A survey on anesthetic procedures for elective surgeries in small animal practices in Flanders

Anesthetische aanpak van electieve chirurgische procedures bij gezelschapsdierenpraktijken in Vlaanderen: een enquête

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ABSTRACT

To the authors' knowledge, this is the first study to report and evaluate the auxiliary anesthetic equipment and procedures used for elective surgical castration procedures with a low perianesthetic risk in small animal practices in Flanders. This online survey showed an overall acceptable standard of anesthetic procedures by veterinarians in Flanders. Practices are fairly well equipped to monitor patients safely during anesthesia. The main areas of improvement include in general an absence of emergency crash kits and a lack of intraoperative fluid therapy. Specifically for feline anesthesia, there appears to be a lack of endotracheal intubation, IV access and anesthetic monitoring. Although postoperative analgesia is offered to most patients, additional attention should be given to provide analgesia for a sufficient period of time.

SAMENVATTING

Aan de hand van een online-enquête werden in dit onderzoek de anesthesieapparatuur en -procedures geanalyseerd en geëvalueerd die routinematig worden gebruikt voor electieve chirurgische castratieprocedures met een laag perianesthetisch risico in Vlaamse dierenartspraktijken. De resultaten van deze enquête tonen een globaal aanvaardbaar niveau van toegepaste anesthesieprocedures. Dierenartspraktijken zijn redelijk goed uitgerust om patiënten veilig te monitoren tijdens de anesthesie. De belangrijkste aandachtspunten zijn in het algemeen het ontbreken van nood-crashkits en het ontbreken van intraoperatieve vloeistoftherapie. Specifiek voor anesthesie bij katten lijkt er een gebrek te zijn aan endotracheale intubatie, IV-toegang en anesthetische monitoring. Hoewel postoperatieve analgesie aan de meeste patiënten wordt aangeboden, dient extra aandacht te worden besteed aan het toedienen van analgesie gedurende een voldoende lange periode.

INTRODUCTION

Veterinarians use anesthetics daily in order to sedate their patients for further examination, to anesthetize them for surgical procedures and to provide analgesia. However, the use of anesthetics does not come without morbidity and mortality risks since they can produce detrimental side effects. For this purpose, it is essential to monitor the patient throughout the anesthetic procedure. This can be done by using the senses and/or with the aid of monitoring devices. An oxygen source and emergency drugs should always be readily available. The Confidential Enquiry into Perioperative Small Animal Fatalities (CEPSAF) study clearly showed the high complication rates associated with anesthesia in companion animals. These complication rates are substantially higher, when compared to human medicine (Brodbelt et al., 2008). It must be said that the findings of that study might already be outdated, but up till now, it is still the most referenced study when reporting complication rates in companion animals. This illustrates the need for further research into

Table 1. Demographic characteristics of the respondents to a survey on anesthetic procedures in small animal practices in Flanders.

Characteristic	Distribution
Period of graduation	
1979 - 1989	6/143 (4.2%)
1989 - 1999	16/143 (11.2%)
1999 - 2009	37/143 (25.9%)
2009 - 2019	84/143 (58.7%)
Time dedication on small animals	
100%	36/143 (25.2%)
>95%	48/143 (33.6%)
>75%	22/143 (15.4%)
>50%	9/143 (6.3%)
>25%	14/143 (9.8%)
>0%	14/143 (9.8%)
Structure of the veterinary practice (*)	
Veterinary practice	120/143 (83.9%)
Veterinary center	11/143 (7.7%)
Veterinary clinic	12/143 (8.4%)
Number of veterinarians in the practice	
1	35/143 (24.5%)
2	36/143 (25.2%)
3	35/143 (24.5%)
4	17/143 (11.9%)
5	9/143 (6.3%)
5+	11/143 (7.7%)
Number of veterinary assistants in the practice	
0	60/143 (42.0%)
1	46/143 (32.2%)
2	19/143 (13.3%)
3	7/143 (4.9%)
3+	11/143 (7.7%)

(*) as defined by 'Code der Plichtenleer, 2015'

how anesthesia is performed in small animal practices. The management of veterinary anesthesia has been evaluated in Colorado (Wagner and Hellyer, 2000), Australia (Nicholson and Watson, 2001), France (Farges, 2012), New Zealand (Sano et al., 2018) and Quebec (Truchetti et al., 2020). However, up till now, to the authors' knowledge, the applied routine anesthetic procedures by veterinary practices in Flanders haven't been described nor the availability of monitoring equipment used in anesthesia. In this study, the results of an online-survey were analyzed to report and evaluate the auxiliary anesthetic equipment and procedures used for elective surgical castration procedures with a low peri-anesthetic risk. The findings are used to gain insight into current anesthetic practice, to make recommendations on how to improve anesthetic management and will serve as a base for future comparisons.

