OCCURRENCE, DIAGNOSIS, MANAGEMENT AND OUTCOMES OF SURGICAL AND DENTAL CONDITIONS AFFECTING HORSES IN NAIROBI COUNTY, KENYA

A thesis submitted in partial fulfillment of requirements for Master's degree of the University of Nairobi

Whisper Kuwenyi (BVSc, UZ)

Department of Clinical studies

Faculty of Veterinary Medicine

University of Nairobi

2023

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

Signature ..... Date. 28 September 2022 ....

Whisper Kuwenyi (BVSc, UZ)

This thesis has been submitted for examination with our approval as University supervisors:

Signature ..... Date ....29/09/2022.....

1. **Prof Mosoti E.G. Mogoa** (BVM, MSc, PhD)

Signature ..... Date....30 September, 2022

2. **Dr. Vijay Varma** (BVM, MSc, PhD)

Signature ..... Date....30 September 2022

3. **Dr. Willy Mwangi** (BVM, MVetSurg., PhD)

DEDICATION

This work is dedicated to my wife and our son Atipamufaro, for their support throughout my research period.

ACKNOWLEDGEMENTS

I would love to express my deepest gratitude to the following people:

Professor Mosoti E.G. Mogoa, Dr. Vijay S. Varma and Dr. Willy Mwangi Edwin for their expert supervisory roles throughout the project.

Dr. Chiuya, Tatenda for assisting in statistical analysis.

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ABBREVIATIONS

ILHP	Idiopathic laryngeal hemiplegia
PBZ	Phenylbutazone
SCC	Squamous cell carcinoma
CVSM	Cervical vertebral stenotic myelopathy
EPM	Equine protozoal myeloencephalitis
EDM	Equine degenerative myeloencephalopathy
EHM	Equine herpesvirus-1 myeloencephalopathy
NSAID	Non-steroidal anti-inflammatory drug
PAL	Palmar-plantar annular ligament
GLM	Generalized linear model
CI	Confidence interval
LR	Likelihood ratio
RTA	Road traffic accident
CT	Computerized tomography

ABSTRACT

The horse industry in Kenya is economically important as it generates taxable revenue and creates employment mostly through horse racing and polo activities. In spite of the benefits associated with this industry, there is paucity of knowledge on surgical and dental conditions that affect horses in Kenya. Equally lacking is proper documentation on management of these conditions and putative factors that might affect the prognosis. This understanding is important to horse practitioners as it leads to improved outcomes. The aim of this study therefore was to determine the occurrence of surgical and dental conditions that afflict horses in Kenya, evaluate their diagnosis and management in addition to factors that affect their outcomes.

This was a retrospective study in which veterinary clinics treating horses in Nairobi County were purposively selected. However, the outbreak of COVID-19 pandemic during the study period curtailed the number of practices that could be recruited and thus only one clinic was sampled. Horse clinical records over a 10-year period were retrieved from this clinic and examined. Data that included diagnosis, diagnostic approach, anaesthesia, management technique, post-operative treatment and outcome of each case were captured. Descriptive statistics for the dental and surgical conditions were computed while logistic regression model was used to identify risk factors for unsatisfactory case outcomes.

A total of 921 case records were retrieved and evaluated. Of these, 45.3% (417/921) were dental while 54.7% (504/921) were surgical cases. Overall, there was a decline in the number of dental and surgical cases from 2010 to 2019. The dental [45.3% (417/921)], reproductive [22.6% (208/921)] and integumentary [16.4% (151/921)] systems were mostly affected. Specifically, teeth overgrowth (41.4%) and entire males for castrations (20.8%) were the most prevalent conditions evaluated and subsequently, teeth rasping and castration were the most frequent techniques performed. Diagnosis in 94.5% (870/921) of these cases was based on clinical signs only, while radiography and endoscopy were used sparingly. Anaesthesia and analgesia for

dental and surgical conditions mostly employed use of Xylazine and Xylazine-Ketamine combination. Penicillin-Streptomycin, Phenylbutazone and Tetanus toxoid were routinely given in the post-operative period. Only 2.2% (20/921) of the cases evaluated had an unsatisfactory outcome with the major post-operative complications being swelling, bleeding and suture dehiscence. In the logistic regression model the outcome of the surgical cases was significantly more likely to be unsatisfactory if it was localized to the respiratory (OR: 34.58; 95% CI: 3.89-309.05; $p < 0.001$), reproductive (OR: 9.43; 95% CI: 2.40-62.24; $p = 0.004$) and integumentary (OR: 7.41; 95% CI: 1.58-52.15; $p = 0.017$) systems as compared to the dental system.

The study concluded that dental and surgical conditions are prevalent in horses in Nairobi County but are nevertheless associated with satisfactory outcome following their diagnosis and management. The study thus recommends that equine practitioners need to familiarize themselves with these conditions, invest more in the diagnostic tools that would enhance timely and accurate diagnosis and further build the skills and expertise needed for management of these cases. The study further recommends that there be continuous professional development topics related to these conditions which should be delivered to new graduates and practitioners less exposed to these cases. This will hence improve on the clinical outcomes and the welfare of horses in Kenya.

CHAPTER ONE

1.0 INTRODUCTION

The precise number of horses in Kenya is unknown, although some horse practitioners put the population at 6000 (Gitari *et al.,* 2017). The majority of these horses are used for sport wherein the main sporting activities include show jumping, polo and racing; while others are used for recreational horseback riding (Livestock Kenya, Undated). Among these activities, horse racing and polo are the most popular. Horse-racing takes place at Nairobi's Ngong racecourse, the only horse racing track in the region and currently, Kenya has up to 200 horses that are actively involved in racing competitions (The East African, 2014). These horses, and the racing industry contribute revenue to the country's economy from taxes levied on bets placed on race horses. The industry also generates income and supports many livelihoods through employment creation and service provision through their relationship with animal feed suppliers and veterinary services. Horses provide satisfaction to those who use them for leisure riding and associated activities. Studies carried out on the economic impact of the sport horse industry in Great Britain (The Henley Centre, 2004), New Zealand (Matheson and Akoorie, 2012) and Ireland (Corbally, 2017) show its importance to the economies of the respective countries.

1.1 Occurrence of surgical and dental conditions in horses

Working and racing horses are exposed to various health conditions in the course of their use, and some of these require surgical interventions**.** There is a relationship between the kind of activities or use horses are put into and the type of afflictions they suffer (risk factors) and this has been established in studies on such conditions as colic or acute abdominal disease (Gitari

et al., 2017), lameness (Samiullah *et al*., 2017) and musculoskeletal injuries *(*Kane-Smyth *et al*., 2016).

The teeth of horses are hypsodont meaning that they do not stop erupting throughout the horse's life. Domestication and changes in diet have resulted in the horse's teeth needing constant maintenance to keep them healthy. Dental problems have been reported in at least 95% of geriatric horses (Nicholls and Townsend, 2016) thus regular dental care is very important in horse practice as a preventive measure. Without attrition, horse teeth tend to overgrow producing sharp edges which result in discomfort when the horse is masticating. In some cases, soft tissue damage of the cheeks occurs resulting in horses losing condition and their performance (Dixon and Dacre, 2005). Apart from teeth overgrowth, other dental conditions which require the surgeon's intervention include; trauma, diastema, infundibular caries (cavities) and periodontal disease. Once dental conditions have been established, different approaches and techniques are employed in diagnosis and management of these conditions (Nicholls and Townsend, 2016). Studies documenting dental problems suffered by horses in Kenya are scarce. However, one study has been carried out in donkeys (Ndurumo, 2008).

The body system of the horse may be classified into; alimentary system, respiratory system, nervous system, eye and adnexa, reproductive system, integumentary system and the musculoskeletal system (Williams, 2012). Clinicians in practice are at times presented with horses with conditions affecting different body systems, some of which require surgical intervention. A retrospective study on risk factors for morbidity and anesthesia-related mortality in clinics focusing on elective/emergency surgeries in horses, showed that the surgical procedures carried out reflect the different body systems affected. These included,

umbilical and inguinal herniorrhaphy, castration, periosteal elevation, ophthalmic surgery, stitch ups and dentistry (Laurenza *et al.,* 2020).

1.2 Management procedures for surgical and dental cases in horses

In horse practice, the veterinary surgeon is obliged to have knowledge and expertise for addressing each surgical condition. The surgeon is therefore expected to be knowledgeable on most, if not all the surgical and dental conditions likely to be encountered in practice. It is also important for the surgeons to understand the pathophysiology of these surgical and dental conditions and have the necessary skills and competence to manage them for desirable outcomes. Such knowledge includes the ability to use different surgical instruments properly and to avoid post-surgical complications as this has a detrimental impact on the surgical outcome (Williams, 2012).

During management of surgical and dental conditions of animals, surgeons require the support of other specialties like anesthetists / anesthesiologists and imaging technicians. Those involved in these joint efforts should have the necessary skills and experience as these have been shown to influence the outcome of management of surgical conditions in horses. These skills and experience are gained through appropriate training and exposure to the different surgical conditions that affect horses (Laurenza *et al.,* 2020).

Wormstrand *et al.,* (2014) affirm that knowledge of these surgical conditions and their prognostication is important for clinicians and owners as this facilitates proper decision making on treatment options. For best outcomes in the management of surgical and dental conditions of horses, critical evaluation of the patient should be done prior to any surgical intervention for

better outcomes post operatively. Hendrickson, (2007) suggests that the surgeon should always evaluate whether surgery is necessary or not. Availability of the proper facilities, the capabilities of the surgeon, the need for technical help, implications on the animal welfare and the economic value of the animal should be considered when deciding to perform surgery or not.

1.3 Surgical outcomes

Surgical outcomes in horses can be divided into uneventful recovery, post-surgical complications or death. Post-surgical recovery in horses is mainly dependent on early referral and other factors which include the type of anesthesia used, the surgical technique and equipment as well as the aftercare (Putnam *et al.*, 2014; Laurenza, *et al*., 2020). The training and experience of the surgeon as well as owner's compliance with discharge instructions play a significant role in determining surgical outcomes.

1.4 Objectives

1.4.1 General Objective

The general objective of this study was to determine the occurrence, diagnosis, management and outcome of surgical and dental conditions of horses in Nairobi County, Kenya.

1.4.2 Specific objectives

The specific objectives of this study were:

1. To determine the occurrence of surgical and dental conditions of horses in Nairobi County from January 2010 to December 2019.
2. To evaluate the diagnosis and management of the surgical and dental conditions of horses in Nairobi County from January 2010 to December 2019.

3. To determine factors that affected the outcomes of surgical and dental procedures in horses in Nairobi County, Kenya from 2010 to 2019.

1.5 Hypotheses

The hypotheses of the study were as follows:

H0: Horses in Nairobi County did not suffer from surgical and dental conditions

H1: Horses in Nairobi County suffered from a variety of surgical and dental conditions

1.6 Research problem and justification

There are a limited number of studies comprehensively evaluating common surgical and dental conditions that affect horses in Kenya with only two studies available, one reporting on interventions for colic (Gitari, *et al.,* 2017) and the other on orthopedic conditions (Samiullah *et al.,* 2017). A study documenting the surgical and dental conditions that affect horses, their diagnostics, managements and outcome is therefore imperative and warranted. Such studies will be of great benefit to the equine practitioners as it will provide evidence-based knowledge that can lead to timely diagnosis, selection of most suitable management option and overall improvement on outcome from surgical interventions. Additionally, the information generated from this study will inform the design of continuing professional development courses for in-service training as well as guide the veterinary curriculum in training institutions to align to the demands of clinical practice.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General introduction

Clinicians in practice are frequently presented with horses with afflictions of the different body systems, some of which require surgical intervention. The success of any surgery is dependent on a thorough pre-surgical evaluation of the patient. Prognosis of the disease depends on the extent of the sickness, clinical findings, laboratory and diagnostic imaging data. Abnormalities are then identified from this information and managed prior to any surgical intervention, unless in emergency situation where delayed surgery could worsen the prognosis. Often, these abnormities are managed by giving fluids, oxygen supplementation and anti-inflammatory therapies. The aim of the surgical intervention is to minimize tissue trauma as well as to mitigate the underlying sickness whilst reducing complications (Carr, 2012).

Different surgical and dental conditions require specific surgical techniques to manage them effectively. Thus, it is very important for the clinician to have a concise knowledge of the anatomical landmarks of the patient and further plan properly (from skin incision to closure) before carrying out any dental or surgical intervention (Williams, 2012). This literature review aims at outlining some of the common surgical and dental conditions encountered in horse practice and further highlight the recommended management procedure and the postoperative complications encountered in horse practice.

2.2 Alimentary canal

The common surgical conditions of the alimentary canal include laceration of the tongue; trauma to the lips, cheek and gum; neoplasia of the oral cavity soft tissue and colic (Fuller and Abutarbush, 2007).

2.2.1 Tongue lacerations

This condition is clinically characterized by protrusion of the tongue and bleeding from the mouth, hyper salivation, anorexia, dysphagia, halitosis and pyrexia. Lacerations of the tongue should be urgently managed as they cause dysphagia and consequently weight loss in all animals (Wilson and Anthony, 2007). Lacerations are often transverse in orientation and mostly affect the free part of the tongue (Auer and Stick, 2006). Lacerations of the tongue are caused by inappropriate use of the bit, during dental floatation, self-inflicted bites and sometimes due to trauma by foreign bodies (Mohammed *et al*., 1991). Management of tongue lacerations may involve either primary closure, second intention healing or glossectomy. The method of management depends on the extent, duration and location of the injury (Lang *et al.*, 2014).

Management of tongue laceration is not without complications and these may include difficulty in feeding due to postoperative pain, post-surgical infections, excessive swelling and suture dehiscence. Recommendations for minimizing these complications include prudent use of antibiotics and optimal pain management by use of non-steroidal anti-inflammatory drugs. Use of oral antiseptics has been found to reduce post-surgical complications (Gerard, 2007). In terms of post-operative feeding, feeding of mashes is encouraged (Lang *et al.*, 2014).

2.2.2 Oral tumours in horses

Neoplasms of the oral cavity in horses are rare and incidentally diagnosed during routine dental or oral examination. Consequently, oral tumours are detected at an advanced stage when metastasis has occurred thus complicating their management and worsening the outcome (Dixon and Head, 1999). Oral tumors are either of dental or extra-dental origin and the commonly encountered ones include squamous cell carcinomas (SCC), ameloblastic carcinomas, dental cementomas, fibromas, ameloblastomas, complex odontomas and hemangiosarcomas (Snook and Wakamatsu, 2011). Clinical signs associated with oral neoplasia in horses include uncontrolled salivation, halitosis, quidding, discharge from the nose, anorexia, and weight loss (Auer and Stick, 2012). Diagnosis is usually by clinical signs, direct visualization and imaging while surgical excision complemented by chemotherapy or radiotherapy are recommend in managing oral neoplasia (Tremaine, 2014).

2.2.2.1 Oral squamous cell carcinomas in horses

Oral SCC in horses are rare and when they occur, they are generally slowly progressive yet malignant. The risk factors for oral SCC include mucosal irritation and ultraviolet light. This irritation could be due to foreign bodies, chronic wounds, epulis or periodontal disease (Tornago *et al.*, 2017). Horse oral SCC are mostly found on the gingiva even though any other part of the mouth can be affected. They have been also found on the tongue, hard palate, soft palate and even guttural pouches (Knottenbelt and Kelly, 2003). A breed predisposition has been documented with the draught breeds having an increased incidence (Auer and Stick, 2012).

There are various treatment modalities for oral SCC and these include radiation therapy, systemic therapy (use of Doxorubicin, Cisplatin, 5-Flourouaracil and Carboplatin),

photodynamic therapy, immunotherapy and surgical excision (Tornago *et al.*, 2017). Surgical management is not easy due to limited anatomical access to the horse's mouth. Localized and small tumours are managed surgically and the prognosis tends to be better when surgery is augmented by adjuvant treatment (Tremaine, 2014).

2.2.2.2 Ameloblastic odontogenic carcinomas

Odontogenic tumours arise primarily from dental tissue and commonly present as non-painful and slow growing masses. There are no reported specific risk factors associated with the occurrence of ameloblastic odontogenic carcinomas in horses (Pirie and Dixon, 1993; Shreeg et al., 2022). Management of these tumours is through surgical excision and in cases where the mandible is affected, partial hemimandibulectomy is recommended (Mendenhall *et al.*, 2007). Prognosis is usually good post-excision of small sized tumors but guarded in cases of local tissue invasion (Hackett and Baxter, 2008).

2.2.3 Colic

Colic is regarded as the most common condition affecting the digestive system of horses and a leading cause of mortality in domesticated horses. Studies elsewhere have indicated that 28% of reported horse deaths annually are as a result of colic (French *et al.*, 2002; Salem *et al*., 2016). Although there are many types of colic in horses, only impaction (obstructive) and displacement (extra-luminal) colic normally require surgical intervention (Bihonegn and Bekele, 2018). The indicators of surgical intervention in cases of colic in horses include, poor or no response to medical treatment; severe abdominal pain which is protracted even after administration of analgesics, and compromised cardiovascular and bowel circulatory statuses. One of the key indicators of compromised circulation of the bowel in horses is abnormalities

in peritoneal fluid. The fluid becomes yellow or white. In cases of gastric rupture, the fluid becomes green, brown or red (Gitari *et al.*, 2017).

