



Antibiotic Use in Veterinary Surgery: Perioperative Practices and Associated Factors in Kenya

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ABSTRACT

Antibiotics are extensively used in animals undergoing surgery to prevent surgical site infections (SSIs) and improve surgery outcomes. The current study aimed to evaluate perioperative practices among Kenyan veterinarians and determine their correlation with perioperative antibiotic administration. The present study employed a cross-sectional survey design, in which a structured questionnaire was distributed to veterinarians in Kenya who were registered with the Kenya Veterinary Board. Detailed information on respondents' demographics, types of surgical procedures, perioperative practices, antibiotic usage patterns, and the incidence of SSI were collected. Eighty-three veterinarians participated in the study from January 1, 2023, to June 30, 2023, comprising 48 (57.8%) males and 35 (42.2%) females. The average number of surgeries performed monthly was 8.7, primarily elective and reconstructive procedures. Hand scrubbing before surgery was widely practiced (86.7%); However, only 42.2% adhered to recommended techniques, which include using a scrub solution followed by 70% ethyl alcohol disinfection. The primary sterilization methods were chemical immersion (49.4%) and autoclaving (37.5%). The majority of respondents (85.5%) considered antibiotic use optimal, primarily based on their personal experience (74.7%). Antibiotics were predominantly administered postoperatively (67.5%) and were highly likely to be used in contaminated, dirty, and emergency surgeries. Penicillins and cephalosporins were the most commonly used antibiotic classes perioperatively. Antibiotic usage was notably correlated with the surgeon's educational background, routine hand scrubbing, and adherence to ideal scrubbing protocols. The present study highlighted the existing perioperative antibiotic practices and identified main risk factors for antimicrobial misuse among veterinarians in Kenya.

Keywords: Antibiotic use, Infection, Antimicrobial resistance, Surgery, Veterinarian

INTRODUCTION

Antimicrobial resistance (AMR) is a growing global health challenge affecting both humans and animals, identified as one of the top ten threats to public health worldwide (CDC, 2020; WHO, 2020). Given the widespread and often indiscriminate use of antibiotics, antimicrobial resistance may emerge as the next global pandemic unless immediate and effective measures are implemented (Eshrati et al., 2025). A recent World Bank model predicted that by 2050, drug-resistant infections may lead to substantial economic losses and a sharp rise in mortality (World Bank, 2017). In veterinary medicine, antibiotics are commonly used to treat bacterial infections and prevent complications such as surgical site infections (SSIs); however, the misuse or overuse of antibiotics can accelerate AMR (Weese et al., 2015; Cavalli et al., 2025). A recent study found that antibiotics are administered to animals predominantly for metaphylaxis or growth promotion, thereby directly contributing to the emergence of resistant pathogens such as *Salmonella* and *Campylobacter* species (Vasantha et al., 2025). The non-therapeutic application of antibiotics leads to antibiotic-resistant pathogens, thereby compromising critical treatments for animal health and productivity and posing a risk to human health (Adesokan et al., 2022).

In small animal surgery, antibiotics are routinely administered prophylactically to reduce the risk of SSIs (Cavalli et al., 2025). Despite the advantages of antibiotics, there is a growing concern about the lack of standardized guidelines, particularly in regions such as Africa, where the high prevalence of multidrug-resistant pathogens and limited diagnostic resources necessitate effective stewardship (Adekanye et al., 2020; Odoi et al., 2021). Numerous high-income countries have developed and/or implemented evidence-based veterinary perioperative antibiotic protocols, including those from the World Small Animal Veterinary Association (WSAVA) and the International Society for Companion Animal Infectious Diseases (ISCAID), to promote antimicrobial stewardship (Weese et al., 2019; Frey et al., 2022). These guidelines are established based on species-specific responses, appropriate dosing based on pharmacokinetic-pharmacodynamic (PK/PD) targets, and emphasize the critical importance of administering within one hour prior to



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incision (Pelligand et al., 2024). In countries such as Kenya, where there are no locally validated frameworks, veterinary practitioners often depend on outdated texts or directly replicate protocols from disparate geographic regions. These practices might not properly address local antimicrobial resistance patterns, accessible drug formularies, or endemic pathogens (Odoi et al., 2021; Ogwuche et al., 2021).

Although guidelines exist, perioperative antibiotics are frequently misused or overused in veterinary medicine because of misinterpretation or incomplete risk assessment. Prophylactic antibiotic use should be based on the type of surgery and patient-specific factors (Sørensen et al., 2024). Concerns about prolonged surgical durations, breaches in aseptic technique, or inadequate case preparation are frequently addressed with excessively prolonged antibiotic protocols rather than by addressing the underlying technical or environmental issues (Grubb et al., 2020; Garcia Stickney et al., 2022). Antibiotics should not replace surgical management. It is more effective to control factors such as surgical duration, intraoperative contamination, and post-operative care by improving surgical practices and protocols (Weese et al., 2015). The misuse ultimately contributes to antimicrobial resistance, increasing the threat to both animal and public health (Weese et al., 2015; Odoi et al., 2021). The aim of the present study was to assess current perioperative antibiotic use practices among veterinary surgeons in Kenya and to identify key factors that influence antibiotic use.

MATERIALS AND METHODS

Ethical approval

Ethical approval was obtained from the Faculty of Biosafety, Animal Use and Ethics Committee, University of Nairobi, Nairobi, Kenya (FVM BAUEC/2023/630).

Study design

The present study was a cross-sectional study carried out between January 2023 and June 2023. The sample size was calculated using Formula 1 for estimating a single proportion in a cross-sectional study (Stevenson, 2021).

$$N = \frac{Z^2 \cdot p \cdot (1-p)}{d^2} \quad (\text{Formula 1})$$

Where n is the initial required sample size, Z is the standard normal deviate corresponding to the desired confidence level, assuming a 95% confidence level, a margin of error of $d = 5\%$, and an expected proportion of $p = 50\%$. The calculation yielded an initial sample size of 384. Since the total number of registered veterinary clinics in Kenya was approximately 100, a finite population correction was employed, leading to a minimum required sample size across approximately 80 clinics. All eligible clinics were selected to maximize participation and enhance representativeness (Stevenson, 2021).

