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Volatile Anesthesia in Algeria: Field Survey & Technical Demonstration in Dogs

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Abstract

The present work consisted of a field survey on the conduct of general anesthesia in dogs, as well as the elaboration of a demonstrative photographic atlas which retraced the various steps of practical realization of the volatile general anesthesia in this species. Our study was conducted by questioning 62 veterinary practitioners in eleven regions in Algeria (6 in the Center, 4 in the East, and 3 in the West). Data showed that 98.39% of the veterinarians practice a pre-anesthesia consultation, however, only 9.67% declare to know and to adopt the American Society of Anesthesiologists (ASA) classification. 96.78% use a fixed general anesthesia by repeated re-administrations of ketamine (65%), the combination of tiletamine-zolazepam (26.66%) and propofol (8.33%). The remaining (3.22% of practitioners) perform volatile halothane-maintained anesthesia after induction with ketamine (50%) or propofol (50%). Four veterinarians among 62 (6.46%) monitor reflexes to assess the depth of anesthesia despite using dissociative agents (ketamine or tiletamine) that retain these reflexes throughout the anesthesia. Only 3.23% of the surveyed veterinarians perform instrumental monitoring of cardiovascular, respiratory and metabolic parameters, and the vast majority (96.77%) only monitor heart and respiratory rates and do not use anesthetic sheet (checklist). For the elaboration of the atlas, 6 cycles of volatile general anesthesia were performed outside of any surgical procedure for a demonstrative purpose. A total of 72 photographs were made, then sorted and classified according to the sequence of the different practical stages of the procedure. For each step, we have developed in a box a summary of essential knowledge to acquire. This atlas may serve as a learning tool for students and veterinarians practicing volatile anesthesia. At the end, the authors highly recommend for veterinarians' anesthetists the systematic practice of a pre-anesthetic consultation with an ASA classification, and to avoid dissociative agents for induction in order to be able to monitor reflexes and assess the depth of narcosis.

Keywords: Dog, volatile anesthesia, questionnaire, photographic atlas, veterinary field.

INTRODUCTION

In clinical practice for small animals, anesthesia plays an increasingly important role in performing surgeries and other medical procedures (Sharma, 2024). Indeed, veterinary clinics offer their clients approaches with complicated procedures and long and painful operations. This situation requires the veterinarian to have good pain control and rigorous maintenance of the animal's vital functions. Therefore, the implementation of an adapted anesthetic protocol, coupled with continuous monitoring of the anesthetized animal, appears essential (Bourdeaux, 2012). This is in agreement with the dictum “there are no safe anesthetic agents, there are no safe anesthetic procedures, there are only safe anesthetists” for the entire anesthetic process in every practice (Grubb et al., 2020).

Volatile anesthesia is typically the first choice when a long duration of anesthesia is required (Mofidi and Vesal, 2024): it provides stable narcosis and allows almost instantaneous control of the administration and therefore of the anesthetic effect. Following cessation of administration, the animal often recovers quickly. On the contrary, it is difficult to modulate the depth of anesthesia as precisely and quickly with injectable agents (except when they are administered by perfusion) (Gargiulo et al., 2012). Furthermore, volatile agents (isoflurane, halothane, sevoflurane) have few absolute contraindications known in veterinary medicine (Verwaerde and Estrade, 2005).

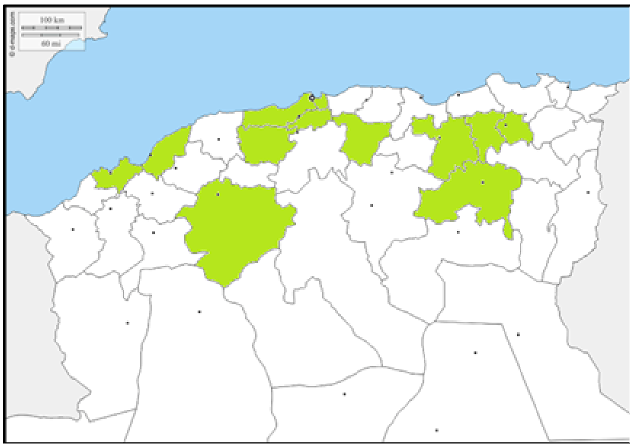
In many veterinary structures worldwide, anesthesiology and reanimation are practiced as a discipline independent of surgery and entrusted to specialized veterinary and para-veterinary staff. In these structures, volatile anesthesia with specific expensive equipment is widely used compared to fixed method not only in surgical procedures but also as part of the ideal method of euthanasia, since death in acceptable conditions to both the animal and its owner must not generate anxiety or pain and loss of consciousness before causing death is therefore essential (Ko, 2019). The situation in the Algerian veterinary clinics seems to be different. Indeed, anesthesia is regarded as an accessory task entrusted to the surgeon or his assistant staff. In addition, no data concerning the use of volatile anesthesia in small animals are available.