MATERIALS AND METHODS

An online survey (Google Form questionnaire) about anesthesia protocols and auxiliary equipment commonly used in small animal private practices in Belgium, as part of a master dissertation, was distributed by email to the veterinary staff of the Small Animal Department, Faculty of Veterinary Medicine, Ghent University. Additionally, the survey was shared on social media; alongside others on the specific veterinary Facebook group of SAVAB-Flanders (Small Animal Veterinary Association Belgium). The poll was held from July 2019 until October 2019 and was completed by 143 practicing veterinarians in Flanders. The questionnaire consisted of 31 questions, of which, 24 multiple choice questions and 7 open questions, divided in four sections. In section one, the demographics of the respondents was focussed upon, in section two, inquiries were made regarding the available anesthetic equipment, in section three, the anesthetic procedures for specific interventions were investigated, and in section four, the critical reflection of the respondents was encompassed as to their own anesthetic procedures.

RESULTS

Demographics

All participating veterinarians obtained their master's degree at Ghent University (n=143). The year of graduation spans from 1979 to 2019. The average year of graduation was 2009 and the median was 2012. The majority of respondents (84.6%) graduated after 1999. When asked about their professional time dedication, 74.1% declared to spend more than 75% of their time on small animal medicine.

The organization of a veterinary practice in Belgium is divided into three categories: Veterinary Practice, Veterinary Center and Veterinary Clinic, as defined by 'Code der Plichtenleer, 2015'. The percentage of respondents who worked in a Veterinary Practice, a Veterinary Center or a Veterinary Clinic, was respectively 83.9%, 7.7% and 8.4%, from which 24.5% were solo practitioners, 25.2% worked in associations with either three (24.5%), four (11.9%), five (6.3%), six and more (7.7%) colleagues. With regard to employment of veterinary assistants (nurses), 42% of the respondents did not employ an assistant, whereas 32.2% employed one, 13.3% employed two, 4.9% employed three and 7.7% employed more than three assistants (Table 1).

Auxiliary anesthetic equipment and monitoring devices

Of all respondents, 7.7% did not have any oxygen source available. Amongst the inhalant anesthetics, isoflurane was used by 88.8% and sevoflurane by 1.4% of the veterinarians, whereas 9.8% of the respondents declared not to use inhalant anesthesia. Of the veterinarians using inhalation anesthetics, the vast majority (76.7%) used oxygen as the sole carrier gas.

Infusion pumps to deliver intravenous fluids were available to 51% of the respondents, whereas the availability of syringe drivers for the administration of specific drugs as a continuous rate infusion was far less (20.3%). Mechanical ventilation was accessible in 30.1% of the practices. A crash kit with emergency drugs was available to 35% of the participants. When asked about the available monitoring equipment, 76.2% of the respondents indicated the presence of a pulse oximeter and 67.1% had access to capnography. Other devices that were reported to be present, were the electrocardiogram monitor (43.4%), apnea-detector (40.6%), non-invasive blood pressure monitoring (36.4%), extra person to monitor (32.2%), temperature probe (31.5%), gas analysis (21.7%) and esophageal stethoscope (4.9%). A small number of respondents (8.4%) declared not to have any monitoring devices present in their practice (Table 2).

Table 2. Presence of auxiliary anesthetic equipment and monitoring devices in practices (n=143) in a survey on anesthetic procedures in small animal practices in Flanders.

Auxilliary equipment	
Infusion pump	51.0%
Crash kit	35.0%
Mechanical ventilator	30.1%
Syringe driver	20.3%
Monitoring devices	
Pulse oximeter	76.2%
Capnograph	67.1%
ECG	43.4%
Apnea detector	40.6%
Blood pressure monitor	36.4%
Extra person available	32.2%
Temperature probe	31.5%
Gas analysis	21.7%
Esophagal stethosope	4.9%
None	8.4%

Anesthetic procedure

When asked about routine pre-anesthetic check-up, all veterinarians indicated to perform cardiac auscultation on their patients. Lung auscultation was performed by 84.6 % of the respondents and 81.1% additionally examined the mucosae for perfusion parameters. Peripheral arterial pulse palpation, mucosal capillary refill time measurement and measurement of body temperature were performed by respectively, 53.8%, 44.8% and 12.6% of the respondents (Table 3).

Table 3. Pre-anesthetic check-ups performed by veterinarians (n=143) in a survey on anesthetic procedures in small animal practices in Flanders

Heart auscultation	100%
Lung auscultation	84.6%
Mucosae	81.1%
Capillary refill time	53.8%
Pulse palpation	44.8%
Body temperature	12.6%

The respondents were asked about the weekly number of surgical neutering procedures with a low peri-anesthetic risk based on the American Society of

Table 4. Characteristics of elective castration surgeries performed by veterinarians (n=143) in a survey on anesthetic procedures in small animal practices in Flanders.