Veterinary clinics and surgeons' selection

Sampling was conducted at the clinic level rather than the individual veterinarian level because perioperative antibiotic practices were influenced by clinic-specific protocols, available resources, and institutional norms. Furthermore, with only around 100 registered veterinary clinics in Kenya, selecting clinics at the individual level was more feasible and enabled coverage of a wider range of geographic areas and practice types. When multiple veterinarians were present at a clinic, clinic management selected one respondent directly involved in perioperative decision-making to avoid clustering effects and overrepresentation of individual clinics.

To achieve targeted sampling, a list of all registered and active small animal veterinary practices in Kenya was obtained from the Kenya Veterinary Board. Formal invitations to participate in the study were sent to the head veterinarian at each clinic. A total of 112 veterinary clinics across Kenya were invited to participate in the study. The aim of the survey was to purposively interview at least one veterinarian at each veterinary clinics in Kenya. Questionnaires were distributed through Google Forms to veterinarians who provided consent to participate in the study. The Google Forms remained accessible for six months, with bi-weekly reminders sent to all veterinarians who had not yet completed and returned the questionnaires.

Data collection

Data on knowledge and practices toward antibiotic use in the perioperative period were collected using an established questionnaire. The questionnaire was distributed to a licensed veterinarian employed at a recognized veterinary clinic in Kenya. The questionnaire was divided into four sections and included both closed-ended and a few open-ended questions. Section 1 included questions to collect respondents' demographics, such as gender, qualification level, years of practice, and monthly surgical procedures. Section 2 focused on perioperative surgical practices, including scrubbing methods, sterilization of surgical instruments, and aseptic preparation. Section 3 was the pivotal part of the

questionnaire and aimed at collecting data on antibiotic use across different surgical procedures, preferred antibiotic groups, timing and duration of administration, knowledge of and relevance to perioperative prophylactic antibiotics, and sources of information on antibiotic use in surgical patients. Lastly, Section 4 focused on knowledge of postoperative surgical site infections. The questionnaire was pretested, and its questions were refined before distribution to veterinarians. Additionally, the questionnaires were serialized to identify respondents, particularly those who preferred to remain anonymous.

Data analysis

Data were initially entered into Microsoft Excel 2010, coded, and imported into Stata 15.1 software for statistical analyses. For categorical variables, proportions were calculated; for continuous variables, the range, standard deviation, mean, mode, and median were computed.

To identify factors associated with perioperative antibiotic use, a multilevel mixed-effects logistic regression analysis was used. Antibiotic use was considered ideal when the veterinarian selected optimal use, and suboptimal when the veterinarian selected either underuse or overuse. Ideal perioperative antibiotic use was coded as 0, while suboptimal use was coded as 1. Univariable regression analysis was initially performed to assess the associations between all predictor variables and antibiotic use. All variables with $p \leq 0.3$ were then included in the multivariable logistic regression. Initially, correlations between predictor variables were evaluated using pairwise correlations. The final model was then fitted manually using backward stepwise elimination, retaining predictor variables with P-values of 0.05 or less. Plausible biological interactions between significant explanatory variables in the final model were analyzed. The overall performance of the model was evaluated using the area under the receiver operating characteristic curve (AUC).

Final multivariate logistic regression model checking was conducted to assess whether the model fit the data. The goodness-of-fit test was performed with Pearson chi-square ($P \geq 0.05$) and was considered acceptable; when the fit was not acceptable, the covariate patterns were restricted to 10, and the Hosmer-Lemeshow chi-square test was conducted. Overall predictive ability was assessed by evaluating the model's sensitivity and specificity, and a receiver operating characteristic curve was generated. Multicollinearity was assessed using the variance inflation factor, with values equal to or less than 10 (≤ 10) considered acceptable.

RESULTS

The demographic of the respondents

The questionnaire was distributed to 112 veterinarians; however, only 83 veterinarians provided consent and completed the questionnaire, resulting in an overall response rate of 74.1% (Table 1). Of the 83 respondents, 48 (57.8%) were male, and 35 (42.2%) were female. Regarding education, 80.7% (67/83) of respondents had only a Bachelor of Veterinary Medicine degree, while the remaining respondents (16/83) had attained postgraduate training at the Master's or Doctoral level. Most respondents had 2-5 years of clinical practice experience. Additionally, 50.6% (42/83) of the veterinarians were involved in mixed-animal practice, while 41% (34/83) and 8.4% (7/83) were exclusively in small- and large-animal practices, respectively.

Table 1. Demographic profile of the veterinarians who participated in the study between January and June 2023, Kenya

Demographic	Category	Number of respondents (n = 83)	Percentage of the respondents (%)
Gender	Male	48	57.8
	Female	35	42.2
Level of study	Undergraduate	67	80.7
	Postgraduate	16	19.3
Country of training	Kenya	81	97.6
	Outside Kenya	2	2.4
Duration in practice	< one year	18	21.7
	2 – 5 years	41	49.4
	6 – 9 years	16	19.3
	>10 years	8	9.6
Type of practice	Mixed practice	42	50.6
	Small animal practice	34	41.0
	Large animal practice	7	8.4

Surgical practices among the respondents

Type and frequency of surgical procedures

The median number of surgeries per practice in a month was 5, with a range from 1 to 100 and an IQR of 7. When the respondents were asked to indicate the types of surgeries, they had frequently performed in the last six months, elective procedures such as spays and castrations were the most commonly mentioned, with 43 out of 83 respondents citing these surgeries. The elective surgeries were followed by reconstructive surgeries (42/83), orthopedic surgeries (5/83), and abdominal and emergency surgeries (2/83), while ocular and neurological surgeries were each reported by one respondent (Figure 1).