Thus, our work aimed to survey the conduct of general anesthesia by veterinary practitioners in dogs in Algeria, as well as the elaboration of a photographic atlas for demonstrative purposes. This atlas traced the different stages in the process of volatile general anesthesia and may serve as a learning tool for students and veterinary practitioners interested by the topic. We highlighted the difference between inhalation anesthesia and fixed method as well as the importance of monitoring cardiovascular, respiratory and metabolic parameters and other reflexes in pre-anesthetic, anesthetic, and post anesthetic phases.

Material and Methods

Study area

Our study was divided into 2 parts. The first part was a survey among veterinary practitioners, spread over eleven regions of Algeria, regarding the use and the conduct of general anesthesia. The second part, the demonstrative atlas, was conducted at the level of "Biotechnologies Platform for Animal Medicine & Reproduction" (BIOMERA platform), Saad Dahleb Blida University 1 (Blida, Algeria). This is a Research Platform organized into four technical sections, including the medicine and surgery section used for carrying out our work (Figure 1).



Geographic distribution of the survey sample in Algeria

Surgery section of BIOMERA for the elaboration of the atlas

Figure 1. Study area for the 2 parts of the work

Animals

For the elaboration of the atlas, three puppies belonging to BIOMERA platform were used, of a common breed, aged 3 to 5 months and weighing between 4 and 6 kg.

Materials

Electrocardiography (ECG), Ultrasound and echocardiography

For the special examination of the cardiac function during the pre-anesthetic consultation, a CardiMax FX-7202 electrocardiograph (FUKUDA DENSHI, Japan) was used (Figure 2). It is a three-channel device with a continuous ECG display dial and touch adjustment and a patient cord with four limb electrodes (Red, Black, Green, Yellow) and six precordial electrodes (V1-V6).

For the abdominal ultrasound and pre-anesthetic echocardiographic examination, we used a MyLab Class C Vet veterinary ultrasound scanner from ESAOTE (Netherlands), equipped with four probes (Linear, Convex, Micro-convex and Cardiac), several modes (B, M, Color Doppler, Pulsed Doppler and Continuous Doppler) as well as various licenses, including abdominal and cardiology (Figure 2).

Electrocardiogram CardiMax FX-7202 Ultrasound MyLab Class C VET, ESAOTE

Figure 2. Electrocardiograph, Ultrasound and echocardiograph

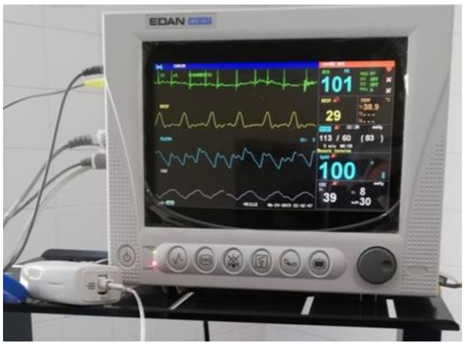
Volatile anesthesia machine

The anesthesia machine of the operating room of BIOMERA platform, Moduflex Optimax Coaxial® (DISPOMED, Canada) comprising two patient circuits namely a re-inhalation circuit (semi-closed) and a BATH circuit (semi-open), was used. This veterinary device is the first to incorporate a coaxial socket in both circuits. This coaxial system replaces the old system represented by the conventional filter circuit with “Y” connections. It has the advantage of reducing the size of the piping and the heat loss by preheating the inspired gases with the expired gases, as it eliminates the possibility of a bad connection (Figure 3).

Figure 3. Volatile Anesthesia machine “MODUFLEX Optimax Coaxial ®”

Multi-parameter monitor (The scope)

For monitoring cardiovascular, respiratory and metabolic parameters, a veterinary monitor, EDAN iM8 VET ® was used (Figure 4). This device is connected to the animal by means of several electrodes and interfaces adapted to canine use allowing to measure and to monitor continuously the following parameters: Heart rate and rhythm (HR, HR), electrocardiographic trace (ECG), noninvasive blood pressure (NIBP), percentage of hemoglobin saturated with oxygen (SpO2), respiratory rate and rhythm (RR, RR), capnography (End Tidal CO_2: ETCO2) and temperature (rectal or esophageal probe).



Multiparameter monitor, EDAN iM8 VET ®

Connection of electrodes to the animal

Figure 4. The multiparameter monitor

Methodology

Survey

We conducted a survey using a questionnaire that aimed to collect information on general anesthesia use in canine patients from sixty-two (66) veterinary practitioners.

