
Observations on the effectiveness of post-operative administration of nutrients and fluids in dogs and cats

Greco Mariana, Henea Mădălina Elena, Ghețu Vlad, Rusu Oana-Raluca, Rîmbu Cristina Mihaela

University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad", Iași
Faculty of Veterinary Medicine
marygreco@gmail.com

Abstract

It is estimated that thousands of surgeries are taking place in dogs and cats every year. Today, major trauma associated with operations is minimal due to modern techniques, but nevertheless, the patient's body requires a recovery period, and nutrition is one of the important elements that can speed up the process of healing in many ways, by providing the necessary protein and energy to the body. Pain relief as well as balancing the body after surgery, especially in serious situations, is important for the patient's well-being and comfort, as they contribute to its faster and more effective recovery. The postoperative period in animals requires special attention to the pursuit of the operated patient and the immediate treatment of possible imbalances and complications that may occur. Pain, hypothermia, shock, vomiting, nerve phenomena (excessive vocalizations) are the main phenomena that unspeakable patients manifest in the postoperative period. The mechanisms for the production and maintenance of nociceptors are multiple, tolerance for pain is an individual parameter in relation to the age, gender, terrain and mental state of the patient. Because around postoperative care there is a multitude of opinions and controversies from the owners, sometimes even veterinarians, it was necessary that through this study we make known the benefits of specialized care and the need for permanent monitoring of the patient within the first 72 hours after surgery, by administering drug therapy to reduce pain, relieve the patient, as well as to support large functions.

Keywords: anesthesia, postoperative recovery, analgesia, nutrients, fluids

Anesthesia and post-anesthetic supervision

Anesthesia is a state of unconsciousness that is induced to the animal, being of major importance whenever surgery is needed. Anesthesia acts both on the central nervous system and on the other systems of the body (Bjorling et al., 1983).

The components of anesthesia are analgesia (suppression of pain) and immobilization of the patient, in humans there is amnesia (suppression of memory), about which no data are specified in animals (Boscan et al., 2010). The drugs used to achieve anesthesia, which are usually different combinations of substances, reach all three desiderated, some substances using for the analgesic effect (Buprenorphine) or sedatives (Acepromasine), and other for induction of complete anesthesia (Xilazine, Medetomidine, Ketamine).

The operative act is a factor that acts aggressively on the body. Depending on the intensity of the intervention, the local lesion appears, and through the central and endocrine-vegetative nervous system, a series of other physiological changes occur that affect the organism generally and represent a post-aggressive disease or a post-operative disease (Brodbelt et al., 2007).

Prior to any anesthesia and surgical intervention, the patient must be evaluated to establish the appropriate anesthetic and surgical protocol (Boscan et al., 2010; Brodbelt et al., 2007; Zacher et al., 2010). Signal data such as race, age, weight will be followed; anamnesis - pre-existing conditions, current medication, previous surgeries; general physical examination and on devices and systems that must be compulsory to include thermometry, cardio-pulmonary obedience with heart rate and respiratory rate, pulse assessment; laboratory examinations (blood count and blood

biochemical examination - blood glucose, total protein, urea, creatinine, ALT, AST, coagulation time). Depending on the clinical examination and anamnesis, in geriatric animals and those with chronic diseases can also be performed: blood biochemical examination (pancreatic lipase, pancreatic amylase, GGT, alkaline phosphatase, total bilirubin, determination electrolytes and blood gases, ionogram); cardiology examination (EKG, echocardiography); specific serological examinations; radiological examination; ultrasound exam.

Anesthesia monitoring should be performed for all types of anesthesia (Boscan et al., 2010): cardio-vascular monitoring - listening (heart rate, rhythm), peripheral pulse, capillary refill time, ECG, blood pressure measurement; respiratory monitoring: respiratory rate, rhythm, Hb saturation in oxygen (appearance of mucous membranes/pulse oximeter), CO₂ (capnograph), blood gas analysis (Pa CO₂, PaO₂); monitoring of renal excretion (1-2 ml of urine eliminated/kg/hour); temperature monitoring.