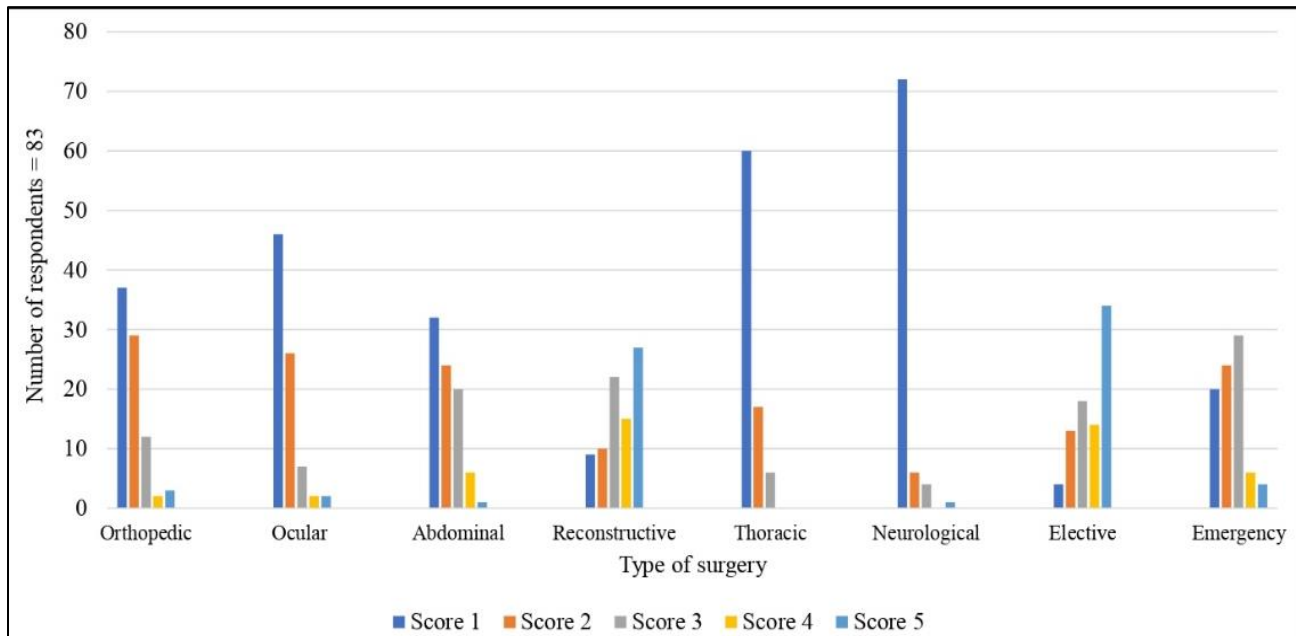


Figure 1. Different types of surgical procedures performed by veterinarians in Kenya between January and July 2023. Score 1: Very low, Score 2: Low, Score 3: Moderate, Score 4: High, Score 5: Very high

Anesthesia and analgesia practices

Most respondents reported using alpha-2 adrenoceptor agonists (90.4%; n = 75) and cyclohexamines (67.5%; n = 56) as common anesthetic agents during surgery. In contrast, benzodiazepines and opioids were rarely used, with only 10.8% (n = 9) and 7.2% (n = 6) of respondents, respectively. Regarding pain management, 55.4% (46/83) of respondents always administered analgesics to surgical patients, 37.3% (31/83) administered them based on the type of surgery, and 7.2% (6/83) did not administer them perioperatively. The most commonly used analgesics were non-steroidal anti-inflammatory drugs (65.1%), followed by corticosteroids (19.3%), drug combinations (7.2%), opioids (6.0%), and local analgesics (2.4%). Regarding the preferred timing for analgesic administration, 51.8% preferred giving analgesics before and after surgery, 34.9% preferred administration postoperatively, and 13.3% preoperatively only.

Preparation for aseptic surgery

The majority of respondents (86.7%) scrubbed their hands prior to a surgical procedure, with 41.0% scrubbing meticulously using a scrub solution, followed by disinfecting their hands with 70% ethyl alcohol. Furthermore, 48% of respondents consistently wore a head covering, 48% utilized a face mask, and 71% wore sterile surgical gloves during surgical procedures. The additional prevalent preoperative surgical practices are summarized in Table 2. Overall, 95.2% (n = 79) of respondents consistently sanitized the surgical site prior to aseptic procedures. The majority of respondents meticulously scrubbed the operative field with a scrub solution and then disinfecting the site with 70% ethyl alcohol. Furthermore, 77.1% (n = 64) of respondents were involved in draping the surgical site, and 97.6% (n = 81) utilized sterilized surgical instruments. The predominant sterilization method for surgical instruments was chemical immersion (49.4%), followed by autoclaving (37.4%) and boiling (13.3%; Table 2). Regarding surgical infrastructure, 96.4% (80/83) of the practices had a room dedicated solely to patient preparation, while only 65% had a room dedicated solely to surgery. Surgical theatres were mainly disinfected after every surgery, as stated by 39.8% of the respondents (Table 2).

Table 2. Perioperative practices among veterinary clinicians in Kenya between January and June 2023

Perioperative practice	Category of the perioperative practice	Number of respondents (n = 83)	Percentage of the respondents (%)
Hand scrubbing	Do not scrub hands	11	13.3
	Always scrubs hands	72	86.7
Hand scrubbing technique	Disinfect my hands with alcohol	2	2.4
	Always scrub thoroughly using a scrub solution like chlorhexidine	18	21.7
	Scrub thoroughly using the scrub solution and disinfect the hands with alcohol	35	42.2
	Wash my hands using soap/hand wash solutions and disinfect my hands with alcohol	28	33.7
Use of head cover	Do not adorn a head cover	48	57.8
	Always adorn a head cover	35	42.2
Use of face mask	Do not wear a face mask	35	42.2
	Always wear a face mask	48	57.8
Use of sterile gloves	Do not wear sterile gloves	12	14.5
	Always wear sterile gloves	71	85.5
Scrubbing of surgical site	Do not scrub the surgical site	4	4.8
	Always scrub the surgical site	79	95.2
Draping of surgical Sites	Do not drape surgical site	19	22.9
	Always drape surgical site	64	77.1
Use of sterile surgical equipment	Do not use sterilized instruments	2	2.4
	Always use sterilized instruments	81	97.6
Sterilization method	Autoclave	31	37.4
	Boiling	11	13.2
	Chemical sterilization	41	49.4
Clinic has a dedicated surgical theatre	Yes	54	65.1
	No	29	34.9
Disinfecting surgical heaters	Never	10	12
	Twice per year	3	3.6
	Every 3 months	4	4.8
	Monthly	7	7
	Weekly	11	13.3
	Daily	15	18.1
	After every surgery	33	39.8

