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Veterinary LiFE

Magazine for companion-animal practitioners

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INTERNAL DISEASES

Acute cardiogenic pulmonary edema

How to survive a night in the emergency room?

Gallbladder mucoceles in dogs

vet planet
ANIMALS' WELFARE IS OUR PASSION

EDITORIAL PAGE

Dear readers,

We are honored to present you yet another issue of the Veterinary Life magazine that is entitled: Internal Diseases. We hope that each and every one of you will find something interesting within the scope of this publication.

In the case of this issue, we have decided to address (at least briefly) young doctors being just after graduation. Each of us remembers how stressful the first duty and the very first "emergency" case can be. The proper way of dealing with them is explained by A. Calin, MD, A. Wawrzyniak, MD, as well as by R. O`Brien, MD, who have decided to share their knowledge and experience with others.

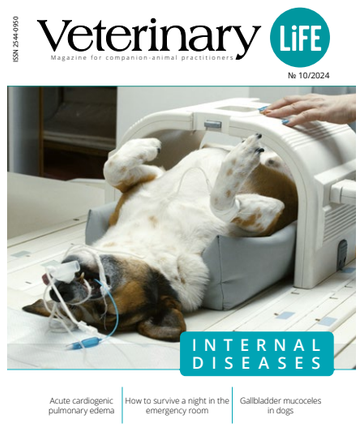
Is there a need to deal with a sudden or acute case? Such patients are almost always difficult. Acute cardiogenic pulmonary edema or acute tumor lysis syndrome - what to do in such cases? It is explained by professor A. Noszczyk-Nowak and K. Kapturska, MD. For a change, we have decided to include a few words pertaining to chronic diseases. P. Sławuta, PhD discusses a new diagnostic indicator, namely - PGF-23. It can be of extreme importance when it comes to chronic kidney disease.

We have something more for you - gallbladder mucocele. It may be that they are not diagnosed very often, but it is worth knowing how they develop, how to diagnose them, as well as how to deal with them. All of those matters are elaborated on by K. Glińska-Suchocka, PhD, who is accompanied by an expert team of gastroenterologists.

In short, there is a lot of fascinating material to read...

Feel free to do so right away!

Agnieszka Kurosad
Editor-in-chief



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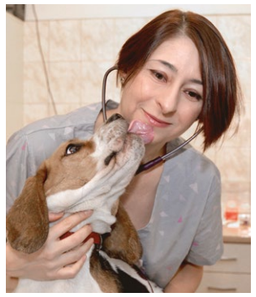

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Abstract: Acute cardiogenic pulmonary edema is a life-threatening condition that requires immediate response. Both diagnostic and therapeutic procedures should be carried out swiftly, but at the same time – in such a manner not to increase the level of animal's stress. The predominant goal of this publication is to elaborate on both diagnostic procedures and treatment of both dogs and cats suffering from acute cardiogenic pulmonary edema.

Keywords: pulmonary edema, heart, heart failure, dog, cat

Introduction

Pulmonary edema (PE) is identified when fluid accumulates in the alveoli or interstitial tissue, preventing a proper gas exchange. In the course of acute heart failure (AHF), blood stasis occurs in the pulmonary circulation. In simple terms, it can be stated that a failing heart does not pump blood effectively through the lungs and the blood accumulates in blood vessels of the lungs. Afterwards, it seeps into the lumen of the alveoli. Acute cardiogenic pulmonary edema (CPE) is often the first manifestation of left ventricular heart failure (LHF) and poses a direct threat to a given animal's life. Most common causes of LHF include Degenerative Mitral Valve Disease (DMVD) in dogs (3) and Hypertrophic Cardiomyopathy (HCM) (4) in cats. Pulmonary edema may be the first manifestation of heart disease in both species. It is vital to properly differentiate between CPE and Non-Cardiogenic Pulmonary Edema (NCPE), which is an abnormal accumulation of fluid in the lung interstitium or alveoli. However, in the second instance, it is not the result of cardiogenic complications or fluid overload. NCPE may be caused by changes in vascular permeability, increase in hydrostatic pressure in pulmonary vessels, or the combination of the two. Possible causes include inflammations in lungs or distant tissues (Acute Respiratory Distress Syndrome, ARDS), airway obstruction (post-obstructive pulmonary edema), neurological diseases such as head trauma or seizures (neurogenic pulmonary edema), paralysis caused by electric shock, re-expansion of a collapsed lung, and drowning (7). The distinction between CPE and NCPE is not always simple. Nevertheless, it is crucial, as treatment varies greatly in both cases and is highly dependent on the cause of PE.

Diagnosis of acute cardiogenic pulmonary edema

An important aspect when it comes to diagnosing CPE is interviewing the owner and determining whether the animal has previously been diagnosed with heart disease or whether it can be included in a group characterized by an increased risk of heart disease (occurrence of heart disease in parents/siblings) or whether it belongs to a breed predisposed to heart diseases of various kinds.

Clinical symptoms that are typical for LHF accompanied by pulmonary edema include: rapid breathing and mixed dyspnea, increased heart rate, possible coughing (often in dogs, very rarely in cats), exercise intolerance, as well as malaise (especially in cats). Dogs often assume a characteristic standing position with their chest legs spread wide, as well as with their head and neck raised, which makes breathing remarkably easier. Such dogs are also unable to lie down due to increased shortness of breath. Cats assume a crouched position on the sternum (sphinx position), breathe through an open mouth, and often hide in hard-to-reach places.

Since in the case of pulmonary edema, laying the animal on its side for an X-ray examination often increases shortness of breath and causes stress to the pet in question, chest ultrasound is becoming increasingly more common in clinical practice. Its major advantage is real-time imaging of the lungs. Additionally, the examination is done in a position that the animal accepts as rather comfortable. A factor pointing to pulmonary edema is the presence of the so-called line B from the pleural line. The number of such lines is directly proportional to the stage of pulmonary edema. What is more, lung ultrasound allows for monitoring the effectiveness of diuretic treatment. The condition for the diagnosis of cardiogenic pulmonary edema is the presence of severe heart disease, which is possible during a focused cardiac ultrasound (FCU) (2). CPE is typically suspected in patients with left atrial dilatation. The exception are dogs that have suffered the rupture of the chordae tendineae and have developed CPE without a significant dilatation of the left atrium. The classic index for assessing the size of the left atrium is the ratio of its size to the diameter of the aorta (LA/Ao) (3). The second parameter of the left atrium assessment is the measurement of the left atrium in the long axis within the scope of a two-dimensional image (LAD). Studies have shown that in dogs with endocardiosis, an indexed LAD value (LADn) being above the cut-off value of 20.3 is an indicator of a high risk of developing pulmonary edema. LAD measurement can also be taken advantage of in cats. Its normal value should not exceed 1.6 cm, while the value below 2.1 cm is strongly correlated with poor prognoses in cats.

If a veterinary cardiologist is available, a thorough echocardiographic examination can be performed to assess both the severity of heart disease and the risk of CPE (1,5,6), providing that the patient's condition allows to perform such a procedure. In dogs, best factors helping to identify the cause of dyspnea are the right parasternal short axis at the level of the papillary muscle and the 4-chamber long axis view, both done at the same sensitivity level (86.7%) and with specificity of 95.6% and 82.2%, respectively. They allow to easily identify canines suffering from CPE. Mitral inflow peak E-wave cutoff value >1.3 m/s, E-wave to isovolumetric diastolic time ratio E/IVRT >2.5, or LA/Ao >2.0 make it possible for professionals to distinguish pulmonary edema from asymptomatic heart disease with 100% specificity (1).

If it is possible to measure the NTproBNP concentration and obtain results within a few minutes, it should be taken into account that the concentration exceeding 2500 pmol/lu in dogs and 270 pmol/lu in cats points to CPE as the cause of shortness of breath.

Treatment of acute pulmonary edema

One of most important aspects when it comes to PE treatment is the implementation of oxygen therapy and diuretics to reduce pulmonary edema. Oxygen supplementation may be ensured by means of an oxygen cage, an incubator with controlled humidity and temperature, or a nasal oxygen cannula. In the case of a significant stress experienced by a given animal and shortness of breath identified, sedation is recommended. It may have the form of butorphanol at the dose of 0.2 to 0.25 mg/kg administered intramuscularly or intravenously, mixture of buprenorphine (0.0075-0.01 mg/kg) and acepromazine (0.01 mg/kg), as well as morphine, methadone, or hydrocodone. If the patient is sedated, caution should be exercised, as well as blood pressure and response to medications given should be monitored (possible respiratory depression) (3).

According to the ACVIM consensus guidelines for the diagnosis and treatment of myxomatous mitral valve disease in dogs (3), in the case of acute CPE, furosemide can be used at the dose of 2 mg/kg administered intravenously (or intramuscularly), followed by 2 mg/kg intravenously or intramuscularly every hour until the patient's respiratory symptoms significantly improve (namely - respiratory rate and respiratory effort decrease) or until the total dose of 8 mg/kg is achieved within 4 hours (Class I, LOE: expert opinion). While dealing with life-threatening pulmonary edema (accompanied by the expectoration of foam) connected with severe dyspnea and poor initial response to a furosemide bolus (respiratory rate failing to decrease within 2 hours), furosemide may also be administered as a constant rate infusion (CRI) at the dose of 0.66-1 mg/kg/hour, 1 hour after initial bolus (Class IIa, LOE: Poor).

Furthermore, pimobendan can be used at the dose of 0.25-0.3 mg/kg orally or intravenously (3,5). Dobutamine (2.5-10 µg/kg/min as CRI, starting at 2.5 µg/kg/min and gradually increasing the dose) may be opted for as a supplement of the abovementioned treatments to improve left ventricular function in patients not responding appropriately to diuretics, pimobendan, sedation, oxygen, and comforting medications. Continuous ECG monitoring is recommended when using dobutamine. Mechanical procedures (such as abdominal paracentesis or thoracentesis) are recommended to relieve effusions deemed sufficient to impair ventilation or cause respiratory failure (3).

A similar CPE treatment protocol can be opted for in the case of cats. Nevertheless, it has to be pointed out that due to the greater likelihood of renal failure, it is recommended not to exceed the dose of furosemide. It should be kept at the level of 6 mg/kg/24h. In felines, diuretic treatment is recommended when it comes to acute heart failure, regardless of the presence of azotemia. In cats with signs of low cardiac output (including hypotension, hypothermia, and bradycardia), treatment based on the use of orally administered pimobendan may be considered, provided that there is no left ventricular outflow obstruction (DLVOTO). The dose of pimobendan used in cats is 0.1-0.25 mg/kg orally every 12 hours (4). Cats with CPE are often additionally diagnosed with intrathoracic fluid, necessitating emergency thoracocentesis. Once the patient's condition is stabilized, it is recommended for such cat to be discharged home as soon as possible. Clinical reassessment of the cat is advised after 3-7 days (assessment of acuteness of LHF symptoms, renal function, as well as serum electrolyte levels).

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Acute Tumor Lysis Syndrome (ATLS) – emergencies in small animal oncology

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Abstract: Tumor lysis syndrome (TLS) is a life-threatening emergency characterized by hyperuricemia, hyperphosphatemia, hyperkalemia, as well as hypocalcemia. Said changes may occur as a result of massive cytolysis of cancer cells occurring either as the outcome of the administration of cytostatic medications, use of ionizing radiation, or appearing spontaneously. Most problematic consequences of metabolic disorders include: cardiac arrhythmias, seizures, renal failure, and sudden cardiac death. From the clinical point of view, the most important matter is to prevent the occurrence of TLS through appropriate risk assessment, monitoring, qualification of patients for anticancer therapy, as well as the use of supportive treatment during oncological therapy. When acute TLS occurs, fluid and symptomatic therapy are taken advantage of to eliminate water and electrolyte disturbances. Targeted therapy may also be opted for, as it allows for the safe elimination of purine and pyrimidine breakdown products from the circulation.

Keywords: tumor lysis syndrome, oncology

Introduction

Tumor lysis syndrome (TLS) is an emergency condition requiring aggressive therapy based on the use of proper medications. Oncology ward patients may experience negative outcomes of effective anticancer therapy if a significant number of cancer cells suddenly disintegrate after chemotherapy and/or radiotherapy (1,2). Timeframe from the start of the treatment to the onset of TLS symptoms ranges from several hours to several days. Most often, the symptoms occur between the second and third day after the induction of therapy. Initial changes in blood tests may be visible after 6 hours - they precede clinical symptoms by up to 24 hours. In dogs, said symptoms are identified from 18 hours to even 8 days after anticancer treatment (2). Moreover, half-body radiotherapy in dogs with lymphoma significantly contributes to the development of acute tumor lysis syndrome (3). The aforementioned syndrome is associated with a high mortality rate and is characterized by a constant, characteristic tetrad of changes in serum biochemical tests: increased uric acid concentration, hyperkalemia, hyperphosphatemia, and hypocalcemia. There are also human medicine-specific reports informing about the occurrence of a spontaneous form of TLS, especially in the case of malignant blood-derived tumors: Burkitt's lymphoma, multiple myeloma, acute myeloid leukemia, as well as anaplastic T- and B-cell lymphomas (4). Even though it is noted that TLS in dogs and cats is rare, just as it is in humans, it affects patients with advanced stages of hematological and/or lymphatic cancers, such as lymphoma (1). In very rare cases, TLS may be observed in humans with solid tumors. Nevertheless, between 1977 and 2011, only 74 such cases were described (5).

The currently accepted and practically applied definition of TLS, including the distinction between its laboratory and clinical forms, is based on criteria proposed in 2004 by Cairo and Bishop (6). According to said criteria, the laboratory form (*subclinical* TLS) is defined as a 25% deviation of at least two of the parameters listed below (in relation to the baseline value determined before the start of therapy) or an increase of a given parameter above the normal value. Examined parameters are: uric acid, potassium, phosphorus, as well as a decrease in serum calcium concentration, which occurs within 4 days of starting anticancer therapy. The criteria also take into account spontaneous cases that may occur up to 3 days before the start of anticancer therapy. The most common complication connected with TLS is metabolic acidosis.

Clinical form of TLS is defined basing on the above-mentioned changes in laboratory parameters, co-occurring with creatinine increase of at least 1-5 times above normal value. It has to be pointed out that the increase in creatinine concentration in blood serum cannot be secondary to other illnesses, such as kidney disease. Both forms of TLS may have clinical implications and involve the induction of an inflammatory response due to the release of huge amounts of cytokines ("cytokine storm") and the deposition of calcium salts in the interstitium, especially in the kidneys. Cytokine release syndrome (CRS) is a severe toxemia associated with the presence of T cell antigen receptor chimeras (such as CAR T cells), which may lead to reactions with proteins outside tumor cells (5,7).

In clinical terms, patients suffering from the discussed condition may experience nausea, vomiting, diarrhea, appetite loss, apathy, hematuria, symptoms of heart failure (including arrhythmias), muscle spasms, epileptic seizures, fainting, and even sudden death (5,8). It has been proven that the occurrence of clinical symptoms of TLS is associated with worse prognoses and an increased risk of death in patients, especially while compared to those with identified changes only in blood biochemical parameters. Moreover, studies based on a mouse model have shown that cellular detritus derived from cytolysis can form emboli in small capillaries, leading to pathophysiological issues similar to those specific for standard small vessel thromboembolism (9).

In practice, a particularly challenging issue may be the diagnosis of TLS in a patient who has not yet been diagnosed with cancer. The differential diagnosis should include sepsis, renal failure due to the obstruction of the urinary tract (contrast-induced nephropathy or rhabdomyolysis), and toxemia (5). To differentiate these diseases, it may be necessary to perform a complete urinalysis with sediment assessment, as well as a biochemical panel of blood serum allowing for the determination of uric acid and lactate dehydrogenase (LDH) concentration. As a standard, a blood count and an ultrasound examination of the excretory system should be carried out as well.

