18**	**3-12**	**1-5**	**0.2-1.5**	**0.1-0.8**	**0.0-0.0**	**0.0-3.0**

KEY: PCV- Packed cell volume, Hb- Haemoglobin concentration, RBC- Red blood cells, WBC- White blood cells, N- Neutrophils, L- Lymphocytes, M- Monocytes, E- Eosinophils, B- Basophils, Ba- Band cells, OCH-Orchidectomy, OVH-Ovariohysterectomy, [a] Statistically significant. DA- before surgery, DB- 2 days after surgery, DC- 4 days after surgery, DD- 7 days after surgery, [a] Statistically significant

Table 2. Temporal relationship between surgical site contaminants and various commonly performed procedures in small animals

Skin defects	Tail docking	Cystotomy	Ovariohysterectomy	Orchidectomy
DA- *S. aureus*	DA- *Klebsiella* spp.	DA- *Enterobacter* spp.	DA- *Staphylococcus aureus.*	DA- Klebsiella spp.
DB- No growth	DB-No growth	DB- No growth.	DB- *Enterobacter* spp.	DB- *Klebsiella* spp.
DC-*Klebsiella* spp.	DC- *S. aureus*	DC- *Klebsiella* spp.	DC- *Enterobacter* spp.	DC- *Enterobacter* spp.
DD- No growth	DD- *Bacillus subtilis*	DD- *Klebsiella* spp.	DD- *Enterobacter* spp.	DD- *Staphylococcus aureus*
DE- *Staphylococcus aureus*	DE- *Bacillus subtilis*	DE- *Bacillus subtilis*	DE- *Micrococcus luteus*	DE- *Staphylococcus aureus*

Key: DA-before scrubbing, DB- after scrubbing, DC- 2 days after surgery, DD- 4 days after surgery, DE- 7 days after surgery

Table 3. Frequency of Surgical Site contaminants isolated in experimented commonly performed procedures in small animals

Organisms	Frequency of isolation
Bacillus subtilis	19
Enterobacter spp.	17
Klebsiella spp.	30
Micrococcus luteus	13
Staphylococcus aureus	27

compliance was only 14% and that only 3% consistently performed hand wash before and after patient contact. Probable cause(s) for negligence amongst veterinarians may be due to caseloads amongst private veterinarians motivated for profit making in some instances, lack of standard facility for hand disinfection amongst suburban and rural veterinary government clinics in developing countries, and antimicrobial abuse by clinicians whom assume eventual infection has been and can be controlled with antibiotics.

Most surgeons of companion animals were inconsistent in implementing asepsis guidelines and often, poor compliance is given to standard and well-established surgical preparation practices Anderson et al. [18]. Surgical asepsis prevents wound contamination originating from the patient or the environment of the patient Verwilghen and Singh [4]. If post surgical infection must be reduced then the surgical team must enforce standard aseptic guidelines for every surgery. Data from this study showed surgical patients are hosts to numerous bacterial genera which may be normal flora on parts of patients. Generally, *Staphylococcus aureus, Klebsiella* spp.*, Enterobacter, Bacillus subtillis* and M*icrococcus* spp. were the organisms isolated as potential contaminants pre and post surgery. *Klebsiella* spp. and *Enterobacter* spp. were isolated after scrubbing, there is invariably, the chance that surgical field is contaminated just after shaving and before scrubbing, this risk extends even to scrubbed sites. It is critical therefore, for scrubbing to be impeccable and detailed in theatre protocols for strict compliance amongst interns; these become imperative in the Veterinary Teaching Hospitals where students are undergoing training.

Several surgical reports have shown a temporal relationship between interventions and enforced compliance to hand washing hygiene and reduction of SSI Thu et al. [19]. Outside the closed operating room, transmission of microbial pathogens via the hands of health care providers such as animal nurses and handlers is possible and has contributed to the high incidence of SSI in veterinary medicine Thu et al. [19]. There is no substitute to hands scrubbing hygiene in the reduction of SSI. It is therefore regarded as one of the most effective strategy in reducing and preventing nosocomial and surgical site infections in veterinary medicine. This was evident from the study as only *Klebsiella* spp persisted after hand scrubbing amongst five genera of bacterial contaminants. It is important to thoroughly use highly potent scrub solutions and employ thorough scrubbing technique.