The questionnaire was mainly aimed at determining the proportions of veterinarians practicing volatile or fixed general anesthesia as well as the protocols applied and also the percentage of practitioners monitoring cardiovascular, respiratory and metabolic parameters.

This questionnaire was designed according to the different stages of performing volatile or fixed general anesthesia. It includes fourteen (14) closed questions with several proposals as well as a space for an optional extended response.

Sixty-six (66) veterinarians were contacted, of which 62 responded favorably to the survey and 4 practitioners apologized for lack of time. After collecting all the survey forms (questionnaires), the data collected were entered and processed using an Excel table for calculation, tabulation and graphic presentation.

Demonstrative atlas

For the preparation of this atlas, 3 puppies were used to carry out six 6 cycles of general anesthesia. The latter was performed outside of any surgical procedure for demonstrative purposes. Before each anesthesia, we performed a pre-anesthetic consultation with several examinations (clinical and complementary) in order to assign our animal an ASA classification score and to define an appropriate protocol.

The actual volatile general anesthesia was carried out in four stages:

-A preparatory phase including premedication (acepromazine for tranquilization).

-A phase of achieving unconsciousness (induction): We used an induction first with sevoflurane under a mask then with propofol (Provive®) injected in IV (slow).

-A maintenance phase throughout the duration of the procedure: We maintained general anesthesia at a concentration varying between 1 and 3% sevoflurane with 100% oxygen using the non-rebreathing circuit known as BAIN on spontaneous breathing.

-A phase of complete awakening of the animal.

During these cycles of anesthesia, a total of seventy-two (72) photographs were taken, then sorted and classified following the sequence of the different stages of general anesthesia. For each stage, we have developed a summary of the essential knowledge to be acquired in the form of a box.

Ethical Statement

All the animal studies were conducted with the utmost regard for animal welfare, and all animal rights issues were appropriately observed. No animal suffered during the course of the work. All the experiments were carried out according to the guidelines of the Institutional Animal Care Committee of the Algerian Higher Education and Scientific Research (Agreement Number 45/DGLPAG/DVA.SDA. 14). All the animals handling was done with the consent of the pet owners.

Results

Survey

This section presents the results of the survey conducted in numbers and percentages. Table 1 summarized the answers of the veterinary practitioners (n, %) regarding the questions of the survey in relation with the conduct of pre-anesthetic consultation, premedication, and the general anesthesia used.

Table 1. Proportions of veterinary practitioners according to pre-anesthetic consultation, premedication, and general anesthesia conducted

Parameter-Question		**N (%)**	**Parameter-Question**		**N (%)**
Pre-anesthetic consultation	Yes	61 (98.39)	**Induction**	Gaseous (under mask)	0
	No	1 (1.61)		Fix-Ketamine	1(50)
Time interval between pre-anesthetic consultation-surgery	48 H	30 (48.4)		Fix-Propofol	1 (50)
	24 H	16 (25.8)	**Drugs used for premedication**	Phenothiazines (Acepromazine)	56 (90.32)
	Same day	16 (25.8)		Alpha-2-agonists	2 (3.23)
ASA classification	Yes	6 (9.67)		Anticholinergics	4 (6.45)
	No	56 (90.33)	**Premedication-induction interval**	30 min	25 (40.32)
General Anesthesia	Volatile	2 (3.22)		20 min	4 (6.45)
	Fixed	60 (96.78)		10 min	6 (9.68)
Halogens for volatile Anesthesia (premedication)	Halothane	2 (100)		2 min	1 (1.61)
	Isoflurane	0		Same time	26 (41.94)
	Sevoflurane	0	**Fixed anesthesia**	Ketamine	39 (65)
				Tiletamine+zolazepam (Zoletil®)	16 (26.67)
				Propofol	5 (8.33)

Table 2 included the practice of parameters monitoring as reported by the veterinarians.

Table 2. Parameters monitoring by the veterinary practitioners

Parameter-Question		**N (%)**	**Parameter-Question**		**N (%)**
Parameters monitoring	Yes	60 (96.77)	**Recording Parameter frequency**	5 min	3 (4.84)
	No	2 (3.23)		10 min	6 (9.67)
				15 min	3 (4.84)
Type of parameter monitoring	Clinical	60 (96.77)		30 min	50 (80.65)
	Instrumental	2 (3.23)	**Reflex control**	Yes	4 (6.46)
				No	58 (93.54)
Parameter monitored	HR	60 (96.77)			
	PR	60 (96.77)	**Anesthesia Sheet (checklist)**	Yes	2 (96.77)
	T°	2 (3.23)			
	SpO2	2 (3.23)		No	60 (3.23)
	ETCO2	2 (3.23)			
	NIBP	2 (3.23)			
	ECG	2 (3.23)			

Photographic Atlas

The photographs taken during our work successively present the pre-anesthetic consultation, the preparation of the equipment (anesthesia machine, venous catheterization and intubation, preparation of drugs and the aspirator for extubating) and finally, the anesthesia which is divided into four stages, namely premedication, induction, maintenance and awakening (Figure 5).