Pathogenesis

The pathogenesis of tumor lysis syndrome consists of several main disorders, each of which may pose a serious threat to the patient's life. In order to ensure the effective treatment of the syndromes discussed, it is vital to understand mechanisms leading to the changes observed. After cytolysis, cancer cells release remarkable amounts of purines and proteins, such as potassium, phosphorus, and lactates. Nucleic acids and proteins are immediately degraded into uric acid in the liver. A sudden increase in potassium levels, often aggravated by renal failure, may lead to acute, life-threatening cardiac arrhythmias (bradycardia).

Nephropathy caused by the crystallization of uric acid and xanthines

Acute renal failure with oliguria results from the crystallization of uric acid and secondary damage to renal tubules caused by forming crystals. Their deposition in the lumen of renal tubules may lead to their obstruction, which ultimately causes disturbances in the outflow of primary urine. Said crystals are also toxic to the tubular epithelium - they induce local inflammatory processes and stimulate the immune system to respond to oxidative damage (10,11). Dissolved uric acid may induce hemodynamic changes, leading to a decrease in perfusion as a result of reflex vasoconstriction caused by disturbances in autoregulatory processes. Among them, the most vital one is the disturbance of the balance between vasodilation and vasoconstriction, known as the so-called crystal-independent damage path (10,11). Moreover, uric acid adversely affects the proliferative and regenerative abilities of proximal tubule cells (11,12). Epithelial cells are hypoxic and damaged as a result of processes related to developing inflammation or reperfusion damage.

An additional component when it comes to TLS-related nephropathy is calcium phosphate formed in the interstitial tissue and small vessels, leading to progressive renal calcification and mechanical damage to renal tubules (11). After cell breakdown, adenosine triphosphate and nucleic acids are released. Due to the fact that cancer cells contain nearly four times more phosphorus than normal ones, their lysis leads to severe hyperphosphatemia. The formation of calcium phosphate also causes a decrease in the concentration of calcium in the blood serum. Hypocalcemia may manifest itself in tetanic contractions, cardiac arrhythmias, or convulsions (13,14).

There is a simple formula making it possible to estimate the risk of renal calcification basing on the concentration of calcium and phosphorus in the patient's blood serum. If the product of the concentration of both elements exceeds 60 mg^2/dL^2, the risk is relatively high and the introduction of hypouremic preparations (allopurinol, razburicase) is then advised (15).

In dogs, aside from English Bulldogs and Dalmatians, uric acid is metabolized in the liver to allantoin by uricase, so most canines will not develop hyperuricemia during acute TLS (16,17). Nevertheless, uric acid may have a detrimental effect on many internal organs, especially - on the excretory system (18). It may lead to vasoconstriction, disturbances in autoregulation processes and mechanical damage to tissues, mainly due to contact with its crystallized form (10,19). Interestingly enough, mild hyperuricemia is sometimes reported in dogs with lymphoma even before the initiation of chemotherapy. Given the significant increase in uric acid concentration after anticancer therapy, the oxidation capacity of hepatic uricase may be exceeded (3). Due to differences in the metabolism of purines and pyrimidines in comparison to human patients, sepsis is a much more common fatal complication of chemotherapy in dogs than TLS (2).

Risk assessment

Factors increasing the risk of tumor lysis syndrome (TLS) include: the presence of large solid lesions (exceeding 10 cm in diameter), severe leukocytosis (> 500,000/μL), increase in LDH exceeding twice the normal value, as well as multi-organ infiltration with/or extensive bone marrow infiltration during diagnosis (specific types of cancer and the associated risk of developing TLS are described in Table 3 (20). It has to be pointed out that the increase in the likelihood of TLS development is also influenced by factors unrelated to cancer, such as advanced age, chronic kidney disease, oliguria, anuria, increased uric acid concentration, dehydration, changes in urine pH, and the simultaneous use of nephrotoxic medications. Excessively low urine pH contributes to the development of uric acid nephropathy, while excessively high pH may lead to the precipitation of calcium phosphate (4). Decreased glomerular filtration may significantly limit the excretion of potassium and phosphorus by the kidneys. The utilized anesthesia (necessary during radiotherapy and similar treatments) may lead to hypoxia in the kidney area by reducing blood pressure and consequently causing perfusion.

In humans, there are three risk groups when it comes to TLS:

1) low risk patients (< 1% chance of developing TLS)
2) moderate risk patients (1-5%)
3) high risk patients (> 5%)[5]

With the exception of solid cancers that are highly sensitive to chemotherapy, such as neuroblastoma, germ cell tumor and small cell lung cancer, which are considered risk category 2, all solid tumors and indolent forms of malignant hematogenous growths are associated with a low risk of developing TLS (21). In turn, acute leukemias and

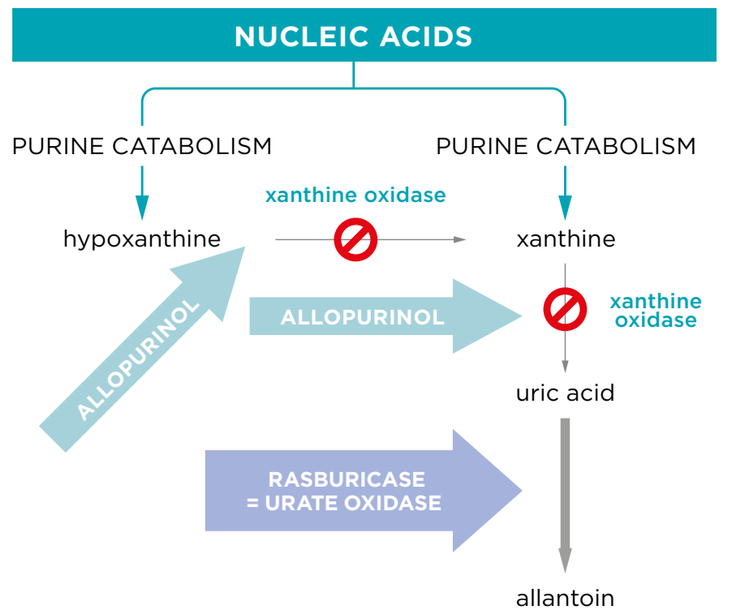

Fig. 1. Purine catabolism and the mechanism of hypouremic medication activeness. Physiologically, the breakdown of nucleic acids ends with the production of uric acid from xanthine. By utilizing rasburicase, it is possible to transform it into highly soluble allantoin, which is easily excreted in urine.

Burkitt lymphomas are characterized by the highest risk of developing TLS (Table 3).

A more frequent occurrence of TLS has also been observed after the use of molecular, targeted therapies, such as monoclonal antibodies, as well as kinase inhibitors, including tyrosine kinases, especially in comparison to standard chemotherapy.

Moreover, a liver that has previously been damaged as a result of pharmacotherapy and/or tumor infiltration (with an increase in ALT, AST, ALKP and TBIL concentrations in blood serum) increases the risk of fatal outcome in cases of acute TLS. The rapid death of a significant number of cancer cells may exceed the liver's ability to metabolize their breakdown products, especially when renal clearance is impaired.

Due to the prevalence of TLS in small animals, risk factors for its development have not been clearly identified. Nevertheless, according to case reports published so far, the following appear to be significant:

- severe cancer (chemo- and radiosensitive), especially stage IV and V lymphoma;
- high ALKP concentration before starting a given therapy;
- strong reaction of the lesion to the therapy used (large cytoreduction in a short time);
- co-occurring chronic kidney disease.[22]

Actions to be undertaken. Preventive measures

By far the most important and effective aspect of treatment in the case of tumor lysis syndrome is its prevention, which consists primarily in maintaining water and electrolyte balance and/or opting for dialysis, depending on the stage of TLS development (Table 2). The purpose of fluid therapy is to maintain intravascular volume, as well as create conditions conducive to the elimination of uric acid and phosphates from the body. In the case of symptoms of overhydration or when the appropriate level of diuresis is not achieved despite the administration of adequate amounts of fluids, it may be recommended to use loop diuretics. Diuretic thiazides are contraindicated mainly due to the fact that they increase the concentration of uric acid in the blood serum and may interact with allopurinol.

Oncology ward patients are recommended to drink 1.5-2 liters of water daily 2 days before starting chemotherapy. Intravenous fluid therapy is necessary in patients at increased risk at least 24 hours before the administration of cytostatic drugs and when they are unable to take an adequate amount of water orally. Patients with severe co-occurring diseases, such as diabetes or circulatory failure, should be particularly monitored for the possibility of developing pulmonary edema (4, 23). It is recommended to maintain a constant level of hydration for the next 48 hours after administering the medications (23).

Allopurinol, a xanthine oxidase inhibitor, prevents the production of uric acid from xanthine and hypoxanthine (they are released due to the degradation of nucleic acids), which in turn reduces the risk of damage to renal tubules through precipitated uric acid crystals. The dose opted for in humans is 600-800 mg orally, divided into two or three doses/day, depending on the results of blood tests, type of cancer, and the condition of the excretory system. If necessary, it is also possible to administer the medication intravenously. Supportive therapy is started 1-3 days before chemotherapy, along with the intensive hydration of the patient. It continues for 10-14 days, until the symptoms disappear (11). It is recommended in patients characterized by low to moderate risk of developing TLS. Due to the elimination of allopurinol in the urine, patients with chronic kidney disease may require dose reduction. Patients taking azathioprine, cyclophosphamide, or 6-mercaptopurine may also require dose reduction or discontinuation of allopurinol, mainly due to the risk of intensified cytostatic effects. Side effects of allopurinol include mild dermatological symptoms, hematological, or digestive system disorders, such as: rash, diarrhea, leukopenia, and thrombocytopenia. Less than 3% of patients develop serious complications, including cutaneous hypersensitivity reactions, acute interstitial nephritis, and xanthine nephropathy.

Allopurinol should be used with caution, especially while combining it with other active substances that may lead to high concentrations of xanthines in urine. The excessive alkalinization of urine, although reducing the risk of uric acid crystal formation, causes the formation of xanthine stones and the precipitation of calcium phosphate, which is characterized by lower solubility in high pH urine (11,24).

Even though it theoretically has a slightly broader spectrum of action and higher potential as an inhibitor due to the ability to inhibit both the oxidized and reduced forms of xanthine oxidase, febuxostat is currently used as a part of replacement therapy in the case of allopurinol intolerance and in patients suffering from chronic kidney disease (11,25). Only 1-6% of the medication in question is excreted in an unchanged form by the kidneys, so patients with mild to moderate excretory dysfunction do not require adjustment of the therapeutic dose. The medication is introduced 24 hours before the administration of cytostatic agents and discontinued when the risk of developing TLS decreases to a minimum. Side effects of the aforementioned medication include Stevens-Johnson syndrome, anaphylaxis, and sudden cardiac death (11,26). Due to said fact, the FDA has issued a warning limiting the use of febuxostat in patients with hyperuricemia (11).

Effects of xanthine oxidase inhibitors are visible within a few days, whereas the use of razburicase allows to significantly reduce the concentration of uric acid in the blood serum within just a few hours. Razburicase is a recombinant urate oxidase produced by genetically modified *Saccharomyces cerevisiae*, capable of converting uric acid to allantoin. Allantoin, being 5 to 10 times more soluble, allows for the safe elimination of metabolites from the body. In humans, razburicase is recommended for patients characterized by the high risk of developing TLS, whose uric acid exceeds 8 mg/dl of blood serum. No dose adjustment is required in patients with renal disease. It is worth mentioning that razburicase catalyzes the elimination of uric acid in blood and serum at room temperature, so the blood must be collected in chilled test tubes and immediately sent to the laboratory in ice. The analysis of the sample must be done within 4 hours from the moment of its collection. The medication is introduced 4-24 hours before administering cytostatic medications. The standard dose is 0.2 mg/kg daily, as an intravenous drip infusion, administered over 30 minutes, for the maximum of 5 days (27). In patients belonging to the low-medium risk group, lower doses prove to be effective (0.15-0.2 mg/kg), which allows for a significant reduction in therapy costs (21). Furthermore, even individual doses of 3-4.5 mg in patients whose uric acid concentration is <12 mg/dL may be sufficient, providing that biochemical and clinical parameters are monitored. Side effects of razburicase include hypersensitivity, anaphylaxis, severe hemolytic anemia, as well as methemoglobinemia in patients with glucose-6-phosphate dehydrogenase deficiency (11). As the aforementioned mutation is more common in African, Asian, and Mediterranean populations, the administration of the medication to patients belonging to such groups requires prior genetic testing.

Repeated administration of the discussed medication is not recommended due to the increased risk of anaphylaxis upon repeated contact with the substance (28). The medication is intended for patients at high risk of TLS, whose initial uric acid concentration is very high or who already show clinical symptoms of the syndrome. It is particularly useful in patients with kidney disease or heart failure who cannot undergo aggressive fluid therapy (11). In cases of severe leukemia, human medicine initially attempts to slowly reduce WBC by using hydroxyurea, before opting for highly active substances and/or gradually increasing doses of said substances, including small-molecule inhibitors (11, 29, 30).

Hemodialysis is vital when the concentration of phosphorus may cause severe kidney damage. It is the most effective treatment currently. Unfortunately, it is still not always easily available to veterinary patients (5,6).

Monitoring

In patients undergoing chemotherapy, especially due to malignant tumors of the hematopoietic or lymphatic system, it is required to monitor the concentration of potassium, uric acid, calcium, creatinine, as well as lactate dehydrogenase activity. It is also vital to assess diuresis and water and electrolyte balance. The frequency of follow-up examinations depends on the risk of TLS development - it begins before the administration of cytostatic medications and continues until the risk of TLS development ceases to exist, which depends on the type of therapy used (11,31). Safe monitoring involves assessing the patient undergoing therapy at specific intervals, depending on the TLS risk classification. High-risk patients are to be monitored every 4-6 hours, medium-risk patients: every 8-12 hours, and patients with a low risk of developing TLS - after 24 hours (5, 31).

It should be remembered that in cases where no significant changes in the ionogram are observed, the patient does not have fluid and electrolyte disorders and/or there is no significant reduction in the size of the tumor, it is advisable to consider another cause of the observed symptoms not being TLS (18).

Treatment

The choice of crystalloids depends on the patient's fluid and electrolyte balance status, starting with isotonic saline (2-3 L/m^2/day, IV) in the hypovolemic patient with hyponatremia. Patients with preserved function of the excretory system do not require diuretics. After excluding hypovolemia and obstruction of the excretory system, loop diuretics can be introduced (15). Fluid therapy is continued until serum LDH normalizes or until remission occurs.

Hyperkalemia

It is a life-threatening condition that may be exacerbated by the presence of metabolic acidosis. Patients with serum potassium levels >6.5 mmol/L require continuous electrocardiographic monitoring and urgent nephrological consultation. The initiation of hemodialysis/hemofiltration should be considered (11). Complications connected with hyperkalemia include conduction disturbances and arrhythmias, the prolongation of the PR segment, QRS complexe widening, and weakening of the contractile function of the heart muscle (5, 31). Nevertheless, electrocardiographic changes in dogs with hyperkalemia are not always visible due to co-occurring disorders in the form of changes in the concentration of sodium, chlorine, magnesium, and calcium, as well as changes in the pH of venous blood, which also affect ECG results (16,32,33). Before hemodialysis begins, 10% dextrose and insulin are introduced to move potassium from the intravascular compartment into the cells. Alternatively, it is possible to use inhaled beta-agonists, for example – in the form of albuterol. Of all the dangers associated with tumor cell lysis and the pathophysiology of TLS, hyperkalemia is the most troublesome one for both cardiac and skeletal muscles.

Serum potassium levels should be monitored every 4-6 hours. It is advisable to avoid exogenous sources of potassium (drug/dietary ingredients). In order to prevent life-threatening arrhythmias, intravenous administration of calcium salts may be considered.

Hyperphosphatemia

Malignant tumor cells may contain up to four times more phosphate than healthy ones. Their content increases significantly in hyperproliferative states, such as blast crisis (5, 11). In human lymphoma cells, the concentration of phosphorus may exceed physiological values in normal lymphocytes 6 times (22). Hyperphosphatemia requires immediate treatment by reducing phosphate content in the diet, limiting fluids containing high concentrations of phosphates, avoiding bicarbonates, and opting for non-calcium phosphorus-binding substances. In patients with severe, acute hyperphosphatemia, treatment in an intensive care unit, including renal replacement therapy, is necessary to prevent the widespread deposition of calcium salts in peripheral tissues.