Antibiotic use perioperatively

The majority of veterinarians (85.5%) rated their perioperative antibiotic use as optimal, and only 6% (n = 5) reported overuse. Regarding the factors influencing perioperative antibiotic use and selection, 74.7% (n = 62) of respondents indicated that their prior knowledge and experience played important roles, while 37.3% (n = 31) used culture and sensitivity results (Table 3). Antibiotics were administered primarily postoperatively (67.5%), with the primary goals of prophylaxis and therapy, as reported by 66.3% (n = 55) of respondents. Furthermore, 59.1% (n = 49) of veterinarians either agreed or strongly agreed that administering an antibiotic was unnecessary when meticulous perioperative asepsis was carried out (Figure 2).

A general trend was observed in the frequency of antibiotic use across different surgical procedures. The utilization of antibiotics was more prevalent in contaminated surgical procedures compared to clean surgeries. In clean surgeries, the most frequently preferred classes of antibiotics were penicillin and tetracycline, which were cited by 68.7% and 12% of respondents, respectively. In clean-contaminated surgeries, penicillin emerged as the most commonly mentioned class, accounting for 69.9% of responses, while sulfonamides, tetracycline, and cephalosporins were each noted by 6%. Among contaminated surgeries, cephalosporins were the most commonly used antibiotic class (Table 4).

The frequency of antibiotic use during specific surgical procedures, indicated that the highest usage was observed in emergency surgeries at 49.2% (n = 41), followed by reconstructive surgeries at 43.2% (n = 36), abdominal surgeries at 38.4% (n = 32), thoracic surgeries at 36% (n = 30), and orthopedic surgeries at 33.6% (n = 28; Figure 3).

Penicillin was the most preferred class of antibiotics in elective, emergency, and reconstructive surgical procedures, as indicated by 74.7% (n = 62), 59.0% (n = 49), and 57.5% (n = 46) of the respondents, respectively. In ocular surgeries, respondents predominantly favored penicillin at 32.1% (n = 26), followed by aminoglycosides at 21% (n = 17), and antibiotic combinations at 16.0% (n = 13). Furthermore, penicillin, sulphonamide, and antibiotic combinations were the preferred antibiotics for application in abdominal surgeries. Moreover, 38% (n = 30) of the veterinarians preferred penicillin for orthopedic procedures, whereas 22.8% (n = 18) preferred cephalosporins. Antibiotic combinations and penicillin were the most commonly used medications in thoracic and neurological surgeries. The details regarding the preferred antibiotics for particular surgical procedures are presented in Table 5.

Table 3. Antibiotic prescription, factors influencing antibiotic use, and intended purposes of perioperative antibiotic administration among veterinarians in Kenya between January and June 2023

Variable	Category of the variable	Number of respondents (n = 83)	Percentage of the respondents (%)
Prescription rate	Optimal	71	85.5
	Under	3	3.6
	Over	5	6.0
	Not sure	4	4.8
Factors influencing the choice of antibiotic	Bacterial culture and susceptibility	31	37.3
	Peer-reviewed scientific literature	14	16.9
	Textbooks	23	27.7
	Online sources	11	13.3
	Recommendation	24	28.9
	Prior knowledge and experience	62	74.7
Purpose of antibiotic therapy	Prophylactic	19	22.9
	Therapeutic	8	9.6
	Both prophylactic and therapeutic	55	66.3
	Don't give antibiotics perioperatively	1	1.2
Timing of antibiotic administration	Pre-operative	4	4.8
	Post-operative	56	67.5
	Intraoperative	3	3.6
	Preoperatively and postoperatively	19	22.9
	Do not give antibiotics perioperatively	1	1.2

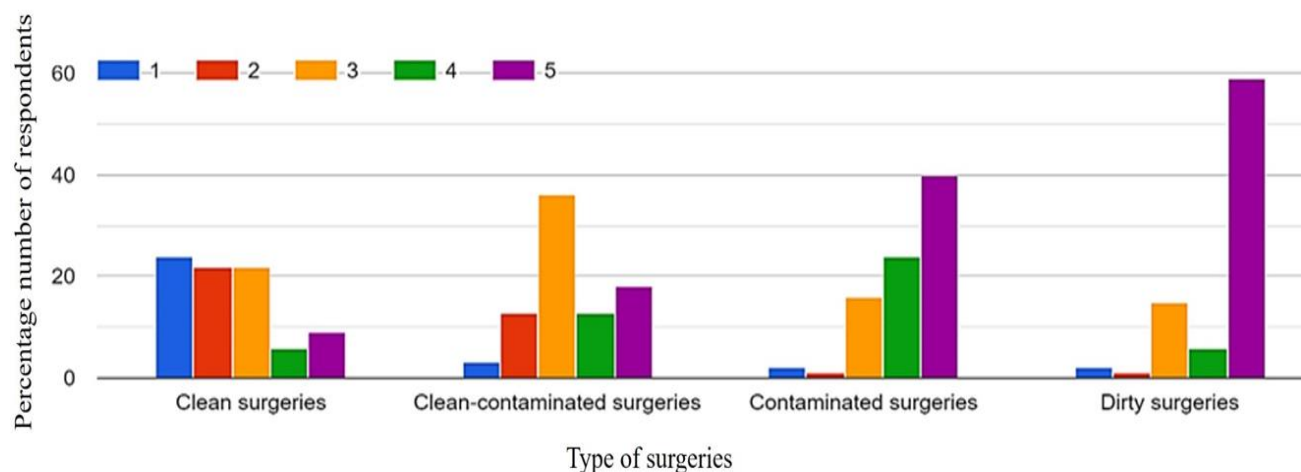


Figure 2. Different types of surgical procedures grouped by surgical sterility in Kenya between January and July 2023. Score 1: Very low, Score 2: Low, Score 3: Moderate, Score 4: High, Score 5: Very high