Number of elective castration surgeries on weekly basis	Dog		Cat	
	Male	Female	Male	Female
<2	62.2%	63.6%	37.1%	36.4%
2 – 5	33.6%	32.2%	49.0%	49.7%
5 – 10	4.2%	4.2%	10.5%	11.2%
10 – 20	0.0%	0.0%	3.5%	2.1%
20 – 30	0.0%	0.0%	0%	0.7%
Assisting veterinarians during surgery if present (n=117)	25.6%	78.6%	9.4%	9.4%
Assisting veterinary nurses if present (n=83)	58.0%	75.0%	46.0%	37.0%

Table 5. Peri-operative anesthetic procedures and monitoring during elective castrations by veterinarians (n=143) in a survey on anesthetic procedures in small animal practices in Flanders.

	Dog		Cat	
	Male	Female	Male	Female
Intubation	71.3%	87.4%	2%	16.8%
IV acces	77.6%	90.9%	2.8%	10.5%
IV Fluids	36.4%	57.4%	0.7%	4.2%
Pulse oxymetry	60.1%	64.3%	18.2%	26.6%
Capnometry	55.9%	63.6%	4.2%	11.9%

Anesthesiologists (ASA) classification for anesthetic morbidity and mortality assessment (ASA I-II). Castration of male and female dogs occurred less than twice weekly in respectively 62.2% and 63.6% of the practices. The castration of male and female cats was performed two to five times a week in 49.0% and 49.7%, respectively. When an ovariectomy in a dog was performed in practices with availability of other veterinarians, 78.6% had an additional veterinarian assisting during the procedure. In practices with availability of veterinary nurses, the nurses assisted in 75% of the castrations of female dogs (Table 4).

Endotracheal intubation was performed in respectively 71.3% and 87.4% of male and female dogs undergoing castration, whereas only 2% of male cats and 16.8% of female cats had their airways secured during castration. Intravenous access was rare during the castration of male (2.8%) and female cats (10.5%), whereas a venous catheter was placed in female (90.9%) and male (77.6%) dogs undergoing castration. Intraoperative fluids were administered during the castration of female dogs (57.3%) and male dogs (36.4%). In cats, 0.7% of male and 4.2% of female cats received fluid therapy during these procedures. Pulse oximetry and capnometry were the modalities of monitoring that know widespread use. Both were used more frequently during procedures in dogs than in cats (Table 5).

The responses regarding the premedication of anesthesia unveiled a large variation of different protocols. The drugs were categorized per class: α_2-agonists, major tranquilizers, minor tranquilizers and

Table 6. Premedication protocols and anesthetic drugs used for elective castrations by veterinarians (n=143) in a survey on anesthetic procedures in small animal practices in Flanders.

	Dog		Cat	
	Male	Female	Male	Female
Premedication protocol				
α_2 agonist	16.8%	13.3%	58.0%	52.4%
α_2 agonist + opioid	64.3%	64.3%	36.4%	40.6%
α_2 agonist + opioid + minor tranquilizer	4.2%	4.2%	2.1%	2.8%
α_2 agonist + minor tranquilizer	2.1%	2.1%	/	0.7%
Major tranquilizer	1.4%	2.1%	/	/
Major tranquilizer + opioid	3.5%	6.3%	/	/
Major tranquilizer + opioid + minor tranquilizer	0.7%	0.7%	/	/
Major tranquilizer + α_2	0.7%	0.7%	/	/
Major tranquilizer + α_2 + opioid	2.1%	1.4%	/	/
Minor tranquilizer + opioid	2.8%	2.8%	/	/
none	1.4%	2.1%	3.5%	3.5%
Premedication drugs (*)				
α_2 agonist	90.2%	86.0%	96.5%	96.5%
Major tranquilizer	8.4%	11.2%	/	/
Minor tranquilizer	9.8%	9.8%	2.1%	3.5%
Opioid	77.6%	79.7%	38.5%	43.4%
Butorphanol	34.3%	26.6%	18.2%	17.5%
Methadone	28.7%	39.2%	2.1%	4.2%
Buprenorphine	14.7%	14.0%	18.2%	21.7%

(*) Overview of specific anesthetic drugs that were mentioned in different protocols.

Table 7. Anesthetic drugs used for induction and maintenance for elective castrations by veterinarians (n=143) in a survey on anesthetic procedures in small animal practices in Flanders.