Hypocalcemia

Only patients having clinical symptoms of hypocalcemia should be supplemented with low doses of calcium until symptoms disappear (11). Calcium levels are usually spontaneously compensated after the correction of serum phosphate levels. Unfortunately, phosphates released from cancer cells precipitate in renal tubules, leading to a decrease in calcium concentration in blood serum (5). Both hyperkalemia and hypocalcemia may lead to arrhythmias or even cardiac arrest in extreme cases (5,9).

Monitoring patients with hyperphosphatemia/hypocalcemia includes: determining the concentration of specific compounds in the serum every 4-6 hours, eliminating food products with high phosphorus content from the diet, introducing phosphorus-binding preparations and preventing nephrocalcinosis. Before treating hypocalcemia, the concentration of phosphorus in blood serum should be reduced, unless the occurring cardiac arrhythmias require immediate pharmacological intervention (11).

Renal replacement therapy (peritoneal dialysis, kidney transplant)

Peritoneal dialysis is not recommended in the discussed case. The earlier therapy is started, the greater the chances of achieving therapeutic success. The utilization of continuous renal replacement therapy in a dog with acute TLS and complications such as acute kidney injury (AKI) and intravascular coagulation syndrome – DIC (17) has been described. DIC syndrome may be yet another fatal TLS-specific complication requiring immediate intervention (34). Examinations carried out in the field of human oncology indicate that CRRT can effectively help eliminate pro-inflammatory cytokines that determine the likelihood of shock and sepsis occurrence (17,35).

Allopurinol serves as the medication of choice in patients at average risk of developing TLS. The dose is usually 100 mg/m^2 every 8 hours (max 800 mg/day) and must be reduced in the case of simultaneous use with azathioprine or mercaptopurine, as well as in patients with acute renal failure (11). The medication in question can be administered orally or intravenously. In dogs, it is administered orally at the dose of 10 mg/kg every 8 hours or 15 mg/kg every 12 hours for up to 4 weeks. It is also utilized in the treatment of leishmaniasis. In cats, it can be administered in the following manner: 10-20 mg/kg orally, every 12 to 24 hours. It should be used with caution in patients with chronic kidney disease.

Razburicase is recommended for patients at a high risk of developing TLS or with renal failure. It allows for the conversion of uric acid into highly soluble allantoin, which forms physiologically in dogs (except for Dalmatians and English Bulldogs). It is the medication of choice in patients diagnosed with TLS. The dose recommended is as follows: 0.2 mg/kg once a day for 5-7 days. As described above, it must not be used in patients with G6PD deficiency. Side effects include methemoglobinemia, hemolysis, and anaphylactic reactions (11, 36).

Febuxostat is a new medication to be administered orally that reduces the concentration of uric acid in blood serum. It selectively inhibits xanthine oxidase and can be used in patients allergic to allopurinol (11, 19). Significant benefits associated with the use of febuxostat include: no need to modify the dose in patients with renal failure, less severe interactions with other medications, as well as high selectivity and specificity of the medication allowing to limit the impact on other enzymes involved in the metabolism of purines and pyrimidines (11).

An important factor when it comes to the use of fluid therapy is the limitation of the amount of fluids administered depending on the condition of the patient's circulatory system and kidney functioning. In each case, the dose of fluids should be selected individually. The following calculation

Table 1. Updated TLS definition based on Cairo and Bishop (2004), with subsequent modifications. ZLG (tumor lysis syndrome in the English nomenclature - TLS), upper limit of normal (ULN), lower limit of normal (LLN) (6,38,39)

		Uric acid	Potassium	Phosphorus	Calcium
Laboratory tumor lysis syndrome (2 or more criteria listed) identified within 24 hours of observation		Above ULN or +25% increase over base value	Above ULN or +25% increase over base value	Above ULN or +25% increase over base value	Below LLN or 25% decrease compared to the base value
Human		> 8 mg/dL (475 umol/L)	> 6.0 mmol/L	> 4.5 mg/dL (1.5 mmol/L)	calcium: < 7 mg/dL (1.75 mmol/L) or ionized calcium < 4.5 mg/dL (1.12 mmol/L)
Dog		< 0.5 mmol/L (0.2 – 0.9 mg/dL)	4.1 – 5.4 mmol/L (16.0 – 21.0 mg/dL)	0.9-2.0 mmol/L (2.5-6.3 mg/dL)	2.1 – 3.0 mmol/L (8.4 – 11.5 mg/dL)
Cat		< 0.11 mmol/L (0 – 1.9 mg/dL)	4.1 – 5.6 mmol/L (16.0 – 22.0 mg/dL)	1-2.2 mmol/L (3.0 – 6.8 mg/dL)	2.0 – 2.78 mmol/L (8.0 – 11.1 mg/dL)
Clinical ZLG (laboratory + at least one of the listed criteria)		Creatinine increased min. 1.5x above ULN	Cardiac arrhythmias or sudden cardiac death secondary to hyperkalemia	n.d	Convulsions, paresthesia, broncho- or laryngospasm, hypotension, or circulatory failure secondary to hypocalcemia
Human		OR >0.3 g/dL (26.5 µmol/L) OR diuresis < 0.5 mL/kg/h for 6 h			
			LDH	**ALKP**	**CREA**
Other lab parameters. Important when it comes to TLS diagnosing	**Dog**		105 – 1683 U/L	20-155 U/L	79.6-150.3 µM/L (0.9 – 1.7 mg/dL)
	Cat		161 – 1061 U/L	23-107 U/L	88.4 – 159.1 µM/L (1.0 – 1.8 mg/dL)

should be made: % dehydration x body weight [kg] = fluid deficit in liters (18.37). Patients with advanced cancer may be sensitive to overhydration, defined as fluid accumulation of more than 10% of body weight (18.37). The development of fluid overload suggests end-stage renal failure - in such a case, the only solution is to opt for renal replacement therapy. An attempt can be made to convert from oliguria/anuria to polyuria by opting for vasoactive medications (including mannitol, hydrochlorothiazide, furosemide, and dopamine). Nevertheless, such a procedure is connected with a significant risk of failure and the prognosis of a given patient then becomes unfavorable (18).

Prognosis

In the case of TLS, mortality in humans is high and varies widely depending on the study cited - from 5 to even 79% (14). The occurrence of the subclinical form TLS does not increase the risk of death among oncology ward patients. Nevertheless, patients suffering from the clinical form of TLS are characterized by increased mortality, as clearly indicated by pieces of research conducted on humans. Acute renal failure is a strong, independent risk factor for the development of chronic renal failure and increased patient mortality in the long term. Moreover, acute renal failure resulting from tumor lysis syndrome may reduce the chance of long-term remission of cancer, inter alia by means of limiting the use of certain cytostatic medications, which, although effective, are contraindicated in such a scenario.

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Table 2. Scale for assessing the severity of TLS (based on Cairo & Bishop, 2004)(5,6,8)

	Stage I	Stage II	Stage III	Stage IV	Stage V
Creatinine	Increase of min. 1.5 x above the upper limit of norms (ULN) For a dog: For a cat:	1.5-3x above ULN	3-6x above ULN	> 6x ULN	Death
Rhythm disturbances	Transient on its own	Not requiring immediate intervention	Symptomatic, not pharmacologically controlled, requiring implantation of heart rhythm modifying devices	Potentially fatal	Death
Convulsions	NONE	One episode of generalized seizures or infrequent focal seizures not significantly affecting the quality of life; well controlled with pharmacotherapy	Consciousness disturbances during seizures, inability to pharmacologically control convulsions	Prolonged and recurrent seizures (*status epilepticus*, drug-resistant epilepsy)	Death

Table 3. Factors associated with the risk of TLS and a brief description of the procedure. *even though TLS is rare in these cases, it is characterized by a high mortality rate (approx. 60%) (14)

Risk of developing TLS	Low	Moderate	High
Depending on cancer type	Chronic leukemias: myeloid, lymphocytic solid tumors*	Chronic lymphocytic leukemia (CLL) – only if WBC exceeds 50*109/L or molecular/targeted therapy has been introduced	Acute leukemia, lymphoma Burkitt
Particular emphasis on lymphomas	Low severity – from small lymphocytes, marginal zone, mantle, or cutaneous T-cell lymphoma	Multifocal B lymphoma, peripheral T lymphoma	
Preventive strategy	Monitoring	Fluid therapy *orally*, IV if the patient requires it, allopurinol*; rasburicase** if uric acid levels are high	IV fluid therapy + *orally*; allopurinol + rasburicase
Frequency of follow-up tests	every 24 hours	every 8-12 hours	every 4-6 hours

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Table 4. Described cases of TLS in veterinary medicine. Until 2007, 6 cases of TLS were described in dogs and one in a cat. [22] Overview of all cases discussed in veterinary medicine by 2024

Patient data	Clinical symptoms	Changes in laboratory parameters	Imaging-based diagnosis	Procedure	Symptoms of TLS	Ref.
Age: 7.5 Body weight: 27.5 kg Neutered male boxer	Exercise insufficiency, urinary incontinence	Neutrophilia, lymphopenia, thrombocytosis, hypercholesterolemia, increase in ALKP, prolongation of PT, urine specific gravity of 1.014, proteinuria (UPC 4.4), hemoglobinuria	Chest – no changes; Abdominal ultrasound - large hyperplastic lesion, approx. 10 cm in diameter, infiltrating the hindabdomen	Surgical resection of HSA	Hyperkalemia (no changes in ECG)	Chohan, 2009[16]
Age: 5 Body weight: 27 kg Neutered male American Pit Bull Terrier	Swelling around the jaw, anorexia, hematochezia, generalized lymphadenopathy, tarry stools	Leukocytosis, anemia, thrombocytopenia, In BAC – multifocal lymphoma	n.d	Chemotherapy in the L-CHOP regimen	Azotemia, severe hyperphosphatemia 24 mg/dL, severe hyperkalemia 8.7 mEq /L, hypocalcemia 6.3 mg/dL →acute renal failure with DIC (prolongation of PT and PTT); urine specific gravity of 1.014; proteinuria (300 mg/dL)	Martin, 2010[17]
Age: 5 Body weight: n.a. Neutered female German Shepherd	Generalized lymphadenopathy, Exercise insufficiency, selective appetite	Leukocytosis with neutrophilia, Multifocal B-cell lymphoma	Hepato- and splenomegaly, enlarged sublumbar and mesenteric parts of the lymphatic system	Chemotherapy in the L-CHOP regimen	Jaundice, hyperuricemia, hyperphosphatemia, azotemia, jaundice, hyperbilirubinemia, DIC with fatal outcome	Mylonakis, 2007[22]
Age: 11 Body weight: 11 kg Castrated mixed breed male	History of diabetes, diagnosed and treated for 2 years	Low calcium concentration sensitized the cells of the conduction system to mild hyperkalemia, leading to clinical manifestations.	Gastrointestinal endoscopy: 12 cm hyperplastic mass with ulceration in the colon (as a result of biopsy - colon adenocarcinoma)	Surgical resection	Hyperglycemia, max up to 30.7 mmol/L; Hyperkalemia 19.7 mmol/L increasing to 28 mmol/L; bradycardia 29 bpm (atrial arrest, sinus arrest)	Hampton, 2020[40]
Age: 6 Body weight: 13 kg Neutered female Scottish terrier	Generalized lymphadenopathy	Mild thrombocytopenia, increase in ALKP and ALT	Hepato - and splenomegaly	Radiotherapy	Severe metabolic acidosis; diarrhea, fever, tachycardia, shortness of breath, increased blood pressure, weak pulse; hyperphosphatemia, hyperkalemia, hypocalcemia, hypoalbuminemia, prolongation of PT and aPTT; increase in fibrinogen and D-dimer degradation products [DIC] decrease in bicarbonate concentration in blood serum; renal parameters within reference standards	Vickery, 2007[2]
Age: 13 Body weight: 17 kg Neutered mixed breed female	Cough, anorexia, shortness of breath	Neutrophilia, thrombocytopenia, increase in ALT, ALKP	12x12 cm mass in the cranial mediastinum with secondary waterstinum, BAC - thymoma	Radiotherapy	Lethargy, anorexia, dementia; AKI; hyperphosphoatemia, hypocalcemia, hypernatremia, increase in AST, LDH and CK, metabolic acidosis/postmortem: extensive renal tubular necrosis and hemosiderin deposits	Wada, 2021[41]
Age: 2 Body weight: 2 kg European shorthair female cat		Leukocytosis, lymphoblasts in peripheral blood, Azotemia, Hyperphosphatemia, Hyponatremia, Hyperchloremia	Water in chest, a mass in the cranial mediastinum identified	L-asparaginase intraperitoneally, prednisone PO + radiotherapy	Hyperkalemia, hyperphosphatemia, hypocalcemia, Hyperuricemia, Hyperphosphatemia, Azotemia and metabolic acidosis -» respirations several dozen hours after the initiation of therapy; hypothermia, bradycardia (60 bpm) - due to the lack of electrical activity of the atria; Hospitalization – 7 days	Calia, 1996[1]
Age: 10 Neutered Abyssinian female cat	Sudden death	Multifocal B-cell lymphoma	n.d	Asparaginase + vincristine	Fatal case	Tamura, 2013[42]

package insert.

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Gallbladder mucoceles in dogs

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Abstract: Gallbladder mucocele is a frequently diagnosed biliary tract disease in dogs. If left untreated, mucocele can lead to the obstruction of biliary ducts and biliary peritonitis. The etiopathogenesis of the disease in question is multifactorial in character. Most common causes of mucocele are: racial and genetic predispositions, endocrinopathy, as well as improper nutrition. Clinical symptoms are non-specific. The diagnosis of the disease includes basic laboratory blood tests and the ultrasound examination of the abdominal cavity. Cholecystectomy is the treatment of choice. In the initial phase of the disease, pharmacological treatment can be opted for.

Keywords: mucoceles, gallbladder mucous cysts, dog gallbladder, liver

Gallbladder mucoceles (GBM) are an increasingly frequently diagnosed disease of the canine bile ducts. Gallbladder mucinous cysts occur as a result of excessive mucus production by the mucous glands of gallbladder epithelium (1, 2, 3, 4, 5, 6, 7). During the development of the disease in question, thickened bile characterized by a green-black hue and semi-solid consistency accumulates in the lumen of the gallbladder.

The etiopathogenesis of the disease is multifactorial in character. One of formulated hypotheses assumes that mucoceles are formed as a result of hyperplasia of the mucus-secreting gland and the excessive accumulation of mucin in the lumen of the follicle. In animals, two types of mucin are produced in the gallbladder, namely - Muc5b and Muc5ac. The main component found in canine bile is Muc5b mucin (6). In animals with gallbladder mucoceles, the content of Muc5ac mucin is several times higher than in healthy animals, with no changes observed in the content of Muc5b. It is probably the cause of the increased viscosity of follicle mucus and the formation of mucoceles (6).

Cats have fewer mucous glands in their gallbladders while compared to dogs, which may explain why gallbladder mucoceles are very rarely diagnosed in the case of said species.

Another hypothesis formulated assumes that the formation of gallbladder mucoceles may be caused by disturbances in the composition of bile acids, which may in turn affect gallbladder motility and lead to increased mucin secretion. Research conducted by Kakimoto et. al. has shown that dogs with gallbladder mucinous cysts have notably lower concentrations of taurodeoxycholic acid, especially while compared to healthy animals. It is one of the main bile acids that can be identified in this animal species. The effect of lowered concentration of bile acids on the formation of mucoceles has not been fully studied, but it is known that their reduction causes cholestasis (3). Animals with hyperadrenocorticism are at high risk of developing gallbladder mucoceles as a result of the increased concentration of unconjugated bile acids: deoxycholic and chenodeoxycholic acid (5).