Patient monitoring varies depending on the species and the complexity of the intervention and should include (figure no. 1):

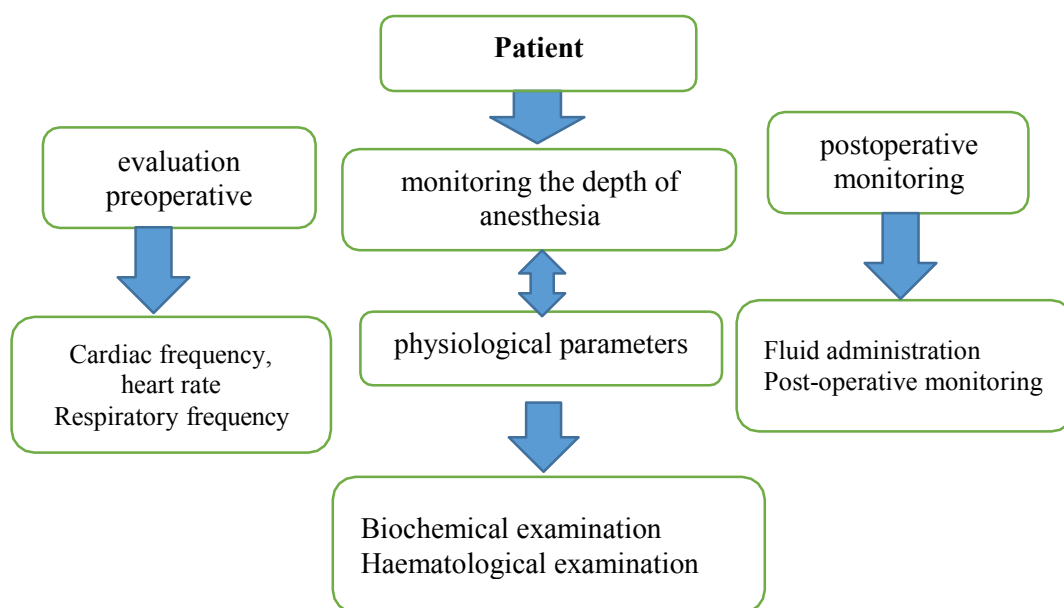


Fig. 1. Pre- and postoperative evaluation in dogs and cats

General anesthesia in dogs and cats is often accompanied by different side effects and even complications related to both anesthesia and the actual surgical act such as (Weiser et al, 2008; Windsor et al., 2004): shock (occurs frequently in the first hours after surgery and is recognized by tachycardia, filiform pulse, hypotension, mucosal cyanosis, drowsiness), respiratory depression, nausea, vomiting, rhythm and heart rate disorders, hypoxia, aspiration pneumonia, external bleeding at the level of the operative plague, thromboembolism, bronchospasm, laryngospasm, operative plague infection, anxiety, tremor.

The reaction from the operated organism and the clinical manifestation are different depending on the intensity, depending on the extent and duration of the intervention, the biological field, the type of anesthesia, the age of the patient, the quality of the preoperative preparations, the type of intervention, the intensive care measures that will be applied later (Brodbelt et al., 2007). It is believed that each operative act will trigger the postoperative disease, which may be of apparent, serious or fatal intensity. It is also appreciated that the intensity of the postoperative disease is different from one animal to another.

Following a surgery performed on an animal, especially those of the pet, more attention is needed on the awakening and hospitalization stage (Brodbelt et al., 2007). Thus, the animal will be monitored until it has the stability to take the stand alone position, physiological or to move without support, in addition it is necessary to provide a special microclimate, a room with low light intensity, warm and will be sitting on a mattress on the ground level.