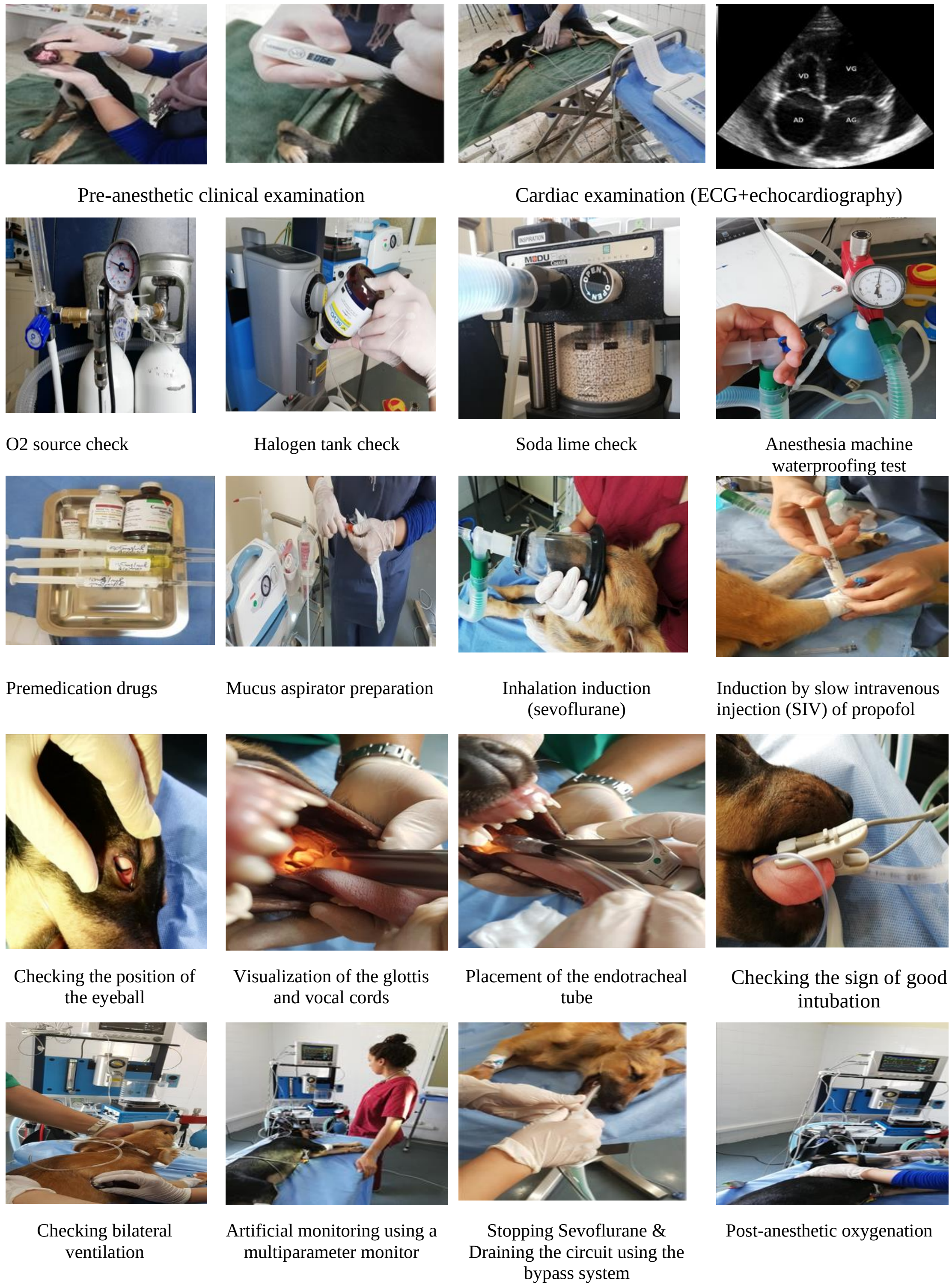


Figure 5. Demonstrative atlas of the steps of volatile anesthesia as followed in BIOMERA platform

The three puppies used in our work underwent a complete clinical pre-anesthetic examination with the collection of the animal's medical records (Cardiac and respiratory auscultation, examination of the mucous membranes color, rectal temperature measurement). Because of their young age, a thorough examination of cardiac function was performed to look for possible congenital cardiac malformations often discovered incidentally.