Predisposing factors

It is possible to identify a remarkable number of predisposing factors when it comes to the formation of gallbladder mucoceles. Mucinous gallbladder cysts are most common in middle-aged or older dogs. Females are more predisposed then males when it comes to their formation.

Predisposed breeds include: Shetland Sheepdogs, Cocker Spaniels, and Miniature Schnauzers (1). In recent years, mucoceles have also been found to be more common in Pomeranians and Border Terriers. In the case of Shetland Sheepdogs, the formation of gallbladder mucoceles is associated with the ABCB4 1583_1584G gene mutation (1,7). It is also worth mentioning that mucoceles are more common in animals with endocrinopathies: hyperadrenocorticism, hypothyroidism, diabetes, as well as in animals subjected to long-term steroid therapy (2,6).

Factors that increase the likelihood of disease development include: high levels of triglycerides and cholesterol in blood serum caused by fat metabolism disorders, high-fat diet, and nephrotic syndrome. Another predisposing factor when it comes to the formation of mucoceles are gallbladder motility disorders. According to some authors, their formation is promoted by treatment based on the utilization of progestogen compounds, which reduce the contractility of smooth muscles of the gallbladder. It should be remembered that mucoceles may form in animals suffering from long-term thickening of bile in the gallbladder and with identified stones in the gallbladder.

Clinical symptoms

In the initial phase of the disease, dogs often show no clinical symptoms. As it develops, non-specific symptoms may start to appear, such as lethargy, appetite loss, vomiting, diarrhea, and weight loss. They may last from several weeks to even several months. In the advanced phase of the disease, the following symptoms can be identified: pain in the foreabdomen, polyuria, increased thirst, and mucous membrane yellowing. In the case of the

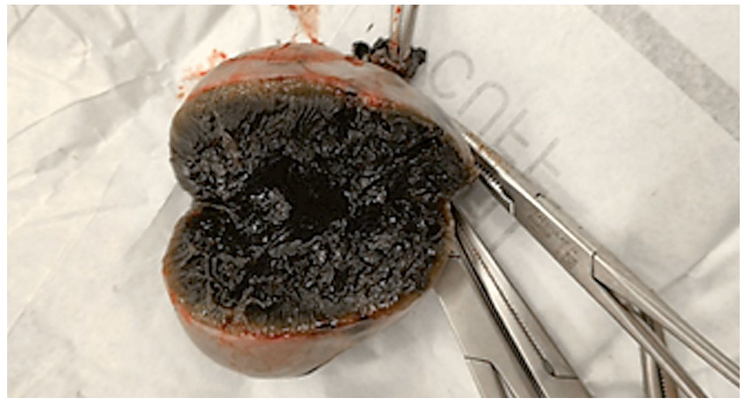

Fig. 1. Cross-section of the gallbladder after cholecystectomy. Mucoceles of the gallbladder.

inflammation of gallbladder wall or its rupture, fever, tachycardia, rapid breathing, and symptoms of ascites may be observed (6).

Laboratory test results

In the initial phase of the disease, the increase of the activeness of alkaline phosphatase (ALP) and gamma glutamyltransferase (GGT) is observed. What is more, in some cases, there is a notable increase in cholesterol and triglyceride levels. As the disease progresses, aspartate (AST) and alanine (ALT) aminotransferesis activeness increases, together with total bilirubin levels. In some scenarios, a notable increase in DGGR lipase is observed as well.

When it comes to the initial phase of biliary obstruction, an increase in the concentration of bile acids is identified. Nevertheless, the aforementioned parameter does not allow for the assessment of disease progression, as in its later phases, said value returns to normal. A sensible examination that allows for a remarkably early diagnosis of extrahepatic bile duct obstruction caused by mucoceles is the analysis of the presence of bilirubin in urine. Due to low renal threshold for the excretion of conjugated bilirubin, its presence in urine precedes the occurrence of jaundice (6). In animals with gallbladder wall inflammation or its rupture, the blood count-based test shows leukocytosis with neutrophilia.

In the case of biliary peritonitis, the fluid collected from the peritoneal cavity for examination has the characteristics of exudative fluid. It is green and bloody in color and is characterized by high specific gravity (>1.032), high total protein concentration (>5000 cells/μL), and high number of leukocytes (>30 g/L).

A test allowing for the differentiation of biliary peritonitis from other causes of ascites is the examination of total bilirubin concentration in the fluid and later on – comparing it with values in peripheral blood. In the case of biliary peritonitis, the total bilirubin concentration in the fluid from the peritoneal cavity is several times higher than its concentration in blood serum.

$$\frac{\text{total bilirubin concentration in the fluid taken from the peritoneal cavity}}{\text{total bilirubin concentration in blood serum}} > 2$$

Diagnostics

The final diagnosis of gallbladder mucoceles is based on the results of ultrasound examination and - in some cases – on the outcomes of computed tomography.

Ultrasound examination makes it possible to differentiate between 6 stages of mucoceles:

1. motionless echogenic bile filling the entire gallbladder,
2. incomplete stellate shape of gallbladder lumen,
3. typical stellate shape of gallbladder lumen,
4. combination of stellate and kiwi fruit shape,
5. kiwi fruit shape with residual echogenic bile in the central part,
6. cross-section of a kiwi fruit without echogenic bile in the central part.

If the gallbladder cannot be seen during an ultrasound examination in a patient previously diagnosed with mucocele and there is free fluid in the peritoneal cavity, gallbladder rupture can be suspected. In the majority of cases, it is caused by gallbladder wall necrosis and may lead to biliary peritonitis (6).

Treatment

Pharmacological treatment of gallbladder mucoceles can be opted for in animals in the initial phase of the disease, especially if there are no signs of inflammation or necrosis of the gallbladder wall or the obstruction of bile ducts (6). Such a treatment form typically incorporates the administration of: ursodeoxycholic acid at the dose of 15–25 mg/kg orally, twice a day, as well as s-adenosyl-l-methionine SAMe at the dose of 20–40 mg/kg orally, once a day on an empty stomach.

As little as two cases of complete animal recovery after the exclusive use of pharmacological treatment have been described in the literature of the subject (8). Before starting the medication-based therapy, it is vital to inform the owner that the treatment is only intended to slow down the progression of the disease. A patient undergoing pharmacotherapy should have follow-up blood tests performed every 6 weeks, including a liver profile and an ultrasound examination. In the case of liver parameter worsening and progressive changes in the ultrasound image, the removal of the gallbladder is recommended.

The method of choice when it comes treating mucoceles is cholecystectomy. As bile stasis in the gallbladder may lead to the formation of secondary infections, broad-spectrum antibiotic therapy should be introduced before the procedure (7). Currently, laparoscopic gallbladder removal is performed quite often.

Laparoscopic cholecystectomy can be performed in canines that do not show signs of extrahepatic biliary obstruction. Major complications that are strongly connected with the procedure include: bile leakage into the peritoneal cavity, incorrect ligation of the cystic duct, as well as gallbladder rupture.

In the event that the procedure discussed above cannot be performed laparoscopically, laparotomy is recommended. During the procedure, it is advised to take a liver sample from a lobe located rather far from the gallbladder in order to assess changes in the organ parenchyma. Furthermore, a microbiological examination of bile and a histopathological analysis of the gallbladder wall should be performed. After the procedure, it is recommended to implement long-term choleretic treatment, especially when it comes to Shetland Sheepdogs, in the case of which the disease may be of genetic origin. In other cases, the cause of the disease should be determined (hyperlipidemia, endocrine disorders) and afterwards – the appropriate treatment should be initiated. It has to be indicated at this point that mortality in animals after cholecystectomy ranges from 20 to 40%.

Preoperative factors that may have a negative impact on the patient's prognosis include: hyperbilirubinemia, hypoalbuminemia, age, leukocytosis, increased heart rate before anesthesia, urokinemia, as well as hyperphosphatemia (7).

If the animal develops gallbladder rupture and sterile peritonitis as a result of the disease, the prognosis should be good

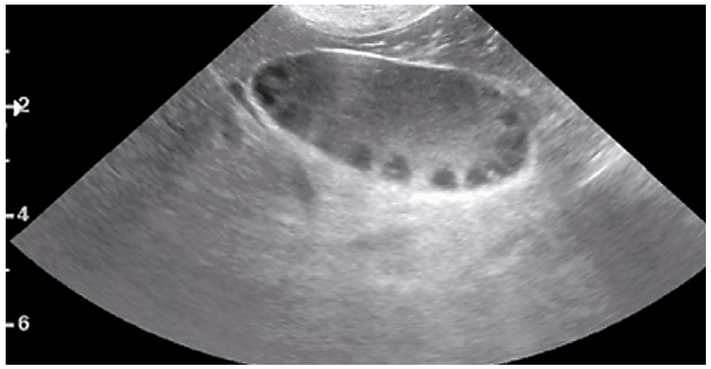

Fig. 2. Ultrasound image of a mucinous gallbladder cyst.

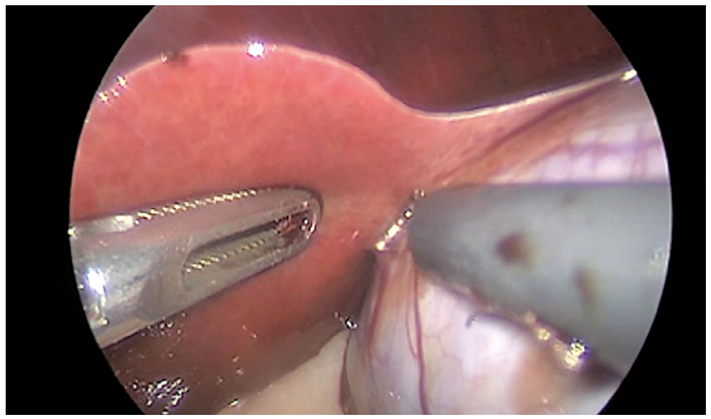

Fig. 3. Laparoscopic gallbladder removal procedure.

cautious. Unfortunately, in the case of septic peritonitis, mortality rate ranges from 80 to 100% in animals.

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Fibroblast growth factor 23 (FGF-23) as a new diagnostic indicator in feline chronic kidney disease

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Abstract: Chronic kidney disease (CKD) is associated with hyperphosphatemia, reduced levels of vitamin D metabolites, and hyperparathyroidism. The syndrome in question is known as chronic kidney disease - mineral bone disorder (CKD-MBD). An increase in fibroblast growth factor-23 (FGF-23) is an early biomarker of CKD and an independent risk factor for both kidney disease progression and survival time.

Keywords: FGF-23, CKD, chronic kidney disease, fibroblast growth factor-23

Fibroblast growth factor - FGF-23 is a 32 kDa protein secreted by osteocytes in response to the increased concentration of phosphorus and calcitriol (which is the active form of vitamin D3) in the blood. It is removed from the plasma by kidneys (5). FGF-23 interacts with parathyroid hormone (PTH) and calcitriol in a feedback loop manner: calcitriol synthesis is activated by PTH, which leads to the increased absorption of calcium and phosphate from the intestines. PTH increases the activeness of osteoclasts, releasing calcium ions and phosphates from bones. At the same time, it affects the kidneys to maintain the proper concentration of calcium ions through absorption (distal tubule) and excretion (proximal tubule) of phosphates (3). Both PTH and calcitriol increase the secretion of FGF-23, which prevents the increase in plasma phosphate concentration. It reduces the reabsorption of phosphates in the proximal tubules, inhibiting the synthesis of calcitriol, and halting the secretion of PTH - it prevents the further transfer of calcium and phosphates from the diet and bones into the extracellular fluid. Thanks to said fact, the bones, intestines, and kidneys work together to integrate the processes of maintaining calcium and phosphorus homeostasis, maintaining bone mass, regulating the concentration of ionized calcium, and preventing the concentration of phosphate from increasing to the level that would lead to the mineralization soft tissues rather than bones (2,3). The factor that is necessary for binding FGF-23 to a specific receptor, thus stimulating its activeness, is a cofactor – the so-called Klotho protein, which is active mainly in distal tubules of the kidneys and plays an important role in maintaining the proper concentration of FGF-23. Klotho protein deficiency in humans and animals causes symptoms similar to FGF-23 deficiency, such as hyperphosphatemia and increased calcitriol concentration with the tendency to soft tissue calcification (1,6). The fact that FGF-23 is involved in maintaining phosphate homeostasis justifies the advisability of performing FGF-23 tests for diagnostic purposes (1).

FGF-23 as a diagnostic factor

FGF-23 is a diagnostic and prognostic factor in the case of chronic kidney disease (CKD) and is associated with mineral and bone disorders - the so-called CKD-MBD (mineral and bone disorder) (3). Phosphates are freely filtered in the renal glomeruli from blood into primary urine, from which, depending on the current requirement, they are reabsorbed in the proximal tubule. Thanks to said fact, the body can balance the demand for phosphorus and is able to "recover" it from primary urine (4). The amount of phosphorus excreted by the kidneys is closely correlated with the efficiency of the glomeruli, which is determined by the glomerular filtration rate - GFR. GFR disturbances caused by glomerular damage are equivalent to the limited filtration of phosphorus into primary urine, thus retaining it in the plasma, which causes hyperphosphatemia. In early stages of CKD, the increase in phosphorus is compensated by the increase in the activity of parathyroid hormone, which increases the urinary excretion of phosphorus. This allows for the normalization of blood phosphorus concentration at the expense of actual renal hyperparathyroidism. Nevertheless, said mechanism is short-lived in nature, as subsequent nephrons are constantly damaged – they are targets of PTH activity. The concentration of phosphorus in the serum increases, despite the boost in the activity of the hormone (4). The described compensation phenomenon means that the initial increase in blood phosphorus concentration is not visible in laboratory tests, because hyperparathyroidism develops much earlier. When it comes to chronic kidney disease, circulating levels of FGF-23 increase in order to compensate for the decreased ability of the kidneys to excrete phosphate. The increased synthesis of FGF-23 together with the Klotho cofactor inhibits the reabsorption of phosphorus in the proximal tubules of the kidneys. It allows the remaining functioning nephrons to excrete more phosphates (3,5). FGF-23 additionally inhibits the synthesis of calcitriol in the kidneys, which in turn reduces the absorption of phosphorus from the intestine. This is an early stage of CKD development, which takes place before the increase in parathyroid hormone concentration. Therefore, capturing said moment during the early diagnosis of CKD is crucial, especially in cats, in the case of which an increase in serum phosphorus concentration above 0.9-1.45 is correlated with an increase in mortality (4). The concentration of FGF-23 in plasma during the initial diagnosis of CKD also serves as an indicator of the risk of mortality in the course and showcases the possible progression of CKD in cats and dogs. In more than 25% of patients with elevated FGF-23 concentration, there is an increase in plasma creatinine concentration within the next 12 months observed. It has to be remembered that FGF-23 may be elevated in the case of hypomagnesemia, which

Table 1. Reference values of SDMA and CREA in different stages of CKD (7).

Parameter	Species	Stage 1 No azotemia Creatinine normal	Stage 2 Mild azotemia Normal/moderately elevated creatinine	Stage 3 Moderate azotemia	Stage 4 Severe azotemia
Creatinine mg/dL (µmol/L)	DOG	<1.4 (125)	1.4-2.8 (125-250)	2.9-5.0 (251-440)	>5.0 (440)
	CAT	<1.6 (140)	1.6-2.8 (140-250)	2.9-5.0 (251-440)	>5.0 (440)
SDMA (µg/dL)	DOG	<18	18-35	36-54	>54
	CAT	<18	18-25	26-38	>38

stimulates the secretion of FGF-23, even in cats suffering from normophosphataemia (3). Chronic inflammation may also contribute to the activation of osteocytes through circulating cytokines and lead to increased FGF-23 concentration in plasma (causing, for example, chronic periodontal disease) (3).

The prolonging high concentration of FGF-23 may lead to kidney damage, soft tissue mineralization, and osteodystrophy. In humans, it has been suggested that osteocyte function is impaired as the expression of the Klotho protein in the kidneys decreases. Reduction in Klotho release in tissues occurs as a result of the activeness of uremic toxins and proteinuria. It has also been shown that FGF-23 induces genes responsible for the synthesis of pro-inflammatory factors: TNF-α in spleen cells and macrophages, as well as IL-6 and CRP in hepatocytes. Therefore, it may play an important role in the pathogenesis of generalized inflammation observed in the case of CKD and lead to both vascular changes and the formation of calcifications in vessels and soft tissues (1,3,7).