2.2.3.1 Impaction (obstructive) colic

Impaction colic occurs when ingesta blocks the digestive tract. These obstruction events can occur throughout the gastrointestinal tract, though the large colon is most frequently affected. Small colon impaction, predisposed by myenteric ganglionopathes, also occurs in horses (Ortolani *et al.*, 2021). On the other hand, ceacal impaction accounts for 5% of horses with gastrointestinal obstructive disease (Aitken *et al.*, 2015). The pathogenesis of obstructive colic is closely linked with altered gut motility, poor dentition and poor nutrition (Bihonegn and Bekele, 2018). The site of obstruction has an impact on the management and prognosis of impaction colic (Jennings *et al.*, 2014). Surgical intervention is often required in ceacal and small colon impaction whereas a higher proportion of large colon impaction can be successfully managed with medical therapy (Aitken *et al.*, 2015).

2.2.3.2 Displacement (extra-luminal) colic

The colon of the horse is highly predisposed to displacement due to its greater motility and limited attachments to the body wall (Whyard and Brounts, 2019). The occurrence of displaced colons has been reported in about 33% of horses subjected to exploratory laparotomy (Smith and Mair, 2010). There are different types of colonic displacements with the common ones being retro-flexion of the pelvic flexure, left dorsal displacement, non-strangulating volvulus of the large colon and right dorsal displacement (Smith and Mair, 2010; Whyard and Brounts, 2019). Colonic displacements could be strangulating or non-strangulating. Non-strangulating displacements occur when there has been some movement of the bowel out of its normal position resulting in partial or complete luminal obstruction with the vasculature not compromised while strangulating obstruction occurs, when the colon takes a 270-degree

rotation (Proudman *et al.*, 2005). The aetio-pathogenesis of large colon displacement in horses is multivariate but the common causes are alterations in the motility of the gastrointestinal tract, distension due to gas accumulation, large colon migration as well as excess uptake of carbohydrates resulting in too much fermentation (Sellers and Lowe, 1986; Smith and Mair, 2010; Whyard and Brounts, 2019).

Surgical management of colic is not without complications. The commonly encountered ones include thrombrosis of the jugular vein, incisional herniation, ileus, wound suppuration, re-laparotomy and colic (French *et al.*, 2002). These complications normally result in prolonged hospitalization of the patient, increased cost to the client, patient discomfort and delayed return to work of the affected animal (Dukti and White, 2008; Freeman, 2018).

2.3 Eye and adnexa

Tumours are the most common condition of the eye that require surgical intervention in horses. The most common ocular neoplasia in horses are the SCC, sarcoids, lymphomas and hemangioma/hemangiosarcomas (Montgomery, 2014).

2.3.1 Ocular squamous cell carcinoma

Ocular squamous cell carcinoma is a malignant skin tumour that affects the ocular muco-cutaneous junction (Zanichelli *et al*., 1994) and accounts for more than 90 % of the horse ocular tumours. Overall, it is regarded as the second most cause of cancer in horses after sarcoids (Chen *et al*., 2020; Crausaz, *et al*., 2020). Horses that lack pigmentation around their eyes are at a greater risk as well as those with a chestnut based coat. The commonly affected locations are the limbus, cornea, conjunctiva and the third eyelid (Drazek *et al.*, 2015). The commonly affected breeds are those with the least pigmentation such as American Paint horse, the Quarter

horse and the Appaloosa (Kafarnik *et al.,* 2009). The mean age of occurrence of the SCC has been reported to be around 11 years while gender predisposition is unclear (Drazek *et al.*, 2015). It is believed that prolonged exposure to sunlight and absence of periocular pigment plays a very significant role in the aetio-pathogenesis of ocular SCC. Ultraviolet light results in mutations in the *p53* gene which regulates genome integrity and cell cycle. Mutations will result in compromised DNA repair followed by stimulation and generation of neoplastic cells (Drazek *et al.*, 2015).

Development of a white, pink or red, friable, exuberant growth on the palpebral surface of the nictitating membrane are some of the clinical signs of SCC and confirmatory diagnosis is by histopathology (Sandmeyer *et al*., 2019). Excision of the tumor with a wide clean margin is effective in management of SCC but where this is not practical or achievable, adjunctive therapy can be instituted to destroy the remaining cancer cells. Surgical management and concurrent use of adjunctive therapy has been found to be associated with lower rates of recurrence (Mosunic *et al.*, 2004). The common adjunctive therapies instituted are cryotherapy, radio-frequency hyperthermia, photodynamic therapy, immunotherapy (Mosunic *et al.*, 2004, Giuliano, 2010). In cases whereby the whole eye is affected, enucleation or exenteration is recommended. Recurrence is the main postoperative complication and can be mitigated by ensuring wide margin surgical excision and concurrent use of an adjunctive therapy (Dugan *et al.*, 1991; Giuliano, 2010).

2.3.2 Ocular lymphomas

Ocular lymphomas are rare and account for only 1.3–2.8% of all tumours affecting horses (Martabano *et al.*, 2019). Diagnosis of intraocular lymphoma is difficult because the clinical signs (eyelid swelling, ocular discharge and third eyelid swelling) are identical to those of uveal

inflammation (Schnoke et al., 2013; Montgomery, 2014). Treatment of intraocular lymphoma should include atropine and topical corticosteroids. Systemic corticosteroids have proved to be effective in a number of cases. Enucleation is usually not indicated due to the grave prognosis of systemic lymphosarcoma (Germann *et al*., 2008)

Extraocular lymphosarcoma is uncommon in horses and generally manifests as eyelid inflammation or diffuse, periocular swelling. Extra ocular lymphosarcomas involving the eyelids have a poor outcome compared to those on other extraocular locations (Giuliano, 2016). According to Schnoke *et al.*, (2013) presence of bilateral extraocular lymphosarcoma in multiple locations does not affect the prognosis. Surgical resection is the mainstay therapy in managing lymphosarcomas. Intralesional steroid administration and systemic corticosteroids have also proved to be useful (Schnoke *et al.*, 2013).

2.3.3 Ocular hemangiosarcomas

Ocular hemangiosarcomas are rarely encountered in the horse and are generally regarded as malignant (Pinn *et al*., 2011). The common clinical sign is a sero-sanguinous discharge from either the eye or nostril or both. The prognosis for ocular hemangiosarcomas is generally regarded as poor and metastasis to the draining lymphatic system frequently occurs (Pinn *et al.*, 2011). Ocular hemangiosarcomas can be grouped as either of the capillary or of the cavernous type. This classification is based on the size of the vascular channels formed (Wegge *et al* ., 2009). The nictitating membrane and the conjunctiva are usually affected by hemangiomas and hemangiosarcomas. In some cases, metastasis occurs to draining lymph nodes, the eye itself and muscles of the face. The lymph nodes which are usually affected are the retropharyngeal, mandibular and the cervical lymph nodes (Sansom *et al.*, 2006).

Surgical options available are complete exenteration and keratectomy however, metastasis still occurs even after surgical intervention. There is equally a high probability of recurrence at least two years post-surgery (Pinn *et al.*, 2011)

2.3.4 Ocular sarcoid

Sarcoids are locally invasive fibroblastic cutaneous tumours that are the most common neoplasms of horses and donkeys worldwide. The incidence of sarcoids in horses range from 12.5 to 67% of all neoplasms and about 39% occur around the periorbital region (Taylor and Haldorson, 2013). Sarcoids occur in six clinically distinguishable forms namely nodular, occult, fibroblastic, verrucose, mixed and malignant. Inactive sarcoids tend to be aggressive if disturbed by injury, inappropriate treatment or biopsy. Despite periocular sarcoids being non-metastatic, they significantly affect the aesthetics and function of horses (Byam-Cook *et al*., 2006). Periocular sarcoids are generally difficult to manage leading to a poor prognosis (Newton, 2000). Surgical excision of sarcoids is a challenge because the tissues surrounding the eye, especially the eyelids, are fragile and tissue trauma during surgery may interfere with the function of the eyelids (Knottenbelt and Kelly, 2003).

2.4. Nervous system

The common conditions that affect the nervous system of horses are, cervical vertebral stenotic myelopathy (CVSM), equine protozoal myeloencephalitis (EPM), equine degenerative myeloencephalopathy (EDM), and equine herpesvirus-1 myeloencephalopathy (EHM). However, CVSM is the only condition that is of surgical importance (Johnson and Reed, 2015).

2.4.1 Equine cervical vertebral stenotic myelopathy

Cervical vertebral stenotic myelopathy (CVSM) is commonly referred to Wobblers syndrome. It is a pathological condition that occurs in horses due to narrowing of the cervical vertebral canal and compression of the spinal cord often in combination with mal-alignment and malformation of the cervical vertebrae. Stenosis of the vertebral canal occurs anywhere from the first cervical vertebral body (C1) to the first thoracic vertebral body (T1). Wobbler syndrome presents in horses as incoordination but otherwise the horses appear relatively normal. The animals tend to appear bright and alert with the temperature and digestive processes normal, and the history may or may not indicate trauma to the head or cervical regions (Johnson and Reed, 2015). The term 'Wobblers syndrome' is commonly used to describe the nervous clinical signs observed in the affected animals. Young horses tend to be over represented while thoroughbreds, warmbloods and quarter horses appear to be the more prone breed of horses (Johnson and Reed, 2015). The aetio-pathogenesis of the Wobblers syndrome is multifactorial with genetics, changes in copper and zinc ratios, accelerated growth rates and trauma being reported as important risk factors (Janes *et al.*, 2014). When affected by CVSM, horses tend to exhibit spasticity, symmetrical ataxia as well as weakness in hind legs and occasionally the forelegs, stumbling, toe dragging and general weakness. At physical examination clinicians may observe worn out shoes due to toe dragging (Szklarz *et al.*, 2018).

Although diagnosis relies mainly on clinical presentation, radiography and myelography provide valuable information that can aid in confirming CVSM in horses. However, the two techniques are generally unreliable due to high number of false positives. Vertebral canal stenosis is the most common radiographic finding which could be from the first cervical vertebral body to the first thoracic vertebral body (T1) (Beccati *et al.*, 2018). The surgical procedure of choice in the management of this problem is the implantation of a titanium-based,

threaded kerf-cut cylinder. Swelling at the surgical site is the most common complication and often horses may not return to normalcy after surgery (Szklarz *et al.*, 2018).

2.5 Respiratory system

Some of the surgical procedures of the upper respiratory system in horses include soft palate resection, guttural pouch drainage and flushing, ventriculocordectomy, tracheostomy and excision of tumors (Hendrickson, 2007). The most commonly encountered surgical conditions of the respiratory system in horses include laryngeal hemiplegia, dorsal displacement of the soft palate, entrapped epiglottis as well as ethmoid hematomas (Barakzai and Hawkes, 2010).

2.5.1 Progressive ethmoid hematoma

Progressive ethmoid hematoma is a non-neoplastic mass in the nasal passages and paranasal sinuses of horses. The aetio-pathogenesis of ethmoid hematoma is not completely understood but involves repeated hemorrhage which causes progressive enlargement of the mass. Stich *et al.*, (2001) reported a prevalence of 0.04% while in other studies progressive ethmoid hematomas have been reported to affect 4% of horses suffering from nasal conditions and 10% of horses undergoing nasal or sinus surgery. The incidence of progressive nasal hematomas appears to increase with age but generally affects horses with an average age of 9.9 years with a range of 4 weeks to 20 years (Stich, *et al.*, 2001). Histopathology is the definitive confirmatory test of progressive ethmoid hematomas though other diagnostic techniques like radiography and endoscopy are useful in determining the extent of the lesion (Textor *et al.*, 2012). A variety of treatment options are available and these include surgical reduction with cryogens or laser, intralesional formalin injection and surgical resection. Regardless of treatment method, the prognosis of progressive ethmoid hematomas is guarded due to high recurrence rate (Stich *et al.*, 2001).

2.5.2 Laryngeal hemiplegia

Laryngeal hemiplegia is a progressive upper airway obstructive condition of horses that limits their performance and causes upper respiratory tract noise. This upper airway condition is commonly seen in thoroughbred racehorses though cases have been reported in warmblood horses, ponies and draft horses (Clercq *et al*., 2018). Clercq *et al*., (2018) suggests that at least 40% of large-breed horses have some degree of laryngeal asymmetry. The condition is often idiopathic and most frequently affects the left side. Right sided laryngeal hemiplegia is very rare and is usually related to pathologies causing nerve malfunction (Clercq *et al*., 2018). The incidence of left recurrent laryngeal neuropathy in horses has been reported to range from 2.6% to 8.3% (Davenport *et al*., 2001). The presenting clinical signs are exercise intolerance and a roaring respiratory noise. Endoscopy is the most common applied diagnostic technique but laryngeal ultrasonography provides detailed information useful in arriving at a diagnosis of laryngeal hemiplegia (Davenport *et al*., 2001). Laryngoplasty has thus far remained the gold standard surgical treatment method in laryngeal hemiplegia while nerve grafting and pacemakers are potential alternative therapies (Clercq *et al*., 2018). The overall success rates for laryngoplasty range from 48% for thoroughbred horses to 95% for non-racing breeds of horses. The major complication of laryngoplasty is failure of the prosthesis to maintain arytenoid abduction, causing roaring and exercise intolerance. Loss of arytenoid abduction has been reported to contribute to 20% of laryngoplasty failures in horses (Auer and Stick, 2012).

2.5.3 Dorsal displacement of the soft palate

This is a pathological condition commonly witnessed in horses during very intense exercising. There are different theories relating to the aetio-pathogenesis of this condition which include neuromuscular dysfunction, epiglottic malformation and hypoplasia (Holcombe *et al.*, 1999;

Ducharme *et al.*, 2003; Cercone *et al.*, 2019). Thoroughbreds and standardbreds are commonly affected with reported incidence being 10-20 %. The common clinical sign associated with dorsal displacement of the soft palate includes exhibition of loud inspiratory or expiratory noises. This clinical sign has been observed in at least 70-80% of horses with dorsal displacement of the soft palate (Barakzai and Hawkes, 2010). Diagnosis relies on endoscopy and history consistent with ridden performance and a horse that chokes, snores, gurgles or swallows the tongue when exercising (Cercone *et al.*, 2019). Management consist of palatoplasty surgeries whose reported outcomes is varied. The common palatoplasty surgical procedures and their success rates are: sternothyrothoideus myectomy (58%-60%), staphylectomy (60%) and Nd:YAG (neodymium-doped yttrium aluminum garnet) laser augmentation (66%) (Cercone *et al.*, 2019).

2.5.4 Guttural pouch diseases

Diseases of the guttural pouches are of paramount importance to horse owners and practitioners. They have a very significant impact as far as the well-being of horses is concerned. Commonly encountered conditions include guttural pouch empyema, mycosis and tympany (Kachwaha *et al.*, 2016).

2.5.4.1 Guttural pouch mycosis

Fungal infection of the guttural pouches is rare but life threatening. No sex, age or breed predisposition has been described for this condition. The main clinical signs are bilateral or unilateral epistaxis as well as malfunctioning of the cranial nerves which is characterized by dysphagia. The affected animals have food in their nares, drool saliva and in some extreme cases aspiration pneumonia can occur (Pollock, 2007). Endoscopy is the gold standard tool for

diagnosis of guttural pouch mycosis in horse. A history of epistaxis coupled with observed clinical signs also aids in diagnosis. Medical management is usually not satisfactory however, studies generally recommend normograde ligation of the internal carotid and occipital arteries of the affected side. The trans-arterial coil embolization technique which has a success rate of between 70 and 87 % is highly recommended. Dysphagia and epistaxis are the common complications encountered postoperatively (Dobesova *et al.*, 2012).

2.5.4.2 Guttural pouch empyema

This is a condition which affects guttural pouches and results in purulent exudate as well as chondroids in the pouches. The clinical signs associated with empyema include unilateral/bilateral swelling of the guttural pouches, swelling of the submandibular or parotid lymph nodes, stertor and dysphagia (Dixon and James, 2018). Endoscopy is used for definitive diagnosis but radiographs are equally useful. Surgical management aims at removing the chondroids in the pouches (Perkins *et al.*, 2003). The guttural pouches are usually approached through the Viborg's triangle (Hawkins *et al.*, 2001). Transendoscopic removal of small chondroids has been described and is recommended as it is less traumatic (Dixon and James, 2018).

2.5.4.3 Guttural pouch tympany

This is a pathological condition of the horse which is characterized by a unilateral or bilateral distention of the guttural pouches with air. Sometimes this happens with or without fluid accumulation. Guttural pouch tympany is regarded as congenital and is commonly seen in the first few months after birth (Freeman, 2015). The tympany occurs when there is malfunction of one or both of pouch orifices, so that it (they) act(s) as a one-way valve(s) i.e. allow air into but not out of pouch. Continuous distention of pouch then occurs. Fillies have been found to be more affected than colts. The Arabian and Paint horse foals are over represented (Borges

and Watanabe, 2011). Surgical treatment is the management of choice. Fenestration of the median septum is done to allow trapped air in the defective pouch to exit through the contralateral pharyngeal orifice (Kachwaha *et al*., 2016).