The three puppies in our study were all classified ASA1.

Before each anesthesia, the technical platform must be systematically installed, calibrated and checked (working condition, functionality of the machines and tools). It must also be organized ergonomically, i.e. all equipment must be easily accessible without disturbing the anesthesiologist or surgeon (prevent cables and tubes from crossing). The premedication was carried out using a phenothiazine (Acepromazine) at a dose of 0.25 mg, 20 to 30 min before induction. The latter was done per inhalation (sevoflurane) under mask, and also by slow intravenous injection (SIV) of propofol (cephalic vein).

Before induction under mask, the animal received pure oxygen for a few minutes to ensure good tissue saturation. Induction was done with a maximum percentage of 7% sevoflurane in an O_2 flow of 4 L in order to saturate the alveoli with sevoflurane. The interest was to have a loss of consciousness in 2 min.

The position of the eyeball (fixed tilt) was checked, the endotracheal tube was fixed after the visualization of the glottis and the vocal cords and the bilateral ventilation was also verified.

The choice of the endotracheal tube was made according to: The weight of the animal, the space between the nostrils, so we took a larger caliber tube and another smaller caliber, by the equation: live weight/4 + 4.

End of induction = start of maintenance = surgical stage

During the maintenance phase, cardiac and respiratory auscultation should always be continued to detect failure in the event of accidental extubation. Gas maintenance was done with Sevoflurane (1 to 3%). Oxygen flow was 1 L in the BATH circuit (Flow = 200 mL).

During the awakening phase, the animal should receive a quantity of post-anesthetic oxygen to eliminate any residual halogen in its lungs.

Parameter disturbance

During the experiment, we faced a case of tachypnea with normoventilation ($ETCO_2$: 35-45 mm Hg; VC: 8-15 mL/Kg) (Figure 6). We verified the narcosis and improved the analgesia (morphine). Then, we increased the O_2 flow.

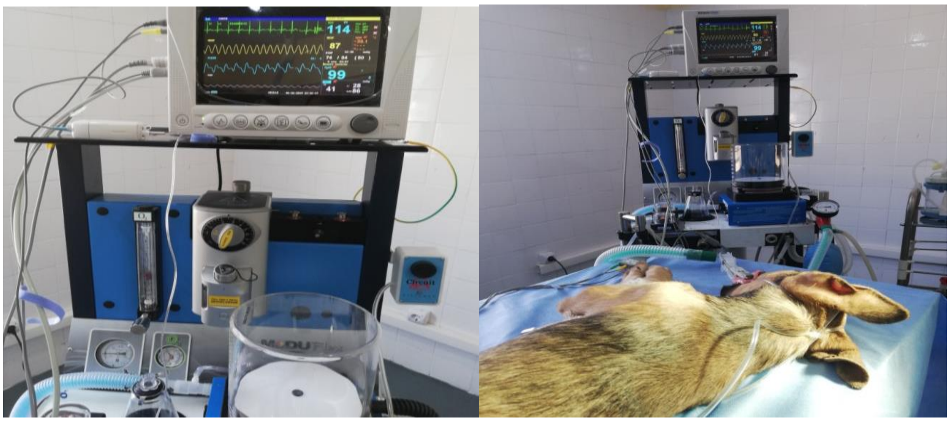


Figure 6. Tachypnea with normoventilation observed in Flooky

Discussion

In the veterinary clinic or in hospital, the anesthesia process includes four phases: preanesthesia, induction, maintenance, and recovery (awakening) (Grubb et al., 2020). The pre-anesthetic consultation and stabilization (if necessary) must be carried out, in the presence of the owner, within 48 to 72 hours preceding the anesthesia. It aims to assess the general condition of the patient, in order to detect physical and/or metabolic abnormalities, likely to increase the anesthetic risks and to avoid drug interactions if the patient received previous medication (Seahorn and Robertson, 2002; Sharma, 2024). It includes several stages, the collection of medical records (history), the most complete and precise general clinical examination possible, and finally, additional examinations. These three phases make it possible to determine the anesthetic risk incurred based on the ASA classification on a scale ranging from 1 to 5 or U (emergency) (Muir, 2007; Muir et al., 2009). It allows to adapt an anesthetic protocol that takes into account the state of health. The information collected is essential for establishing the anesthetic protocol best suited to the patient's state of health and the duration of the procedure to be performed and the anticipation of possible incidents (Bednarski et al., 2011).