Clinical interpretation of FGF-23 concentration

As is has been observed, in early stages of CKD, plasma creatinine and phosphate concentrations are within normal limits. In said case, the diagnosis is made on the basis of: SDMA concentration, presence

Table 2. Phosphate reference values during individual stages of CKD basing on IRIS in cats (3)

IRIS CKD STAGE	Phosphate concentration ranges during specific stages of CKD
Stage 1	0.9 - 1.45 mmol/L
Stage 2	0.9 - 1.45 mmol/L
Stage 3	0.9 - 1.6 mmol/L
Stage 4	0.9 - 1.9 mmol/L

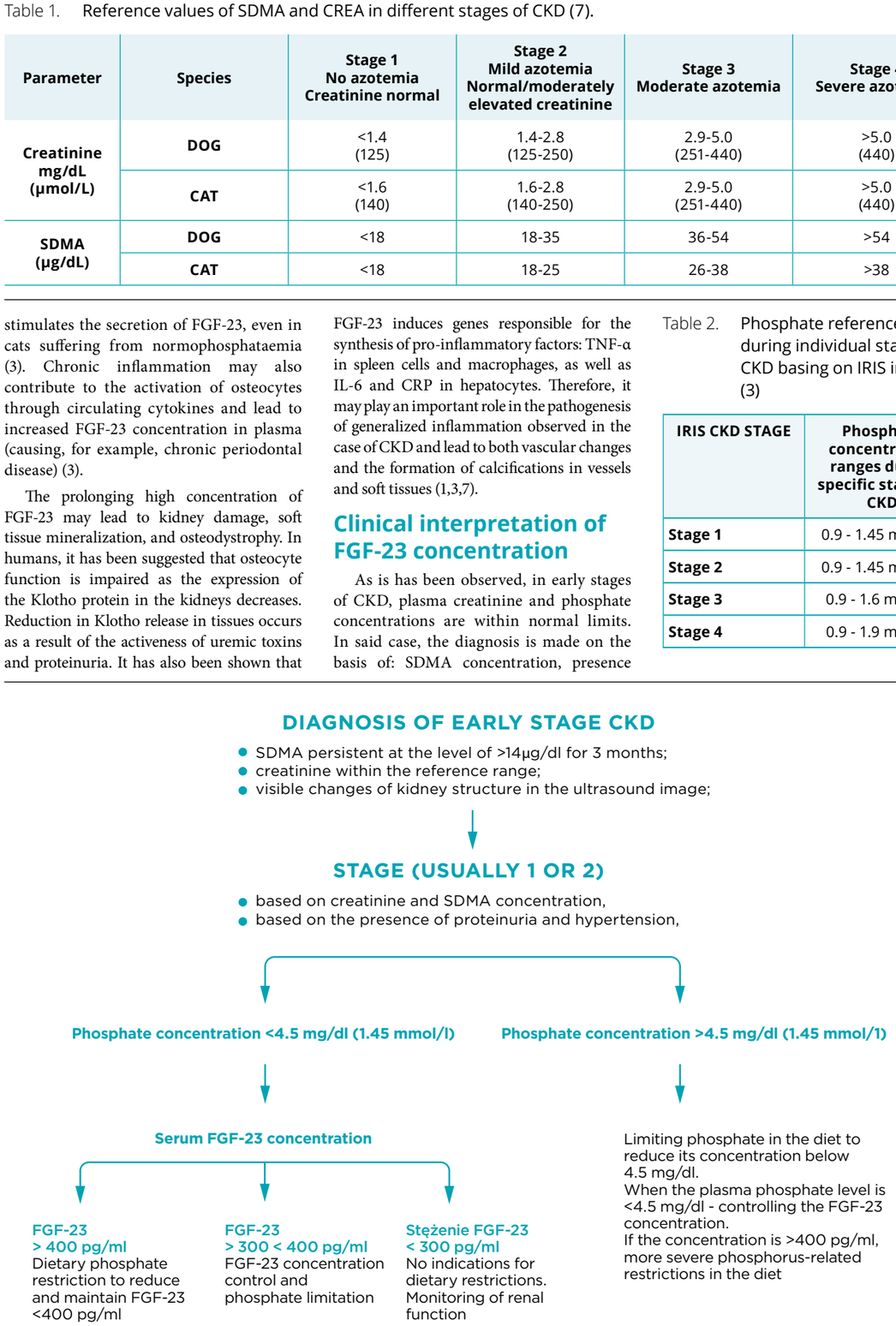

Fig. 1. Diagram showing the usefulness of FGF-23 in serum in the case of treating cats in the early stage of CKD, basing on IRIS (3).

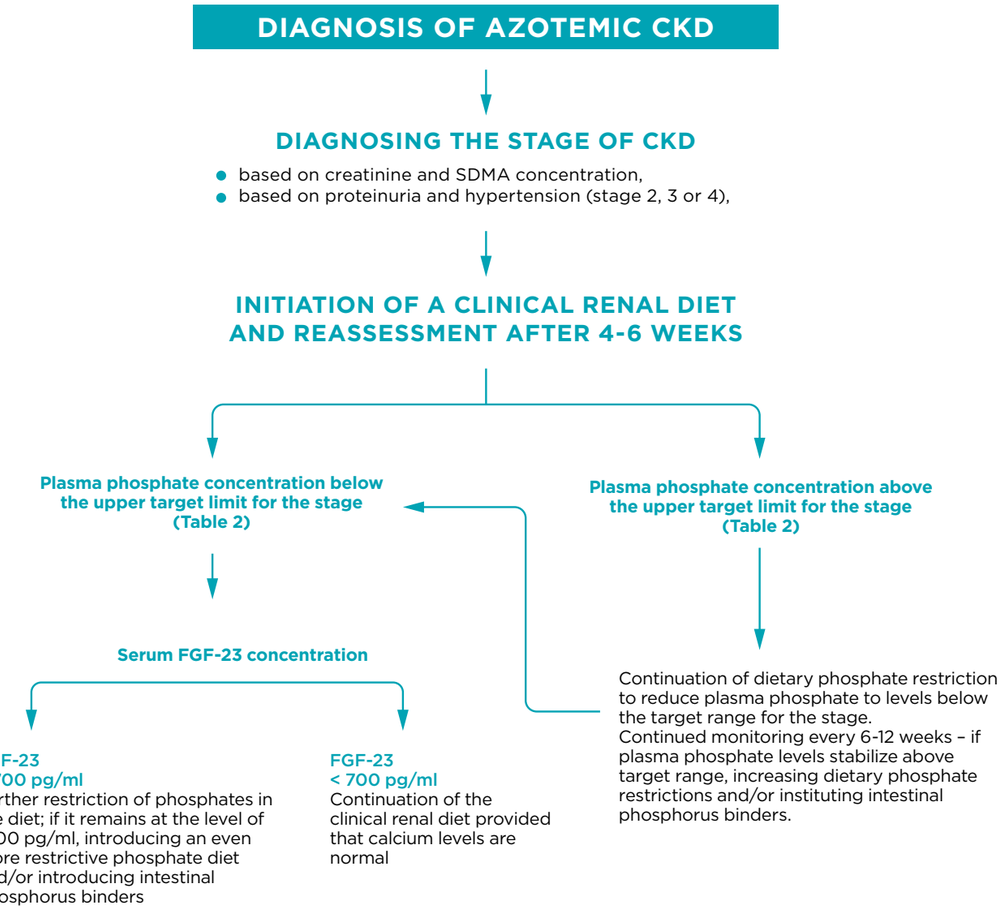

Fig. 2. Diagram showing the usefulness of FGF-23 in serum in the case of the treatment of cats with azotemic CKD, according to IRIS (3).

of proteinuria, and hypertension (Tables 1 and 2). Therefore, it is extremely important to measure FGF-23 in order to determine whether a cat patient requires limiting phosphates in the diet to prevent the development of the disease as early as possible. Diet-based therapy and repeated testing of phosphate levels after 4 weeks allow for the determination of whether the patient responds to the therapy properly (3). In cats diagnosed with CKD, it is also important to assess calcium concentration in plasma. When limiting phosphates in their diet, they may develop hypercalcemia.

Plasma FGF-23 concentrations in healthy cats without bone mineral-specific disorders should oscillate within <300 pg/mL. If the plasma FGF-23 concentration is between 300 and 400 pg/mL, the cat should be monitored regularly. If the FGF-23 concentration increases to the level of >400 pg/ml, treatment based on a phosphate-limiting renal diet is recommended. (Figure 1) (3). In advanced stages of CKD, the concentration of FGF-23 in the blood may exceed the norm over 1000 times (5.6).

It is assumed that in cats diagnosed with CKD, in response to limiting phosphorus in the diet, the FGF-23 concentration should remain below 700 pg/ml. Without the use of medications that bind phosphorus in the gastrointestinal tract, it is only possible in cats in the second stage of CKD. It means that if, despite continuous diet-based therapy, the FGF-23 concentration exceeds 700pg/ml, it is necessary to introduce medications limiting the absorption of phosphates in the intestines (2,3). It has to be noted that it may take up to several months to reduce the FGF-23 concentration in plasma to the desired level (<700 pg/ml) (Figure 2) (3). The authors of the study recommend the use of phosphorus-binding medications regardless of the stage of the disease development.

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Sick cat in a hospital – recommended diet, dosing, and administration method

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Abstract: Due to its high susceptibility to stress (anorexia, food aversion) and specific habits, a cat is a very difficult patient when it comes to dietary therapy, especially in the case of hospital treatment. If its health issue does not require a radical change in diet, the situation is simpler than the one requiring developing a new diet. Any change of food in an environment that is unfamiliar to a given cat is the source of additional stress. Therefore, if possible, namely – if there are no contraindications to use appetite stimulating medications - it is recommended to take advantage of them. Nevertheless, if pharmacological treatment does not bring the expected results, it is advised to introduce forced feeding.

Keywords: cat, hospitalization, diet

Due to its high susceptibility to stress, nutritional idiosyncrasies, and specific habits (neophobia, neophilia), a cat is a very difficult dietary patient in the case of hospitalization. In the first stage after admitting the cat, a detailed nutritional interview should be conducted with the owner. The animal itself should be weighed and its condition should be properly assessed during a clinical examination (BSC, Body Condition Score), combined with muscle mass examination. It is also vital to carefully examine the cat's oral cavity in order to exclude any and all changes that could affect the cat's ability to consume food independently.

The diet of a sick cat has to always be adjusted to its current needs and complement the therapy. Nevertheless, the recommendations may be different for an animal that was hospitalized as a result of an injury (caused, for example, by a traffic accident) and for a cachectic animal suffering from chronic renal failure. A key aspect is to adjust the form of the diet to the available methods of administration. For example, it is recommended to opt for the use of liquid diets in the case of tube feeding or tasty moist diets in the case of cats being able to feed themselves independently. In the discussed scenario, a thorough nutritional interview is of great importance, as it helps determine the cat's preferred flavors, food types, and entire diets.

Determining energy demand in a hospitalized cat

To determine the nutritional dose, it is required to estimate the daily energy requirement (DER). It depends on a number of factors, including: animal's nutritional status (body weight, condition), appetite or lack thereof, as well as the extent of physical activity performed (remaining exclusively in a cage, complete immobilization, or the possibility of staying in a controlled enclosure) (8). The Perea Risk Assessment Protocol, modified by Taylor S., can turn out to be highly useful in such a case (14, 16) (Table 1).

When it comes to cats staying exclusively in cages, their DER should be equal to RER (Resting Energy Requirement). Only in kittens and other animals with extensive injuries (caused by burns or other factors), the DER value may be a multiple of the RER (3). In patients taking advantage of an enclosure, the calculated DER value may range from 1.1 to 1.2 x RER. It should be remembered that RER in a hospitalized patient is always calculated by taking into account its current body weight, regardless of whether it is overweight or underweight (16). A given cat's RER is calculated basing on its metabolic or total body weight (Table 2) (12). Calculation based on metabolic body mass (lean body mass, LBM) determines the factual energy demand of metabolically active tissues, which are muscles (7, 12). The rule is that in the case of cats with optimal body weight, the following power is used: 0.67. Nevertheless, when it comes to obese cats, it is always recommended to use a power of 0.64 (12).

Choosing a diet and determining the food dose for hospitalized cats

In hospitalized cats that stay in cages and do not require a specific diet, easily digestible food can be opted for (gastrointestinal diet) (15). If a cat is underweight and there are no other health concerns, it is sensible to introduce a nutritional diet with higher calorie content to support the healing process (15). Both of the aforementioned diets include the so-called highly digestible, low-residue foods characterized by a high content of basic nutrients (protein, fat, vitamins, minerals). Their use is connected with the need to ensure optimal nutrition with a minimal, yet relatively concentrated food dose. If a specific disease is identified, appropriate, dedicated diets are recommended that are developed in accordance with the indications contained in PARNUTS. It is important to note that in addition to the appropriate choice of diet, its proper form and method of administration have to be established (moist diets: liquid to be administered through a tube or in the form of pâté, minced meat, or dry food), basing on the needs of the sick cat.

Protection against the refeeding syndrome (RS)

Refeeding syndrome (RS) is a complex disorder that occurs in extremely malnourished animals and humans when they are refeeded. RS may occur in cats, dogs, horses, ruminants, and humans starved for a long time or that do not eat for various reasons. It is characterized by numerous metabolic disorders, particularly hypophosphatemia, hypokalemia, and hypomagnesemia. Thiamine deficiency, disturbed glucose homeostasis, as well as water and electrolyte imbalance are also commonly diagnosed. To reduce the risk of the occurrence of said syndrome in sick cats, water and electrolyte-specific disorders should be eliminated before feeding. Chan, basing on recommendations developed for humans by the European Society of Clinical Nutrition and Metabolism (ESPEN) suggests that in high-risk feline patients, fluids should be administered within the first 24 hours of therapy and supplemented with: phosphates (0.01–0.03 mmol/kg/h), potassium (0.05 mmol/kg/h), and magnesium (0.01–0.02 mmol/kg/h) (2, 5). Nevertheless, the administration of the specified ions is only possible if their values do not exceed the upper limit of the reference range in control blood tests performed during the first 3 days of treatment (5). Additionally, it is recommended to include thiamine at the dose of 25 mg/cat, administered by means of subcutaneous or intramuscular injection. Only after alleviating water and electrolyte-specific disturbances can supplementary feeding be started. However, it has been noticed that even with the daily food dose of 6 kcal/1 kg of body weight of the sick cat, refeeding syndrome may occur. Therefore, it is recommended that the initial food dose should not exceed 20% of the calculated RER (5, 16). If no undesirable symptoms are observed in the animal, the daily food dose should be increased by approximately 10-25% to reach the full dose, equal to RER, within the next 4-10 days (5, 16). It is also advised to weigh a given cat daily and conduct regular blood tests. If there are no gastrointestinal disorders, blood results are normal, and the cat has maintained its appetite, the daily food dose should be increased to achieve the desired body weight.

Treatment in the case of decreased appetite

If the animal was not starved before being admitted to the hospital and was eating the food intended, the daily dose should be left practically unchanged. Nevertheless, it is worth calculating the amount of calories the cat consumes to be prepared to eventually change the animal's diet.