After performing a surgery on pets, it would be advisable to undergo preventive and curative treatment to avoid some unwanted situations, such as complications. Given the unpleasant phenomena that may occur, it is necessary that animals under anesthesia be carefully monitored to ensure adequate depth of anesthesia, animal homeostasis, early observation of potential complications. Rapid postoperative recovery of animals has been evident since the 1980s, when Kehlet et al. first established that the more pronounced the response to stress during the perioperative period, the longer the recovery after the intervention. Recent guides typically list 15 to 20 preoperative factors that need to be considered for improved recovery (Louisa Susanne Slingsby et al., 2000). Stress response is a homeostatic mechanism that induces hormonal and metabolic changes that occur in response to anesthesia and surgery (Desborough et al., 2000).

The postoperative supervision and care, careful and complete, aims to speed up the healing, reduce the hospitalization period and prevent the postoperative sequelae. Post-anesthetic surveillance should be carried out in a specially designated space (post-anesthetic recovery room) that will ensure the management of patients with post-operative progress for a limited period of time (hours, days).

The patient should not be given to the owner immediately after anesthesia, as there are major risks incompatible with life, but this happens today in 90% of cases. Both the specialist doctor and the owner have the obligation to care for the patient immediately after the surgery and it is necessary to know some important care strategies. The patient's supervision during the first 48 to 72 hours must be permanent in order to detect early the postoperative incidents and complications and to administer the specific treatment of the manifestations as soon as possible (Desborough și colab., 2000). Thus the following will be examined: the general appearance of the patient (the color of the mucous membranes, the skin indicating the hydration state); physiological parameters such as pulse, frequency, rhythmicity, amplitude, blood pressure that will be measured from 15 to 15 minutes or 30 to 30 minutes in the first hours; respiratory rate; temperature; vomiting, surveillance of the operative wound.

The patient's position will be changed from hour to hour within the first 24 hours postoperatively, to promote lung expansion and to prevent hypostatic pneumonia.

The quality and thoroughness of these care depends largely on the postoperative evolution and the absence of complications.

Postoperative rehabilitation

Rehabilitation after surgery at present is based only on providing injectable analgesia, using non-steroidal anti-inflammatory drugs, but in severe situations of the operative processes,

analgesia is insufficient to improve the patient's condition and induce postoperative recovery. Post-anesthetic surveillance in veterinary medicine, especially in pets, is a very important part of the anesthesia activity, because after the intervention the patient is taken home, where severe complications can occur.

The immediate postanesthetic period is a critical period, in which the residual consequences of anesthesia and the effects of the surgery may manifest, which may involve a life-threatening risk for the patient (Desborough și colab., 2000). Patient management in the immediate postanesthetic period includes evaluation and monitoring of vital functions and surgical wound (hemorrhage), treatment of postoperative symptoms (pain, nausea and vomiting, chills) and antagonizing treatment of residual effects of anesthesia (Boscan et al., 2010; Brodbelt et al., 2007).

After a surgery performed on the pets, which are mainly represented by dogs and cats, they will become more difficult as a result of the operation due to the hemodynamics of the body, by the anesthesia undergone, by the lost fluids and the diseases that can appear postoperatively. In other words, special attention is recommended on the following steps of preparing the animal for anesthesia, performing anesthesia, proper surgery, waking up, treatment and post-operative care.

It is essential that, after the post-operative stage, the concentration of minerals, salts, fluids that have an important mission in the physiological processes and are decisive in ensuring the proper functioning of organs and tissues occurs in the body of the pet (Boag and Hughes, 2007; DiBartola and Bateman, 2012; Helio et al., 2017).

Therefore, there is a rich range of pharmaceuticals, fluids, minerals and vitamins that are involved in stimulating the anabolic processes of the body, which helps to restore the tissues after some surgery in animals, which favors the energy and tissue regeneration processes, which maintain the state. health, they prevent complications following surgery and are an important part in healing different diseases.