Table 4. Antibiotics used in elective, emergency, ocular, abdominal, reconstructive, orthopedic, thoracic, and neurologic veterinary surgeries in Kenya between January and June 2023

Surgery	Preferred antibiotics	Number of respondents (n = 83)	Percentage of the respondents (%)
Elective	Penicillin	62	74.7
	Drug combinations	5	6
	Tetracycline	5	6
	Others	11	13.3
Emergency	Penicillin	49	59
	Drug combination	11	13.3
	Tetracycline	7	8.4
	Cephalosporin	6	7.2
	Others	10	12.1
Ocular	Penicillin	26	32.1
	Aminoglycosides	17	21
	Drug combinations	13	16
	Lincosamides	4	4.9
	Others	23	26
Abdominal	Penicillin	24	29.6
	Sulphonamides	17	21
	Drug combinations	17	21
	Tetracycline	7	8.6
	Cephalosporin	5	6.2
	Others	13	13.6
Reconstructive	Penicillin	46	57.5
	Drug combinations	10	12.5
	Tetracycline	6	7.5
	Cephalosporin	5	6.2
	Sulphonamide	3	3.7
	Lincosamides	3	3.7
	Other drugs	10	12.1
Orthopaedic	Penicillin	30	38
	Cephalosporin	18	22.8
	Drug combination	14	17.7
	Fluoroquinolone	4	5.1
	Other drugs	17	16.4
Thoracic	Penicillin	28	35.4
	Drug combination	16	20.3
	Aminoglycoside	9	11.4
	Tetracycline	6	7.6
	Cephalosporin	5	6.3
	Other drugs	19	19
Neurological	Drug combinations	20	25.6
	Penicillin	19	24.4
	Cephalosporin	8	10.3
	Aminoglycoside	5	6.4
	Tetracycline	4	5.1
	Fluoroquinolone	4	5.1
	Others	25	27.7

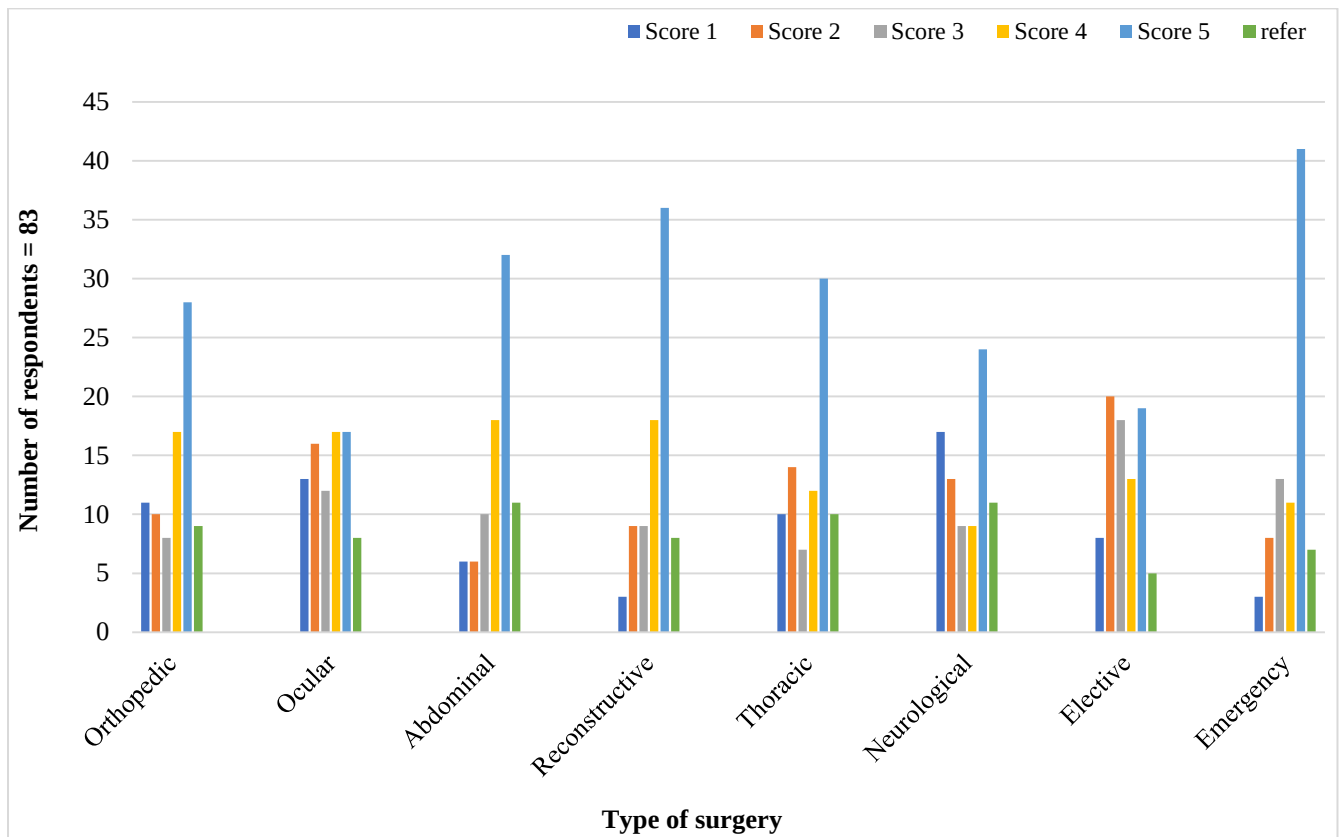


Figure 3. Antibiotic use in different small animal surgical procedures in Kenya between January and July 2023. High antibiotic use was observed in reconstructive, orthopedic, abdominal, thoracic, neurological procedures, elective, and emergency surgeries. Score 1: Very low, Score 2: Low, Score 3: Moderate, Score 4: High, Score 5: Very high