	Dog		Cat	
	Male	**Female**	**Male**	**Female**
Induction (*)				
Propofol	50.3%	54.5%	3.5%	4.9%
Alfaxalone	22.4%	24.5%	0.7%	1.4%
Ketamine	37.1%	29.4%	95.8%	96.5%
Inhalation	3.5%	3.5%	1.4%	2.1%
Maintenance (*)				
Inhalation	71.3%	78.3%	9.1%	26.6%
Ketamine	11.2%	10.5%	27.3%	27.3%
Alfaxalone	1.4%	1.4%	0.0%	0.7%
Propofol	6.3%	0.7%	1.4%	1.4%
None	11.2%	2.8%	64.3%	48.3%
Ketamine (**)	22.4%	13.3%	91.6%	75.6%

(*) Overview of specific anesthetic drugs that were mentioned in different protocols
(**) All veterinarians who responded with "None", used ketamine as an induction agent

opioids. This resulted in eleven different protocols for dogs, four for male cats and five for female cats. In dogs, the combination of an α_2-agonist with an opioid was utilized most frequently: 64.3% for both male and female dogs. In cats, the solo administration of an α_2-agonist was selected in 58.0% of male cats and 52.4% of female cats. Opioids were integrated more in protocols for dogs than for cats. In male dogs, they were used in 77.6% of the protocols and for female dogs in 79.7%. Male cats were administered opioids in 38.5% of the protocols and in 43.5% of the protocols for female cats. Butorphanol was the opioid of choice in 34.3% of male dogs, 26.6% of female dogs, 18.2% of male cats and 17.5% of female cats. Major tranquilizers were selected for use in dogs only, respectively in 8.4% of protocols of male dogs and 11.2% of female dogs (Table 6).

Four different induction agents were used by the respondents: propofol, alfaxalone, ketamine and inhalation anesthetics. In dogs, propofol was the drug of choice in 50.3% and 54.5% of male and female dogs, respectively. Most cats received ketamine as an induction agent, respectively 95.8% and 96.5% of male and female cats. For maintenance of general anesthesia, the same four drugs were mentioned alongside the option "none". Inhalation anesthetics were the drugs of choice for maintenance in 71.3% and 78.3% of male and female dogs, respectively. Ketamine was used in 91.6% of male cats and 75.6% of female cats when corrected for the answer "none" (Table 7).

As a final question, the veterinarians were asked to give their standard post-operative analgesic protocol. Six different protocols involving non-steroidal anti-inflammatory drugs (NSAID) and opioids were put forward. In dogs, NSAID administration for three to five days was the most popular. For male dogs, this was the case in 49.0% of the responses compared to 60.8% for female dogs. Single administration of an NSAID was the analgesic protocol of choice in cats. In male cats, 72.7% of the veterinarians opted for this

Table 8. Analgesic protocols used for post-operative pain relief for elective castrations by veterinarians (n=143) in a survey on anesthetic procedures in small animal practices in Flanders.

	Dog		Cat	
	Male	**Female**	**Male**	**Female**
NSAID once	39.9%	18.9%	72.7%	54.5%
NSAID once + opioid	2.1%	4.9%	2.1%	1.4%
NSAID 3-5 days	49.0%	60.8%	9.1%	36.4%
NSAID 3-5 days + opioid	4.9%	11.9%	0.7%	1.4%
Opioid	1.4%	1.4%	0.7%	0.7%
None	2.8%	0.7%	14.7%	5.6%

approach, whereas this was performed in 54.5% of the female cats. (Table 8).

Reflection

In the fourth section of the survey, the respondents were asked to critically reflect on their anesthetic procedure. The response for this question was lower (100/143) than for the previously answered questions. Most respondents indicated that they were content with their current approach, with 64% of the respondents replying that they do not wish to make changes to their protocol. Future points of improvement that were mentioned are: the use of more monitoring (15%), improved analgesia (7%), the use of more individualized protocols (7%), the increased use of volatile anesthetics (6%), more IV access (3%) and more intubation (2%).

DISCUSSION

This survey was answered by 143 veterinarians over a period of three months. Most respondents had recently graduated, with 2013 being the median graduation year. Only 22 respondents obtained their master's degree over twenty years ago. Although there are no data available about the average age of veterinary practitioners in Flanders, the young age of most of the respondents seems not entirely representative for the entire professional practicing group in Flanders. There might be a connection with the online distribution of this survey through social media, since these platforms are more generally used by younger individuals (Ozimek and Bierhoff, 2016). The majority of respondents (74.1%) spend more than three quarters of their time on the care of companion animals. This fits well with the aim of this study, which was to evaluate the anesthetic protocols of small animal practitioners. Most veterinarians (83.9%) work in small veterinary practices, which is typical for the Flemish veterinarian landscape, although there is a tendency to form associations with other veterinarians, since only 24.5% of the respondents work as solo practitioners. Currently, 58.0 % of the respondents employs at least one veterinary assistant.