The use of various nutrients, fluids and minerals during the pre- or post-operative period in pets is very important because it helps to restore the body's balance and reduces the recovery period (Goggs and Hughes, 2008; Davis et al., 2013). In addition the use of these substances intravenously also offers a number of advantages represented that goes directly into the bloodstream, exerts its effect immediately and fully absorb.

Postoperatively, it is necessary to ensure analgesia by administering non-steroidal anti-inflammatory drugs (carprofen, meloxicam, cimicoxib, robenacoxib, tolfenamic acid, etc.), which have both anti-inflammatory and analgesic effect, or opioids (buprenorphine, tramadol 2-4 mg / kg at 8-12 hours per bone) with prolonged analgesic effect, for 3-5 days depending on the reactivity of the patient (Louisa Susanne Slingsby, Avril Waterman-Pearson, 2000).

It is necessary that immediately after anesthesia (regardless of its type) and surgery, intravenous fluids (lactating ringer, ringer, physiological serum) should be administered depending on the specific individual needs for maintaining volume and blood pressure (Cornelius et al., 1978).

Some clinicians, as well as most of the owners, the latter for financial reasons, do not support postoperative fluid therapy only in very serious cases, although this should be an integral part of anesthesia and surgery because it improves heart rate, stimulates breathing, tissue infusion and produces diuresis, leading to a faster recovery from anesthesia, with diminished adverse effects.

The therapeutic doses of fluids in the case of dehydration are 10 ml/kg/hour in pets, but in the case of postoperative recovery, small doses of fluid are suggested, 3 ml/kg/hour in the cat and 5 ml/kg/h respectively dogs (Davis et al., 2013), the doses being able to increase according to the patient's needs. These doses come from a growing body of evidence from both human and

veterinary medicine, which suggests that high doses of fluids, particularly in healthy patients, can induce adverse reactions (Brodbelt et al., 2007; Boscan et al. al, 2010). It is known that errors in fluid management (usually fluid overload or overload) in human patients following surgery have been identified as a common cause of postoperative morbidity.

In the last period, ample scientific evidence has been accumulated to guide the selection of the appropriate drugs and strategies postoperatively, depending on the needs of each patient and each type of operation (Kehlet, 1982; Macintire, 2008; Ljungqvist et al., 2010). However, postoperative fluid therapy in dogs and cats still needs specific investigations and reassessments.

Further research is needed to identify which specific combinations of these components are most appropriate for individual patients in each operative and postoperative circumstance. Thus, different protocols and countless methods have been developed and addressed for improving recovery after surgery (Seeler DC., Thurmon JC., 1985).

Need for postoperative fluid therapy

It is known that the post-anesthetic period in the first 12-48 hours is critical as a result of bleeding, sweating, edema following surgery and water consumption in small quantities, which can lead to dehydration of the animal with serious consequences on postoperative evolution (Moraillon et al., 1997). Initially, the water is mobilized from the extracellular level that produces hemoconcentration, then the dehydration gradually worsens, after 3-4 days from the intervention and leads to the mobilization of the water from the intracellular level with severe hypotension until the collapse.

The clinical manifestations in the post-operative diseases can be very different and are depending on the operative trauma, the severity of the disease, the nature of the determining factors and of the favorable ones (Deborah et al., 2018; Moraillon et al., 1997). Therefore, small changes can initially result, which may worsen over time, then entering the category of postoperative complications. Postoperative disorders include several symptoms such as circulatory, digestive, nervous, respiratory, humoral and urinary disorders, to which the febrile reaction is added (Brodbelt et al., 2007; Martindale et al., 2013).

Nervous symptoms depend on the algogenic factors, the type of anesthetic and the degree of protection. These factors give a harmful reaction on the body which reacts by drowsiness, adinamia, decubitus, apathy, inadequacy. The operated area presents with a living pain, which will be alleviated after 24 to 48 hours and therefore if the pain persists will induce a state of discomfort which indicates an abnormal evolution (Brodbelt et al., 2007).