Table 5. Univariable predictors of antibiotic use among veterinary surgical patients in Kenya between January and July 2023

Predictor variable	P-value
Surgeons' level of education	0.192
The country where the veterinary degree was acquired	0.202
Perform reconstructive surgery often	0.073
Anesthesia where alpha-2 agonists are used	0.068
Surgeons always scrub their hands	0.005
Surgeons always wear gloves	0.272
Use of the ideal hand scrubbing technique	0.010
Method of instrument sterilization	0.185
Antibiotic use based on culture and sensitivity	0.127
Antibiotic use based on online literature	0.207
Antibiotics based on recommendations	0.298
Antibiotic use based on prior knowledge	0.168
Surgical site infections in emergency surgery	0.112
Surgical site infections in ocular surgery	0.218
Surgical site infections in abdominal surgery	0.028
Surgical site infections in reconstructive surgery	0.033
Surgical site infections in other surgeries	0.141
Use of the ideal surgical site scrubbing technique	0.010
Chemical sterilization of the instrument	0.067
Autoclave surgical instrument	0.127

Univariable associations $p \leq 0.3$ of predictor variables with antibiotic use in veterinary surgical patients in Kenya

Surgical site infection

Occurrence of surgical site infections

The majority of respondents (85.5%, 71/83) reported a low frequency of postoperative SSI (score <2), whereas only a small proportion (4%, 3/83) assigned a high score (4). However, the incidence of SSI was significantly higher in reconstructive and orthopedic surgeries (scores 4-5) than in ocular and elective procedures (scores 1-2; Figure 4).

The most frequently selected antibiotic class for SSI treatment was penicillin (42.2%, 35/83), with 22.9% of respondents choosing two or more antibiotics and 15.7% selecting cephalosporins (Figure 5). Furthermore, 68% of respondents either agree or strongly agree that the use of prophylactic antibiotics can significantly reduce SSI (Figure 6).

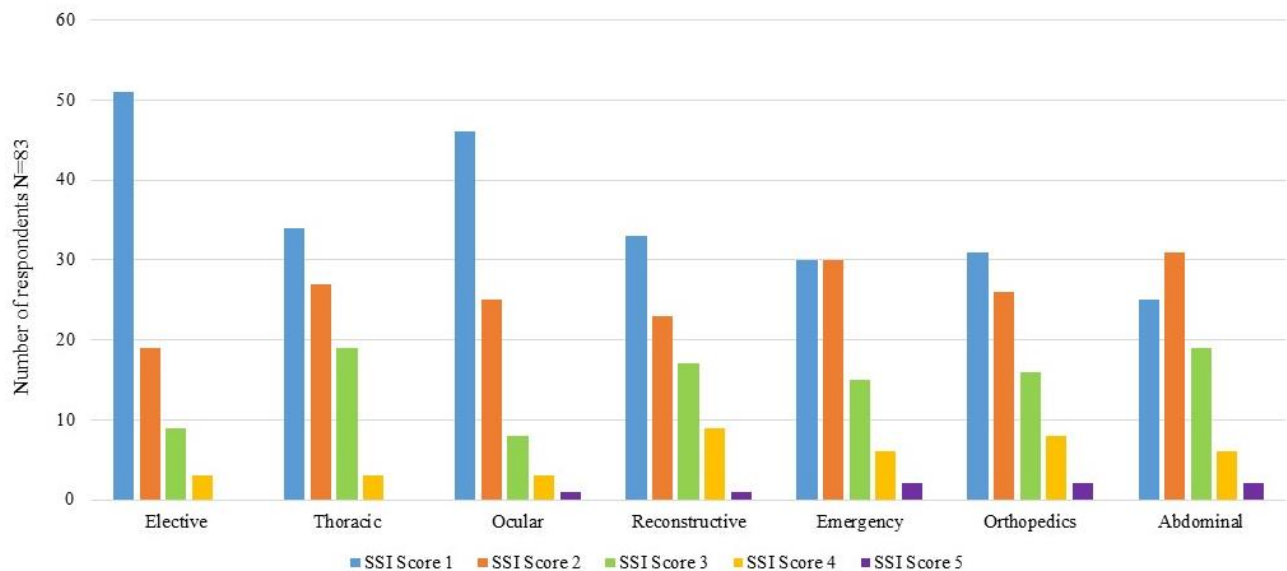


Figure 4. Surgical site infection rates in different small animal procedures in Kenya between January and July 2023. SSI score 1: Very low occurrence, SSI score 2: Low occurrence, SSI score 3: Moderate occurrence, SSI score 4: High occurrence, SSI score 5: Very high occurrence