2.5.5 Epiglottic entrapment

Epiglottic entrapment refers to dorsal displacement of the hypertrophied or edematous subepiglottic mucosa and aryepiglottic folds over the epiglottis (Lee and Lee, 2019). The notched edge and the normal vascular pattern of the epiglottis is not visible because of a retroverted aryepiglottic fold and the involved mucosa. Epiglottic entrapment is a primary respiratory condition and has been reported to occur intermittently or persistently in race horses. Curtiss *et al*., (2020) reported that epiglottic entrapment has a prevalence of around 0.72-2.1% in thoroughbred racehorses. The primary complaint from horse owners is exercise intolerance and abnormal respiratory noise. Endoscopy is the recommended tool for diagnosing epiglottic entrapment in horses (Coleridge *et al.,* 2015). A variety of surgical interventions and their recurrence rates have been reported (Adams, 2000). Trans-nasal axial division with unshielded/shielded bistoury is a common surgical technique used to treat epiglottic entrapment. The recurrence rate of trans-nasal axial division has been reported to range from 5%-15% while those for transendoscopic electrosurgical axial division and laser axial division are about 40% and 4%, respectively (Lee and Lee, 2019).

2.6 Reproductive system

The common horse surgical procedures of the reproductive tract include; castration, cryptorchidectomy, Caslick's operation, urethroplasty, equine penile amputation and Aanes' repair of perineal laceration (Hendrickson, 2007). Caesarean sections are done when there is difficult or protracted birth (Mehrjerdi, 2010). Castration is the most performed surgical procedure in horses (Giusto *et al*., 2016) and is indicated for controlling breeding and reducing

or preventing the difficulties associated with riding or keeping entire male horses. Open or closed castration can be done depending on preference of the veterinarian.

2.6.1 Cryptorchidism

This is a congenital condition where one (unilateral) or both (bilateral) testes fail to descend into the scrotum. A cryptorchid refers to a horse that does not have two testes palpable in their entirety below the external inguinal rings (Mahmud *et al.,* 2015). Typically, it is detected at birth or shortly thereafter. The common synonyms are undescended testicle, retained testicle, rib ridgling, proud cut and high flanker (Searle *et al*., 1999). The failure of the right and left testicle to descend occurs with nearly equal frequency (Mahmud *et al.*, 2015). Left sided testicles that fail to descend are more likely to be found within the abdomen compared to right testicles which are equally likely to be found within the abdomen or inguinal canal. It is important to note that failure of both testicles to descend is uncommon, affecting 9 to 14% of horses (Searle *et al*., 1999).

Cryptorchidism is an inherited disorder and, although the genetics of the condition are complex and not completely resolved in the horse, the use of cryptorchid stallions for breeding is therefore not recommended (Bladon, 2002). Diagnosis is normally done when there is no history of castration in addition to the absence of one or both testes on palpation of the scrotum. Other diagnostic tests include; rectal examination, ultrasound examination, hormonal assays (plasma or serum testosterone and estrone sulfate) and diagnostic laparoscopy. Cryptorchidectomy is done to remove the undescended testes. The procedure is best done under general anaesthesia and the common surgical options include inguinal, parainguinal, suprapubic, paramedian and flank approaches. Recently laparoscopy has gained ground and can be done in standing or recumbent animals (Searle *et al*., 1999, Stratico *et al*., 2020).

Complications commonly encountered include; hemorrhage which can be avoided by careful application of ligatures, sepsis which is minimized by observing aseptic procedures where necessary, colic, oedema, hydrocele, funiculitis and evisceration (Searle *et al*., 1999; Stratico et *al*., 2020).

2.6.2 Dystocia

Dystocia refers to difficulty in foaling and has a reported prevalence rate of 4% in thoroughbred horses and 10% in draught horses (Frazer *et al*., 2010). On the other hand, caesarean section is the surgical removal of a foal through the abdominal and uterine wall. The procedure is primarily an emergency and performed when there is little feasibility of delivering the foal vaginally. Caesarean section is reported to be performed in about 15% to 25% of mares admitted to horse referral hospitals and bears a good success rate of 81% to 91% in mares but poor survival rate in about 4% of foals (Abernathy-Young *et al.*, 2012). A foaling rate of 36% was reported after caesarian section in 16 mares bred for 25 seasons (Juzwiak *et al.*, 1990). Complications that often occur following a caesarian section include peritonitis, hemorrhage, incisional infection and dehiscence, septic metritis and retained fetal membranes (Lanci *et al*., 2022).

2.6.3 Penile and preputial lacerations

Penile and preputial lacerations are not uncommon and tend to occur due to injuries when horses attempt to jump over barriers or when they try to breed over a fence. Other possible causes could be horses falling over sharp objects or mare's hairs lacerating the penis during coitus. Sometimes the use of small stallion rings to inhibit erection and sexual behavior when exposed to mares during racing, work, or performance results in wounds of the penile shaft (Morrow, 1986). If left unattended, there is high chance that infections will set in resulting in

cellulitis and marked swelling. Penile wounds are stitched if not infected and preferably with a soft and non-irritating absorbable or non-absorbable suture. Absorbable sutures are used to stitch the urethra when it is severed. Penile amputation is considered when there is severe penile trauma (Perkins *et al.*, 2003).

2.6.4 Third degree perineal lacerations

These occur during unassisted foaling where the hooves of the foal tear into the vestibule-vaginal junction resulting into extensive damage and necrosis of tissues. Surgery is recommended but often delayed for up to 4 weeks to allow receding of the marked perineal swelling that occurs post foaling (Saini *et al.*, 2013). If the perineal lacerations are not corrected, then the mares are predisposed to endometritis. The two common surgical procedures described for correcting perineal lacerations are Aanes' and the Goetz technique (Mehrjerdi, 2010). The most common complications which occur postoperatively are suture dehiscence, recurrence of the vaginal fistula, urine pooling, constipation and tenesmus (Saini *et al*., 2013).

2.7 Integumentary system

Wounds and tumors are the most common skin conditions of horses that require surgical intervention. The common skin tumors in horses are sarcoids, melanomas, SCC, mast cell tumors and lipomas (Auer and Stick, 2012).

2.7.1 Skin lacerations

Horses are prone to full thickness skin lacerations and are usually attributed to the environment and the lifestyle of the horse. Legs and other body parts get caught in panels, fences, gates and wires resulting in lacerations of varying degree. In some cases, riding accidents, trailer

accidents and kicks may result in skin lacerations (Caston, 2012). Deep wounds are closed in two layers with the inner layer apposing muscles and fascia and the second layer closing the skin. Hemorrhage is generally managed by identifying and ligating the bleeding vessels. Common complications that occur postoperatively include suture dehiscence and post-surgical infections. Infections can be limited by debriding and lavaging wounds as well as use of appropriate antibiotics (Auer and Stick, 2012).

2.7.2 Skin tumours

Neoplasms of the horse include: sarcoid, fibroma and fibrosarcoma, melanoma and melanosarcoma, squamous cell carcinoma, and lymphosarcoma (Shah, 2015). The common diagnostic tools for cutaneous masses of horses include the use of clinical signs, and histopathological methods (Gore and Griffin, 2008; Shah, 2015).

2.7.2.1 Melanomas

Melanomas are skin tumours commonly seen in horses with black or grey colored coat (Nicholls, 2016). The tumors tend to appear as rounded, raised, black nodules of varying size (Metcalfe *et al.*, 2013). Studies have indicated that of all horse skin tumours, melanomas account for 18.7% (Scott and Miller, 2011). Management is usually by sharp surgical excision, and cryosurgery. Surgical debulking in conjunction with the use of cisplatin can be done in advanced cases (Metcalfe *et al.*, 2013).

2.7.2.2 Equine sarcoids

Equine sarcoids are the most common tumours affecting horses and account for more than half of skin tumours (Knottenbelt, 2019). Classification is mainly based on gross appearance and clinical signs. Six types of sarcoids can be distinguished and these are: occult, verrucous, nodular, fibroblastic, mixed and malignant. The areas commonly affected are the ear pinnae,

peri-ocular region, lips, neck, extremities and ventrum (Taylor and Haldorson, 2013). Sarcoids have been found not to metastasize, however, owners are concerned as they affect the aesthetics of horses. In some cases, the function of the horse is compromised depending on size and location of the sarcoid (Knottenbelt and Kelly, 2003). Management of sarcoids includes excision of the tumours that are in areas easily accessible such as the skin. Wide clean margins of about 2-3cm should be resected to remove all extensions of the sarcoid into surrounding areas, thus preventing recurrence (Hawkins and Mccauley, 2005; Shah, 2015). A success rate after surgical excision ranges from 30-50% and recurrence normally occurs after 6 months (Knottenbelt and Kelly, 2003).

2.7.2.3 Lipomas

Lipomas are benign, well differentiated and slow growing submucosal tumours of adipose tissue in origin (Gandini *et al*., 2022). They are commonly seen in horses, occurring as mesenteric or cutaneous masses. Older horses are more prone to pedunculated lipomas while subcutaneous type occur more in young horses especially those below 2 years of age. Lipomas are best removed through surgical excision (Gandini *et al*., 2022).

2.8 Musculoskeletal system

2.8.1 Upward fixation of the patella

Upward fixation of the patella in horses is characterized by an extended stifle and flexed fetlock which occurs due to failure of the medial patellar ligament as well as the para-patella fibrocartilage to disengage from the medial ridge notch of the femoral trochlea when the limb flexes (Tnibar, 2019). The clinical signs associated with this condition include failure of the horse to extend the leg and tense patellar ligaments on palpation. The condition is managed surgically by performing medial patella desmotomy. The complication that is commonly

encountered postoperatively is the fragmentation of the patella distally as a result of excessive pressure on the middle patellar ligament (Wilson, 2006).

2.8.2 Stringhalt

Stringhalt is characterized by continuous flexing of the hind limb with an exaggerated flexion of the hock. Further, the hind limb of a horse with stringhalt, is brought up underneath the abdomen with the fetlocks contacting the abdominal wall ventrally (Maxie, 2015). There is no known breed, sex and age predisposition. Many cases of this condition recover spontaneously without any treatment. Surgical intervention is normally regarded as a salvage procedure which facilitates the horse to have a normal gait but not to return to normal function. Myotenectomy of the lateral digital extensor tendon as well as some portion of the muscle has been shown to give the best results (Maxie, 2015).

2.8.3 Contracture deformities/flexural deformities

Contracture deformities of the deep digital flexor tendon are commonly seen in foals but some few cases have been identified in older horses (Kidd, 2003). The condition results in the limbs of the affected animals deviating in a sagittal plane when viewed from sideways. The condition is due to failure of the ligaments to elongate enough to match limb bone growth. Flexural deformities can be classified as mild, moderate or severe. While severe deformities cannot be corrected, mild and moderate deformities are managed by performing an inferior (distal) check ligament desmotomy. Desmotomy is done in order to allow for the realignment of the bones of the digit deep digital flexor unit and the lengthening of the deep digital flexor musculotendinous unit (Tnibar, 2019). Complications associated with this procedure include post-operative swelling, dehiscence and post-operative scarring (Tnibar, 2019).

2.8.4 Palmar-plantar annular ligament constriction

Chronic lameness in performance horses is usually attributed to palmar-plantar annular ligament (PAL) constriction (Hawkins and Churchill, 1998). The function of the annular ligaments is to hold the superficial and deep digital flexor tendons in the digital tendon sheath at the level of the metacarpophalangeal and metatarsophalangeal joints (Garvican *et al.*, 2016). The aetio-pathogenesis is due to the constriction of flexor tendons that is triggered by fibrosis/scarring of tendons as well the thickening of annular ligament (McGhee *et al*., 2005). Diagnosis is normally done through use of ultrasonography. The general medication includes the use of nonsteroidal anti-inflammatory drugs (NSAIDS) and flushing. When there is no response to medical treatment, the palmar/plantar annular ligament can be transected (Chan *et al*, 2000).

2.8.5 Splint bones fractures

Amputation of the splint bones (second and fourth metacarpal bones) is not uncommon in horse practice and is usually as a result of fractures (closed/open) of traumatic origin (Jackson *et al*., 2007). Fractures normally occur anywhere along the length of the bones. The splint bones are prone to trauma because they have minimal soft tissue cover. Splint bone fractures can be simple, comminuted or compound. Additionally, the comminuted fracture may be complicated by the development of osteitis, osteomyelitis and/or bone sequestrum. X-rays are the gold standard for diagnosis of splint bone fractures. While conservative treatment can be done, healing time is prolonged and is complicated by excessive callus formation. Therefore, amputation of a fractured distal splint bone is the preferred management option (Ross and Dyson, 2011).

2.8.6 Sesamoid fractures

Sesamoid fractures are common in racing horses with some predisposition being described for thoroughbreds and standardbreds (Schnabel and Redding, 2016). These fractures vary in severity and could be simple, minor and in extreme cases catastrophic. Horses with catastrophic sesamoid fractures are usually euthanized (Schnabel and Redding, 2016) while those with simple to moderate fractures tend to have moderate to severe lameness. Diagnosis is usually through radiography and management is by surgical extraction of bone fragments. Arthroscopic surgery is preferred to arthrotomy as it is associated with minimum tissue trauma (Schnabel *et al.*, 2006).

2.8.7 Chip and slab fractures in horses

Carpal chip fractures (osteochondral fractures) are a common cause of lameness in racehorses. Trauma is the primary etiological factor, which is almost always associated with exercising too fast. Chips occur on the dorsal aspect of the joint. In the middle carpal joint, the most frequent sites are the distal radial carpal bone, proximal third carpal bone, and the distal intermediate carpal bone. In the radiocarpal joint, the most common locations are the proximal intermediate carpal bone, distal lateral radius, proximal radial carpal bone, and the distal medial radius (Aiello and Mays, 2016). Diagnosis is based on clinical signs of synovitis and capsulitis and radiographic demonstration of osteochondral chip fragment(s) (Davidson, 2002). The treatment of choice is arthroscopic surgery. The overall prognosis is highly dependent on the degree of articular cartilage damage within the joint identified on arthroscopy.

Slab fractures extend from one articular surface to another articular surface. In the carpus, slab fractures occur in both frontal and sagittal planes. The most common fracture is a frontal slab fracture of the radial facet of the third carpal bone, followed by fractures of the intermediate facet and both facets of this bone. The treatment of choice is lag screw fixation for fractures

that are less than 10 mm or removal of the fracture fragments if they are thin or not amenable to lag screw fixation (Stephens *et al*., 1988; Aiello and Mays, 2016).

2.8.8 Umbilical and abdominal wall hernias

Umbilical hernias are widespread in different animal species and in horses they make up about 0.5 to 2% of all the hernias in foals (Markel *et al*., 1987; Whitfield-Cargile, 2011). While congenital (umbilical and inguinal) hernias are common, acquired abdominal hernias are also encountered. These are regarded as secondary and occur as a result of blunt trauma on the body wall. Diagnosis of hernias is usually by physical reduction of the hernia contents into the hernia ring while ultrasound can be used to evaluate the contents of the hernia sac. Hernia contents usually consists of intestines, fat and body organs (e.g. spleen, bladder) (Elce *et al*., 2005). Surgical correction involves repairing the defect by using a synthetic mesh which can be implanted into retroperitoneal space while smaller hernias can be reduced by using sutures. In cases of large hernias with intestinal strangulation, the affected intestine might have to be transacted and anastomosed. Prognosis for smaller hernias is generally good whereas it varies for large hernias. Post-operative complications include swelling and recurrence of the hernia due to dehiscence (Elce *et al.*, 2005).

2.9 Dentistry

Veterinarians attending to horses needing dental assessment and care are obliged to have sound knowledge of the equine dental and periodontal anatomy. This knowledge forms the basis of diagnosing and managing dental abnormalities (Staszyk *et al*., 2015). Equines with dental problems present differently. The common clinical signs observed in horses with dental problems are weight loss, mandibular/maxillary swelling, head shaking, quidding, malodorous

breath, nasal discharge and draining tracts (Ndurumo, 2008). A thorough physical dental examination should therefore be done before intervention is done. The examination should aim at quantifying dental and oral disorders as well as establishing the best treatment option. The dentition, gingiva, tongue, salivary systems and buccal cavity mucosa should all be evaluated during examination. The treatment should aim at assisting mastication and normal closure of the mouth (Baker, 1998; Tremaine and Pearce, 2012).

2.9.1 Dental overgrowth and sharp edges

Dental overgrowth and sharp edges, also called enamel points, tend to cause lacerations or trauma to the tongue and cheeks when chewing. This results in quidding (food falling from the mouth during mastication), poor mastication and slow chewing (Dixon and Dacre, 2005). Dental overgrowth is mainly attributed to the fact that the horse maxilla is wider than the mandible. The overgrowth therefore tends to be on the buccal side on the maxilla and on the lingual side on the mandible. Equine teeth continue to grow throughout the horse's life and without attrition, the teeth tend to overgrow producing sharp edges (Nicholls, 2016). To reduce overgrowths, more than one session of tooth rasping annually is recommended. Sedation is recommended in temperamental animals during the procedure (Marshall *et al*., 2012).

2.9.2 Retained deciduous teeth

Retained deciduous teeth, also known as dental caps are normally evident after full eruption of the permanent teeth. When not attended to, the retained caps result in impaction, prevent normal eruption and cause displacement. Other consequences of retained caps are lacerations and infection of the gums. The condition is usually managed through removal of the retained caps under sedation (Dixon and Dacre, 2005).