The respiratory signs are represented by the change of the dynamics of the respiration, which will become frequent, superficial due to the change of the blood composition by the presence of endotoxins. It will influence the respiratory center due to chemoreceptors and pain (Davis et al., 2013; Hopper et al., 2012).

Circulatory symptoms occur due to primary or secondary hemorrhages and due to intense post-traumatic proteolysis leading to changes in pulse and blood pressure. The pulse will be accelerated, after the second day after the surgery, it will remain so for a period, then it will return to normal value, which indicates a favorable result (Silverstein et al., 2012).

The tachycardic pulse, but diminished in amplitude, may indicate secondary bleeding, but the drop in blood pressure shows a shock state. The difference between the pulse and the temperature or the diminution of the blood pressure indicates the shock compensated with a serious situation (Silverstein et al., 2012).

Digestive signs appear due to neurovegetative changes and show hypotonia or intestinal paresis, tympanism, constipation.

Urinary symptoms result from dehydration or retention of urine, which will cause the appearance of bladder. The clinical signs are oliguria or anuria, followed by uremia. If the oliguria persists quite frequently it is a first manifestation of the postoperative complication.

Following the intervention the operators may develop a febrile reaction, which is classified as aseptic and septic. Aseptic fever appears after the operation, the next day. After the resorption of the pyrethogenic substances from the traumatic outbreak or of the thermal center disturbance by breaking the balance between the production and the loss of heat (Davis et al., 2013). The thermal rise is 1 - 2 °C and will decrease from the 3rd or the 4th day. If the fever recurs after 3-4 days after the surgery and is maintained at a high level, it indicates a septic complication. It must be checked whether there have been any complications at the level of the traumatic outbreak in the wound. Hypothermia, hypoglycemia, dehydration, and overdose of anesthetic may contribute to prolonged recovery.

The prognosis within the postoperative disease can be classified as favorable, reserved or severe when emergency intervention is required.

The immediate post-anesthetic management of the patient includes the evaluation and monitoring of the vital functions, of the surgical wound, the treatment of the post-operative symptoms: pain, vomiting, hypotension, chills, etc., and the antagonizing treatment of the residual effects of the anesthesia (Hansen B and DeFrancesco T, 2002).

General postoperative treatment is instituted when the animals have undergone laborious interventions, in cases of chronic diseases that can lead to prolonged convalescence, in the case of high blood loss through trauma, in severe dehydration. Many homeowners refuse medical care and post-operative supervision, accusing either of lack of time or of financial failure. Some serious symptoms that may occur within the first 24 hours after surgery, such as hypothermia or hypoglycemia, most commonly seen in young or low-burden patients, may be detected and resolved by a specialist veterinarian and not by the owner.

Choosing the type of fluid or the combination of fluids is a real challenge for the therapist who has to take into account the composition of the fluids the patient loses, the molecular architecture of the solution they administer, as well as its distribution between the body's water compartments (Davis et al., 2013). Regarding the rate of infusion administration, it is an important step, because iatrogenic hyperhydration must be avoided, which will result in the accumulation of water in the intravascular sector, which leads to blood dilution, hemolysis, hypertension, overload of the heart.

In order to adjust the rate of the infusion, the quantity to be infused will be divided into correction fluid, maintenance fluid and liquid to compensate for losses that may occur through drainage, vomiting, urine, fecal matter. It should be included in the calculation and body temperature.

For the efficiency of the therapeutic measures, protocols have been developed that ensure the optimization of the physiological parameters as early as possible; Delaying adequate fluid therapy in critical conditions (trauma, septic shock, hemorrhagic shock, burns or in the patient with increased surgical risk) is associated with increased mortality.

Volumic therapy for the critically ill should be applied as soon as possible in order to restore effective circulating volume and optimize cardiac output. These conditions are absolutely necessary to ensure the oxygen supply at the cellular level, which is why volemic resuscitation is essential for achieving the balance between oxygen consumption and oxygen transport at tissue

level. In case of severe tissue oxygenation disturbances, cell death and multiple organic dysfunction can be achieved (Rebecca Kirby and Elke Rudloff, 2016). Intravascular volume recovery is required in various clinical situations such as: extracellular, haemorrhagic or non-hemorrhagic volume loss (absolute hypovolemia) or blood flow distribution (from distributive shock).

