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Management of Systemic Inflammatory Response Syndrome (SIRS) and Evaluation of Survival Rate in Cats Exposed to Trauma

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ABSTRACT

Background: Systemic inflammatory response syndrome (SIRS) is a complex condition that may be associated with sepsis or may progress with trauma, burns and major surgery. The aim of this study was to evaluate the systemic inflammatory response syndrome and survival rate in traumatized cats.

Methods: The study material consisted of 34(22.66%) cats diagnosed with SIRS among 150 cats who were traumatized by falling from a height. Cats were monitored and vital signs such as pulse, respiration, arterial blood pressure, oxygen saturation and body temperature were recorded. In addition, laboratory whole blood and biochemical tests were performed. In the treatment of cats with SIRS, it was aimed to provide circulatory support and support measures to keep the animal alive.

Result: 27(79.41%) cats with SIRS died due to lung failure or multi-organ failure and 7(20.58%) cats survived. The prognosis in SIRS patients with trauma depends on the patient's response to aggressive treatment and supportive care. SIRS has a high mortality rate. Common causes of death include cardiovascular collapse, multi-organ dysfunction and acute lung injury.

Key words: Cats with trauma, Survival rate, Systemic inflammatory cats (SICs), Systemic inflammatory response syndrome (SIRS).

INTRODUCTION

In cats and dogs in small animal clinics, systemic inflammatory response syndrome (SIRS) can occur from an infectious or non-infectious cause. Early identification of patients at risk and their clinical symptoms and initiation of treatment as early as possible are important for survival (Randels, 2013; Sharp, 2018; Eroğlu and Kırbaş, 2020; Sun *et al*., 2021).

The term SIRS was first used in 1991 by the American College of Chest Physicians and the Society of Critical Care to describe the systemic activation of inflammation leading to organ failure in critically ill patients. However, SIRS may not always be related to sepsis and it may be associated with many different diseases, traumas, burns and major surgery (Pugin, 2012; Randels, 2013; Silverstein, 2015; Sharp, 2018). For the diagnosis of SIRS, the specific systemic symptoms listed in Table 1 must be present (Randels, 2013; Silverstein, 2015).

SIRS should be suspected in weak or collapsed cats. Cats with SIRS are also called systemic inflammatory cats (SICs). SICs typically present with hypotension and icterus and lie on their side. They usually have bradycardia, rather than tachycardia as expected. Non-hyperthyroid SICs are usually anorexic, so early feeding may be required, but remember that these patients are hypotensive or shocked. Anemia is common in SICs. These cats appear to be near death, typically for a few days before they begin to recover (Silverstein, 2015; Caserta *et al*., 2018).

The most obvious difference between SIRS and sepsis is based on whether there is an underlying infection (Pugin, 2012; Silverstein, 2015; Sharp, 2018; Huo *et al*., 2021; Yazlık *et al*., 2022). Once it has been determined that a patient has clinical evidence of SIRS, with or without sepsis, it is critical that the underlying disease process be corrected and the oxygen capacity of the tissues not compromised so that treatment can be initiated promptly (Pugin, 2012; Lord *et al*., 2014; Silverstein, 2015).

Deaths within the first hour after major trauma are usually due to head trauma or bleeding. In patients who survive this, death may occur in the first 24 hours, normally due to hypoxia, hypovolemia or severe head trauma (Lenz *et al*., 2007; Brøchner and Toft, 2009; Lord *et al*., 2014; Huo *et al*., 2021; Çatalkaya *et al*., 2022). If a seriously injured patient survives these first two episodes, there is a high risk of developing immunological dysfunction, followed by sepsis or systemic inflammatory response syndrome (SIRS). This can lead to multi-organ dysfunction with a high

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probability of death (Lenz *et al*., 2007; Lord *et al*., 2014; Sharp, 2018).

The aim of this study was to evaluate the systemic inflammatory response syndrome and the survival rate of cats exposed to trauma.

MATERIALS AND METHODS

This study was carried out on 34 cats diagnosed with SIRS among 150 cats of different breeds, ages and genders who were exposed to trauma as a result of falling from a height in Dicle University Veterinary Faculty, Department of Veterinary Surgery between 2021-2023. The study protocol was approved by the Dicle University Health Sciences Application and Research Center Local Ethics Committee (E-35582840-020-541775).

In the initial evaluation of each cat, anamnesis information, clinical signs and physical examination findings were included. In addition, clinical laboratory tests were performed and CBC, serum biochemical analysis, blood lactate concentration, acid-base status and coagulation profiles were determined. In the evaluation of these data, the reference ranges published by DeClue *et al*. (2011) were used (Table 2).

Diagnostic imaging findings (chest, skeletal and abdominal bidirectional radiography and chest and abdominal ultrasonography) and length of hospital stay were noted along with the emergency treatment administered.

Each of the cats was monitored. Diastolic arterial blood pressure (DAP), mean arterial pressure (MAP) and systolic arterial pressure (SAP) readings were recorded; Hypertension was defined as SAP > 150 mm Hg and hypotension as SAP < 90 mm Hg. Hypoxia was defined as an oxygen saturation <94% as measured by pulse oximetry. Body temperatures were recorded with a rectal probe. Coagulopathy was defined as three or more of thrombocytopenia, prolonged prothrombin time, prolonged partial thromboplastin time, or prolonged active clotting time. Acute kidney injury was defined as at least 1.5-fold increase in serum creatinine concentration from baseline. Hepatopathy was defined as at least 2-fold increase in serum alanine aminotransferase activity, serum alkaline phosphatase activity, or serum bilirubin concentration. In all these definitions, the report published by Lux *et al*. (2018) was taken as reference.