If a particular animal has a reduced appetite or does not want to eat at all, the reaction should be very quick due to the high risk of fatty liver syndrome occurring (especially if the cat is overweight). Unfortunately, hospitalization itself is a strong stress-inducing stimulus, which may cause both aversion to the food already served and deepen the existing hyporexia in this species. Therefore, in cases where it is possible to include appetite stimulating medications, such an approach should be opted for. Recommended appetite stimulants along with advised doses are provided in Table 3 (2, 16, 17). Unfortunately, not all of them are available on the Polish market, although it should be noted that significant progress in the effective stimulation of appetite in cats has been made after the introduction of mirtazepine ointment (prep. Miratаz) to the market. If the pharmacological stimulation of appetite is ineffective or cannot be taken advantage of, as well as if it is not possible to administer any food orally (in the case of injuries to the facial part of the skull), an intraesophageal, intragastric, or enteral tube should be placed in the animal. Nevertheless, due to the low availability of elemental diets required for enteral nutrition, said type of tube is not as popular as its other alternatives. Probes that are inserted by creating a fistula placed in the esophagus or stomach do not have the same requirements regarding the degree of food fragmentation as those placed internally. They are additionally characterized by a relatively large diameter, which expands the range of diets that can be taken advantage of when it comes to supplementary feeding. It is also worth mentioning the nasal probe, the insertion of which does not require full anesthesia, although premedication is required in aggressive animals. Said probe is popular due to the ease of its insertion, the lack of or minimal required premedication, relatively short duration of its use (usually from 3 to 5 days), and the ease of its removal (16). It is always required to secure it (by sewing it, gluing it to the skin, and putting on a collar). A typical problem with this type of feeding tube is its small diameter, which requires the use of liquid diets. There is also the possibility of its clogging if it is not properly secured (it has to be rinsed before and after each meal). It is worth indicating the limited number of liquid diets available on the Polish market that are adequate to the type of therapy being conducted. Most cat foods come in the form of a pate that must be diluted with water to be then administered through a feeding tube. Unfortunately, dilution with water reduces the amount of calories that can be administered at one time. Therefore, high-calorie liquid diets have a major advantage over other types of foods, at least when it comes to nasal feeding..

Table 1. Risk factor assessment protocol (14, 16)

EVALUATED PARAMETER	ASSESSMENT OF RISK FACTORS		
	LOW	MODERATE	HIGH
Food intake below 80% RER for less than 3 days	Yes		
Food intake below 80% RER for 3 to 5 days		Yes	
Food intake below 80% RER for more than 5 days			Yes
Decrease in the current body weight		Yes	
Intense vomiting/diarrhea			Yes
BSC (Body Condition Score) <4/9			Yes
MCS (Muscle Condition Score): moderate to severe loss of muscle mass			Yes
MCS (Muscle Condition Score): slight loss of muscle mass		Yes	
Hypoalbuminemia		Yes	
Expected duration of illness: <2 days	Yes		
Estimated duration of illness: 2-3 days		Yes	
Estimated duration of illness: >3 days			Yes
RECOMMENDATIONS for taking action	If there are **≥2 or more**, it is recommended **to immediately start feeding** until the patient is fully stabilized		
	If **<2**, it is recommended to **monitor** the patient basing on its daily assessments		

Table 2. Various methods of calculating DER for hospitalized cats staying in cages (12)

No.	DER=RER (kcal/day)	Body weight (kg) at BSC: 3/5	Body weight (kg) at BSC: 4/5
		4	6
1	70 x (monthly)^{0,67}	177	
2	70 x (monthly)^{0,64}		220
3	30 x (monthly) + 70	190	250

Regardless of the type of probe selected, the amount of daily food dose is calculated basing on the RER of the sick cat. On the first day, the amount of food should correspond to 33% of RER, on the next day - to 66% of RER. On the third day, the dose should be equal to 100% RER (16). Starting tube feeding in the first days of feeding requires the use of antiemetics.

As of currently, two feeding methods can be taken advantage of: having the form of boluses administered several times a day and a continuous infusion (CRI, constant rate infusion). The choice depends on the patient's individual tolerance resulting from the need for longer immobilization during CRI. Nevertheless, there is no scientific evidence indicating that one of the indicated feeding methods grants more benefits to the animal than the other one. In the case of a constant infusion, it is recommended to set its rate at 3 to 8 mL per hour and ensure a safe position with a straight neck and raised head in order to protect the animal against regurgitation (16). An infusion pump is usually used for CRI. However, when using bolus-based doses, it is recommended for their single volume to range from 5 to 15 mL/kg of cat's body weight (16). It is also worth mentioning that forced feeding does not exempt the caretaker from offering a given cat a meal served in a bowl every day. Typically, within a few days, the cat becomes interested in food and the tube does not prevent it from eating moist food. If the cat shows interest in food and the amount of food consumed for several consecutive days is approximately 80% of its energy requirement, it is then possible to remove the feeding tube, while at the same time still monitoring the daily food intake and the animal's body weight.

Table 3. Selected medications used to stimulate appetite in cats together with their brief characteristics (2, 16, 17)

No.	Medication	Daily dose	Recommendations in the case of renal failure	Recommendations in the case of liver diseases	Other comments
1	Mirtazapine	1.88 mg/cat orally every 12-24h – 3.5 mg/kg/cat orally every 72h	It is recommended to reduce the standard dose by 30 to 50%	Liver dysfunction reduces clearance by up to 30%	It causes an increase in ALAT. Do not use together with cypoheptadine
2	Capromorelin	2 mg/kg orally every 24 hours			Not available in Poland. Side effects: vomiting, excessive salivation, stupor, transient bradycardia, drop in blood pressure. Contraindicated in cats with acromegaly. Use with caution in diabetic cats.
3	Cyproheptadine	1–4 mg/cat, every 12-24 hours	1 mg/cat orally every 12 hours. Decreased elimination in renal failure.	Not recommended in the case of fatty liver disease	Possible agitation, hemolysis
4	Diazepam	0.2 mg/kg slow intravenous infusion, once <0.05–0.50 mg/kg slow intravenous infusion, once <0.5–1.0 mg/kg intravenously as a single dose	To be used cautiously in renal failure	Contraindicated in the case of liver dysfunction. In the case of severe liver failure, the dose should be reduced by 25-50%. Do not use in the case of liver lipidosis	Avoid taking the drug orally to reduce the risk of acute liver necrosis
5	Oxazepam	0.25–0.50 mg/kg orally every 12–24 hours <2.0–2.5 mg/cat orally every 12 hours	To be used cautiously in renal failure	To be used cautiously in the case of liver dysfunction. In the case of severe liver failure, the dose should be reduced by 25-50%. Do not use in the case of fatty liver disease.	There have been reports of hyperacute liver failure
6	Prednisolone	0.25-0.5 mg/kg orally every 24-48 hours	No published reference data	No published reference data	Palliative treatment only
7	Nandrolone	2.5 mg/kg intramuscularly every 2-3 weeks	Contraindicated in nephritis	Contraindicated in the case of liver dysfunction	Palliative treatment only
8	Megestrol acetate	1 mg/kg orally every 12-24 hours 2.5 mg every 24 hours for 4 days, then every 48-72 hours 0.25-0.5 mg/kg every 24 hours orally for 3-5 days, then every 48-72 hours	No published reference data	It is metabolized in the liver, so the dose should be reduced by 25-50%.	Palliative treatment only. Not for long-term use.

To summarize the topic of feeding hospitalized cats, it can be stated that it is still a very difficult issue due to their specific requirements, metabolism, as well as high susceptibility to stress. Nevertheless, it seems that an appropriate combination of properly selected pharmacotherapy, diet, and method of administration both reduces the risk of malnutrition in hospitalized cats and allows for an adequate body nutrition.

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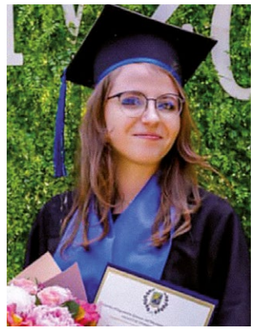
How to survive a night in the emergency room?



Alexandra Calin, DVM, MRCVS, Great Britain

Introduction

Being a young doctor working in the emergency department may turn out to be quite a challenge. We all know this, because we have all been in such a situation at some stage of our lives. Examining the past, I have to admit that I started working in the emergency room too early. I lacked experience, as well as a solid theoretical background. Despite said shortcomings, I had to find a way to provide my patients with a proper care during my shift and survive until the end of it. It is worth emphasizing that working at night is also a challenge for a young doctor accustomed to performing his or her tasks during the day. That is why I approach night shifts differently today. Looking back at the tasks I faced and methods of handling them, I have prepared a list of things that helped me survive my initial night shifts and understand my role as a veterinarian better.

1. Preparation for the shift - check if you have everything and know where everything is

In the case of emergencies, every minute counts. Therefore, you cannot waste your time looking for necessary medications, tools, or other important devices.

You always need to know exactly where in your office or hospital the following can be found:

1. medications: propofol, diazepam, potassium, glucose, calcium salts, furosemide, painkillers, etc.
2. basic equipment: laryngoscopes, endotracheal tubes, oxygen masks, needles of unusual sizes, peripheral venous catheters and cannulae, as well as a tracheostomy set.

Furthermore, you should prepare protocols pertaining to the most common emergency procedures that you will definitely need in advance.

2. Do not be afraid of books

Do not hesitate to take advantage of them, but at the same time - do not bring every possible book pertaining to the field of emergency medicine to work. Choose the publication that will probably be the most suitable for you, that is a pleasure to read, that you understand properly, and that makes remembering important information easy. You can also mark key sections in the case of an emergency. In my case, the most useful books have been:

1. L.A. Cohn, E. Cote: *Cote's Clinical Medicine Advisory for Dogs and Cats*,
2. G. Poli: *the Minivet guide*
3. K. Douglass, K. Macintire, S.C. Drobatz, W. Haskins, D. Saxon: *Manual of Small Animal Emergency and Critical Care Medicine*

They have been supplemented with my notebook containing personal notes. When it comes to exotic animals, the following may be of use:

1. *BSAVA Exotic Pets manual*
2. *BSAVA Formulary for exotic species*

3. Set priorities and always opt for the triage

"Emergency" patients simply cannot wait. When you start your shift, you may learn that you will be busy until midnight. Being a young doctor on a night shift makes one feel a bit like a hero. There is an immense need to prove to both oneself and everyone else that one can handle whatever is waiting in the waiting room. Since there are various patients, from those with pets that have suffered accidents to individuals who have decided to consult a dog's ear infection with a professional, I would like to advise to opt for the so-called "triage" and set priorities. Always pre-select patients in the waiting room and choose the most urgent cases. Always take care of the patients who require urgent analgesia (e.g. acute OA attack, inadequately controlled post-operative pain, pain associated with eye injuries, or sudden limping).

Remember that your job as an ER doctor is to quickly analyze all cases, select the most urgent ones, and stabilize them. You cannot allow yourself to devote all your attention to otitis externa or FAD, when you know that there is an unstable patient in the hospital or an animal on the way to the clinic that has survived a traffic accident. It has to be said that not every night will be difficult, but when you come to a night shift, you should make decisions assuming that it will be problematic.

4. Take a complete clinical history, but do not let it take up too much of your time

The most important thing when it comes to the emergency room is to act quickly: the priority is to stabilize the animal. Nevertheless, it is also crucial to understand or learn about the circumstances that have brought the patient to you. Therefore, always follow a simple rule: stabilize the animal first, then ask the owner about key details pertaining to its condition.

Since you are in the emergency room, do remember that communication with the owner is vital to achieve a positive result of undertakings performed. Emphasize the seriousness of the situation, explain why certain actions have been taken and what procedures should be undertaken during the consecutive steps.

Do not leave caregivers without providing them with crucial pieces of information! I would like to mention that we often forget that owners are individuals who do not have specific knowledge and for whom medical jargon may not be understandable. Therefore, try to make the explanation of the situation and the specificity of procedures to be performed next as simple as possible.

5. Listen!

If this is your first shift at the hospital and you have an experienced team of technicians at your disposal, as well as if there is a single qualified nurse who has been working in a given place for years, it should highly motivate you. If you have any doubts, share them with the person helping you in the hospital. It is quite common that an experienced technician knows more than it is assumed and can help with a difficult issue you encounter for the very first time. It is worth being open to all suggestions and taking them into account when considering further actions to be taken. My current perspective on working in the emergency department has largely been shaped by nurses (and technicians) with whom I have had the pleasure of working. I know that when it comes to the emergency room, it is always worth thinking holistically while at the same time observing and listening to the experienced staff. Said approach will improve your work in the hospital, which is never based on actions performed by a single person only.

It is also worth mentioning mistakes resulting from the fixation on a single problem that too much attention is attached to. This is often the case with anesthesia. I recommend reading about the Bromiley case ("Bromiley Case"), which was quite popular in social media some time ago.

6. Safety first

The safety of your team must always come first. The threat may come from an aggressive patient, an aggressive caregiver, other people accompanying the patient, as well as those being completely unrelated to the patient.

Remember that you work at night! Therefore, before starting the duty, check whether all doors are closed and the front door bell works properly. Do not leave windows open in a room that you are not currently using. Always check cameras. Make sure that you have a safe place in the clinic and that your phone is always with you in the case of an emergency.

If you feel unsafe when confronting your pet's caregiver or if a given person is aggressive, ask him or her to remain in the waiting room while you examine your pet.

An aggressive animal itself may also be quite a challenge. Aggression may result from many reasons, including pain or fear. Nevertheless, if an animal is aggressive, you must first take care of yourself, because it is the only way to make sure that you can help the animal. Therefore, do not release animal guardians from their obligation to help.

Remember, the dog knows them and can be much calmer in their presence. It is also less likely that it is going to bite them while they are holding it and you are examining it.

7. Treat medical records as your insurance

Full medical documentation always serves as your protection, both when the patient leaves the hospital the next day and when it unfortunately does not survive the night. Therefore, try to include a full clinical examination (or at least a basic "database" in emergency situations), treatments undertaken along with medications used (taking into account their dose), as well as procedures performed. Take note of all the options offered to the caregiver, including their costs and approvals obtained. What is more, discuss any possible or common complications connected with the procedures performed, as well as make sure that the owner is aware of the risks of said procedures. All the aforementioned elements are often omitted because one focuses on saving the patient and postpones completing the documents until later.

Since in emergency situations there is a very high probability that you will have no time to check all the costs, it is worth having a price list in a paper form at hand to provide owners with costs of individual tests, procedures, and animal hospitalization.

8. Do not be afraid to ask for help

Most of us have a tendency to do everything by ourselves and then bring ourselves down for not being able to cope with a particular task. If you are unable to move on or are unsure how to handle a given case, do not hesitate to ask! If you have a more experienced doctor on call, call him or her and ask what to do next. If you work alone, do not wait and call another clinic to ask for help in a given case.

9. Treat the patient, do not focus on the poisoning agent

If you happen to have a patient with symptoms of poisoning, but you do not know the type of poison, call the Poison Control Center (VPIS*), which is always ready to help.

*The author works in Great Britain. Unfortunately, such professional services are not available in Poland.

Ideally, if patient's symptoms of poisoning are "textbook" ones, you will immediately know what to do. Unfortunately, it is a rare occurrence. Always examine the patient, stabilize it, and then do what you have to do, rather than blindly following instructions included in a given book.

10. Is a procedure in the middle of the night really necessary?

The debate about whether routine procedures should be performed in the middle of the night should not be started at all. The answer is simple: no. The same rule applies when you are on a night shift and you are the only doctor in the clinic. Of course, there are situations where surgical procedures are necessary, but you need to be sure that the priorities are set properly and you have the right team to take care of the operated patient, as well as of those who may appear in the waiting room. Remember, emergency conditions such as gastric torsion or open pyometra must be stabilized before the procedure. Even a blocked cat needs a proper preparation for anesthesia (for example, if there has been a high level of potassium in the blood identified) if it is to survive the procedure.

Imagine a situation where you are alone on duty with one technician. The shift is quiet, nothing is happening, so you decide to perform a surgery on a dog with open pyometra, which is already stable and has been kept in the hospital. Halfway through the procedure, a desperate caregiver rings the door with his or her animal that has been hit by a car. What to do in such a situation? Will you leave the patient on the operating table halfway through the procedure? Will you leave a critical patient in the waiting room? Will you explain to the owner how to perform POCUS while you finish the procedure?

Working in the emergency room requires one to think, anticipate, and manage both resources and staff available in order to avoid high-risk situations, such as the one described above, where – due to one's own fault – there is the need to make difficult choices.