Nutritional supplements help heal wounds faster while others reduce pain, edema, discomfort and itching. The most commonly used vitamins, minerals and antioxidants are vitamin C (it is indicated by experts because it helps promote healing and is the key nutrient needed to produce collagen, which contributes to tissue recovery), vitamin K (anti-hemorrhagic), complex B (accelerates wound healing, increases protein synthesis, and the amount of cells used to repair lesions) (Hansen B and DeFrancesco T, 2002).

One of the major supplements is zinc, which, in various medical researches, has been found that supplementation with this mineral can increase the healing rate after surgery by 43% in some cases. It plays a vital role in the immune system, can reduce inflammation, inhibit the development of bacteria and contribute to the creation of scar tissue, while a deficit can make scarring difficult.

Another important supplement is vitamin A, known to activate the production of connective tissue, including collagen, which helps to form new blood vessels, which is needed in newly formed tissue. It is important in the healing process that occurs after surgery, because it increases the resistance to infections by stimulating the body's immune function.

Fluid administration (isotonic, hypertonic, or colloid electrolytic crystalloids) effectively restores circulating intravascular volume, improves pregnancy and cardiac performance, according to Frank Starling law. This ensures optimal cardiac output and adequate oxygen transport at the cellular level. Postoperative care should be such as to minimize discomfort and consequences of any disability in the operative procedure. The solutions that provide the energy needed for the body are represented by solutions containing injectable carbohydrates such as glucose solution, sorbitol solution, fructose solution and plastic nutrient solutions (Rebecca Kirby and Elke Rudloff, 2016).

Liquid substances used postoperatively, such as fluids and vitamins, offer the advantage of neutralizing a wide range of toxic substances in all states of aggregation. These substances have the property of binding the toxicant, thus achieving a stable complex in the gastrointestinal tract, until the time of elimination through the urine and feces (Ramsey I, 2014).

The efficient hydro-electrolytic rebalancing for rehydration will be performed parenterally by intravenous administration of isotonic sodium chloride serum, glucose serum and other solutions. In cases where a significant amount of blood has been lost, hemotransfusion can be used. During a day, the transfusion will be administered divided into 3-4 times, because a large amount of fluids can cause the appearance of pulmonary, cerebral edema, convulsions, chills, prostration.

The benefits of fluid therapy can sometimes be overshadowed by the practice of aggressive administration of volemic solutions. The critically ill patient has microcirculation and capillary permeability disorders in the systemic inflammatory response syndrome. Excessive solutions can lead to fluid accumulation in various sectors of the body (McNamara RM et al., 1993). Clinically peripheral edema, pulmonary edema, intracerebral edema appear, and intra-abdominal

hypertension and abdominal compartment syndrome (Daniel Chan, 2015; Dava Cazzolli and Jennifer Prittie, 2015; Katja Adamik, et al., 2015). In severe forms, polycompartment syndrome can be reached, a situation characterized by systemic edema and increased pressure in various compartments (limbs, cerebral, ocular, abdominal, intrathoracic) with severe repercussions on perfusion pressure. The consequences in such situations are represented by the occurrence of lesions of tissue ischemia and multiorgan dysfunction (Katja Adamik, et al., 2015). Numerous studies reveal the significant correlation between the net positive water balance and the increase in

mortality (Daniel Chan, 2015; Dava Cazzolli and Jennifer Prittie, 2015; Katja Adamik, et al., 2015).

Animals that have undergone postoperative surgery should receive analgesic drugs. Analgesics are given immediately after the surgery. If the animals continue to show signs of pain or have other problems after surgery they should be evaluated individually, performed a series of additional analyzes and treated.