An oxygen source is available to 92.3% of the polled veterinarians. Access to oxygen is vital when sedative agents are used that can cause respiratory depression. In addition, they are indispensable for the use of volatile anesthetic agents. This is reflected in 90.0% of the participating veterinarians who indicated to use inhalant anesthetics. Moreover, 69.2% of the respondents indicated to vaporize volatile anesthetics in pure oxygen only. This is an acceptable practice for shorter procedures, especially in the absence of gas analysis and pulse oximetry. However, for anesthetic procedures of longer duration, hyperoxemic complications, such as cellular damage, microvascular vasoconstriction and pulmonary injury, can occur (Lellouche and L'Her, 2020). To avoid these complications, a mixture of pure oxygen and medical air can be used to titrate the fraction of inspired oxygen (FiO_2) to 60%. It is evident that this can only be done safely if gas analysis and pulse oximetry are available.

Equipment to deliver intravenous fluids and drugs, such as infusion pumps (51.0%) and syringe drivers (20.3%) is not very common. Mechanical ventilators are present in 30.1% of the practices, which is relatively high compared to 14.1% of the practices in New Zealand (Sano et al., 2018), 25.0% in Quebec (Truchetti et al., 2020) and comparable to 28.0% of the practices in France (Farges, 2012). With an increased interest in laparoscopic procedures for gonadectomies (Katić and Dupré, 2017; Marvel, 2022), the presence of mechanical ventilators in practices is suspected to increase in the coming years, since they are a prerequisite to safely perform laparoscopic procedures (de Rezende and Mama, 2022).

Merely 35.0% of veterinarians have an emergency crash kit readily available. However, it is one of the key recommendations of the RECOVER publications to have a pre-stocked arrest station in areas where animals are routinely anesthetized (Boller and Fletcher, 2020; McMichael et al., 2012). In contrast, 55.7% of the veterinary practices in France are equipped with an emergency kit or trolley (Farges, 2012). Truchetti et al. (2020) even reported that 93.0% of the veterinary practices in Quebec have access to emergency crash carts. This seems like a major point of improvement that can be made in Flanders.

According to the results of the survey, a pulse oximeter is present in 76.2% of the veterinary practices in Flanders, comparable with 73.2% in New Zealand. Nevertheless, in Quebec, up to 95.3 % of the practices are equipped with a pulse oximeter. In France on the other hand, only 32.4% of the practices are equipped with a pulse oximeter (Farges, 2012; Sano et al., 2018; Truchetti et al., 2020). Capnometry is available in 67.1% of the Flemish practices, which is quite high compared to 9.8% in New Zealand, 22.5% in France and 33.3% in Quebec (Farges, 2012; Sano et al., 2018; Truchetti et al., 2020). An apnea detector was reported by 40.6% of the respondents in Flanders, 44.0% in France, 73.2 % in New Zeeland and 32.5% in Quebec (Farges, 2012; Sano et al., 2018; Truchetti et al., 2020). Capnometry offers a continuous monitoring of P_aCO_2 and thus of alveolar ventilation, venous return and metabolism, which makes it a very powerful monitoring modality (Schauvliege, 2016), whereas an apnea detector only gives information regarding the respiratory rate, thus making it a far less reliable monitoring device (Southall et al., 1980). Overall, it can be concluded that practices in Flanders are fairly well equipped to monitor routine anesthetic procedures.

Pre-anesthetic cardiac auscultation is performed by all the polled veterinarians which is in compliance with their colleagues of New Zealand (97.3%), Que-

bec (97.3%) and Colorado (98.0%) (Sano et al., 2018; Truchetti et al., 2020; Wagner and Hellyer, 2000).

Although endotracheal intubation is common during castration in both male (71.3%) and female (87.4%) dogs, it is rarely done in female cats (16.9%) and very rarely in male cats (2.0%). In New Zealand, dogs and cats are usually intubated, in 99.1% and 77.7% of the cases, respectively (Sano et al., 2018). Intubation ensures a patent airway and protect the lungs from aspiration of fluids among others (Mosley, 2015). In the CEPSAF study (Brodbelt et al., 2008), airway-related issues are identified as being a significant cause of anesthetic-related death and morbidity in cats. The feline airway is delicate and the larynx is prone to spasm, so maintaining a patent airway is essential during general anesthesia and the recovery phase (Robertson et al., 2018). It should be stressed that even when an injectable anesthetic protocol is applied, intubation should be considered to maintain a patent airway.

Intravenous access has a myriad of advantages: anesthetic drugs take effect more quickly and can be reduced in dose, additional analgesic drugs can be delivered more rapidly during the procedure, it facilitates the administration of emergency drugs and it enables intravenous fluid therapy (Grubb et al., 2020). Even for elective surgical procedures, these benefits appear to be well known by veterinarians in Flanders, given the high number of respondents indicating to place an IV catheter in dogs (90.9% female dogs, 77.6% male dogs). This is comparable to dogs in France (72.3%) but the percentage is higher than for dogs in New Zealand (50.2%) and Quebec (30.6%). In cats however, IV access is reported to be rare in Flanders (10.5% of female cats, 2.8% of male cats). This is a lower incidence than for cats in New Zealand (35%) and Quebec (12.4%). The low percentage of IV catheter placement might be attributed to the higher technicality to obtain vascular access in felines, especially when vasoconstriction occurs due to premedication with α_2-agonists. In general, the duration of procedures in cats is shorter and an IV catheter might thus be perceived as redundant. Nevertheless, it is recommended to always secure IV access in cats (Robertson et al., 2018).