2.9.3 Dental trauma

Dental trauma is usually as result of external, bit-related and in some cases iatrogenic trauma during dental procedures. External trauma from kicks can also result in mandibular fractures or dental fractures or both while iatrogenic dental fractures sometimes occur during cutting of dental overgrowths (Barnett, 2015). Management of dental trauma includes flushing and debridement of devitalized tissues as well as antibiotic therapy. Dietary management by feeding soft food is also recommended. Tooth extraction is recommended but sometimes might be delayed since there might be need to assess dental viability and stability of mandibular fractures (Dixon *et al.*, 2000).

2.9.4 Supernumerary teeth

Supernumerary teeth also known as polydontia or hyperdentition, are excess teeth that erupt from any of the dental arcades (Dixon *et al.,* 2005). Supernumerary teeth are uncommon in horses and the prevalence of the condition is unknown (Earley *et al*., 2020). Veterinarians have morphologically categorized supernumerary teeth into supplemental teeth and rudimentary teeth. Supplementary teeth resemble normal teeth while rudimentary ones are usually smaller in size. Supernumerary incisors of horses always belong to the permanent dentition and are reported more commonly in horses than are supernumerary cheek teeth (Eksteen, 2017). Dental overgrowth and diastemata are clinical signs commonly associated with supernumerary teeth. These clinical signs predispose horses to periodontal disease and maxillary sinusitis (Dixon *et al.,* 2000). Radiography is the most common diagnostic technique used to diagnose supernumerary teeth. Retained deciduous teeth is the main differential diagnosis of supernumerary teeth and they can only be differentiated using radiography (Tremaine and Casey, 2012). Supernumerary teeth are commonly managed by regular assessment of the dentition coupled with aggressive dental floating to minimize the opportunity for soft tissue

damage by unopposed tooth elongations or sharp enamel points (Eksteen, 2017). If complications arise, the supernumerary tooth or displaced adjacent tooth should be extracted.

2.9.5 Equine odontoclastic tooth resorption and hypercementosis

Equine odontoclastic tooth resorption and hypercementosis (EOTRH) is a painful condition which primarily affects the canines and the incisors of the horse. Physical examination of the teeth reveals teeth which are lytic from inside, irregular and bulbous. Sometimes there is gingival receding as well as shifting of incisor positioning (Staszyk, *et al*., 2008). As the disease progresses, there will be external and internal resorption of the dental structure. Excessive production of cementum occurs. Inflammation and infection of the alveolar bone usually occurs resulting in reduced structural support of the teeth, tooth fracture, fistula formation and pain. Radiographically the changes commonly observed can be summarized as widened periodontal space, osteomyelitis (which could include alveolar and surrounding bone), shifting of the teeth and increased radio-density of the alveolar tooth root (Kreutzer *et al*., 2007). Risk factors for EOTRH include age and breed. It has been established that horses above 15 years of age are more prone to EOTRH. The commonly affected breeds include the warmbloods and thoroughbreds. Periodontal disease and excessive dentistry are other risk factors associated with EOTRH (Pearson *et al*., 2013).

Management of EOTRH involves extraction of the affected teeth. Sedation and regional anaesthesia are the recommended anaesthetic protocols. After extraction, flushing and rinsing should be vigorously done using 0.12% chlorhexidine and use of systemic antibiotics is encouraged with trimethoprim/sulfamethoxole as the drug of choice. Post extraction, a splint can be applied to prevent teeth drifting (Rucker and Wilson, 2009).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study design

This was a retrospective study where clinical records of horses treated at selected veterinary practices in Nairobi County were examined. The records were of those horses treated over a 10-year period beginning January, 1st 2010 up to December, 31st 2019. Relevant, surgical and dental data were extracted as outline in section 3.4.

3.2 Study area

The study was conducted in Nairobi County which is the capital city of Kenya. The county is highly cosmopolitan and spans an area of 684 km^2 with an estimated population density of over 3,017 persons/km^2 (Kenya National Bureau of Statistics, 2019). Nairobi County is located at longitude 36°50′ East and latitude 1°17′ South. The County has an average annual rainfall of about 925 mm with ambient temperatures ranging from 12 – 24^o C (Rourke, 2011). Figure 1 shows the map of Nairobi County, where this study was conducted.

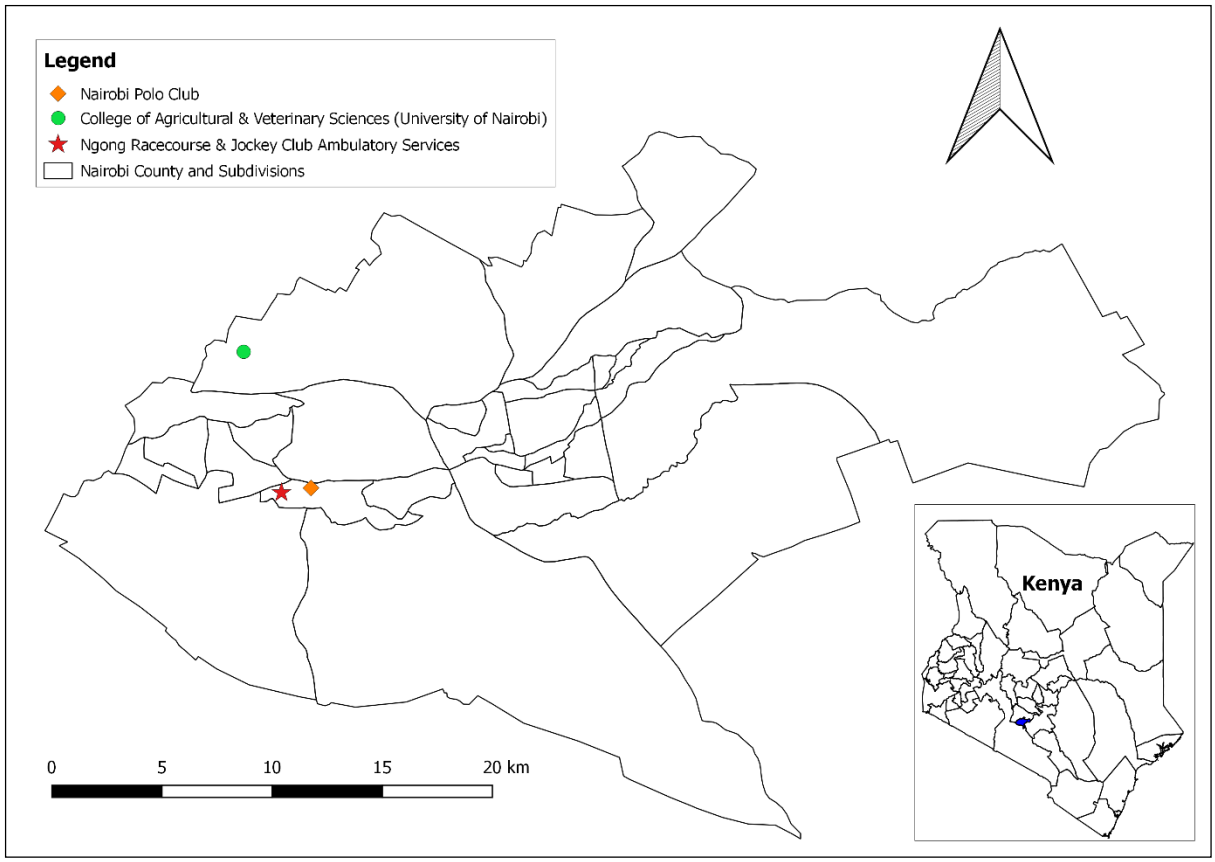

Fig. 1 Map of Nairobi County and its divisions, showing the location of the Ngong racecourse, Nairobi polo club and the Jockey Club ambulatory services equine practice from which clinical records used in this study were obtained. Country and county boundary data were downloaded and re-published under CC BY 4.0 license from the World Resources Institute website (https://www.wri.org/resources/data_sets). The map was developed using QGIS software version 3.16.1 (https://www.qgis.org/en/site/).

Nairobi County was purposively selected in this study for the following reasons;

1. The County has the highest population of horses in Kenya, estimated to be at least 3,200 (Gitari *et al.*, 2017)
2. Both the jockey and polo clubs of Kenya are located in Nairobi County thus high number of horses compared to other parts of the country.

3. The County has a relatively higher number of horse practitioners as compared to other parts of Kenya.

3.3 Selection of Veterinary clinics

After obtaining a sampling frame of all the Veterinary clinics in Nairobi County from the Kenya Veterinary Board database, the clinics of interest to this study were purposively identified using the following criteria:

1. Veterinary clinics that treated horses.
2. Veterinary clinics that had been in operation at least from January, 1st 2010 up to December, 31st 2019.
3. Veterinary clinics that kept comprehensive clinical records either manually or digitally.
4. The willingness of clinic owner/veterinarian to participate in the study.
5. Veterinary clinic/practicing veterinarian that were registered by the Kenya Veterinary Board.

Formal requests were sent to the head veterinarian at the selected clinics inviting them to take part in the study. Those that responded positively were recruited into the study. Records of horses whose ailments were managed surgically and/or those diagnosed and treated for dental conditions were identified and examined.

3.4. Data Collection

3.4.1 Specific Objective 1. To determine the occurrence of surgical and dental conditions that affected horses in Nairobi County from January 2010 to December 2019.

To achieve this objective, the tentative or confirmed diagnosis necessitating dental/surgical management was determined from the retrieved records. For ease of further data processing, surgical conditions were classified based on the affected body system as alimentary,

respiratory, nervous, eye and adnexa, reproductive, integument and musculoskeletal system as recommended by Auer and Stick (2012). Whereas the oral cavity - and its associated structures - is part of the alimentary system, in this study, it was intentionally isolated from the rest of the alimentary system due to the specificity of the conditions that affect it and the unique diagnostic and management approach.

3.4.2 Specific objective 2. To evaluate the diagnosis and management of the surgical and dental conditions that affected horses in Nairobi County from January 2010 to December 2019.

To achieve this objective, the following data were extracted from clinical records that met the selection criteria outlined in this study: diagnostic techniques utilized for each surgical and dental condition; the surgical procedure carried out; type of anaesthesia (general or local anaesthesia); anaesthesia protocol; antibiotics administered; analgesic(s) used and post-operative care employed.

3.4.3 Specific objective 3. To evaluate the factors that determine outcomes of surgical and dental procedures in horses in Nairobi County, Kenya.

To achieve this objective, records were evaluated to establish the outcome following management of surgical and dental conditions. For the purpose of this study, the outcomes were classified as being satisfactory or unsatisfactory. A satisfactory outcome was defined as one in which the surgical or dental condition was managed and the patient recovered without having any notable complication. Unsatisfactory outcome was defined as one in which the surgical or dental condition that was managed ended up with notable complication(s) which affected the healing process and resulted into either recovery after managing the complication or euthanasia/death even after managing the complication.

3.5 Data management and analysis

The data were entered into Microsoft Excel, cleaned, filtered and saved as comma separated values (.csv) in preparation for further analysis. Descriptive analysis, line graphs and tables were used to illustrate the yearly occurrence of specific surgical/dental conditions calculated by dividing the number of specific surgical/dental conditions by the total number of surgical/dental cases in that particular year. Line graphs were made in Microsoft Excel® while heat maps were created in R® version 4.0.3, using the *ggplot2* package. All figures were then exported into Adobe Illustrator CS ® for further editing and visualization.

For statistical analysis, logistic regression was used to evaluate the determinants of the outcome of surgical procedures performed at Veterinary clinics from the list of independent variables, which was performed in R® version 4.0.3 using the generalized linear model (GLM) for binary responses. The outcome was classified as either satisfactory or unsatisfactory based on the criteria described in section 3.4.3. Body system affected, anaesthesia and post-operative treatment were included as the independent variables. The frequency of an unsatisfactory surgical outcome was estimated for each of the independent variable categories. Body system affected (*Dental, Eye and adnexa, Integument, Reproductive, Musculoskeletal, and Respiratory*) was used in the analysis as recorded while anaesthesia was recoded into *General anaesthetic* (Xylazine-Ketamine, Gaseous maintenance), *Sedation* (Medetomidine-Butorphanol, Medetomidine-Butorphanol-Local anaesthetic, Xylazine only), *Local anaesthetic* (Lignocaine) and *No anaesthetic* when no chemical restraint was used.

The use of post-operative treatments was coded '*NO*' where it was not used and '*YES*' where Methylprednisolone (Depomedrol), Penicillin-Streptomycin (Penstrep), Phenylbutazone, Tetanus toxoid and Medetomidine, Gentamicin, Flunixine meglumine, Xylazine, Neomycin-

Polymyxin-Dexamethasone (Maxitrol), Bandaging and Ketoprofen (Ketosol) were used singly or in any combination. To determine the independent variables that were associated with the outcome of a surgical case, univariable logistic regression analysis was performed and variables with a univariable likelihood ratio test of *p*-value < 0.1 were included into the multivariable models. In the multivariable model, odds ratios, confidence intervals, and *p*-values were estimated, with a *p*-value of < 0.05 being considered statistically significant.

CHAPTER FOUR

4.0 RESULTS

Although three veterinary clinics in Nairobi County were targeted in this study, data were collected from only one practice. This was occasioned by COVID-19 pandemic that limited movement and social interaction. The practice where the data were collected deals exclusively with horses and is amongst the oldest clinics, handling over 80% of surgical and dental cases of horses in Kenya.

4.1 The occurrence of surgical and dental conditions that affect horses in Nairobi County

4.1.1 Occurrence of surgical and dental conditions

A total of 952 surgical and dental cases managed from January 2010 to December 2019 were identified from the clinical records. However, 31 cases were removed due to incompleteness, thus leaving a total of 921 cases. Of the 921 conditions, 45.3% (417/921) were dental while 54.7% (504/921) were surgical cases.

4.1.2 Distribution of surgical and dental conditions per year

The number of dental and surgical cases managed in horses per year is presented in Table 1 below. Generally, the highest number of dental and surgical cases in horses were managed in the year 2012 [139/921 (15.1%)] while the lowest number was recorded in 2019 [38/921 (4.1%)]. The highest number of dental cases in horses was recorded in the year 2012 (82/417) with the lowest number managed in 2019 (15/417). Surgical cases were highest in 2013 (78/504) and lowest in 2018 (21/504). Overall, the number of dental and surgical cases in horses in Nairobi County decreased gradually from 2012 to 2019 as depicted in Figure 2 below.

Table 1: A summary of the number surgical and dental cases that affected horses in Nairobi County, Kenya from January 2010 to December 2019

Year	Number of dental conditions per year	Number of surgical conditions per year	Total number of cases per year
2010	36	73	109
2011	77	60	137
2012	82[a]	57	139[e]
2013	42	78[c]	120
2014	38	52	90
2015	57	40	97
2016	22	58	80
2017	25	42	67
2018	23	21[d]	44
2019	15[b]	23	38[f]
Total	**417**	**504**	**921**

Key: [a] Represents the year in which highest number of dental cases were managed in horses

[b] Represents the year in which lowest number of dental cases were managed in horses

[c] Represents the year in which highest number of surgical cases were managed in horses

[d] Represents the year in which lowest number of surgical cases were managed in horses

[e] Represents the year with the highest total number of dental and surgical cases

[f] Represents the year with the lowest total number of dental and surgical cases

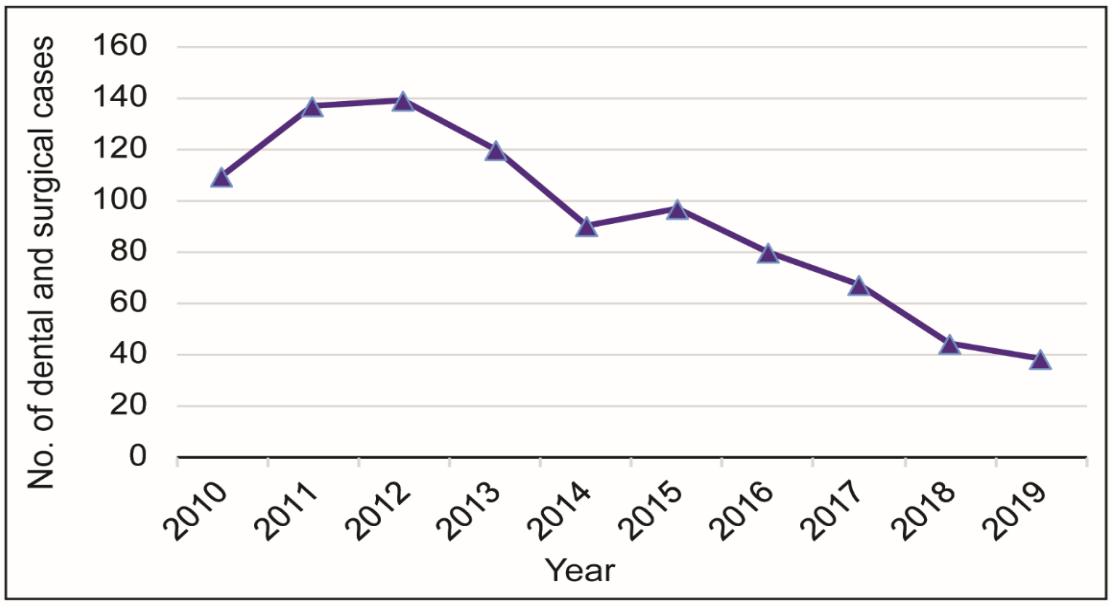

Figure 2: Trend in the occurrence of surgical and dental cases managed in horses in Nairobi County from January 2010 to December 2019

4.1.3 Distribution of surgical and dental cases per body system

Overall, in the period between January 2010 and December 2019, 45.3% (417/921) of horses presenting to the practice were treated for dental conditions. Two hundred and eight out of 921 (22.6%) horses underwent surgical procedures involving the reproductive system, 16.4% (151/921) the integumentary system, 10.5% (97/921) the musculoskeletal system, 3.7% (34/921) the eye and adnexa, while 1.5% (14/921) of surgeries involved the respiratory system (Table 2). Notably, there were no surgical procedures recorded that involved the alimentary and nervous system in horses in Nairobi County over the 10-year study period. In reference to specific conditions, 41.5% (382/921) of horses in Nairobi County were treated for teeth overgrowth between January 2010 and December 2019. Castrations in entire males were done in 20.8% (192/921) cases, then lacerations (11.9%), lameness (4.3%), sarcoids (3.8%), umbilical hernias (2.7%) and wolf tooth (2.6%). The frequency of occurrence of specific conditions based on body system is shown in Table 2.