Treating animal pain today has become a major issue in veterinary medicine. The American Animal Hospital Association (AAHA) has recently launched a "AAHA / AAFP Pain Management Guidelines for Dogs and Cats" with the American Association of Feline Practitioners. This guide points out that pain management improves the recovery process of the disease, surgery or injury, reduces stress and increases the animal's well-being.

With all these indications and recommendations, in conclusion the major advantage is the owner's attitude towards his pet, how he respects the veterinarian's instructions, monitoring the physiological parameters such as urination and defecation, followed by the post-operative feeding, which together will lead to improvement daily health status of the pet.

Conclusions

Any surgery will weaken the body, but there are measures that help speed the recovery of the pet. The more complex the intervention and the higher the incisions, the longer the convalescence will be.

It is necessary for postoperative patients to receive a diet rich in fluids, minerals and vitamins to ensure maximum healing and maintaining body functions.

Fluid therapy in the critical patient is a challenge for the clinician, because in order to choose the appropriate therapeutic behavior, the patient's volemic status must be properly evaluated and prompt intervention for clinical and paraclinical optimization.

Thus, a well-established and applied supportive therapy can help reduce morbidity and mortality, in the case of animals that have undergone surgery, having maximum efficiency if performed systematically.

Bibliography

1. Bjorling DE and CA Rawlings (1983). Relationship of intravenous administration of Ringer's lactate solution to pulmonary edema in halothane-anesthetized cats, *Am J Vet Res* 44(6): 1,000-1,006.
2. Boag A and Hughes D (2007). Fluid therapy. In King LG and Boag A (eds), *BSAVA Manual of Canine and Feline Emergency and Critical Care*, BSAVA, Gloucester: 30-45.
3. Boscan P, Pypendop BH, Siao KT, Francey T, Dowers K, Cowgill L and Ilkiw JE (2010). Fluid balance, glomerular filtration rate, and urine output in dogs anesthetized for an orthopedic surgical procedure, *Am J Vet Res* 71(5): 501-507.
4. Brodbelt DC, Pfeiffer DU, Young LE and Wood JL (2007). Risk factors for anaesthetic related death in cats: results from the confidential enquiry into perioperative small animal fatalities (CEPSAF), *Br J Anaesth* 99(5): 617-623.
5. Cornelius LM, Finco DR and Culver DH (1978). Physiologic effects of rapid infusion of Ringer's lactate solution into dogs, *Am J Vet Res* 39(7): 1,185-1,190.
6. Daniel L. Chan (2015). The swinging pendulum between consensus and controversy in veterinary emergency and critical care, *Journal of Veterinary Emergency and Critical Care*, 25, 1, (1-3).
7. Dava Cazzolli and Jennifer Prittie (2015). The crystalloid-colloid debate: Consequences of resuscitation fluid selection in veterinary critical care, *Journal of Veterinary Emergency and Critical Care*, 25, 1, (6-19).
8. Davis H, Jensen T, Johnson A, Knowles P, Meyer R, Rucinsky R and Shafford H (2013). American Animal Hospital Association (AAHA); American Association of Feline Practitioners (AAFP; 2013). AAHA/AAFP fluid therapy guidelines for dogs and cats, *J Am Anim Hosp Assoc* 49(3): 149-159.