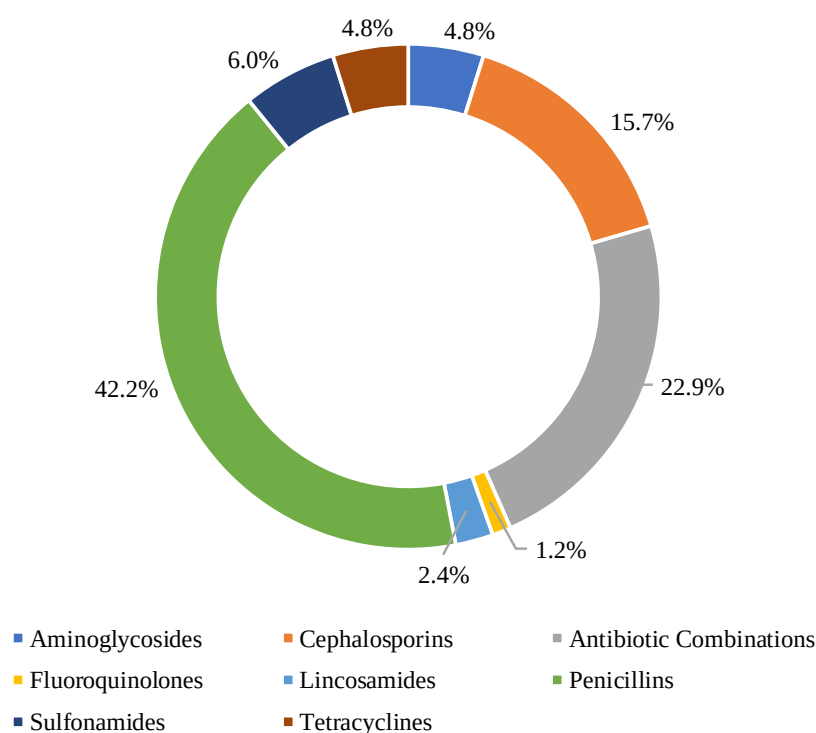


Figure 5. Preferred choice of antibiotics to treat surgical site infections in small animal surgeries in Kenya between January and July 2023.

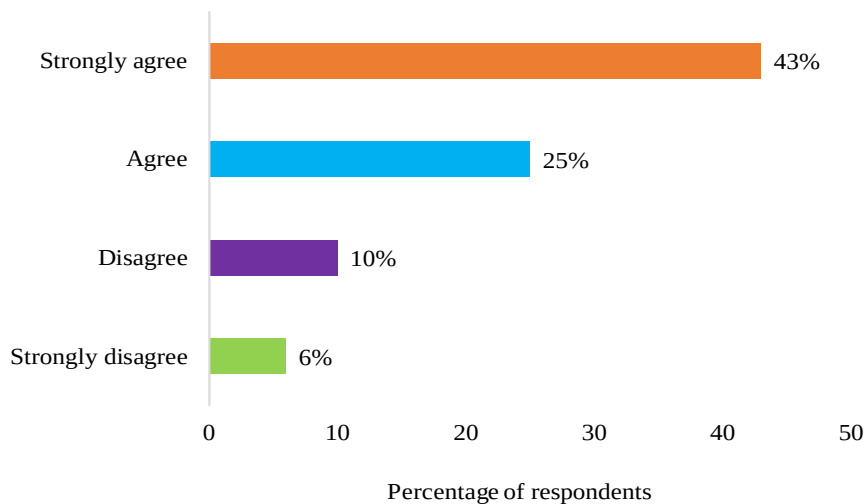


Figure 6. Perceptions of 83 veterinarians who participated in this survey regarding the role of prophylactic antibiotics in minimizing surgical site infections in small-animal surgeries in Kenya between January and July 2023.

Factors associated with antibiotic use in veterinary surgical patients

The final antibiotic-use model identified three variables significantly associated with antibiotic use in veterinary surgical procedures ($p < 0.05$). These variables were surgeons' level of education, whether surgeons always scrub their hands, and the use of optimal surgical site scrubbing techniques (applying a scrub solution followed by disinfecting the site with 70% ethyl alcohol; Table 6). The likelihood of antibiotic use in veterinary surgical cases was decreased by 10% when surgeons consistently performed hand scrubbing prior to surgery, and by 8% when the surgical site was prepared using an optimal sterilizing technique. Surgeons with a Bachelor of Veterinary Medicine degree exhibited a times higher likelihood of administering antibiotics to surgical patients compared to those with postgraduate qualifications.

Table 6. Final multilevel mixed-effects logistic regression model of antibiotic use in veterinary surgical procedures in Kenya between January and July 2023

Variable	Category	OR	95% CI	P-value
Educational level of surgeons	Bachelor of veterinary medicine	10.01	1.39 - 72.12	0.022
Surgeons always scrub their hands	Yes	0.10	0.17 - 0.58	0.01
Use of ideal surgical site scrubbing technique	Yes	0.08	0.01 - 0.50	0.008

OR: Odds ratio, CI: Confidence interval

DISCUSSION

The current study is among the first to report antimicrobial use practices during the perioperative period among veterinarians in Kenya. Most respondents in the present study were young veterinarians primarily engaged in mixed- and small-animal practices. The veterinarians have completed a curriculum that highlighted antimicrobial resistance and antimicrobial stewardship, incorporating these essential subjects into their clinical practice. Furthermore, due to their limited clinical experience, young veterinarians might be more likely to overuse antimicrobials during the perioperative period as a preventive strategy against SSI. Since the majority of respondents were veterinarians working in clinical settings, their perioperative medication decisions were likely influenced by individual clinical judgment and the operational practices of their respective hospitals or clinics.

The present study revealed that veterinarians primarily performed elective and reconstructive surgeries, and antibiotic administration during the perioperative period was often determined by the nature of the surgical procedure. Elective surgeries are categorized as clean procedures that generally do not require antibiotic administration (Jessen et al., 2019), particularly when aseptic protocols and meticulous surgical techniques, including surgical scrubbing, gowning, and the use of sterilized tools and materials, are followed (Nelson, 2011; Frey et al., 2022). These protocols and evidence were consistent with the present findings, as very few veterinarians reported administering antibiotics during elective and ocular surgeries, which were predominantly clean procedures. Notably, a study by Vasseur et al.