In reference to specific conditions per body system, the most prevalent dental condition was teeth overgrowth at 91.6% (382/417) while castration (entire males), [92.3% (192/208)] was the most common surgical procedure involving the reproductive system. In the musculoskeletal system, the most prevalent condition was lameness while lacerations were predominant in the integumentary system. In the eye and adnexa, the most prevalent condition was SCC whereas ethmoid hematoma was the more common condition of the respiratory system (Table 2).

Table 2: The distribution of specific surgical and dental conditions affecting horses in Nairobi County, Kenya from January 2010 to December 2019

Body system	Number of cases per system (% of the overall cases N=921)	Specific condition / procedure per system	Number of a specific condition per system (% of a specific condition per body system)
Dental conditions	417 (45.3)	Teeth overgrowth	382 (91.6) #
		Wolf tooth	24 (5.8)
		Broken tooth	7 (1.7)
		Dental caps	2 (0.4)
		Retained caps	1(0.2)
		Tooth gap impaction	1(0.2)
Reproductive	208 (22.6)	Castration	192 (92.3) #
		Cryptorchidism	10 (4.8)
		Pneumovagina	4 (1.9)
		Hematoma	1 (0.5)
		3rd degree vaginal tear	1 (0.5)
Integument	151 (16.4)	Laceration	104 (68.9) #
		Sarcoid	31 (20.5)
		Foreign body	4 (2.6)
		Hematoma	2 (1.3)
		Exuberant granulation	2 (1.3)
		Abscess	1 (0.7)
		Carpal hygroma	1 (0.7)
		Draining tract on maxilla	1 (0.7)
		Growth	1 (0.7)
		Keloid	1 (0.7)
		Lymphoma	1 (0.7)
		Melanoma	1 (0.7)
		Seroma	1 (0.7)
Musculoskeletal	97 (10.5)	Lameness	40 (41.2) #
		Umbilical hernia	25 (25.8)
		Angular limb deformity	11 (11.3)
		Flexural deformity	4 (4.1)
		Upward fixation of the patella	4 (4.1)
		Chip fracture	3 (3.1)
		Annular ligament syndrome	1 (1.0)
		Bleeding from umbilicus	1 (1.0)
		Clubfoot	1 (1.0)
		Extensor tendon rupture	1 (1.0)
		Fracture	1 (1.0)
		Stifle swelling	1 (1.0)
		Suspensory ligament	1 (1.0)
		Tendinitis	1 (1.0)
		Tendon contracture	1 (1.0)
		Tendon injury	1 (1.0)
Eye and adnexa	34 (3.7)	Squamous cell carcinoma (SCC)	15 (44.1) #
		Laceration	6 (17.6)
		Sarcoid	4 (11.8)
		Blocked nasolacrimal duct	3 (8.8)
		Growth	2 (5.9)

		Lacrimation	1 (2.9)
		Melanoma	1 (2.9)
		Scleral growth	1 (2.9)
		Trauma	1 (2.9)
Respiratory	14 (1.5)	Ethmoid hematoma	5 (35.7) [#]
		ILHP	3 (21.4)
		Specific diagnosis not recorded	3 (21.4)
		Growth	2 (14.3)
		Sinus bulge	1 (7.1)

Key: [#] Indicates the highest specific condition per the body system

* **ILHP:** Idiopathic laryngeal hemiplegia

4.2 Diagnosis and management of surgical and dental conditions that affected horses in Nairobi County from January 2010 to December 2019.

4.2.1 Diagnostic approaches to horse surgical and dental conditions

Diagnosis of surgical and dental cases in horses was based on three approaches: clinical signs (most of them were highlighted in the records), radiography and endoscopy. Diagnosis in 94.5% (870/921) of dental and surgical cases that affected horses in Nairobi County was based on clinical signs. Radiography was employed in 5.1% (47/921) of the cases while the remaining 0.4% (4/921) of cases relied on endoscopy for diagnosis (Table 3).

Table 3: The proportion of surgical / dental cases affecting horses in Nairobi County as diagnosed by clinical signs, radiography and endoscopy

Diagnostic approach	**Number of cases diagnosed (% out of overall cases N=921)**	**Specific diagnosis / Procedure**	**Number of specific diagnoses (% of all cases diagnosed by clinical signs)**
Clinical signs	870 (94.5)	Teeth overgrowth	382 (43.9)[#]
		Entire males for castration	192 (22.1)
		Laceration	110 (12.6)
		Sarcoid	35 (4)
		Umbilical hernia	25 (2.9)
		Wolf teeth	24 (2.8)
		Lameness	20 (2.3)
		Squamous cell carcinoma	15 (1.7)
		Cryptorchid	10 (1.1)
		Growth	5 (0.6)
		Foreign body	4 (0.5)
		Pneumovagina	4(0.5)
		Blocked nasolacrimal duct	3 (0.3)
		Broken tooth	3 (0.3)
		Hematoma	3 (0.3)
		ILHP	3 (0.3)
		No specific diagnosis	3 (0.3)
		Dental caps	2 (0.2)
		Exuberant granulation	2 (0.2)
		Melanoma	2 (0.2)
		3rd degree vaginal tear	1 (0.1)
		Abscess	1 (0.1)
		Bleeding from umbilicus	1 (0.1)
		Carpal hygroma	1 (0.1)
		Clubfoot	1 (0.1)
		Draining tract on maxilla	1 (0.1)
		Extensor tendon rupture	1 (0.1)
		Flexural deformity	1 (0.1)
		Keloid	1 (0.1)
		Lacrimation	1 (0.1)
		Lymphoma	1 (0.1)
		Retained caps	1 (0.1)
		Scleral growth	1 (0.1)
		Seroma	1 (0.1)

		Sinus bulge	1 (0.1)
		Stifle swelling	1 (0.1)
		Suspensory ligament injury	1 (0.1)
		Tendinitis	1 (0.1)
		Tendon contracture	1 (0.1)
		Tendon injury	1 (0.1)
		Tooth gap impaction	1 (0.1)
		Trauma	1 (0.1)
		Upward fixation of the patella	1 (0.1)
Radiography	47 (5.1)	Lameness	20 (42.6)[#]
		Angular limb deformities	11 (23.4)
		Broken tooth	4 (8.5)
		Chip fracture	3 (6.4)
		Flexural deformity	3 (6.4)
		Upward fixation of the patella	3 (6.4)
		Annular ligament syndrome	1 (2.1)
		Ethmoid hematoma	1 (2.1)
		Fracture	1 (2.1)
Endoscopy	4 (4.3)	Ethmoid hematoma	4 (100)[#]

Key: ILHP: idiopathic laryngeal hemiplegia

[#]Indicates the most common specific condition diagnosed

Teeth overgrowth cases [382 (43.9%)], entire males needing castrations [192 (22.1%)] and lacerations [110 (12.6%) made up the major proportion of the dental/surgical cases in which clinical signs were used as the diagnostic approach. Lameness [20 (42.6%)] and angular limb deformities [11 (23.4%)] cases were majorly diagnosed by radiography while all the cases diagnosed by endoscopy were ethmoid hematomas. Table 3 shows the detail on the use of these diagnostic approaches in horses while Figure 3 shows how these approaches were sometimes used in combination for the diagnosis of selected dental/surgical cases. The specific cases where diagnostic tools were used in combination include lameness (clinical signs and radiography), flexural deformities (clinical signs and radiography), ethmoid hematomas (endoscopy and radiography) and broken teeth (clinical signs and radiography) (Figure 3).

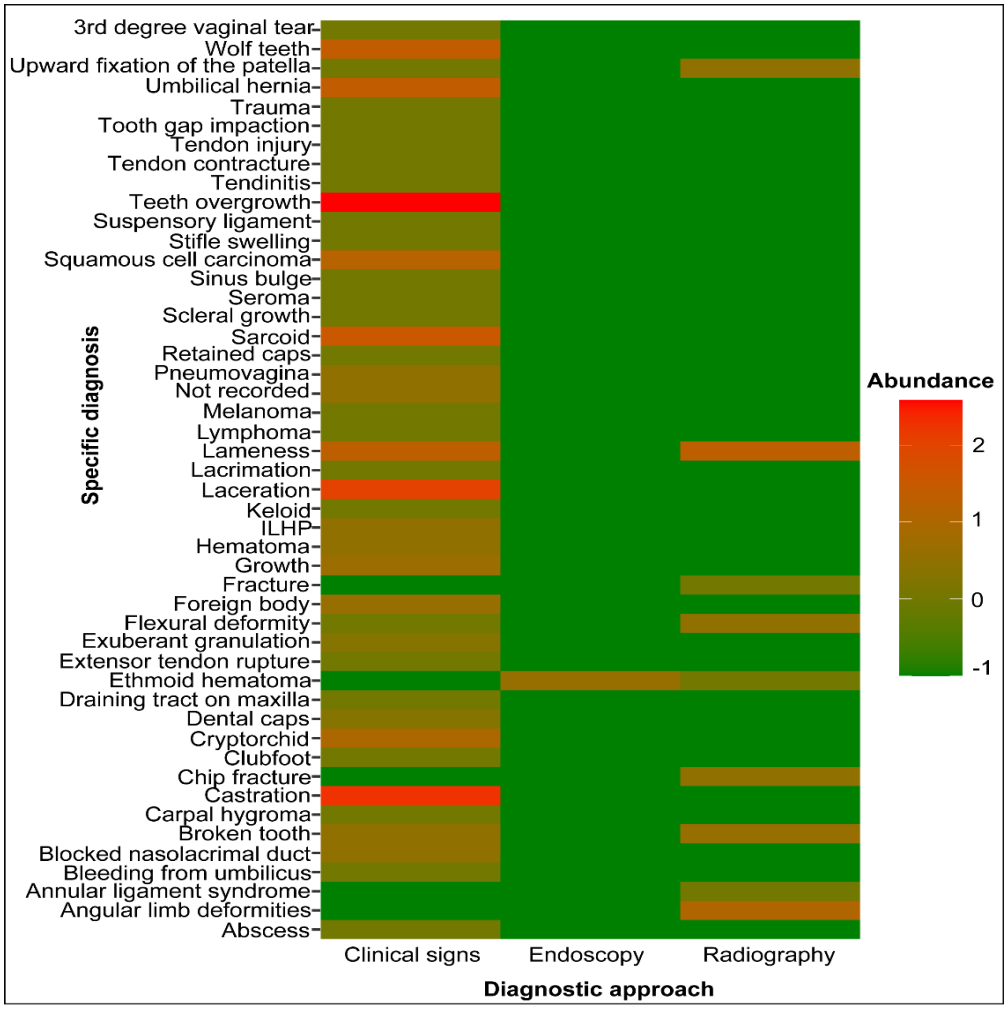

Figure 3: Heat map depicting the approach used in arriving at a diagnosis of specific surgical and dental conditions in horses in Nairobi County from January 2010 to December 2019.

ILHP: idiopathic laryngeal hemiplegia

4.2.2 Anaesthesia protocols used for management of surgical and dental conditions in horses

In reference to anaesthesia / anaesthesia adjuncts, xylazine alone was the most common protocol, and was used in 46.7% (419/921) of all the dental and surgical cases. Other protocols of anaesthetics/anaesthetic adjuncts used were Ketamine + Xylazine [262/921 (28.4%)], Butorphanol + Detomidine [25/921 (2.7%)], Butorphanol + Detomidine + Local anaesthesia (Lignocaine) [19/921 (2.1%)], Local anaesthesia alone (Lignocaine) [7/921 (0.7%)] and gaseous anaesthesia which was used in only two out of the 921 cases. These two cases were a cryptorchidectomy and a castration. Based on the records, no form of chemical restraint was indicated as used in 19% (176/921) of dental and surgical conditions attended to in horses in Nairobi County over the 10-year study period (Table 4).

Of the 430 dental/surgical cases in which Xylazine alone was used as a sedative, teeth overgrowth was the most common condition managed, followed by lacerations and lameness. The majority of the dental/surgical cases where Ketamine-Xylazine combination was used involved castrations, repair of umbilical hernias and management of sarcoids while in the cases where no chemical restraint was used, 83% were teeth overgrowth. Detomidine-Butorphanol combination was mostly used in the stitching up of lacerations and excision of SCC. Detomidine-Butorphanol-local anaesthetic was mainly used for foreign body removal and excision of sarcoids. The most common cases managed with local anaesthetic only were lacerations (Table 4).

Table 4: Anaesthetic / anaesthetic adjunct protocols that were used in the management of surgical / dental cases affecting horses in Nairobi County over the 10-year study period

Anaesthetic / anaesthetic adjunct protocol	**Number of cases managed by protocol (% out of overall cases: N=921)**	**Dental/surgical condition / procedure**	**Number of cases managed (% of overall cases managed with protocol)**
Xylazine	430 (46.7)	Teeth overgrowth	293 (68.1)[#]
		Laceration	56 (13)
		Lameness	30 (7)
		Wolf teeth	15 (3.5)
		Sarcoid	5 (1.2)
		Castration	3 (0.7)
		Squamous cell carcinoma	3 (0.7)
		Pneumovagina	3 (0.7)
		Broken tooth	3 (0.7)
		Growth	2 (0.5)
		Foreign body	2 (0.5)
		Blocked nasolacrimal duct	2 (0.5)
		Upward fixation of the patella	2 (0.5)
		Ethmoid hematoma	2 (0.5)
		Umbilical hernia	1 (0.2)
		Hematoma	1 (0.2)
		Melanoma	1 (0.2)
		Carpal hygroma	1 (0.2)
		Lacrimation	1 (0.2)
		Lymphoma	1 (0.2)
		Retained caps	1 (0.2)
		Tendon injury	1 (0.2)
		Tooth gap impaction	1 (0.2)
Ketamine-Xylazine	262 (28.4)	Castration	169 (64.5)[#]
		Umbilical hernia	24 (9.2)
		Sarcoid	14 (5.3)
		Angular limb deformities	11 (4.2)
		Cryptorchid	9 (3.4)
		Laceration	6 (2.3)
		Teeth overgrowth	5 (1.9)
		Squamous cell carcinoma	4 (1.5)
		Flexural deformity	3 (1.1)
		ILHP	3 (1.1
		Wolf teeth	3 (1.1

		Chip fracture	2 (0.8)
		Broken tooth	1 (0.4)
		Clubfoot	1 (0.4
		Draining tract on maxilla	1 (0.4
		Exuberant granulation	1 (0.4
		Growth	1 (0.4
		Scleral growth	1 (0.4
		Tendinitis	1 (0.4
		Tendon contracture	1 (0.4
		Tendon injury	1 (0.4
*No chemical restraint used/Stated	176 (19%)	Teeth overgrowth	83 (47.2)[#]
		Laceration	27 (15.3)
		Castration	12 (6.8)
		Lameness	9 (5.1)
		Sarcoid	8 (4.5)
		Wolf tooth	6 (3.4)
		Upward fixation of patellar	4 (2.3)
		Ethmoid hematoma	3 (1.7)
		Squamous cell carcinoma	3 (1.7)
		Dental caps	2 (1.1)
		Growth	2 (1.1)
		Hematoma	2 (1.1)
		Abscess	1 (0.6)
		Bleeding from umbilicus	1 (0.6)
		Blocked nasolacrimal duct	1 (0.6)
		Broken tooth	1 (0.6)
		Chip fracture	1 (0.6)
		Extensor tendon rupture	1 (0.6)
		Flexural deformity	1 (0.6)
		Fracture	1 (0.6)
		Melanoma	1 (0.6)
		Pneumovagina	1 (0.6)
		Seroma	1 (0.6)
		Sinus bulge	1 (0.6)
		Stifle swelling	1 (0.6)
		Suspensory ligament damage	1 (0.6)
Detomidine-Butorphanol	25 (2.7)	Laceration	12 (48)[#]

		Squamous cell carcinoma	4 (16)
		Broken tooth	2 (8)
		Sarcoid	2 (8)
		Castration	1 (4)
		Exuberant granulation	1 (4)
		Foreign body	1 (4)
		Lameness	1 (4)
		Teeth overgrowth	1 (4)
Detomidine-Butorphanol-Local anaesthetic	19 (2.1)	Foreign body	6 (31.6)[#]
		Sarcoid	6 (31.6)
		Laceration	4 (21)
		Annular ligament syndrome	1 (5.3)
		Castration	1 (5.3)
		Squamous cell carcinoma	1 (5.3)
Local anaesthetic	7 (0.7)	Laceration	5 (71.4)[#]
		3rd degree vaginal tear	1 (14.3)
		Keloid	1 (14.3)
Gaseous maintenance	2 (0.2)	Cryptorchid	1 (50)[#]
		Castration	1 (50)

Key: ILHP: idiopathic laryngeal hemiplegia

[#] Indicates the most common specific condition managed

*Included for completeness (no chemical restraint used/not recorded)

4.2.3 Techniques/procedures used in the management of horse surgical and dental conditions

A number of procedures / techniques were used to manage different surgical and dental ailments in horses (Table 5). Teeth rasping, castration and surgical stitch ups were the most common management procedures employed in the recorded cases over the 10-year study period. In the management of horse dental conditions, teeth rasping was the most common management procedure carried out / technique used, especially to deal with teeth overgrowth; followed by teeth extraction especially in cases of wolf teeth, broken teeth and dental caps, among others. Castration was the most frequently carried out surgical procedure in the reproductive system in entire male horses followed by cryptorchidectomies and Caslick operations (Table 5).