Our survey revealed that 98.39% of the practitioners declare that they carry out a pre-anesthetic consultation. However, this information turned out to be erroneous (certainly due to misunderstanding), when compared to the percentage of veterinarians performing (9.67%) or not (90.33%) an ASA classification. 56 out of 62 practitioners (90.33%) stated that they were not aware of this concept of ASA classification. Given this situation, we would be allowed to conclude that all operated animals will be considered ASA1 and will undergo the same anesthetic protocol. This attitude could expose patients of other ASA classes to an anesthetic risk (Grubb et al., 2020).

In clinical practice, practitioners use a variety of anesthetic drugs and techniques during medical procedures to render the patient unconscious/unresponsive (Ferreira et al., 2020).

Our data revealed that only 3.22% of veterinarians practiced volatile anesthesia and 96.78% fixed general anesthesia by iterative re-administrations of ketamine (65%), the combination of tiletamine-zolazepam (26.66%) and propofol (8.33%). Maintenance of narcosis by iterative bolus consists of maintaining anesthesia by repeated injections of a low dose of anesthetic agent each time the animal begins to wake up. This technique, although widely used for its simplicity, appears to be the most chaotic and unstable method because the animal is constantly switching from very deep to very light anesthesia (Verwaerde and Estrade, 2005). In addition, the fixed agents used by the veterinarians according to the results of our survey (ketamine and tiletamine-zolazepam) are the least suitable for maintaining unconsciousness by iterative bolus (Pascoe, 1992).

Thus, ketamine (with an initial duration of action of approximately 20-30 minutes) used by repeating boluses at the half-dose of induction often leads to a prolongation of awakening.

In the case of the tiletamine-zolazepam combination (with an initial duration of 30-40 min) re-administered at half-dose, it should be noted that the metabolism and elimination of tiletamine and zolazepam do not occur at the same speed. Too many re-administrations (more than 2 or 3) are often the cause of prolonged and uncomfortable awakening in dogs (Weil, 2019).

Unlike dissociative molecules, propofol (with an initial duration of action of 10-15 minutes) which unfortunately is only used by 8.33% of the veterinary practitioners questioned in our survey, does not accumulate and its kinetics are almost not modified by iterative re-administrations and its awakening time is therefore not significantly modified. Thus, although maintenance by iterative bolus is not recommended, propofol is the most widely used, intravenous available drug, pharmacokinetically best suited to this type of procedure, particularly for practitioners who opt for fixed anesthesia (Verwaerde and Estrade, 2005; Ferreira et al., 2020).

A good alternative to the iterative bolus could be offered to veterinarians who cannot perform volatile anesthesia, it is the administration by perfusion of fixed agents which provides a stable narcosis (Beths et Pydendop, 2007). This maintenance method is quite simple to implement and does not require any specific equipment such as a device for regulating the infusion flow rate (syringe pump or infusion pump) or, failing that, pediatric tubing (60 drops/mL) (Weil, 2019).

Although ketamine can be administered by infusion alone or in combination with xylazine, propofol remains the ideal agent for maintaining infusion narcosis because it is rapidly redistributed and metabolized (into an inactive metabolite). Recovery after stopping the infusion is rapid in dogs. Unfortunately, none of the veterinarians practice the administration of fixed anesthetic agents by infusion.

Compared to fixed anesthesia performed by iterative bolus of an associative anesthetic agent, administration by inhalation or volatile anesthesia represents a better choice justified by efficacy, safety and comfort. The advantages of volatile anesthesia compared to fixed method by a dissociative agent can be summarized as follows: Dissociative anesthetics (ketamine) provide pseudo-narcosis with preservation of reflexes, hence the impossibility of assessing the depth of narcosis by clinical monitoring. In addition, halogens (notably sevoflurane) have many advantages over fixed anesthetic agents (ketamine) in the following areas: Depth of narcosis; speed of induction and awakening (Wake-up with sevoflurane, for example, is rapid "5-15 min" and comfortable, whereas with ketamine, it is slow "4-5 hours" with vocalization, agitation, contractures and frequent tremors); toxicity (potency and safety: particularly for prolonged procedures, due to a lesser cardiovascular depression, a reduced impact on liver and kidney functions) (Gargiulo et al., 2012); reversibility (easy and fast for halogenated drugs, impossible for fixed drugs except in the case of administration by perfusion or in the case of certain drugs participating in anesthetic unconsciousness and having antidotes such as alpha-2-agonists "metedomidine-atipamezole"); continuous monitoring of the administration and modulation of the depth of anesthesia; it promotes rapid recovery and allows quick adjustments and easy maintenance of a steady anesthetic depth; systematic intubation provides protection of the airways and ensures the possibility of permanent oxygenation of the patient; duration of anesthesia (prolonged for halogenated drugs "in particular sevoflurane" and limited for fixed anesthetics "in particular ketamine" which is maintained by iterative boluses); absence of absolute contraindications for halogenated drugs in veterinary medicine (Desbois et Troncy, 2007).