11. Routine is key in the hospital during a night shift

Try to develop your own routine in the hospital ward. At the beginning of a given night shift, examine all your patients, read their charts, get acquainted with tests and procedures performed, as well as establish a further action plan for each of them with the technician. Call animal guardians with pieces of information regarding further actions planned. Always re-examine your patients before the end of your shift. Make sure that all your notes and further recommendations for patient management are understandable and clearly formulated for the next shift.

12. Take care of yourself!!!

When your shift is finally over, go home and take care of yourself.

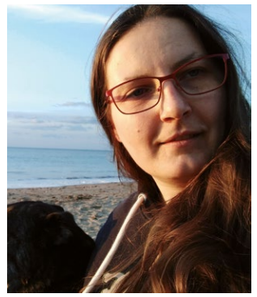
Nevertheless, if you are not satisfied with your job and after your shift you are still worried or have doubts about your behavior, talk to a friend - an experienced doctor. Analyze the actions taken. If you identify an error - think about why it happened and what you missed. Was it due to stress, haste, or did you formulate your instructions to the technician in an unclear manner? Always learn from your mistakes so that you do not make them again in the future. Strive to improve yourself, both as a veterinarian and as a human being. Try not to go home sad and upset. Remember, we are not robots, we make mistakes. Being a young doctor just out of college, I also suffered from the so-called "impostor syndrome" and I still find it very easy to blame myself when things do not go as expected. For a long time, I treated failures as a taboo topic. I did not analyze them and felt that each of them was the end of the world. That is why I want to tell you that it does not matter how many years you work in the field - one or thirty – remember that mistakes do happen. It is quite obvious that we feel terrible when we become aware of them, especially when they were made while treating emergency patients. The most important thing, however, is to be honest with yourself, analyze the case, and find the mistake. Then, plan your behavior in such cases to avoid making a similar mistake again. The most important thing I learned during my first year on the job was that being a veterinarian was hard enough and one should not put additional pressure on oneself.

Therefore, after your shift is over, leave work, call your family and friends, go for a walk with your dog, play with your cat, go to a kickboxing class, put on a face mask, take a hot bath, watch your favorite TV series, or do something else that that will relax you.

Remember: being a veterinarian will take up a large part of your time and working in an emergency department requires different lifestyle-specific choices. However, do not forget about yourself while being surrounded by chaos. Remember that you cannot take care of others if you have not taken a proper care of yourself first.

Congratulations! You have reached the end of your shift!

5 most common procedures in emergency medicine



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Emergency medicine is predominantly oriented towards quick actions. Therefore, it requires specific procedures to be followed that have to be implemented point by point. On one hand, procedures help control stress that always accompanies emergency cases, and on the other – they ensure that nothing has been forgotten about or missed. Five most frequently performed procedures in emergency cases are presented below, accompanied by a short commentary by a doctor being a part of the "Emergency" group.

1. FLUID-BASED THERAPY

How to quickly assess the patient's condition, specify the right fluid to administer, and decide how much of it should be administered?

The amount of fluid to be administered to patients depends on their condition. There is the need to specify whether the patient is struggling with dehydration or hypovolemia. The general definition of dehydration is the reduction of the amount of total water in the body. Hypovolemia, on the other hand, is defined as the decrease of the effective volume of circulating fluids. It should be emphasized that hypovolemia and dehydration are two different conditions, characterized by different pathophysiology and requiring a different clinical approach. Severe and prolonged dehydration may lead to hypovolemia, but hypovolemia can also occur without dehydration. To put it simply, dehydration does not lead to immediate death, but hypovolemia does.

The safest and most sensible choice when opting for a fluid-based therapy procedure is to use the lactated Ringer's solution.

How to assess the patient's condition?

When assessing the patient's condition, the following have to always be taken into account:

1. Heart rate
2. Assessment of mucous membranes (color and CRT)
3. Pulse quality
4. Blood lactate level
5. Hematocrit
6. Total protein
7. Blood pressure

Said parameters will quickly and effectively help the doctor decide on the selection of fluid-based therapy and its intensity. In the case of hypovolemia, the fluid is administered in the form of boluses until normovolaemia is achieved, which has to be then monitored by assessing the following: CRT, blood pressure, and pulse quality.

In the case of dehydration, its degree has to be assessed. It should be remembered that the assessment of the dehydration severity is always estimated and based on the assessment of clinical symptoms (Table 1).

Table 1. Estimation of dehydration severity basing on clinical symptoms

Clinical symptoms	Estimated dehydration
Sticky mucous membranes	5%
Weakened skin turgor	6-8%
Increased heart rate (caution recommended in the case of cats!)	8-10%
Słaby puls	10-12%
Collapse/shock	12-15%

In the case of dehydration, the goal is to improve the overall water balance within 24-48 hours. If a dehydrated patient does not suffer from perfusion disorders, fluid therapy is usually based on the supply of fluid in the amount of 2-3 mL/kg/hour.

2. OXYGEN-BASED THERAPY

Oxygen-based therapy is a life-saving procedure that is generally harmless. If the patient is very stressed upon admission, is in a state of collapse, or is severely weakened, oxygen-based therapy is strongly recommended.

Nevertheless, the question always remains the same, namely - how to take advantage of it? It typically depends on several factors:

1. What method will be best tolerated by the patient?
2. How much oxygen is needed? Note: each method will provide different oxygen values (FiO_2):
   a. oxygen mask: FiO_2 35%-60%, with oxygen flow: 2 to 5 L/min.
   b. slow flow: FiO_2 25%-40%, with oxygen flow: 2-3L/min. Note: This method is not well tolerated.
   c. nasal cannula: values similar to slow flow

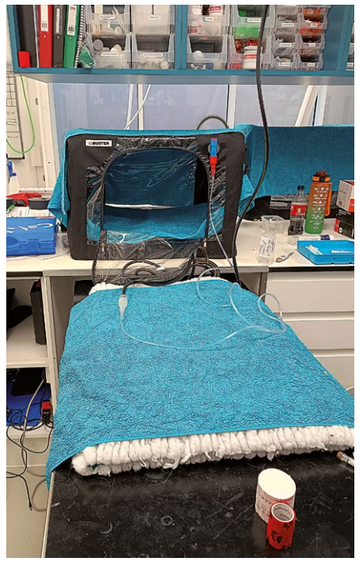


Fig.1. Place for oxygen-based therapy. Photo. A. Wawrzyniak

Fig.2. Patient undergoing oxygen therapy in the wards ICU. Photo. A. Wawrzyniak.

d. intubation: FiO_2 90-100%

What should be prepared?

1. Properly sized oxygen mask
2. Oxygen source
3. Humidifier! Note: Oxygen causes mucous membrane drying
4. Nasal cannula/Oxygen tent/Intubation kit
5. Quiet place that will not be the source of additional stress for the patient

Oxygen therapy monitoring:

1. Assessment of mucous membrane condition
2. SpO2
3. Breathing assessment – breathing pattern and number of breaths per minute.

3. URETHRAL OBSTRUCTION IN A CAT

What should be done before unblocking the urethra?

1. Clinical examination,
2. Palpation of the urinary bladder,
3. Administration of analgesics (opioids) in stable patients - intramuscularly, in unstable patients - intravenous administration.
4. Cannula insertion.
5. Taking blood samples – electrolytes should be checked!
6. Note: potassium should always be checked! If potassium is high >7 mmol and the patient requires quick intervention, calcium gluconate has to be administered!
7. Urethra unblocking

When starting to deal with emergency cases, it is worth spending some time preparing the most frequently used sets. One of them is a kit to be used in the event of a blocked urethra in a cat (the so-called "blocked cat" kit).

What is needed?

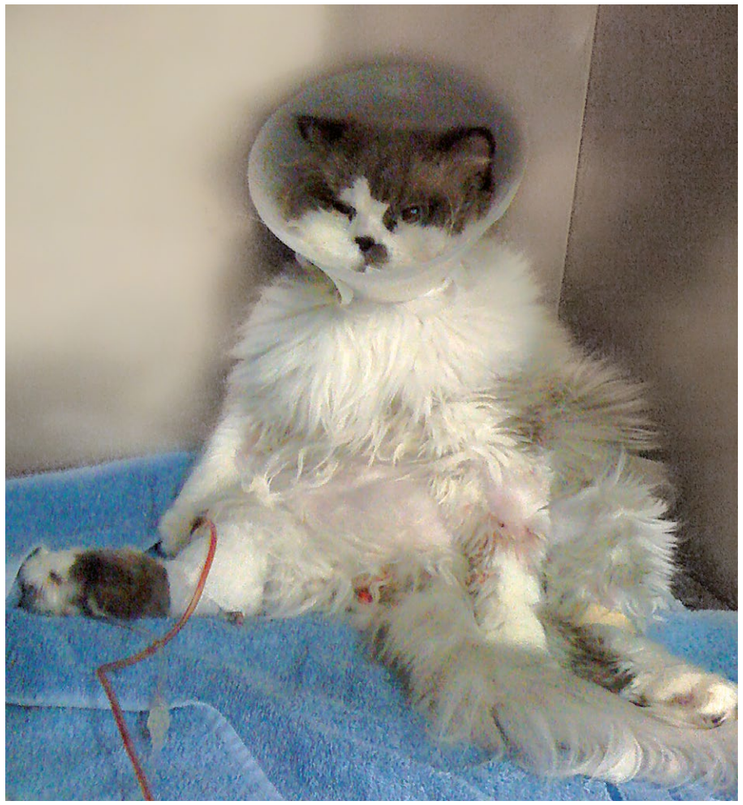


Fig. 3. Collar required for cats after unblocking the urethra. Photo. A. Wawrzyniak

1. Intravenous Cannula
2. "Pink" cannula to unblock the urethra if a catheter cannot be inserted
3. Syringes for collecting urine samples and for rinsing the bladder
4. Lubricant
5. Urine collection kit
6. Sewing kit (in cats, PDS should be avoided at all costs)
7. Lidocaine gel
8. Sterile gloves
9. Protective collar for the cat
10. In the case of local anesthesia - iodine - to prepare the injection site, orange needle and STERILE lidocaine

Urethral catheter.

- It may or may not be equipped with a blade, depending on the doctor's preferences and on the safety of the procedure to be performed.
- In the author's opinion, catheters with an open end and a luer lock system are the best choice

An efficient, small fur trimmer is invaluable. It should be remembered that there is the need to remove the fur from the penis area. It is vital to maintain the sterility of the procedure and to clear the area for catheter positioning sutures.

After determining whether it is safe to administer anesthesia to the patient (potassium should be checked first! If its level is high, calcium gluconate should be administered, as it will allow for performing anesthesia safely), it is possible to proceed with the procedure.

In cats, urethral obstruction caused by an infection is unlikely. Therefore, the entire procedure should be performed in a sterile manner. Antibiotics are not necessary. The task is to avoid contamination of the bladder with bacteria from the environment.

If there is also a plan to administer anesthesia to the sacrococcygeal space, the injection spot must also be disinfected with iodine. The author takes advantage of 2% lidocaine solution for anesthesia at the dose of 0.1 mL/kg.

After inserting the catheter and unblocking the urethra, the urinary bladder should be rinsed. It is recommended to use 0.9% NaCl for said purpose (finally the liquid in question has some use!). It should be remembered to take a urine sample for testing before rinsing the bladder!

Patients staying in hospital should wear a urine collection kit. This will allow the doctor to monitor the amount of urine excreted and adjust the amount of intravenous fluids administered.

4. THORACOCENTESIS

During "emergency" shifts, this procedure is quite commonplace. There is no reason to be afraid of it! What is more, thoracentesis is a frequently utilized diagnostic procedure.

How to prepare for thoracentesis?

Recommended kit:

1. Oxygen and oxygen mask/nasal cannula
2. 20 and 60 mL syringes
3. 16G and 21G butterfly needle
4. Three-way tap
5. EDTA test tubes (for machine testing)
6. Sterile test tubes for cytology and bacteriology
7. Fluid collection container (non-sterile)
8. Lidocaine 1-2 mg/kg (optional)

If the presence of fluid in the chest can be confirmed by ultrasound or X-ray, this is an ideal case. Ultrasound is better tolerated by animals with respiratory failure. Nevertheless, it has to be kept in mind that a patient with respiratory failure should receive oxygen first.

Thoracocentesis can be performed by means of using a butterfly needle or a 20G cannula if there is no appropriate kit available, no time, or no patient stable enough to insert a chest tube.

If, in the assessment of the doctor, the patient requires thoracocentesis, it should be performed immediately. Most patients tolerate said procedure well. The improvement of the animal's condition is remarkable and immediate.

The patient's position when performing the discussed procedure should depend on its condition. The procedure will be easiest for the doctor to perform in the sternal position, but if the animal does not tolerate it, it is recommended to perform the procedure in the side position or with the animal standing.

How to prepare the patient?

It is necessary to shave and disinfect the injection site. Lidocaine gel or cream can be used if the patient is stable and there is the possibility of waiting for the agent to take effect.

How to carry out the procedure?

The needle or cannula should be inserted under the skin from the cranial side of the rib to avoid damaging the nerves and blood vessels.

In the case of fluid, the needle should be inserted abdominally between the 7^{th} and 8^{th} intercostal space. When it comes to air – it should be administered dorsally between the 7^{th} and 9^{th} intercostal space.

If light sedation is required, butorphanol is a sensible choice.

Note: Before insertion, prepare a set for collecting fluid, extensions, syringes, and taps that are already connected to each other. It is very important because such an approach makes it possible to avoid additional stress and confusion during the procedure itself.

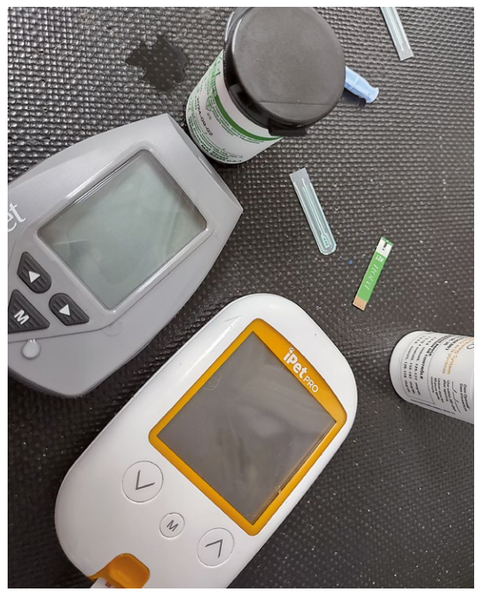


Fig. 4. Quick diagnostics: lactate measurement. Photo. A. Wawrzyniak

Once the patient is stabilized, it is possible to place a chest tube if this is still necessary. In the case of air removal, the drain itself is often not needed because once the patient is stabilized, the accumulated air is absorbed by the body within a few days.

5. EUTHANASIA

Emergency euthanasia is one of the most common procedures performed. Nevertheless, decision about carrying it out should always be dictated by the well-being of the patient, as well as preceded by the assessment of its prognosis, and the possibilities of treatment or lack thereof.

In the case of euthanasia, the following should be considered:

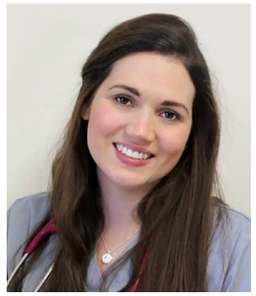
1. Will euthanasia make it possible avoid further suffering of the animal, low quality of life, and pain?
2. Is euthanasia a greater benefit for the animal than for the owner?
3. Is the reason for euthanasia justified?
4. Can further therapy be considered troublesome and not have any positive impact on the animal's quality of life?

Before commencing with the procedure, the doctor has to explain to the caregiver how it is carried out, inform that the animal will not feel pain, as well as notify him or her that the entire procedure is quick. If sedation* is opted for, the doctor should explain that the pet will not be conscious while pentobarbital is being administered. The owner should be granted the opportunity to say goodbye to his or her pet in a quiet spot. He or she should be given the chance to take a tuft of fur, a claw, or to make a paw or nose print of the pet. For some people, it is very important. The doctor should make sure that the caregiver is prepared to euthanize his or her pet. If this is not the case, he or she should be given time to consider such an approach.