Fluid therapy during the peri-anesthetic period helps in correcting additional fluid losses, aids in countering the potential negative effects of anesthetic agents on the cardiovascular system and facilitates the elimination of drugs (Davis et al., 2013; Warne et al., 2018). Despite these advantages, it is not common for veterinarians in Flanders to implement fluid therapy for their routine surgical procedures in dogs and it is very rare in cats. In New Zealand for instance, the use of peri-anesthetic fluid therapy is widely spread (applied in 85% of dogs) (Sano et al., 2018). In Flanders, infusion pumps are only available in 51.0% of the practices, so a lack of equipment might be a partial cause for this.

As reported above, practices in Flanders are well equipped with monitoring modalities such as pulse oximetry (76.2%) and capnometry (67.1%). These devices are often used in dogs but rarely in cats. In the CEPSAF study, it is clearly shown that for healthy cats, the peri-anesthetic mortality rate is twice as high as that for healthy dogs (0.11% versus 0.05%) (Brodbelt et al., 2008). Hence, the use of anesthetic monitoring in cats seems to be another point of improvement that can be made in Flanders.

Premedication is an essential first step in any balanced anesthetic protocol. The appropriate selection of drugs can help to accomplish the tree major goals of anesthesia: loss of consciousness, muscle relaxation and (pre-emptive) analgesia. Furthermore, premedication can significantly improve patient handling in the peri-anesthetic period (Murrell, 2016). Nearly all respondents reported to include premedication in dogs; however, with a wide array of different combinations. Overall, α_2-agonists were omnipresent in the different protocols. They were chosen in 90.2% of the protocols for male dogs, in 86.0% for female dogs and 96.5% for both male and female cats. Their popularity can be attributed to the reliable analgesic, sedative and muscle relaxing effects. Furthermore, α_2-agonists have a rapid onset of action, can be antagonized and their administration can cause significant dose sparing effects. However, they have considerable cardiopulmonary side effects and should therefore only be routinely used in healthy animals (Rankin, 2015; Sinclair, 2003). Acepromazine (ACP) is not used in cats and rarely in dogs by the polled veterinarians in Flanders. This is in contrast with practices in New Zealand and Quebec, where ACP is the preferred sedative (Sano et al., 2018; Truchetti et al., 2020). ACP provides a reliable plane of sedation, but has a slower onset of action and lacks analgesic effects. It acts as an α_1-antagonist and causes vasodilation as a result (Dugdale et al., 2020). For procedures involving laparotomies, the blood sequestration in the spleen might have an impact on visibility. Thus, it could be advised to avoid ACP in these cases.

In this survey, opioids were almost always combined with either α_2-agonists or major tranquilizers, which is beneficial since this has a synergistic effect. Surprisingly, butorphanol was the first opioid of choice in protocols for castration of male dogs, and the second choice for castration of female dogs. As a κ-agonist and μ-antagonist, it can be considered more a sedative than analgesic opioid. Both methadone (full μ-agonist) and buprenorphine (partial μ-agonist) seem more reliable analgesic choices (Taylor et al., 2010). In dogs, premedication with methadone provides superior analgesia compared to buprenorphine (Shah et al., 2018).

For induction and maintenance of anesthesia in dogs, propofol and volatile anesthetics were the most popular. In cats, the vast majority of respondents relied on ketamine for induction. Oddly, up to 64.3% of the veterinarians answered “none” when asked about

their agent of maintenance. Upon closer examination, all these respondents used ketamine as an induction agent, highlighting the versatility of this cheap and reliable dissociative anesthetic agent. On top of this, ketamine has unique stimulating cardiovascular effects and it has a minimal effect on central respiratory drive, whilst having profound analgesic properties as well (Kästner, 2016; Kohrs and Durieux, 1998). Most likely, ketamine is still a preferred induction agent for elective procedures of short duration in both cats and dogs, since it can be administered intramuscularly and has a duration effect of twenty to thirty minutes, allowing elective surgeries to be performed with a single IM administration.