Unfortunately, only 3.22% of the veterinarians surveyed, practice volatile anesthesia. Among them, one practices induction with ketamine and the other with propofol. Both practitioners use halothane for maintenance of anesthesia and none use induction under a halogen mask.

However, it should be noted that veterinarians practicing volatile anesthesia unfortunately represent only 2 out of 62 practitioners, which considerably overestimates the percentages calculated for this fraction of the survey sample with regard to questions relating to the details of conducting volatile anesthesia. For the veterinarian who practices ketamine induction, it should be noted that due to the preservation of reflexes, particularly the oropharyngeal intubation will be difficult with the movements of the glottis and vocal cords, hence the need to use a local contact anesthetic in spray form in this case. Propofol is the best choice for induction because it provides total silence of the glottis as well as temporary apnea which facilitates the procedure and reduces the risks of endotracheal intubation. As for the choice of anesthetic gas, the 2 veterinarians practicing volatile anesthesia use halothane, which is justified by its availability and reduced cost.

In our work, we used a better-quality anesthetic gas with much less risk, which is sevoflurane. The latter has several advantages over halothane; Due to its high minimum alveolar concentration (MAC), sevoflurane (MAC: 2.3) is three times less potent than halothane (MAC: 0.8) and therefore provides three times more safety (Dugdale, 2010). Besides, because of its low plasma solubility, sevoflurane (0.68) has a faster induction and recovery than halothane (2.54) because it is almost four times less soluble in plasma than the second. It should be noted that the plasma solubility of a halogen is inversely correlated with its speed of action and elimination (Bourdeaux, 2012). Furthermore, the interest in using sevoflurane ("high MAC" safety and "low solubility" speed of action) for induction under mask and the risk of using halothane linked to prolonged stress and release of catecholamines which have an arrhythmogenic effect (Weil, 2019).

Anesthesia monitoring is an essential act to assess the depth of narcosis and its consequences on vital functions (cardiovascular, respiratory and metabolic). The purpose of monitoring is to detect any vital functional abnormality early and to remedy it quickly before it worsens (Chandana et al., 2021). Even during deep anaesthesia, the pain and stress produced during a medical act (surgery) stimulates the sympathetic system and activates the inflammatory response. These physiologic responses consist of metabolic, haemodynamic, neuro-endocrine and behavioural modifications, which can lead to serious consequences concerning the animal's health (Margeti et al., 2024).

Monitoring the disappearance of reflexes allows to assess the depth of anesthesia while looking for their reappearance represents monitoring of awakening. The reflexes used in this monitoring are ocular signs (eyeball position and pupil size), mucous membranes color, muscle tone, oropharyngeal reflexes, flexion reflex and sphincter control (Bednarski et al., 2011; Ribeiro et al., 2012).

Four veterinarians out of 62 reported monitoring reflexes to assess the depth of anesthesia. For these veterinarians, it should be emphasized that the maintenance of anesthesia by a dissociative (ketamine or tiletamine) totally interferes with the use of clinical monitoring of reflexes as a means of assessing the depth of anesthesia or of seeking awakening, because dissociative agents preserve these reflexes throughout the anesthesia. It is important to mention that continuous monitoring of depth of anesthesia can provide economic benefits by preventing the wastage of anesthetics, which has been identified as a significant contributor to the total expenses of anesthesia procedure (Shahbakhti et al., 2024).

In this study, 96.77% of practitioners report monitoring cardiovascular, respiratory and metabolic parameters during anesthesia. However, this information loses its value when compared with the previous results stipulating that 96.77% of veterinarians practice clinical monitoring of only two parameters which are heart and respiratory rates. Indeed, only 3.23% of veterinarians practice instrumental monitoring of all parameters. This percentage obviously represents the 2 practitioners who have an anesthesia machine equipped with a multiparameter monitor. This result is in agreement with a systematic review study (Cicero et al., 2018). The latter reported that few centers performed a check of the subject during the study procedures in laboratory animals. In the same context, Uhlig et al. (2015) revealed that no control during anesthesia were described in 439 cases out of 732 (60.0%) of interventions involving the use of anesthesia. In the remaining procedures 293/732 (40.0%) involving anesthesia, the use of monitoring techniques has been described during the only anesthesia 114/293 (38.9%). In 40/293 interventions (13.7%) is no monitoring was specified.

Anesthetic and post-anesthetic monitoring is very important in the recovery phase. It is important to control the side effects that might be from general data, such as heart rate, body temperature and the concentration of gases and electrolytes in the blood, as well as it is important to assess the reflex responses (Cicero et al., 2018). Moreover, the recovery phase is slower and requires support and continuous monitoring in the later stages upon awakening (Swindle et al., 2013).