In the management of surgical conditions of the musculoskeletal system in horses, intraarticular injections with Hyaluronate sodium and Depo-Medrol (Methylprednisolone) were frequently used to alleviate lameness. This was followed by herniorrhaphy performed to manage cases of umbilical hernia and umbilical bleeding (Table 5). Management of surgical cases involving the integument system most frequently consisted of surgical stitch up of lacerations. This was followed by surgical excision for conditions including foreign bodies, growths, keloids and tumours (lymphoma, melanoma and sarcoid) (Table 5). There were a few cases of hematomas, carpal hygromas, seromas and abscesses that were managed by draining. The most commonly used management technique in surgical cases affecting the eye and adnexa of the horse was surgical excision which was used to deal with growths and tumours. This was followed by flushing of blocked nasolacrimal ducts. Lacerations of the eye and adnexa were managed by stitching (Table 5).

Table 5: Management of surgical / dental conditions affecting horses in Nairobi County over the 10-year study period as classified by affected body system

Body system (number of cases)	Management protocol	Number of cases where technique was utilized (% of cases per body system)	Dental/surgical case managed	Number of cases managed
Dental (417)	Teeth rasping	303 (72.7)[#]	Teeth overgrowth	303[a]
	Teeth rasping and extraction	79 (18.9)	Teeth overgrowth	79
	Tooth extraction	34 (8.2)	Wolf tooth	24
			Broken tooth	7
			Dental caps	2
			Retained caps	1
	Flushing	1 (0.2)	Tooth gap impaction	1
Reproductive system (208)	Castration	192 (92.3)[#]	Entire males for castration	192 [a]
	Cyptochirdectomy	10 (4.8)	Cryptorchidism	10
	Caslick operation	5 (2.4)	Pneumovagina	4
			3rd degree vaginal tear	1
	Draining	1 (0.5)	Hematoma	1
Musculoskeletal system (97)	Intra articular injection with Hyaluronate Sodium and Depomedrol	39 (40.2)[#]	Lameness	39 [a]
	Herniorrhaphy	26 (26.8)	Umbilical hernia	25
			Bleeding from umbilicus	1
	Periosteal stripping	12 (12.4)	Angular limb deformity	11
			Flexural deformity	1
	Inferior check ligament desmotomy	4 (4.1)	Flexural deformity	3
			Clubfoot	1
	Medial patellar desmotomy	4 (4.1)	Upward fixation of the patella	4
	Carpal chip surgery	3 (3.1)	Carpal chip fracture	3
	Drains	2 (2.2)	Lameness	1
			Stifle swelling	1
	Annular ligament resection	1 (1.0)	Tendinitis	1
	Annular ligament desmotomy	1 (1.0)	Annular ligament syndrome	1
	Deep digital flexor desmotomy	1 (1.0)	Tendon contracture	1
	Euthanasia	1 (1.0)	Fracture	1

	Robert Jones bandaging	1 (1.0)	Extensor tendon rupture	1
	Splint	1 (1.0)	Suspensory ligament damage	1
	Stitch up	1 (1.0)	Tendon injury	1
Integument system (151)	Stitch up	103 (68.2)[#]	Laceration	103 [a]
	Surgical excision	40 (26.5)	Sarcoid	31
			Foreign body	4
			Melanoma	1
			Growth	1
			Keloid	1
			Laceration	1
			Lymphoma	1
	Drainage	5 (3.3)	Hematoma	2
			Carpal hygroma	1
			Seroma	1
			Abscess	1
	Surgical trimming	2 (1.3)	Exuberant granulation	2
	Exploratory surgery	1 (0.7)	Draining tract on maxilla	1
Eye and adnexa system (34)	Surgical excision	23 (67.6) [#]	Squamous cell carcinoma	15 [a]
			Sarcoid	4
			Growth	2
			Melanoma	1
			Scleral growth	1
	Stitch up	6 (17.6)	Laceration	6
	Flushing	4 (11.8)	Blocked nasolacrimal duct	3
			Excessive lacrimation	1
	Eye enucleation	1 (2.9)	Trauma	1
Respiratory system (14)	Formalin injection	5 (35.7)[#]	Ethmoid hematoma	5 [a]
	Endoscopic examination	3 (21.4)	No specific diagnosis	3
	Prosthetic laryngoplasty	3 (21.4)	ILHP	3
	Surgical excision	1 (2.9)	Growth	1
	Trephination	1 (2.9)	Growth	1
	Flushing	1 (2.9)	Sinus bulge	1

Key:
ILHP: idiopathic laryngeal hemiplegia
The most frequently used technique
[a]The most common dental/surgical case managed

Chemical ablation of ethmoid hematomas via the use of formalin injections was the preferred technique in managing this condition of the respiratory system. On the other hand, prosthetic laryngoplasty was used in the management of idiopathic laryngeal hemiplegia.

4.2.4. Post-operative management of surgical and dental cases of the horse over the 10-year study period

Overall, 49% of the cases in this study did not receive any post-operative treatment. In some of the cases, the records showed some form of postoperative treatment was given albeit without specification. Penicillin-Streptomycin antibiotic combination (Penstrep), Tetanus toxoid and Phenylbutazone were the common post-operative treatments for horse conditions across the different body systems. Specific dental and surgical conditions and their respective specific post-operative treatments are shown in Table 6.

Most of the dental cases did not receive post-operative treatment following their management, especially those involving teeth overgrowth however, when it was given, Tetanus toxoid was the most prevalent post-operative treatment for wolf teeth and teeth overgrowth. In the reproductive system, the most prevalent surgical cases were entire males for castrations and Penicillin-Streptomycin was most commonly used post-operatively followed by Penicillin-Streptomycin/Tetanus toxoid/Flunixin meglumine combination. Gentamicin was also used in combination with Penicillin-Streptomycin in one case of cryptorchidism. However, it is notable that in the majority of these castrations, the specific post-operative treatment given was not recorded or may not have been given at all (Table 6). For cases affecting the musculoskeletal system in horses, bandaging alone and bandaging in conjunction with administration of Phenylbutazone were frequently done post-operatively especially for cases involving lameness

and umbilical hernias. In general, the antibiotic most used for post-operative management of musculoskeletal surgical cases was Penicillin-Streptomycin (Penstrep).

Penicillin-Streptomycin (Penstrep)/Tetanus toxoid/Phenylbutazone combination was frequently used post-operatively in cases affecting the integumentary system of horses in this study. This was more so with respect to cases of lacerations, sarcoids and foreign bodies. However, a number of sarcoid cases also did not receive any post-operative treatment. Penicillin-Streptomycin (Penstrep) featured prominently in most of the post-operative treatment regimens that were given to horses following the management of surgical conditions of the eye and adnexa. Specifically, the Penicillin-Streptomycin/Tetanus toxoid/Phenylbutazone combination was frequently used to cover the post-operative management of lacerations, growths and after excision of SCC (Table 6). In most of the surgical cases affecting the respiratory system of the horse, no post-operative treatment was given while in the few cases that received treatment, Penicillin-Streptomycin and Penicillin-Streptomycin/Tetanus toxoid/Phenylbutazone combination was used.

Table 6: Post-operative management of surgical / dental cases affecting horses in Nairobi County over the 10-year study period

Body system (number of cases)	Post-operative management (Treatment)	Number of cases managed (% of cases per body system)	Dental/surgical case managed	Number of cases (% of cases per management protocol)
Dental system (417)	*None given	352 (84.4)[#]	Teeth overgrowth	336 (95.5)[a]
			Wolf teeth	7
			Broken tooth	5
			Dental caps	2
			Retained caps	1
			Tooth gap impaction	1
	Tetanus toxoid	53 (12.7)	Teeth overgrowth	40
			Wolf teeth	13
	*Not specified	6 (1.4)	Teeth overgrowth	3
			Wolf teeth	2
			Broken tooth	1
	Penstrep/Tetanus toxoid/PBZ	2 (0.5)	Teeth overgrowth	2
	Penstrep/Tetanus toxoid	2 (0.5)	Wolf tooth	1
			Teeth overgrowth	1
	Penstrep/Flunixin/Tetanus toxoid/PBZ	1 (0.24)	Wolf tooth	1
	PBZ	1 (0.24)	Broken tooth	1
Reproductive system (208)	*Not specified	101 (48.6)[#]	Entire males for castration	96 (95) [a]
			Cryptorchid	5
	*None given	36 (17.3)	Entire males for castration	32
			Cryptorchid	3
			Pneumovagina	1
	Penstrep	36 (17.3)	Entire males for castration	36
	Penstrep/PBZ	9 (4.3)	Entire males for castration	8

			3rd degree vagina tear	1
	Penstrep/Tetanus toxoid/Flunixine	9 (4.3)	Entire males for castration	9
	Penstrep/Tetanus toxoid	5 (2.4)	Entire males for castration	3
			Cryptorchid	1
			Pneumovagina	1
	Tetanus toxoid	4 (1.9)	Entire males for castration	2
			Pneumovagina	2
	Penstrep/Tetanus toxoid/PBZ	3 (1.4)	Entire males for castration	2
			Hematoma	1
	Tetanus toxoid/Ketosol	1 (0.5)	Entire males for castration	1
	PBZ	1 (0.5)	Entire males for castration	1
	Penstrep/PBZ/Gentamycin/Tetanus toxoid	1 (0.5)	Cryptorchid	1
	Bandaging/Penstrep	1 (0.5)	Entire males for castration	1
	Flunixine/tetanus	1 (0.5)	Entire males for castration	1
Musculoskeletal system (97)	*Not specified	27 (27.8)[#]	Umbilical hernia	17 (63) [a]
			Angular limb deformities	6
			Flexural limb deformity	2
			Upward fixation of the patella	1
			Annular ligament syndrome	1
	*None given	22 (22.7)	Lameness	13
			Upward fixation of patella	2
			Chip fracture	2
			Extensor tendon rupture	1
			Suspensory ligament	1
			Stifle swelling	1
			Fracture	1
			Tendinitis	1
	Bandaging/PBZ	11 (11.3)	Lameness	10

			Tendon contracture	1
	Bandaging	11 (11.3)	Lameness	9
			Umbilical hernia	1
			Flexural deformity	1
	Bandaging/Not specified	8 (8.2)	Umbilical hernia	4
			Angular limb deformities	3
	Penstrep	4 (4.1)	Angular limb deformities	2
			Umbilical hernia	1
			Bleeding from umbilicus	1
	Depo-Medrol	3 (3.1)	Lameness	3
	Penstrep/Tetanus toxoid/PBZ	3 (3.1)	Flexural deformity	1
			Upward fixation of the patella	1
			Tendon injury	1
	PBZ	2 (2.1)	Lameness	2
			Clubfoot	1
	Bandaging/Flunixine/Tetanus toxoid	1 (1)	Herniorrhaphy	1
	Legend	1 (1)	Chip fracture	1
	Penstrep/Tetanus toxoid	1 (1)	Lameness	1
	Penstrep/Tetanus toxoid/Flunixine	1 (1)	Herniorrhaphy	1
	Sedation	1 (1)	Lameness	1
	Xylazine	1 (1)	Lameness	1
Integument (151)	Penstrep/Tetanus toxoid/PBZ	49 (32.5)[#]	Lacerations	37 (75.5) [a]
			Sarcoid	7
			Exuberant granulation	1
			Lymphoma	1
			Foreign body	3
	Penstrep/Tetanus toxoid	28 (18.5)	Laceration	25
			Sarcoid	2

		Foreign body	1
*None given	23 (15.2)	Laceration	11
		Sarcoid	6
		Melanoma	1
		Keloid	1
		Seroma	1
		Growth	1
		Hematoma	1
		Abscess	1
Tetanus toxoid	12 (7.9)	Laceration	9
		Sarcoid	3
*Not specified	9 (6)	Sarcoid	5
		Lacerations	4
Penstrep/PBZ	7 (4.6)	Laceration	6
		Draining tract on the maxilla	1
Penstrep/Tetanus toxoid/Flunixine	5 (3.3)	Sarcoid	3
		Laceration	2
Penstrep	4 (2.6)	Laceration	3
		Sarcoid	1
Tetanus toxoid/PBZ	4 (2.6)	Laceration	4
PBZ	2 (1.3)	Hematoma	1
		Laceration	1
Bandaging/post-operative treatment	1 (0.7)	Exuberant granulation	1
Butorphanol	1 (0.7)	Sarcoid	1
Depo-Medrol/PBZ	1 (0.7)	Carpal hygroma	1
Maxitrol eye drops	1 (0.7)	Laceration	1
Penstrep/Betadine spray	1 (0.7)	Sarcoid	1
Penstrep/Gentamycin/Tetanus toxoid	1 (0.7)	Laceration	1
PBZ/Flouroacil	1 (0.7)	Sarcoid	1

	Sarcoid cream	1 (0.7)	Sarcoid	1
Eye and adnexa system (34)	*None given	8 (23.5)[#]	Blocked nasolacrimal duct	3 (37.5)
			Squamous cell carcinoma	2
			Laceration	2
			Melanoma	1
	Tetanus toxoid/PBZ	7 (20.6)	Squamous cell carcinoma	6
			Laceration	1
	Penstrep/Tetanus toxoid/PBZ	4 (11.8)	Scleral growth	1
			Laceration	1
			Squamous cell carcinoma	1
			Growth	1
	*Not specified	4 (11.8)	Trauma	1
			Laceration	1
			Squamous cell carcinoma	1
			Sarcoid	1
	Penstrep/Tetanus toxoid	2 (5.9)	Laceration	2
	Penstrep/PBZ	1 (2.9)	Sarcoid	1
	Penstrep/Tetanus toxoid/Flunixin	1 (2.9)	Sarcoid	1
	Penstrep/Tetanus toxoid/Maxitrol eye drops	1 (2.9)	Squamous cell carcinoma	1
	Penstrep/Tetracycline	1 (2.9)	Squamous cell carcinoma	1
	PBZ/Maxitrol	1 (2.9)	Squamous cell carcinoma	1
	Tetanus toxoid	1 (2.9)	Sarcoid	1
	Tetanus toxoid/Maxitrol	1 (2.9)	Growth	1
	Eye ointment	1 (2.9)	Squamous cell carcinoma	1
	Flunixine/Penstrep	1 (2.9)	Squamous cell carcinoma	1
Respiratory system (14)	*None given	10 (71.4)[#]	Ethmoid Hematoma	4 (40) [a]
			No specific diagnosis	3

		ILHP	1
		Sinus bulge	1
		Growth	1
*Not specified	2 (14.3)	ILHP	2
Penstrep	1 (7.1)	Ethmoid hematoma	1
Penstrep/Tetanus/PBZ	1 (7.1)	Growth	1

Key: PBZ: Phenylbutazone

Flunixine: Flunixine meglumine

ILHP: Idiopathic laryngeal hemiplegia

Penstrep: Penicillin-Streptomycin

*Included for completeness

[#]Most common post-operative management protocol per body system

[a]Highest number of cases managed

4.3 Outcomes of surgical and dental procedures in horses.

Nine hundred and one dental and surgical cases (97.8%) that were managed in horses in Nairobi County from January 2010 – December 2019 had satisfactory outcomes and only 2.2% (20/921) were considered to have had an unsatisfactory outcome. Of the 20 cases that had unsatisfactory outcomes, 9 were conditions affecting the reproductive system, 5 the integumentary system and two each affecting the dental, respiratory, and musculoskeletal systems (Table 7). Of the nine cases affecting the reproductive system and recording unsatisfactory outcome, eight were castrations and one was a cryptorchidectomy. The most common post-management complications were bleeding (6/20), followed by swelling (4/20) and suture dehiscence (3/20). Post-operative bleeding and swelling were mostly associated with castrations and cryptorchidectomy, while suture dehiscence was exclusively associated with repair of lacerations (Table 7).