According to the results of the survey, post-operative analgesic drugs are given adequately and appropriately in Flanders. Only a small minority of the polled veterinarians offer no additional analgesia after elective surgical procedures. This is especially the case in male cats, where 14.7% receive neither an NSAID nor opioid after castration. In a study regarding analgesia provision for domestic cats undergoing gonadectomy in New Zealand, Australia and the United Kingdom, no analgesia was provided to male cats in 37.4%, 34.7% and 69%, respectively (Farnworth et al., 2014). It should be stressed that providing analgesia in the peri-operative setting, even in minor surgical procedures, is important from an ethical point of view and because it improves patient recovery on the short and long term. Because of the inflammatory pain caused by the tissue injury, NSAIDs remain the mainstay of analgesia for acute post-operative pain relief (Berry, 2015; Gruen et al., 2022; Mathews et al., 2014). They should be administered for a duration that is in relation to the amount of tissue damage that was afflicted by the surgery. For example, a single NSAID administration for the castration of a male cat seems adequate, whereas this would not suffice for an ovariectomy in a female dog. However, the gold standard of pain assessment is the response to analgesic therapy and owners should therefore be briefed about assessing behavior changes in their pets that identify with pain perception. Clear owner communication is always of major importance.

In general, the respondents indicate to master good practical application of anesthetic principles in their critical reflection. With regard to the anesthetic protocols, the authors can concur. However, the points of improvement that were mentioned in the results of the survey are not quite in proportion with the authors' findings regarding for instance the lack of IV access and endotracheal intubation.

CONCLUSION

The results of this survey show an overall acceptable standard of applied anesthetic procedures by veterinarians in Flanders. Practices in Flanders are fairly well equipped to monitor patients safely during anesthesia. The main areas of improvement include in general an absence of emergency crash kits and a lack of intra-operative fluid therapy. Specifically for feline anesthesia, there appears to be an increased need for endotracheal intubation, IV access and monitoring. Although postoperative analgesia is offered to most patients, additional attention should be given to provide analgesia for a sufficient period of time.

LITERATURE

Berry, S. H. (2015). Analgesia in the perioperative period. *Veterinary Clinics of North America: Small Animal Practice 45*(5), 1013-1027.

Boller, M., Fletcher, D. J. (2020). Update on cardiopulmonary resuscitation in small animals. *Veterinary Clinics of North America: Small Animal Practice 50*(6), 1183-1202.

Brodbelt, D. C., Pfeiffer, D. U., Young, L. E., Wood, J. L. N. (2008). Results of the confidential enquiry into perioperative small animal fatalities regarding risk factors for anesthetic-related death in dogs. *Journal of the American Veterinary Medical Association 233*(7), 1096-1104.

Davis, H., Jensen, T., Johnson, A., Knowles, P., Meyer, R., Rucinsky, R., Shafford, H. (2013). AAHA/AAFP Fluid therapy guidelines for dogs and cats. *Journal of the American Animal Hospital Association 49*(3), 149-159.

de Rezende, M. L., Mama, K. (2022). Anesthesia management of dogs and cats for laparoscopy. In: Fransson B.A. and Mayhew P.D. (editors). *Small Animal Laparoscopy and Thoracoscopy*. John Wiley & Sons, New Jersey, USA, 81-91.

Dugdale, A. H. A., Beaumont, G., Bradbrook, C., Gurney, M. (2020). Sedation and premedication. In: Dugdale, A. H. A., Beaumont, G., Bradbrook, C., Gurney, M. (editors). *Veterinary Anaesthesia: Principles to Practice.* Second edition. John Wiley & Sons, New Jersey, 55-76.

Farges, C. (2012). *Etude sur la Pratique et les Moyens mis en Oeuvre pour l'Anesthésie des Chiens: Résultats d'une Enquête en Ligne auprès des Vétérinaires Praticiens Français*. Masters dissertation. VetAgro Sup. Université de Lyon, France.

Farnworth, M., Adams, N., Keown, A., Waran, N., Stafford, K. (2014). Veterinary provision of analgesia for domestic cats (Felis catus) undergoing gonadectomy: A comparison of samples from New Zealand, Australia and the United Kingdom. *New Zealand Veterinary Journal 62*(3), 117-122.

Grubb, T., Sager, J., Gaynor, J. S., Montgomery, E., Parker, J. A., Shafford, H., Tearney, C. (2020). AAHA anesthesia and monitoring guidelines for dogs and cats. *Journal of the American Animal Hospital Association 56*(2), 59-82.

Gruen, M. E., Lascelles, B. D. X., Colleran, E., Gottlieb, A., Johnson, J., Lotsikas, P., Marcellin-Little, D., Wright, B. (2022). AAHA pain management guidelines for dogs and cats. *Journal of the American Animal Hospital Association 58*(2), 55-76.

Kästner, S. B. R. (2016). Injectable anaesthetics. In: T. Duke−Novakovski, M. de Vries, C. Seymour (editors). *BSAVA Manual of Canine and Feline Anaesthesia and Analgesia*. British Small Animal Veterinary Association, Gloucester, UK, p. 190-206.

Katić, N., Dupré, G. (2017). Laparoscopic ovariectomy in small animals. *In Practice 39*(4), 170-180.