Anesthetic agents frequently used (ketamine, propofol, isoflurane/halothane) influence the carbon dioxide tension in arterial blood (PaCO2) or exhaled (ETCO2) and can lead to respiratory acidosis. They must therefore be carefully monitored all the vital parameters of the animal and restoring fluid and electrolyte balance in case they will be altered (Schwedler et al., 1982; Cicero et al., 2018).

Keeping an anesthesia record is of capital interest and allows the gradual recording of the variation in the different parameters of vital functions. On this monitoring record, the heart and respiratory rates, as well as the instrumental data (EtC02, Sp02, T°), all events (anesthetic or surgical) and the drugs used will be noted at regular intervals. Maintaining this record in real time offers the possibility of intervening in time in the event of an alteration of the parameters in order to prevent cardio-respiratory arrest. In particular, it allows the identification of a possible anesthetic drift and the definition of responsibilities and errors in the event of a fatal incident. In the practice of human anesthesiology, this represents a medico-legal obligation. In veterinary medicine, it constitutes a useful medical support in the event of litigation.

There are several models of anesthetic sheets that differ according to the personalized designs of medical and veterinary structures but which remain equivalent in terms of content. Thus, in this present work, we have designed a simple sheet model which will be adopted at the level of BIOMERA platform.

In our survey, the majority of veterinarians unfortunately do not use an anesthetic sheet. This result is well explained by the fact that this same percentage of practitioners only perform clinical monitoring of the HR and the RR.

It should be noted that among the 2 veterinarians practicing volatile anesthesia and having a multiparameter monitor, only one declared keeping an anesthetic sheet in real time. The other veterinarian declared using the automatic report recorded by the monitor a posteriori. In this regard, we would like to once again mention the crucial importance of monitoring the parameters as they occur and recording them in real time in order to be able to intervene in time in the event of a disturbance of the parameters and thus prevent the fatal incidence of cardio-respiratory arrest.

In order to highlight the importance of monitoring parameters, we present below the specific case of the puppy Flooky anesthetized during the realization of this present work and who suddenly presented during the maintenance phase of anesthesia a disturbance of the parameters with a tachypnea (87 movements/min) associated with a normo-ventilation (ETCO2: 41 mmHg) as well as a hypotension (BP: 74 mmHg/34 mmHg). The rest of the parameters were without particularities. By referring to the decision-making diagram of the actions to be taken to deal with an alteration in the respiratory rate or rhythm and by adopting an elimination approach, we were able to conclude that it was a lack of oxygen supply and that the tachypnea was there to compensate for this hypoxemia to maintain satisfactory oxygen saturation (SpO2 98%) and normo-ventilation (capnography between 35–45 mmHg). A check of the complete O2 supply system quickly allowed us to detect that our endotracheal tube had entered the trachea too far, causing unilateral bronchial intubation confirmed by auscultation of both lung fields. The respiratory parameters stabilized quickly after repositioning the endotracheal tube. The drop in blood pressure appears to be due to the slightly dehydrated initial state of the dog Flooky as well as the hypotensive effect of acepromazine, propofol and sevoflurane, in particular that the time interval between premedication and induction was shortened to 5 min. This hypotension was corrected by the establishment of an infusion of a crystalloid solution.

This alteration of the parameters would have evolved in the absence of real-time monitoring and emergency intervention, towards cardio-respiratory arrest.

Conclusions

At the end of this work, we conclude that the majority of veterinarians questioned practice fixed general anesthesia by iterative re-administrations of ketamine, without reflex monitoring. Only few practitioners perform volatile anesthesia. Instrumental monitoring of cardiovascular, respiratory and metabolic parameters is performed by a minority of veterinarians surveyed. The vast majority control heart and respiratory rates without using an anesthetic sheet (checklist). Based on the above, we would like to recommend for veterinarians wishing to use volatile anesthesia: Systematically perform a pre-anaesthetic consultation with an ASA classification, avoid dissociative agents for induction in order to be able to monitor reflexes and assess the depth of narcosis, maintain narcosis with a quality halogen (sevoflurane) if possible, observe instrumental monitoring of cardiovascular, respiratory and metabolic parameters listed in real time on an anesthetic sheet. For practitioners who prefer or must adopt a fixed general anesthesia: Avoid maintenance of narcosis by iterative bolus of fixed anesthetic agents in favor of administration by perfusion using flow control devices (syringe pump or perfusion pump) or failing that a pediatric tubing (60 drops / mL). If the iterative bolus (repeated administration of a low dose) of a fixed anesthetic agent is necessary, avoid dissociative anesthetics in favor of propofol which remains the available drug, pharmacokinetically best suited to this type of procedure.

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