If the caretaker has consented to the euthanasia of the animal, documents have to be prepared and the signature obtained. The entire procedure should be briefly explained, including the need to shave the hair in the area of intravenous access and peripheral venous catheter insertion. If the insertion of a catheter is not possible, the caretaker should be informed that sedation will be administered intramuscularly. It is also worth asking the caretaker about what he or she would like to do with the animal's body and inform him or her about the possibility of burying it within the area of an animal cemetery.

* In the UK, most euthanasia-related procedures are performed without prior sedation.

Stabilizing patients being in a critical condition. First of all: **DON'T PANIC!**



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PgC Small animal emergency medicine and surgery. MRCVS, Great Britain

Patients registered as "emergency" ones are typically clinically unstable and can be included in the group suffering from life-threatening issues. They can be most serious cases that a young doctor may encounter in the emergency room, as well as become the source of great stress for him or her. This publication aims at elaborating on the proper approach to emergency cases seen through the prism of most important procedures when it comes to emergency medicine.

It is always vital to stabilize the patient as quickly as possible and address the life-threatening condition. Such an approach grants the vet the time necessary to make the correct diagnosis and opt for a proper treatment.

ABC – INITIAL ASSESSMENT OF THE PATIENT

The initial examination makes it possible to specify whether the doctor is dealing with an acute condition, a collapse, or a different life-threatening condition. It additionally allows to estimate the risk of its occurrence in the upcoming future after the patient's admission. Said examination should always be performed with minimal immobilization of the patient in order to reduce stress experienced. It should be carried out for all emergency patients. The main purpose of said examination is to assess the respiratory tract condition (A), respiratory function (B), and the circulatory system condition (C). Regardless of suspicions as to the cause of the emergency, the ABC assessment is always recommended and should be performed as the initial examination.

Airway – respiratory tract

The airway condition should be checked. The vet should assess whether the patient can breathe on its own, whether or not the respiratory tract is blocked, and whether there are any identifiable conditions that may impair its functioning. In emergency cases, such as collapsed trachea, the patient may require intubation. In the event of a complete blockage of the upper respiratory tract – tracheostomy may be needed.

Breathing – respiratory function

Said examination has to be performed while maintaining a certain distance, especially when it comes to stressed patients. The vet has to assess the breathing pattern, breathing effort, number of breaths per minute, as well as pathological sounds audible within the area of the respiratory tract. A quick recognition of abnormalities, such as paradoxical, obstructive, or restrictive breathing allows to act immediately in situations that may threaten the patient's life.

Circulation – circulation assessment

In order to assess whether the patient is in circulatory shock, it is required to assess the heart function and pulse quality. The degree of tissue perfusion and oxygenation should also be examined, together with temperature measurement.

If the ABC assessment has been performed and the patient has been stabilized, a full clinical examination and additional tests required to make the diagnosis can be safely performed. It is worth remembering that stabilizing the patient in emergency situations is the most important and should never be delayed to perform additional tests or a detailed clinical examination. Firstly, it may hinder the initiation of life-saving measures. Secondly, in a patient being in a serious condition, additional procedures may increase the animal's stress and lead to cardiorespiratory failure, collapse, or even death.

INITIAL MEDICAL INTERVENTIONS

Oxygen therapy

Oxygen delivery should be initiated as soon as possible and performed in the least stressful manner possible. For most dogs and cats, a tent or oxygen cage is an ideal option, as it allows the animal to assume a comfortable position and requires minimal holding only. In the case of large dogs and if there is no large enough oxygen tent available, it is possible to utilize the so-called free flow of oxygen by opting for an oxygen mask or a similar device. Nevertheless, it has to be remembered that said method has its limitations and the amount of oxygen delivered is not high. If the patient does not tolerate a slow flow of oxygen or requires its long-term administration, a nasal cannula or an intranasal catheter should be opted for. They, however, require the vet to manually hold the animal. In the case of nasal catheters, knowledge pertaining to the proper mode of performing this procedure is also required.

Pain management and anti-anxiety medications

Analgesia is always necessary in the case of "emergency" patients, especially the ones after trauma or with suspected internal trauma. If it is not possible to determine the cause of pain but its symptoms can be seen, painkillers should always be administered before proceeding to further examination.

The safest solution for "emergency" patients are opioids, mainly due to their high analgesic effectiveness, swift action, and only marginal side effects. In animals with low-level pain that are highly stressed, the best choice is butorphanol, which has an additional anxiolytic effect. Nevertheless, it should not be opted for in patients after injuries, as it does not provide adequate pain relief. Table 1 provides most frequently used opioids when it comes to emergency patients. It is worth remembering that anti-inflammatory drugs and NSAIDS should not be used as first-choice medications in critical patients, especially due to their efficiency and side effects.

Table 1. Pain therapy and anti-anxiety medications

Medication	Dose*	Use
Methadone	**Dogs and cats** 0.1-0.3 mg/kg IV 0.1-0.5 mg/kg IM lub SC	Pain ranging from moderate to severe
Buprenorphine	**Dogs** 0.02 mg/kg IM, IV **Cats** 0.02-0.03 mg/kg IM, IV	Moderate pain
Butorphanol	**Dogs and cats** 0.2-0,5 mg/kg IM, IV, SC	Slight pain. Used as an anxiolytic
Petadin	**Dogs** 2-10 mg/kg IM, SC **Cats** 5-10 mg/kg IM, SC Never to be administered intravenously	Moderate pain. Frequently replaced with methadone.

* Doses may vary depending on product license and formulation. Always check most up-to-date leaflet.

Fluid therapy

Fluid therapy for critical patients should always be administered intravenously. Subcutaneous use of fluids in patients with vascular shock is not recommended, predominantly due to their insufficient absorption. It is also important to remember to measure blood pressure, which must always be checked in patients undergoing fluid therapy. It allows for the optimal specification of the amount of fluids to be administered.

In the case of hypovolemia, crystalloids are typically utilized. It is recommended for the fluids administered to be warmed up beforehand. The initial dose oscillates from 10 to 30 ml/kg/hour and should be administered in boluses given every 15 minutes, combined with the simultaneous assessment of the response to the administered fluid every 15 minutes.

Treatment should be continued until normovolaemia is achieved. Dehydration without concomitant hypovolemia requires opting for the so-called supplementary fluid therapy. It is estimated that dehydration should be corrected within the initial 12-24 hours. If it is not possible to establish an intravenous line (for example – in the case of pediatric patients), the medullary cavity should be chosen for fluid administration.

Body temperature

Measuring body temperature is a very important procedure, mainly because it is vital to treat patients with hyperthermia without fever differently than those with fever. In patients with hyperthermia without fever that may be caused by, for example, heat stroke, it is recommended to cool down the body as soon as possible. The "gold standard" when it comes to active cooling is applying cool water to the body in the form of cold towel compresses, utilizing a fan, or placing the animal in an air-conditioned room. One should avoid opting for the so-called "ice-packs" applied directly to the body, as they may cause a severe contraction of blood vessels and interfere with the process of lowering body temperature. "Ice -packs" are used only in atypical cases. Body temperature can also be lowered gradually through a proper fluid therapy.

In the case of hyperthermia caused by fever, for example being the result of the body's response to an infection, aggressive cooling therapy should never be opted for. The focus should be placed on identifying the cause of hyperthermia and treating it appropriately.

When it comes to patients that are hypothermic, their body should be warmed up by means of using heating mats or Bair Hugger systems. If the vet does not have them at his or her disposal, it is always possible to wrap the animal in bubble wrap, blankets, or similar materials. They will temporarily protect the animal from further heat loss until turning on active heating.

Due to the fact that hypoglycemia and hypothermia conditions are closely related, glucose measurement is a key procedure, especially when it comes to emergency patients.

In the case of hypoglycemia, it is recommended to initially administer 50% dextrose solutions in amounts ranging from 1 to 5 ml. 50% dextrose should be diluted in crystalloids (for example: in 0.9% NaCl solution, Ringer's solution, or a similar agent) to obtain a solution characterized by the concentration of 10% (or less). If intravenous, intraperitoneal, or central access is impossible, it is recommended to administer glucose gel, honey, or a sugar solution orally to the mucous membranes in order to increase the blood glucose level.

SUMMARY

Emergency situations that a young doctor has to deal with may be sometimes overwhelming in nature. Therefore, in such cases, introducing and following emergency medicine-specific procedures ensures the stabilization of the patient's condition and guarantees efficiency. A proper management of the so-called "critical" factors being vital for maintaining basic life functions grants time that may be required for carrying out additional examinations or tests that may allow to make a final diagnosis and implement an appropriate causal treatment.

Fig. 1. Emergency patient undergoing monitoring in the ICU. Photo. A. Wawrzyniak

DIETS

URINARY DOG

Urinary Dog diet intended for adult dogs to dissolve struvite stones and prevent their re-formation.

Composition:
yellow peas (25%), eggs (12%), green peas (12%), hydrolyzed turkey protein (11%), chicken fat (10%), groats buckwheat (10%), dried apple pulp (10%), sodium chloride (3%), salmon oil (3%), hydrolyzed chicken liver (2%), pea flour, dried algae *Ascophyllum nodosum* (0.4%), dihydrate calcium sulfate (0.4%, substance acidifying urine), dried blueberries lingonberry *Vaccinium vitis-idaea* L. (0.3%), mannanoligosaccharides (MOS, 0.02%), products yeast (-glucans, 0.02%), Mojave yucca (0.018%), fructooligosaccharides (FOS, 0.01%), dried sea buckthorn *Hippophae rhamnoides* L. (0.015%), inactivated *Lactobacillus helveticus* HA – 122 (15x10^9 cells/kg)

Analytical constituents:
crude protein – 18%, raw fat – 14%, crude ash – 5.6%, crude fiber – 2.9%, humidity – 10%, fatty acids omega-3 – 0.7%, fatty acids omega-6 – 1.6%, calcium – 0.5%, phosphorus – 0.4%, sodium – 1.2%, magnesium – 0.03%, potassium – 0.4%, chlorides – 1.7%, sulfur – 0.23%, hydroxyproline – 0.25%, vitamin D – 600 IU/kg, methionine – 0.75%.

Packaging:
2 kg, 12 kg

RENAL CAT

Renal Cat diet intended for adult cats to support kidney function in chronic kidney failure.

Composition:
eggs (26%), yellow peas (26%), hydrolyzed salmon protein (10%), hydrolyzed chicken protein (8%), chicken fat (8%), buckwheat (7%), dried apple pulp (6%), salmon oil (2%), hydrolyzed chicken liver (2%), egg shells (source of calcium, 1.5%), yeast (0.8%), potassium citrate (0.8%), pea flour, psyllium husks and seeds (0.6%), dried Ascophyllum nodosum algae (0.4%), shellfish powder (source chitosan, 0.08%), mannanoligosaccharides (0.025%), yeast products (betaglucan) (0.022%), fructooligosaccharides (0.02%), Mojave yucca (0.02%), dried sea buckthorn (0.015%), inactivated Lactobacillus helveticus HA – 122 (15x10^9 cells/kg).

Analytical constituentse:
crude protein – 22%, raw fat – 18%, crude ash – 5.1%, crude fiber – 2.3%, humidity – 10%, calcium – 0.8%, phosphorus – 0.5%, sodium – 0.3%, magnesium – 0.09%, potassium – 0.5%, fatty acids Omega-3 – 0.8%, Omega-3 fatty acids 6 – 2.9%, EPA (20:5 n-3) – 0.2%, DHA (22:6 n-3) – 0.3%, LA (18:2 n-6) – 2.0%, taurine – 0.22%, L-arginine 0.63%.

Packaging:
2 kg, 6 kg

SUPLEMENTS

BIOPROTECT **ULTRA**

BioProtect Ultra is an innovative preparation with a broad spectrum of action in supporting the proper microbiome and protecting the health of the digestive tract. Particularly recommended for animals with gastrointestinal dysbiosis. The preparation combines the features of both pro-, pre- and postbiotics, ensuring a synergistic effect in the intestines. Intended for long-term use, especially in cases of abnormal functioning of the digestive tract, including the pancreas, and in various enteropathies. It can be used on animals of different ages.

Composition:
Inactivated *Limosilactobacillus reuteri, Lactobacillus acidophilus* 50 mg (5 x 10^9 CFU), *Enterococcus faecium* 5 mg (5 x 10^8 CFU), *Yarrowia lipolytica* 100 mg, galactooligosaccharides 100 mg, L-tryptophan 50 mg, sodium butyrate microencapsulated 43 mg.

Packaging:
30 caps.

COSMETICS

IRRIGATION LIQUID

IRRIGATION LIQUID – liquid intended for use in dogs and cats for cleaning and rinsing skin lesions resulting from abrasions, cuts or other types of damage caused to the epidermis. The unique composition of the liquid is based on hypochlorous acid (HClO). Hypochlorous acid binds to the proteins of the cell wall of pathogens, leading to their denaturation, which increases the permeability of the cell wall and consequently leads to its disintegration. Liquid intended for local use.

Packaging:
250 ml, 500 ml

DIAGNOSTICS

BLOOD GLUCOSE MONITORING SYSTEM FOR PETS

Vet Expert BG Vet Pro

The Vet Expert BG Vet Pro is a professional-grade veterinary glucometer for use in dogs and cats.

- Highly accurate and reliable results, thanks to patented measurement technology
- User-friendly interface that streamlines the testing process
- Requires only a small sample of blood
- Designed for use in dogs and cats with special calibration strips
- Allows for simple switching between measurement units (mg/dl or mmol/l)
- Dedicated control solutions enable verification of the device and testing procedure

WHY CHOOSE A VETERINARY GLUCOMETER?

Glucometers adapted from human medicine, though commonly used in veterinary practicies only give a rough estimate of glucose concentrations due to the significant differences in glucose distribution between the plasma and the red cells in humans and in animals. To obtain the most reliable results, a veterinary glucometer calibrated for the specific species should be used.

CAT:
93% in plasma
7% in red blood cells

DOG:
87,5% in plasma
12,5% in red blood cells

HUMAN:
58% in plasma
42% in red blood cells

The distribution of glucose in animal and human blood.

SUPPORT FOR THE DIAGNOSTICS OF HYPERTHYROIDISM IN CATS

Vet Expert Rapid Test Feline T4

This is a quick competitive test that allows for a semi-quantitative assessment of the concentration of total thyroxine (TT4) in the serum or plasma of cats in just a few minutes. It is useful as a screening test for older cats over 7 years of age. The test allows for an initial assessment of thyroid function and is especially recommended when access to the laboratory is difficult. If there are no clinical symptoms, it is worth performing the test at least twice a year.

Species: cat
Test material: serum or heparin plasma
Sensitivity: 97.22%
Specificity: 93.02%
Packaging: 5 tests

Interpretation of the Feline T4 test result

≤ 40 ng/ml	> 40 ng/ml
Correct result	Result increased
Normal thyroid function or artificially low values	Probable hyperthyroidism

VET EXPERT
BASED ON EVIDENCE

CATS & DOGS

VETERINARY WOUNDS CARE

HEALING GEL PLUS

HYDROGEL FOR SKIN WITH WOUNDS SUPPORTING THE HEALING AND SCARRING PROCESS

NEW

HOCI TECHNOLOGY

- DOUBLE WOUND ENVIRONMENT PROTECTION
- A PIONEERING COMBINATION OF ACTIVE COMPONENTS WHICH SUPPORT HEALING AND SCARRING PROCESS
- EFFICACY CONFIRMED BY IN-USE TESTS UNDER THE CONTROL OF VETERINARIANS*

98%	100%	100%	100%
accelerates wound healing	effect of burning and itching reduction	provides an adequate hydration (moisture) at the wound site	ack of adverse effects

*Results of the survey research which was carried out under the control of veterinarians specializing in wound treatment. The study group consisted of 15 animals (dogs and cats). Pet caregivers were provided with Healing Gel Plus and they applied at the wound site twice a day at home.