Kohrs, R., Durieux, M. E. (1998). Ketamine: teaching an old drug new tricks. *Anesthesia & Analgesia 87*(5), 1186-1193.

Lellouche, F., L'Her, E. (2020). Hyperoxemia: the poison is in the dose. *American Journal of Respiratory and Critical Care Medicine 201*(4), 498-498.

Marvel, S. J. (2022). Concepts in sterilization. *Veterinary Clinics of North America: Small Animal Practice 52*(2), 419-436.

Mathews, K., Kronen, P. W., Lascelles, D., Nolan, A., Robertson, S., Steagall, P. V., Wright, B., Yamashita, K. (2014). Guidelines for recognition, assessment and treatment of pain. *Journal of Small Animal Practice 55*(6), E10-E68.

McMichael, M., Herring, J., Fletcher, D. J., Boller, M. (2012). RECOVER evidence and knowledge gap analysis on veterinary CPR. Preparedness and prevention. *Journal of Veterinary Emergency and Critical Care 22*(s1), S13-S25.

Mosley, C.A. (2015). Anesthesia equipment. In: K.A. Grimm, L.A. Lamont, W.J. Tranquilli, S.A. Greene and S.A. Robertson (editors). *Veterinary Anesthesia and Analgesia.* Blackwell, Iowa, USA, 23-88.

Murrell, J. C. (2016). Pre-anaesthetic medication and sedation. In: T. Duke−Novakovski, M. de Vries, C. Seymour (editors). *BSAVA Manual of Canine and Feline Anaesthesia and Analgesia*. British Small Animal Veterinary Association, Gloucester, UK, 170-189.

Nicholson, A., Watson, A. (2001). Survey on small animal anaesthesia. *Australian Veterinary Journal 79*(9), 613-619.

Ozimek, P., Bierhoff, H.-W. (2016). Facebook use depending on age: The influence of social comparisons. *Computers in Human Behavior 61*, 271-279.

Rankin, D. C. (2015). Sedatives and tranquilizers. *Veterinary Anesthesia and Analgesia*, 196.

Robertson, S. A., Gogolski, S. M., Pascoe, P., Shafford, H. L., Sager, J., Griffenhagen, G. M. (2018). AAFP Feline anesthesia guidelines. *Journal of Feline Medicine and Surgery 20*(7), 602-634.

Robertson, S.A., Gogolski, S.M., Pascoe, P., Shafford, H.L., Sager, J., Griffenhagen, G.M., (2018). AAFP Feline anesthesia guidelines. *Journal of Feline Medicine and Surgery 20*, 602-634.

Sano, H., Barker, K., Odom, T., Lewis, K., Giordano, P., Walsh, V., Chambers, J. (2018). A survey of dog and cat anaesthesia in a sample of veterinary practices in New Zealand. *New Zealand Veterinary Journal 66*(2), 85-92.

Schauvliege, S. (2016). Patient monitoring and monitoring equipment. In: T. Duke-Novakovski, M. de Vries, C. Seymour (editors). *BSAVA Manual of Canine and Feline Anaesthesia and Analgesia*. British Small Animal Veterinary Association, Gloucester, UK, p. 77-96.

Shah, M. D., Yates, D., Hunt, J., Murrell, J. C. (2018). A comparison between methadone and buprenorphine for perioperative analgesia in dogs undergoing ovariohysterectomy. *Journal of Small Animal Practice 59*(9), 539–546.

Sinclair, M. D. (2003). A review of the physiological effects of α2-agonists related to the clinical use of medetomidine in small animal practice. *The Canadian Veterinary Journal 44*(11), 885–897.

Southall, D. P., Richards, J. M., Lau, K. C., Shinebourne, E. A. (1980). An explanation for failure of impedance apnoea alarm systems. *Archives of Disease in Childhood 55*(1), 63–65.

Taylor, P. M., Kirby, J. J., Robinson, C., Watkins, E. A., Clarke, D. D., Ford, M. A., Church, K. E. (2010). A prospective multi-centre clinical trial to compare buprenorphine and butorphanol for postoperative analgesia in cats. *Journal of Feline Medicine and Surgery 12*(4) 247–255.

Truchetti, G., Otis, C., Brisville, A.-C., Beauchamp, G., Pang, D., Troncy, E. (2020). Management of veterinary anaesthesia in small animals: A survey of current practice in Quebec. *PLOS ONE 15*(1).

Wagner, A. E., Hellyer, P. W. (2000). *Survey of Anesthesia Techniques and Concerns in Private Veterinary Practice 217*(11), 6.

Warne, L., Bauquier, S., Pengelly, J., Neck, D., Swinney, G. (2018). Standards of care - anaesthesia guidelines for dogs and cats. *Australian Veterinary Journal 96*, 413–427.