-
9. Deborah C. Silverstein and Samantha Hart (2018). Crystalloid Fluid Therapy, Textbook of Small Animal Emergency Medicine, (1089-1096).
 10. Desborough JP. (2000). The stress response to trauma and surgery. *Br J Anaesth.*;85(1):109-17.
 11. DiBartola SP and Bateman S (2012). Introduction to fluid therapy. In DiBartola SP (ed), *Fluid, Electrolyte and Acid-Base Disorders in Small Animal Practice*, Elsevier Saunders, St Louis: 331-350.
 12. Goggs R, Humm K and Hughes D (2008). Fluid therapy in small animals 1. Principles and patient assessment, *In Practice* 30(1): 16-19.
 13. Hansen B and DeFrancesco T (2002). Relationship between hydration estimate and body weight change after fluid therapy in critically ill dogs and cats, *J Vet Emerg Crit Care (San Antonio)* 12(4): 235-243.
 14. Helio Autran de Moraes, Stephen P. Dibartola (2017). *Advances in fluid, electrolyte and acid- base disorders*, Editura Elsevier.
 15. Hopper K, Silverstein D and Bateman S (2012). Shock Syndromes. In DiBartola SP (ed), *Fluid, Electrolyte and Acid-Base Disorders in Small Animal Practice*, Elsevier Saunders, St Louis: 557-583.
 16. Katja N. Adamik, Ivayla D. Yozova and Nadine Regenscheit (2015). Controversies in the use of hydroxyethyl starch solutions in small animal emergency and critical care, *Journal of Veterinary Emergency and Critical Care*, 25, 1, (20-47).
 17. Kehlet H. (1982). The Endocrine-Metabolic Response to Postoperative Pain. *Acta Anaesthesiologica Scandinavica*, Volume 26, Issue s7, Pages: 173-175
 18. Ljungqvist O, Dardai E, Allison SP. (2010). Basics in clinical nutrition: perioperative nutrition. *E-SPEN, the European e-Journal of Clinical Nutrition and Metabolism.*;e93-6.
 19. Louisa Susanne Slingsby, Avril Waterman-Pearson (2000). Postoperative analgesia in the cat after ovariohysterectomy by use of carprofen, ketoprofen, meloxicam or tolfenamic acid. *Journal of Small Animal Practice* 41(10):447-50
 20. Macintire DK (2008). Pediatric fluid therapy, *Vet Clin North Am Small Anim Pract* 38(3): 621-627.
 21. Martindale RG, McClave SA, Taylor B, Lawson CM. (2013). Perioperative nutrition: what is the current landscape? *JPEN J Parenter Enteral Nutr*;37(5 Suppl):5S-20S.
 22. McNamara RM, Schoffstall JM and Fuerst RS (1993). Inefficacy of intraperitoneal fluid administration in a shock model, *Pediatr Emerg Care* 9(2): 77-80.
 23. Moraillon R., Fourrier P., Legeay Y., Lapeire C., (1997). *Dictionnaire Pratique de thérapeutique canine et feline*, 4-e ed., Masson, Paris.
 24. Ramsey I (2014). Potassium salts, In Ramsey I (ed), *BSAVA Small Animal Formulary*, BSAVA, Gloucester: 326-326.
 25. Rebecca Kirby and Elke Rudloff (2016). Fluid balance, Monitoring and Intervention for the Critically Ill Small Animal, (9-28).
 26. Seeler D. C., Thurmon J. C. (1985). Fluid and Electrolyte Disorders. In *Handbook of Small Animal Therapeutics*, Edited by L.E. Davis, New York, Churchill Livingstone,
 27. Silverstein DC, Kleiner J and Drobatz KJ (2012). Effectiveness of intravenous fluid resuscitation in the emergency room for treatment of hypotension in dogs: 35 cases (2000-2010), *J Vet Emerg Crit Care (San Antonio)* 22(6): 666-673.
 28. Weiser TG, Regenbogen SE, Thompson KD. (2008). An estimation of the global volume of surgery: a modelling strategy based on available data. *Lancet.*;372(9633):139-44.
 29. Windsor A, Braga M, Martindale R. (2004). Fit for surgery: an expert panel review on optimizing patients prior to surgery, with a particular focus on nutrition. *Surgeon.*;2(6):315-9.
 30. Zacher LA, Berg J, Shaw SP and Kudej RK (2010). Association between outcome and changes in plasma lactate concentration during presurgical treatment in dogs with gastric dilatation-volvulus: 64 cases (2002-2008), *J Am Vet Med Assoc* 236(8): 892-897