(1985) found no difference in infection rates between dogs subjected to clean surgical procedures who received prophylactic ampicillin and those who received a placebo, supporting the present results. Supporting the present results, Valkki et al. (2020) and Sørensen et al. (2024) indicated that antibiotic prophylaxis did not markedly reduce infection rates in clean, uncomplicated soft-tissue surgeries compared to strict aseptic technique alone

Numerous veterinarians assessed their antibiotic prescription practices as optimal, likely due to the comparatively low incidence of SSI, which was predominantly attributable to rigorous perioperative aseptic protocols. In the present study, the likelihood of antibiotic use in surgical procedures diminished by 10% when surgeons consistently performed hand scrubbing prior to surgery, and by 8% when the surgical site was prepared using an optimal technique. Furthermore, the majority of veterinarians agreed that antibiotics were unnecessary when meticulous perioperative asepsis was maintained. The present findings highlighted the vital role of aseptic preparation in reducing antibiotic use in veterinary patients, as supported by Nelson (2011) and Jessen et al. (2019). Rocktäschel et al. (2020) demonstrated that pre-surgical hand scrubbing notably reduced bacterial counts on the hands in a veterinary setting. Furthermore, proper hand and site preparation can effectively decrease the presence of *Staphylococcus pseudintermedius*, the most frequently isolated organism from canine SSIs, thereby lowering the risk of contamination (Nelson, 2011; Crosse, 2022; Singleton, 2024).

In the current study, veterinarians reported administering antibiotics primarily for prophylaxis rather than therapy. This empirical method for perioperative selection, based on existing knowledge and experience, was anticipated in Kenya. In surgical procedures, antibiotics are primarily used to prevent infections, as the likelihood of infection during surgery is generally low (Cavalli et al., 2025). Therefore, surgeons often cannot obtain samples for culture and sensitivity testing, except in cases of confirmed SSIs (Weese et al., 2015). Previous studies indicated that antibiotic prophylaxis was particularly beneficial in high-risk procedures, such as neurosurgery, where infections could be catastrophic, or orthopedic surgery involving implants and substantial tissue trauma (Nelson, 2011; Valkki et al., 2022; Gulaydin et al., 2024). In these surgeries, antibiotics, particularly cefuroxime or amoxicillin-clavulanic acid, were administered 30-60 minutes prior to the initial incision during orthopedic procedures in both animals and humans, with redosing every 90 minutes intraoperatively until completion of the surgery; after that, no further antibiotic use was warranted (Weese et al., 2015; Sørensen et al., 2024). These findings were inconsistent with the present results, as the majority of veterinarians administered antibiotics postoperatively, whereas only a minority adhered to prophylaxis protocols prior to or during surgery.

In the present study, the decision to use perioperative antibiotics was predominantly influenced by the extent of surgical contamination, with veterinarians reporting higher use in contaminated and dirty procedures than in clean and clean-contaminated surgeries. In clean surgeries, such as elective procedures without entry into contaminated viscera, antibiotic prophylaxis was generally not required. However, Mangram et al. (1999) and Weese et al. (2015) suggested that prophylaxis may be necessary for cases involving longer operative times, implant placement, or immunocompromised patients. This suggestion aligns with the current findings, where administering penicillin prophylactically in orthopedic surgeries notably decreased the rate of surgical site infections by 10%. Clean-contaminated surgeries, involving controlled entry into the gastrointestinal, respiratory, or urogenital tracts, require prophylactic agents such as cefazolin or amoxicillin-clavulanic acid (Boothe and Boothe, 2015). These antibiotics target common skin bacteria, particularly *Staphylococcus pseudintermedius*, which is a frequent cause of surgical site infections (Weese and Van Duijkeren, 2010; Nelson, 2011). Contaminated surgeries, such as those involving fresh traumatic wounds or procedures with gross spillage of gastrointestinal contents, require broader antibiotic coverage, typically including metronidazole for anaerobic activity (Boothe and Boothe, 2015; Weese et al., 2015). The duration of antibiotic administration is typically restricted to 24 hours postoperatively (Eugster et al., 2004; Frey et al., 2022). In contaminated surgeries with existing infections, such as abscess drainage, septic peritonitis, bite wounds, or septic pyothorax, antibiotics function primarily as a treatment rather than a preventive measure (Boothe and Boothe, 2015). In contaminated surgeries, immediate, culture-guided antibiotic treatment targeting pathogens such as anaerobes and *Pasteurella* spp. is necessary, with therapy frequently extending over several weeks (Boothe and Boothe, 2015; Ribeiro et al., 2024). The present study revealed widespread postoperative use of penicillins and cephalosporins across different surgical procedures, often without appropriate indications, such as culture and sensitivity results or evidence of gross contamination or dirty wounds. Previous studies have demonstrated that prolonged postoperative antibiotic administration was not only ineffective for infection control but also contributed to the development of antimicrobial resistance (Nelson, 2011; Cavalli et al., 2025). Effective infection prevention during surgery relies on strict aseptic techniques and the application of fundamental surgical principles such as debridement, lavage, and drainage (Jessen et al., 2019).

CONCLUSION

The present study demonstrated that adherence to perioperative practices that promote aseptic surgery can effectively reduce reliance on antibiotic use in Kenya. The majority of respondents (85.5%) considered their perioperative antibiotic use optimal, with only a small number of veterinarians rating it suboptimal. An important limitation of the present study was the uneven distribution of the outcome variable used in the regression analysis. The current findings may be influenced by decision-making and social desirability biases, as veterinarians might have reported practices they perceived as appropriate rather than their actual practices. Future longitudinal or interventional studies should be conducted to enhance understanding of how perioperative practices affect antibiotic use in Kenyan veterinary practice.

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Authors' contributions

Moffat Njuguna conceptualized the study, collected and analyzed data, and prepared the first draft of the manuscript. Willy Mwangi conceptualized and designed the study, prepared the data collection tools, analyzed data, and revised and proofread the final manuscript. John Mande participated in data interpretation as well as preparation, proofreading, and approval of the final manuscript. All authors have read and approved the final edition of the manuscript before publication in the present journal.

Availability of data and materials

Inquiries regarding the questionnaire and data can be directed to the corresponding author.

Competing interests

The authors declare no conflict of interest.

Ethical considerations

The authors have checked the ethical issues, including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy. The authors confirmed that no AI tools were used for data generation, analysis, or interpretation. The authors are solely responsible for the accuracy, originality, and integrity of the final content before submission, during the revisions, and final publication of the article.

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