Table 7: The details of the horse surgical and dental cases in Nairobi County that had an unsatisfactory outcome over the 10-year study period

System involved	Diagnostic approach	Specific condition	Management	Anaesthesia protocol	Post-operative treatment	Post-operative complication
Respiratory	Endoscopy	Ethmoid hematoma	Intralesional formalin	No	Penstrep	Post op bleeding
Musculoskeletal	Radiography	Angular limb deformities	Periosteal stripping	Xylazine/Ketamine	Penstrep	Post op swelling
Integument	Clinical signs	Laceration	Stitch up	Xylazine/Local	Penstrep/tetanus	Suture dehiscence
Reproductive	Clinical signs	Entire males for castration	Castration	Gaseous anaesthetic	No	Post op bleeding
Respiratory	Clinical signs	ILHP	Prosthetic laryngoplasty	Xylazine/Ketamine	Post-operative treatment	Aspiration pneumonia, death
Reproductive	Clinical signs	Entire males for castration	Castration	Xylazine/Ketamine	Penstrep/PBZ	Post op bleeding
Integument	Clinical signs	Laceration	Stitch up	Xylazine/Ketamine	Penstrep/tetanus/PBZ	Suture dehiscence
Dental	Clinical signs	Teeth overgrowth	Teeth rasping	Xylazine	No	Excessive sweating
Reproductive	Clinical signs	Entire males for castration	Castration	Xylazine/Ketamine	Post-operative treatment	Post op bleeding
Reproductive	Clinical signs	Entire males for castration	Castration	Xylazine/Ketamine	Penstrep/PBZ	Post op swelling
Reproductive	Clinical signs	Entire males for castration	Castration	Xylazine/Ketamine	Penstrep	Choke
Integument	Clinical signs	Sarcoid	Surgical excision	Xylazine/Ketamine	Post-operative treatment	Exuberant granulation
Musculoskeletal	Clinical signs	Clubfoot	Inferior check desmotomy	Xylazine/Ketamine	Bandaging/post-operative treatment	Pyrexia
Reproductive	Clinical signs	Entire males for castration	Castration	Xylazine/Ketamine	Post-operative treatment	Post op bleeding
Reproductive	Clinical signs	Entire males for castration	Castration	Xylazine/Ketamine	Post-operative treatment	Post op swelling
Reproductive	Clinical signs	Entire males for castration	Castration	Xylazine/Ketamine	No	Post op bleeding
Integument	Clinical signs	Laceration	Stitch up	No	No	Suture dehiscence
Dental	Clinical signs	Teeth overgrowth/wolf tooth	Teeth rasping/extraction	No	No	Tooth gap impaction
Integument	Clinical signs	Laceration	Stitch up	Xylazine	No	Surgical site infection
Reproductive	Clinical signs	Cryptorchid	Cryptorchidectomy	Xylazine/Ketamine	Penstrep/PBZ/Gentamycin/Tetanus	Post op swelling

Key: Post-operative treatment: Cases where the post-operative treatment was not specified in the records; Penstrep: Penicillin – Streptomycin; ILHP: idiopathic laryngeal hemiplegia; Local: local anaesthetic; No-No drug or treatment was administered

Logistic regression to determine the association of predictor variables with the outcome of the dental/surgical case was eventually carried out on 880 out of the 921 records assessed. There were no *Unsatisfactory* cases under the *Eye and adnexa* system (34 cases) and for *Local anaesthesia* (7 cases) hence these categories were excluded from the analysis. The affected body system, anaesthetic protocol and post-operative treatment were all univariably associated with the outcome of the dental/surgical case (Table 8) and subsequently included into the multivariable model.

In the multivariable model, anaesthetic protocol and post-operative treatment were not significantly associated with dental/surgical case outcome and hence were sequentially dropped to generate the final model. At each step, the resultant model was compared to the preceding one until the final model contained only the affected body system as a significant predictor of dental/surgical outcome (overall likelihood ratio $p = 0.002$) (Table 9). The outcome of the surgical case was significantly more likely to be unsatisfactory if it was localized to the respiratory (OR: 34.58; 95% CI: 3.89-309.05; $p < 0.001$), reproductive (OR: 9.43; 95% CI: 2.40-62.24; $p = 0.004$) and integumentary (OR: 7.41; 95% CI: 1.58-52.15; $p = 0.017$) systems compared to the dental system. These results imply that the odds of having unsatisfactory outcome was 34 times likely to occur when surgery involved the respiratory system, 9 times when it involved the reproductive system and 7 times likely when it involved the integumentary system as compared to the dental system.

Table 8: Univariable logistic regression analysis of predictor variables associated with outcome of surgical / dental cases affecting horses in Nairobi County over the 10-year study period

Variable	**Category**	**OR**	**95% CI**	**p-value**
Affected body system	Dental	Baseline		Overall LR= 0.002
	Respiratory	34.58	3.89-309.05	*< 0.001*
	Reproductive	9.43	2.40-62.24	*0.004*
	Integument	7.41	1.58-52.15	*0.017*
	Musculoskeletal	4.37	0.52-36.78	0.143
Anaesthetic protocol	No chemical restraint	Baseline		Overall LR= 0.02
	Sedation only	0.49	0.11-2.53	0.359
	General anaesthetic	2.99	0.95- 13.19	0.091
Post-operative treatment	Yes	Baseline		Overall LR= 0.064
	No	0.42	0.15-1.05	0.076

Significant p-values are in italics

Key:

OR: odds ratio

LR: likelihood ratio

CI: confidence interval

Table 9: Final logistic regression model for the outcome of surgical / dental cases affecting horses and associated predictor variables in Nairobi County over the 10-year study period

Variable	**Category**	**OR**	**95% CI**	**p-value**
Affected body system	Dental	Baseline		Overall LR= 0.002
	Respiratory	34.58	3.89-309.05	*< 0.001*
	Reproductive	9.43	2.40-62.24	*0.004*
	Integument	7.41	1.58-52.15	*0.017*
	Musculoskeletal	4.37	0.52-36.78	0.143

Significant p-values are in italics.

Key:

OR: odds ratio

LR: likelihood ratio

CI: confidence interval.

CHAPTER FIVE

5.0 DISCUSSION

This retrospective study describes the common surgical and dental conditions that affect horses in Nairobi County in Kenya. This is a region where the highest number of horses are found in Kenya and is also home to the most prominent veterinary clinics. The information generated in this study can therefore be extrapolated and used as reference by horse practitioners in Kenya. It also contributes to the knowledge on horse practice globally as the common diagnostic and management approaches used are described. This study is amongst the very few worldwide (Penell *et al.*, 2005) and the first one in Kenya to use this comprehensive approach. Previous studies have focused on few selected surgical conditions (Gitari *et al.*, 2017; Samiullah *et al*., 2017).

In the first objective, the study observed that the majority of disorders in horses in Nairobi County were localized to the dental, reproductive and integumentary body systems in that decreasing order of frequency over the 10-year study period. These findings show that in retrospect, most horse practitioners in Nairobi County used the basic presenting clinical signs exhibited by the animal to arrive at a diagnosis. In most of the cases evaluated, Ketamine-Xylazine combination or Xylazine alone, were used to facilitate their management. Post-operative care included administration of a variety of antibiotics, analgesics and Tetanus toxoid, although not in all the cases. Surgical and dental management mostly involved procedures such as castrations and teeth rasping, in tandem with the most prevalent surgical and dental cases recorded, respectively. Expectedly, most of the surgical and dental cases evaluated had a satisfactory outcome. Finally, using the logistic regression model, the body system where the surgical/dental condition was localized was the only significant determinant of the outcome of the surgical/dental case under the risk factor analysis.

The number of surgical and dental disorders in horses that were attended to at the veterinary clinic of interest in this study in Nairobi County, were on the rise from 2010 to 2013 and then declined gradually from 2014 to 2019. Since this study relied upon the availability of records, this trend may highlight the change in record keeping practices by veterinary practitioners at this clinic over the 10-year period. Increase in competition from other practices could also have resulted in this trend. When separated into dental and surgical cases, the data did not give a clear trend line, which could have been due to the fact that only one clinic was investigated in this study and future studies should therefore include more clinics.

Record keeping is vital in clinical practice globally and it is a requirement for all veterinarians in Kenya by the Kenya Veterinary Board and also the various veterinary boards and councils that govern the operations of veterinarians in other jurisdictions. In addition, properly kept records are an important point of reference in practice as well as during any possible disputes that may arise such as claims of negligence or malpractice. At minimum these records should always include complete signalments, diagnostics and treatments offered (Roth, 2017). While the issue of affordability is critical in clinical practice, record keeping can be more routine and efficient, if veterinary practices adopt the use of information management software and systems. This is because manual systems are cumbersome and require physical space for storage of large volumes of records and can be easily lost as they do not have a backup. Additionally, proper record keeping, permits the feasibility of retrospective studies (Similar to the present study) and allows practitioners to improve diagnostic and treatment techniques and possibly come out with new methods that are more effective.

The majority of disorders of horses that were reported during this period affected the dental system. This is expected as most of the horses in Nairobi are likely to be racehorses whose

owners ensure that they get regular dental check-ups (Samiullah *et al*., 2017). Dental disorders are also one of the major ailments affecting horses globally and accounting for up to about 10% of the workload in equine practice. A proportion of dental problems in horses are never diagnosed only to be discovered at post-mortem (Vemming, 2013). Horse teeth are hypsodont in adaptation to a tough fibrous diet which requires prolonged mastication. The continuous chewing action is important as it helps to naturally wears down equine teeth and subsequently prevents overgrowth and associated conditions. Regular dental check-ups are therefore crucial factors in the prevention of dental problems in horses as it is normal nowadays for horses to be fed concentrates and other dietary modifications under intensive management (Ralston, 2021).

Dental conditions are therefore routinely encountered and would expectedly constitute the majority of the surgical and dental disorders reported in horses in Nairobi County during the study period. Teeth overgrowth was the most prevalent dental condition in this study as has been highlighted in other similar studies and horse dental system reviews (Dixon and Dacre, 2005). While details on teeth overgrowth cases retrieved on the present study were not available in the records, the cementum and the dentine are usually involved resulting in cheek and tongue lacerations. The common clinical signs associated with this condition are 'quidding' and development of hamster cheeks (Scrutchfield and Schumacher, 1993). Less prevalent dental conditions observed in this study included wolf teeth, broken teeth, and retained caps. Wolf teeth occur less frequently and are vestigial premolars, generally they affect the performance of horses as they interfere with the bit. However, their management is subjective as their removal is not always warranted. This is because some race horses reach a high level of competitiveness even without their removal (Carmalt, 2007). This is important as the horses that are found in Nairobi are kept for racing and related athletic uses (Samiullah *et al*., 2017). Retained deciduous incisor teeth can result in displacement of the permanent incisors hence

they should be extracted (Scrutchfield and Schumacher, 1993). The records did not highlight any clinical signs which prompted removal of the retained caps.

The reproductive system was the second most affected body system with surgical procedures mostly represented by castrations. Castration is a commonly performed surgical procedure in horses and is performed to reduce testicular cancer, herniation and fractious behaviour in animals unsuitable for breeding (Shoemaker *et al.*, 2004). Geldings have been reported to be better behaved as compared to stallions resulting in most riders preferring to ride geldings (Aune *et al*., 2020). In this study most of the horses were being used for riding and racing and this could explain the high number of castrations. This procedure is routine like dental disorders and is therefore expected to contribute a significant number of cases in horse surgery. In this study, castrations were more than other surgical interventions of the reproductive system such as pneumovagina, vaginal tears and cryptorchidectomies. It is therefore possible to extrapolate that most of the horses presented for surgical treatment at this clinic during this period were males based on the records of the procedures performed.

Cryptorchidism is a common developmental malformation in horses and occurs when one or both testicles fail to descend into the scrotum. The condition is associated with undesirable traits and infertility in horses therefore warranting castration (Stratico *et al.*, 2020). On the other hand, pneumovagina occurs when the function of vulvar lips in preventing the entrance of air and pathogens is hindered by abnormal perineal conformation. This condition reduces the fertility of mares and requires a Caslick vulvoplasty procedure to correct it (Baharudin and Sabri, 2019). In previous studies, a high prevalence of pneumovagina (58%) was reported in mares in Malaysia and in Arabian mares (Baharudin and Sabri, 2019). In the current study, only a few cases were recorded probably because fewer mares were brought to the veterinary

clinics during this period. Also, it has been shown that mares involved in athletic activities such as racing and polo, as is the case with most horses in Nairobi county, have less predisposition to pneumovagina compared to those that are solely involved in breeding or light recreational activities (Markel *et al*., 1987).

Surgical cases involving the alimentary system were not recorded in the period under study. The most common condition affecting the alimentary system is colic which is characterised by severe abdominal pain leading sometimes to death if not properly managed. While the absence of colic surgical cases was unexpected, a related study that retrospectively determined the incidence of colic from 2004 to 2014 found only 3.1% of horses brought to veterinary clinics in Nairobi County having colic (Gitari *et al.*, 2017). It is also important to note that some types of mild colic can resolve without medical/surgical intervention hence may go unreported or unnoticed by the owners. Those that are medically managed normally resolve uneventfully limiting the need for surgical intervention. There is also a limitation in terms of surgical management of equine colic in reference to general anaesthesia and expertise. The outcome of surgical procedures for colic is often poor hence most owners resort to euthanasia rather than investing in surgery (Wright *et al*., 2018). Another reason attributed to its low recorded incidence is because owners are less inclined to report transient colic cases to veterinary clinics but rather attempt to manage these cases themselves. The incidence reported by Gitari *et al.*, (2017) was however close to what has been reported elsewhere (Traub-dargatz *et al.*, 2001; Voigt *et al.*, 2009).

Other conditions that were notably prevalent in horses during the study period included, lameness, lacerations, sarcoids and umbilical hernias. Lameness is a common problem in racing, working as well as jumping horses and its occurrence is associated with a variety of

risk factors (Putnam *et al.*, 2014). These causes and risk factors include but are not limited to direct trauma, metabolic disorders (laminitis), congenital disorders, cellulitis, orthopedic disease, improper shoeing and working on slippery or rocky surfaces (Putnam *et al.*, 2014). In essence lameness is not a disease but rather a clinical manifestation of the above-mentioned etiologies (Stashak, 2002). While in this study the causes of the reported lameness were unspecified, a previous retrospective study in Kenya found that phalangeal, sesamoid and metacarpal fractures were the most common fractures of the distal limb in racehorses which subsequently would lead to lameness (Samiullah *et al*., 2017).

Lacerations in horses were highly prevalent in this study and are usually caused by trauma during foaling, rough handling, road traffic accidents (RTAs), contact with sharp edges (fences, barns) and injuries during examination. Race horses and those used for show jumping are prone to lacerations during transportation and training. These are usually managed with the aim of reducing bleeding, risk of infection and to encourage skin re-apposition (American College of Veterinary Surgeons, 2022).

Sarcoids and SCCs are the most common cutaneous tumors affecting horses of all ages and breed equally (Shah, 2015; Knottenbelt, 2019). They account for about 90% of all tumors affecting horses and expectedly in our study, sarcoids were the prevalent tumor followed by SCCs. These findings are similar to a previous study that determined the trends of nodular cutaneous lesions in horses in Kenya (Shah, 2015). However, in the study by Shah (2015), SCCs were more prevalent than sarcoids. Sarcoids are non-metastatic; however, they can be very aggressive locally. Genetic predisposition together with infection with bovine papillomaviruses have been identified as the risk factors associated with their development. The virus itself is transmitted mostly via formites and insect vectors (Bergvall, 2013). In a related study in Sweden, sarcoids contributed to 4% of the proportional morbidity in horses by

body system (Penell *et al.,* 2005). Intrinsically, sarcoids do not cause death but are associated with reduction in the aesthetic value of the horse leading to euthanasia (Bergvall, 2013).

In the current study, umbilical hernias contributed to 2.7% of the surgical and dental cases that were managed in Nairobi County during the period under study. The frequency of occurrence is within the range 0.5-2% similar to previously reported studies in thoroughbred foals (Orsini, 1997; O'Brien *et al*., 2010). Females have been reported to be more predisposed than males (Freeman and Spencer, 1991). The condition is congenital or caused by abdominal trauma/surgery and occurs when an organ protrudes through a defect in the body wall. Surgical intervention ranging from simple closed techniques to open reduction techniques are usually required to resolve umbilical hernia cases (Orsini, 1997; Umeshwori *et al.,* 2022).

Diagnosis is an important aspect of case management and when done correctly it ensures that the correct treatment is instituted in time to reduce complications and shorten recovery time. Usually, disorders affecting the same body system have a common diagnostic approach. From our study findings, dental and reproductive systems were the body systems for which most interventions were sought in horses in Nairobi County. Dental disorders (teeth overgrowth, wolf teeth, broken teeth) can basically be diagnosed by clinical signs and examination of the oral cavity. Observations during mastication and palpation of cheeks are vital in revealing dental irregularities and some of the common clinical signs to look out for include quidding, hamster cheeks, abnormal positioning of the head during chewing, halitosis and weight loss in chronic cases (Dixon and Dacre, 2005). In this study the records did not capture the clinical signs exhibited by the horses that were suffering from dental disorders, especially teeth overgrowth. In future, these records are important in building a profile of horses suffering from these conditions.