Current widespread consensus recommendation for prevention of SSI elaborated three preventive measures proven to improve patient care if implemented. These measures include: surgical hand preparation, appropriate antimicrobial prophylaxis and post-surgical care available Uçkay et al. [20]. There are a number of simple and low cost interventions with high impact and potential for preventing SSIs. Surgical etiquette, often glossed as insignificant is critical for patients post surgery. It is unlikely that surgeons will not maintain traditional surgical attire: gloves, mask, gown, drapes and host of others. Talking intraoperative, receiving visitors in theaters, changing surgeons intraoperative are all major risks and violations of etiquette responsible for high incidence of SSI in small animals. The World Health Organization stated a simple act of hand hygiene is considered a pillar for prevention of spread of infectious diseases WHO, [21]. Knowledge about standard pre-surgical hand preparation is debatably low in veterinary practice in Nigeria, especially in rural places where trained veterinarians habitually become negligent for lack of standardized monitoring and regulatory policies. The pathogens isolated in the research are common contaminants found on fomites, sometimes as normal flora on skin of medical personnel or around the operating room. These pathogens may likely have been from hands contamination. A recent survey of human and small animal surgeons surprisingly reported surgeon's behavior in the operating theater does not necessarily correlate with their scientific knowledge, resulting to low compliance and creating risks to patients Anderson et al. [19]. An enforceable consensus must be determined and red lines drawn for minimum compliance at all levels of health care provision for all surgical procedures.

Every surgery is open to complications depending on the scope and intensity of post surgical care available. Types of post-surgical complications may include wound infection, wound dehiscence, haemorrhages, septicaemia (fever), intestinal obstruction, oedema, myiasis, shock and death. These complications may be avoided through proper pre-surgical evaluation, aseptic techniques during surgical procedures and post-operative care Barie [22]. Post-surgical care remains a strong determinant of prognosis for both invasive and non-invasive surgeries. Most pathogens contaminants were detected 4 days post surgery indicating poor post surgical care on the average available in most veterinary establishments in Nigeria. There was seldom contamination of surgical sites for most procedures studied two hours post scrubbing. Data from the study showed *Staphylococcus aureus* was persistent at pre, perioperative and postoperative phases of the study. Clinicians are therefore to anticipate this trend in most surgeries. More and wider research to investigate antimicrobial resistance (AMR) and resistance to scrub solutions by isolates of *Staphylococcus* and *Klebsiella* species should be conducted in other studies to enumerate reasons.

A very effective scrub solution will kill a good number of microbes on the skin before an incision is made thereby reducing the microbial load and reducing the chances of an infection occurring Reichman and Greenberg, [23]. Scrubbing to reduce contamination and improve prognosis and rapid recovery has been an old concept but scarcely implemented for all cases in developing countries. It was evident from this research scrubbing is indispensable and amongst core practices to prevent sepsis and assure better patient recovery. Before scrubbing, in group 2 (caudectomy), *S. aureus* was isolated from the swab sample, which is a normal skin flora. After scrubbing, *Klebsiella* spp. was isolated; this means that *Klebsiella* spp. was introduced into the surgical site during scrubbing after the scrub solution removed *S. aureus* from the site. This can be attributed to improper scrubbing techniques. *Klebsiella* spp. persisted at the surgical site post-surgery because it was isolated from the site again two days after the surgery, along with *M. luteus,* four and seven days after the surgery. *Klebsiella* spp. and *M. luteus* are opportunistic organisms that might have contaminated the environment from probable causes like urine, faeces, or nasal discharges Roberts et al. [24].

Most procedures had no microbial contamination the few hours post scrubbing, contamination originating from surgical team, theatre hardware, the environment and the recovery rooms as well as the kennels are the commonest cause of infection and complications after surgery. Post surgically the use of proper restraint methods e.g. collars is important because with no restrain the patient can remove the sutures with its teeth, predisposing the surgical site to infection Turk et al. [25]. The anaemia was attributed to the blood lost during the surgery, while neutrophilia and leukocytosis are signs of ongoing infection as a result of stress of surgery or contamination of surgical site 4 days post-surgery.

5. CONCLUSION

The study provided empirical evidence of sources of SSI in veterinary surgery, the result will also apply to most clinics engaged in common surgical procedures. Genera of microbes isolated include *B. subtillis, Klebsiell* spp*., Enterobacter* spp*., M. luteus, S. aureus. Klebsiella* spp*.* presented the highest frequency as common contaminant of surgical site. Severe anemia resulted from ovariohysterectomy, it was however, expected since surgery was invasive. Scrubbing with standard solution reduced incidence of SSI during surgery, there is a predictable outcome that infections can be minimized and complications prevented with impeccable scrubbing and post-surgical care.

ETHICAL APPROVAL

Guidelines provided in the Veterinary Surgeons Act Cap V3 LFN 2004 as amended were observed on animal use and care. Experimental animals were allowed to recover fully and drug withdrawals allowed. The animals were afterwards kept at the pens of the Department of Veterinary Surgery for undetermined future use.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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