In practice, the oral cavity should be thoroughly examined using a full mouth speculum and accessories such as dental mirrors, flat rasp, intra-oral endoscopy and radiography so as to arrive at a diagnosis of dental disorders (Dixon and Dacre, 2005). Sometimes in fractious horses, sedation may be required for proper examination of the oral cavity (Ramzan, 2002). Overall, in the present study, endoscopy was of limited use which might be due to lack of need, the veterinary practice not affording it or lack of expertise in its use. Expectedly, in all the dental conditions except broken teeth, only clinical signs were used as a diagnostic tool and none of either endoscopy or radiography. In the case of broken teeth, a radiograph, as done in this study or even detailed CT scanning is usually needed to determine the extent of the damage before management (Liuti *et al*., 2018).

As most of the reproductive interventions were castrations and conditions such as pneumovagina, vaginal tears and cryptorchidism, minimal diagnostic work up was required *via* the use of clinical signs. However, inguinal and rectal palpation and sometimes ultrasonography are required before cryptorchidectomy (Stratico *et al.*, 2020). In addition to this, most of the surgical conditions affecting other body systems that were prevalent in this study can also be diagnosed easily using clinical signs. These included but are not limited to bleeding from umbilicus, granulations, clubfoot, stifle swelling, foreign bodies and blocked nasolacrimal duct. In a few cases, clinical signs as a diagnostic tool were combined with radiology to arrive at a definitive diagnosis. This was evident in disorders that included lameness, fractures, flexural limb deformities and ligament syndromes. In all these disorders, clinical signs alone may not be adequate to assess the extent of the disorder and institute proper management (Samiullah *et al*., 2017). A thorough lameness examination is usually one of the cornerstones of proper diagnosis and treatment of a lame horse. This is because in most cases,

advanced imaging equipment is unavailable at veterinary practices unless it is a referral center. In some cases, nerve blocks and blood analysis are required to arrive at a diagnosis (Mitchell, 2012). In this study no information was available on the procedures carried out in this regard.

Endoscopy was only used for the diagnosis of ethmoid hematomas in which it was used in conjunction with radiography. Typical clinical signs of this condition include epistaxis and nasal blockage and in previous studies 96% (22/23) of the cases analyzed were readily diagnosed by the use of endoscopy alone while radiography was mostly used to determine the extent of the disorder before management. The use of CT scan is now highly recommended as it produces cross sectional images of the sinuses thereby overcoming the limitations associated with radiography (Greet, 1992; Barker *et al*., 2013). While clinical experience is an important factor in making a diagnosis, the diagnosis of some disorders such as tumors (SCC, lymphoma and melanoma) in this study just by clinical signs without mention of further assessment such as histopathology may be inconclusive. Moreover, these cutaneous tumors may have similar clinical presentation in the horse. Histopathology is also important in tumor staging to determine the prognosis of tumors (Knottenbelt, 2019). In a previous study to document the cutaneous nodular lesions of horses in Kenya, submission of biopsies for histopathology was low (Shah, 2015) which may highlight inadequacies of veterinary practices in this regard and /or possibly unwillingness of clients to pay extra costs associated with it.

Different anesthetic protocols were used in the management of surgical and dental disorders attended to in Nairobi County during the study period. The commonly used anaesthetic / anaesthetic adjunct was Xylazine-Ketamine combination / Xylazine only, while in some cases no anesthetic / anaesthetic adjunct was recorded as used. Cases where there was no mention of any form of chemical restraint were most likely because the attending clinician did not record

the protocol or drugs used as some of the cases can only be done with some form of chemical restraint / anaesthesia. However, in some of the cases managed by teeth rasping, flushing and draining only, anaesthesia may not have been required. As realized from the first objective of this study, most of the cases in the records during the study period involved entire males for castrations and dental disorders (teeth overgrowth) which can be managed in a standing horse after light sedation, local anaesthetic and physical restraint. Standing chemical restraint is frequently used because of the severe side effects associated with general anesthesia in the horse. These complications have been extensively reviewed elsewhere (Hoffman, 1974).

Xylazine alone was the drug of choice for restraint in 47% of the cases requiring surgical and dental management in horses in Nairobi County. This is plausible given that most of the cases were minor surgeries as mentioned before but mostly also because of its ease of availability, cost-effectiveness (economical) and experience with veterinarians in the country compared to other sedatives. Clinicians are more likely to be more familiar with Xylazine because it is also widely used for small animal sedation (dogs and cats) as most of the veterinary clinics in Nairobi County are mixed practices (Mwangi *et al.*, 2014). The dosage of Xylazine ranges from 0.6-1.0 mg/kg and 1.5-3mg/kg *via* intravenous and intramuscular administration, respectively, where adequate sedation is usually achieved in 84%-91% of horses (Holmes and Clark, 1977). Sedation produced by Xylazine and other alpha-2-agonists such as Detomidine/Medetomidine is more profound compared to that realized for phenothiazines (Acepromazine), however their use is associated with bradycardia, ataxia and rapid arousal and aggression in standing chemical restraint (Hubbell, 2009). In this study phenothiazines were not used in any of the cases. Sole use of Medetomidine is usually contraindicated in horses due to prolonged and pronounced ataxia in comparison to Xylazine (Seo *et al.*, 2011). On the other hand, opioids (Butorphanol)

are rarely used singly but in combination with other sedatives (Hubbell, 2009), as found in this study.

Combining several drugs for restraint is normally more desirable when available as seen in 39.1% of the surgical and dental cases reported here. Xylazine-Ketamine, Butorphanol-Medetomidine and Butorphanol-Medetomidine-Local anesthetic combinations were utilized on a variety of surgical and dental conditions across all the body systems affected. These combinations increase the level of sedation and analgesia more than could be achieved with each drug alone without causing harmful side effects (Leblanc, 1991). The Xylazine-Ketamine combination has been widely used as also reported in this study because it produces relatively safe and reliable anesthesia for minor surgical procedures. However, it may be unsuitable where prolonged anaesthesia is required and in some horses the muscle relaxation effect is poor (Matthews *et al.*, 1991). A Xylazine-Acepromazine combination though not used in this study is widely used by other practitioners mostly because it increases the sedation level while reducing the ataxic side effects of Xylazine (Leblanc, 1991). In this study Acepromazine was not used probably due to priapism and subsequent penile trauma it is known to cause in male horses.

Medetomidine/Detomidine are more potent than Xylazine and have stronger selective alpha-2 agonist effects. Their combination with Butorphanol is reported to be widely practiced in a variety of standing procedures (Taylor *et al.*, 2016). However, this combination was less frequently used in this study and in other related studies probably due to the costs implicated with opioid use. Opioid use is strictly governed by veterinary boards and medicines control authorities in as is the case with Kenya under the Kenya Veterinary Medical Directorate. As such, local access to Butorphanol and other opioids most likely was a factor influencing their

use (Mwangi *et al.*, 2018). Local anesthetic blocks are incorporated where procedures are expected to be painful especially those involving incisions and when the sedatives do not exert enough analgesic effect (Hubbell, 2009). In this study lignocaine was used in castrations, lacerations and SCC excision, however details on why they were specifically utilized in these cases were not recorded.

Only two surgical cases in horses were put under inhalant general anesthesia for castration and cryptorchidectomy. It would have been also interesting to have all the details pertaining to these cases especially as to why they were performed under general anaesthesia when ordinarily such cases are performed using standing chemical restraint. Unfortunately, the details were unavailable from the records. Despite the availability of several drugs that can be used for standing chemical restraint in horses, the final choice usually depends on the temperament, physical and physiological status of the patient, procedure to be performed, available facilities, cost, and most importantly personal preference/experience (Leblanc, 1991; Hubbell 2009).

The management of surgical and dental cases described in this study was tied to the final diagnoses arrived at by the veterinary practitioners. With the majority of cases presenting with dental disorders specifically teeth overgrowth and for elective castrations, it is not then unexpected that 63% of the management involved castration and teeth rasping. A variety of other minor to moderate surgeries then made up the remainder of the surgical and dental management procedures.

Postoperative care is very important in surgically managed disorders especially in major invasive surgery. In the current study, Penicillin-Streptomycin (Penstrep), Tetracycline, Flunixin meglumine, Phenylbutazone and Tetanus toxoid were the common treatments given

as extra-operative cover. Tetanus toxoid is usually given in all horses that have never been vaccinated or are injured/operated on six months after their vaccination (El-Helw *et al.*, 2010).

There is a dearth of information regarding the use of antibiotic prophylaxis in horses in comparison to human surgery. The major reason for antibiotic prophylaxis in surgical cases is to reduce bacterial infection especially in the post-operative period. The efficacy, route of administration, spectrum of action and cost are some of the aspects of the antibiotic to be administered that should be considered (Dallap *et al*., 2012). Antibiotics are administered so as to achieve maximum concentration in tissues during the surgery and sometimes if the half-life is short, re-dosing during the surgery is advised (Southwood, 2006; Dallap *et al*., 2012). Studies in humans show that if the first dose of antibiotics is given only after surgery, the infection susceptibility is not different as to when no antibiotic is used at all (deJonge *et al.*, 2020). The guidelines for achieving excellent post-operative antibiosis therefore, are usually that antibiotics should be given within 60 minutes to the first incision or start of procedure (Burke, 1961; de Jonge *et al.*, 2020). Studies elsewhere have shown that administration of antibiotics after the surgery was not shown to have any benefit over discontinuation of antibiotic after surgery. In fact, it was found to expose patients to the adverse effects associated with antibiotic usage (de Jonge *et al.*, 2020). The frequently used antibiotic in this study was a Penicillin-Streptomycin combination (Penstrep) with only a few cases using Gentamicin and Tetracycline. Penstrep is widely used as it is more affordable and broad-spectrum against the common bacteria that may affect surgical sites. The use of lower generation drugs for prophylaxis has also been advocated for as it avoids the development of antibiotic resistance in bacteria (Dallap *et al*, 2012).

Pain management in the horse during surgery is important as it ensures that the animal is able to stand on its feet after the procedure with minimal pain, as this avoids complications associated with prolonged recumbence. Several analgesics that are used in other animals are unsuitable for use in the horse as they induce post-operative ataxia, sedation or even excitement in some cases (Johnson *et al.*, 1993). The commonly used analgesics in horses include the non-steroidal anti-inflammatory drugs (NSAIDs), Phenylbutazone, Flunixin meglumine and Ketoprofen. Their basic mechanism of action involves the inhibition of cyclooxygenase enzyme thereby preventing the production of inflammatory prostaglandins (Landoni and Lees, 1995). NSAIDs produce analgesia at a local level which prevents the central nervous system side effects such as sedation and ataxia (Johnson *et al.*, 1993). In a previous study there were minimal differences in the nociceptive effects of selected NSAIDs in horses after surgery except for the duration of analgesia which was longer with Flunixin meglumine followed by Carprofen and Phenylbutazone in decreasing order (Johnson *et al.*, 1993). In another study Ketoprofen produced better pain alleviation in laminitic horses than Phenylbutazone (Owens *et al.*, 1995). While these studies highlight the potency of Ketoprofen in comparison to Phenylbutazone, its use may be limited by availability and cost. Accordingly, in this study Phenylbutazone was more frequently used (12%) compared to Flunixin meglumine (2.9%) and Ketoprofen (used in 1 case). Other specific post-operative treatments that were administered included sarcoid cream (Flouroacil) for sarcoids and Butorphanol (sarcoids and SCC).

The outcome of a surgical case depends on several factors beginning with the correct diagnosis, anesthetic protocol, surgical expertise and facilities and appropriate post-operative treatment when needed (Auer and Stick, 2012). While a satisfactory outcome is always desirable, surgical outcome may be unsatisfactory in some cases when the above-mentioned factors are not

adequately addressed. In this retrospective study it was observed that 98% of the surgical cases had a satisfactory outcome.

Several factors that have been described in this study may explain why the surgical outcomes were mostly successful. For a start, most of the surgical cases were uncomplicated and not invasive as evidenced in the specific diagnoses wherein most cases were teeth overgrowth and castrations which can be easily managed with minimal postoperative complications. Technically, castrations are relatively easy procedures to perform and even though some complications occur they are minimal (Getman, 2009). Few cases affected the vital body systems as shown in the results. Uncomplicated and minimally invasive surgical procedures also entail minimal use of general anesthesia and accordingly most of the cases were managed with no anesthesia or with just sedation with Xylazine. This means that the majority of the cases avoided the adverse effects that are usually associated with prolonged maintenance under general anaesthesia in horses.

Analyzing the unsatisfactory cases, most of them involved the respiratory and reproductive systems and were managed with a Ketamine-Xylazine combination. While these factors were not significant predictors of the outcome of the surgery in the logistic regression model they may have contributed to an unfavorable prognosis as explained previously that most of them are carried out under field conditions where there is sometimes a break in aseptic techniques

In this study, as outlined by previous related studies, the common complications associated with castration included post-operative bleeding and swelling with the incidence of swelling ranging from 3.8% to 27% in studies elsewhere (Moll *et al.*, 1995; Kummer *et al.*, 2009). Excessive swelling is usually caused by trauma during surgery and lack of exercise after

surgery. Sometimes the swelling is exacerbated by poor drainage and postsurgical infections as these procedures are carried out in the field. Post-operative administration of NSAIDs and exercise is usually recommended to avoid excessive swelling (Kilcoyne, 2013). In this study, cases that had post-operative swelling, Penstrep alone was given in one of the cases while in the other cases it was combined with Phenylbutazone or the post-operative treatment given was not recorded. Hemorrhage, another commonly encountered complication in castration cases in this study possibly originated from damage of the testicular artery, which should be ligated or emasculated (Kilcoyne, 2013). Suture dehiscence which was associated with laceration stitch ups in this study possibly occurred as a result of limited soft tissue over the wound, excessive movement around the wound and excessive suture tension. As a result, Wilmink *et al.*, (2002) reported about 75% of cases of that nature to heal by second intention.

Exuberant granulation was also encountered in this study after surgical excision of a sarcoid. Its occurrence is usually associated with wounds of the distal limb, excessive motion areas and chronic contamination and inflammation of the site (Shivaraju, 2021). This leads to the development of dark red fleshy exuberant granulation tissue which protrudes out from the wound delaying wound healing (Shivaraju, 2021). Management of exuberant granulation tissue usually involves excision of the protruding tissue, use of corticosteroids and skin grafting in worst case scenarios (Theoret and Wilmink 2016). Also, of note was the occurrence of aspiration pneumonia in one case of ILHP observed in this study which eventually led to the death of the horse. Complications after prosthetic laryngoplasty occur in 9-47% of horses and the common ones are aspiration pneumonia, seromas and coughing (Froydenlund and Dixon, 2014). Aspiration pneumonia may occur post-operatively due to coughing, aspiration of food or dirt particles into the trachea leading to inflammation of the lower respiratory tract, decline in racing performance and in severe cases may lead to death (Froydenlund and Dixon, 2014).

Finally, this study sought to understand the significance of some factors associated with the surgical outcome of each case. Clinically all the factors described in this study were capable of affecting the outcome of a surgical/dental case however only the body system affected was significantly associated with the outcome of the surgical/dental case. Other factors that were analyzed such as anesthetic protocol, use of post-operative treatment were not significant predictors of the outcome of surgery.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

This study concludes and recommends that;

1. Surgical and dental conditions that affect horses in Nairobi County, Kenya are common and mainly affect the teeth, the reproductive and the musculoskeletal system. On the other hand, overgrown teeth, entire males for castrations, lacerations, lameness, sarcoids, umbilical hernias and wolf teeth were the most prevalent specific surgical and dental conditions that affected horse in Nairobi County from January 2010 to December 2019. It is therefore recommended that more training be done with particular focus on the above-mentioned conditions and procedures for both students and practitioners.

2. The number of surgical and dental conditions that affect horses in Nairobi County, Kenya has decreased by over three-fold from 2013 to 2019. Due to the limited number of practices included in our study, it was not conclusive on the reasons for this trend. It is recommended that further studies recruiting more practices are needed to confirm this trend and the possible reasons.

3. Diagnosis of surgical and dental conditions affecting horses in Nairobi County, Kenya was mainly based on clinical features and use of other common diagnostic tools like radiography and endoscopy. Furthermore, management of these surgical and dental conditions was tailored towards a specific condition. This study recommends that other diagnostic aids like ultrasound, CT scans and histopathology be used.

4. Chemical restraint was employed in management of dental and surgical cases in horses with protocols comprising of sedation alone, sedation combined with local anaesthesia or general anaesthesia. The protocols used during the study period are generally widespread in equine medicine and combination therapy is recommended as it reduces the side-effects associated with singly use of anaesthetics.

5. Postoperative management of surgical patients was a common practice mainly involving administration of antibiotics, analgesics and Tetanus toxoid. However, there were still a number of cases where post-operative management was not given, especially those with unsatisfactory outcomes. It is highly recommended veterinarians improve on post-operative management, and particularly the timing of administration of therapeutic remedies like antibiotics.

6. Over 97% of dental and surgical conditions that affected horses in Nairobi County, Kenya from January 2010 to December 2019 were managed and the patient recovered without having any notable complication(s). It is recommended that veterinary practitioners continue embracing best practices in diagnostics and anaesthesia and surgical management of patients in horse practice.

7. The affected body system was the only significant factor that influenced the outcome of surgical procedures in horse in the current study in Nairobi County, Kenya. Furthermore, postoperative complications (Unsatisfactory outcome) were more likely to occur if the condition and hence surgery involved the respiratory, integumentary and reproductive system. We recommend veterinarians to be more vigilant when dealing with cases affecting these body systems.

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