Among the cats included in the study, those meeting at least three of the criteria listed (as previously puplished, Randels (2013) and Silverstein (2015)) in Table 1 were considered SIRS. Cats that were not considered SIRS although they were trauma patients were not included in the study.

It was primarily aimed to keep cats alive for therapeutic purposes. For this, circulation regulation and fluid therapy were performed. Hypoxic cats were kept in the intensive care unit and supplemented with oxygen. In the meantime, attention was paid to excess fluid load and fluid delivery rate. When using crystalloid and colloid fluids to meet the fluid deficit, reference was accepted for the calculation of the fluid deficit and the delivery rate of the fluid (10-15 mL/kg), as reported by Randels in (2013), Silverstein and McGowan (2015). In addition, urine output was monitored and diuretics were administered. Dopamine (Dopamine DBL®, Orna, Turkiye, 5 to 10 μg/kg/min, slowly intravenous) for patients whose hypovolemia persists despite fluid administration at calculated doses. Dobutamine (Dobcard®, Vem, Turkiye, 5-20 μg/kg/min, slowly intravenous) was used in patients whose cardiac depression did not recover with fluid support. Cats were followed frequently for pulmonary edema and pneumonia. Also, Amoxicillin+clavulanic acid (Synulox®, Zoetis, Turkiye, 8.75 mg/kg subcutaneously) and enrofloxacin (Baytril-K® %5, Bayer, Turkiye, 5 mg/kg, subcutaneously) were administered for antibiotic therapy.

RESULTS AND DISCUSSION

Out of 150 cats who were traumatized by falling from a height, 34 of them were diagnosed as SIRS because they showed 3 of the 5 SIRS criteria. The incidence of SIRS due to traumatic causes among cats falling from a height was calculated as 22.66% in this study. In the information obtained from the owners of all these cats, it was confirmed that they had not received any treatment before and it was learned that they were healthy. Of these cats, 19 (55.88%) were male and 15 (44.12%) were female. The cats were from 9 tabby, 6 Sarmanian, 5 British, 4 Scotish, 4 Siamese, 3 Persian, 2 Van, 1 exotic shorthair breeds. Mean body weight was calculated as 3.72±1.37 kg (min 1 kg, max 6 kg) and their age was calculated as 4.58±1.95 years (min 1 year, max 9 years). Some values of clinical variables in cats with traumatic SIRS are summarized in Table 2.

The mean hospital stay was 3.2±1.2 days. In this study, mortality and survival rates were determined as 79.42% (n=27) and 20.58% (n=7), respectively. Of these cats, 16 had acute respiratory distress syndrome, 3 had acute renal failure and 1 had icterus within 24 hours before death. Radiographic images of some cases included in the study are given in Fig 1.

The term SIRS is defined as a systemic activation of inflammation that leads to organ failure in critically ill patients (Lord *et al*., 2014; Silverstein, 2015; Zhang *et al*., 2019; Sun *et al*., 2021; Yazlık *et al*., 2022). SIRS can be associated with many diseases such as pancreatitis, peritonitis, trauma,

Table 1: Accepted criteria for the diagnosis of SIRS in cats. Must meet three of these criteria.

Animal	Temperature (F)	Heart rate (bpm)	Respiratory rate (breaths/min)	White blood cell count ($\times 10^3$) percentage of bands	Band cells
Cats	<100 or >104	<140 or >225	>40	<5 or >19.5	>5

As reported Randels (Brøchner and Toft, 2009) and Silverstein (Comstedt *et al*., 2009).

burns and major surgery. That is it may not always accompany sepsis (Comstedt *et al*., 2009; Randels, 2013; Silverstein, 2015). In our study, cats with SIRS were included among the patients who were exposed to trauma in the form of falling from a height. Thus, cats with trauma-induced SIRS were tried to be clinically standardized.

Specific systemic manifestations must be present to diagnose SIRS (Pugin, 2012; Silverstein, 2015; De Clue, 2017). In cats, the recommended criteria for SIRS were derived from a retrospective study of clinical findings in cats with severe sepsis confirmed at autopsy (Silverstein, 2015; De Clue, 2017). For a diagnosis of SIRS to be made, at least 2 of the 5 criteria must be present in dogs and at least 3 of 5 criteria in cats. Sensitivity increases with the use of stricter inclusion criteria; therefore, the presence of more SIRS criteria in a given patient increases the likelihood of a true systemic inflammatory process (Silverstein, 2015; Eroğlu and Kırbaş, 2020). However, sensitivity varies between 77-97% in dogs and 64-77% in cats, depending on the criteria used and reference values (Silverstein, 2015; De Clue, 2017). In our study, cats that had at least three of the criteria listed in table 1 among the traumatized cats were considered SIRS. According to this rate, it can be said that the incidence of SIRS among cats who have been traumatized by falling from a height is 22.66%. Therefore, we recommend that the SIRS criteria be considered in the evaluation of a traumatized cat.

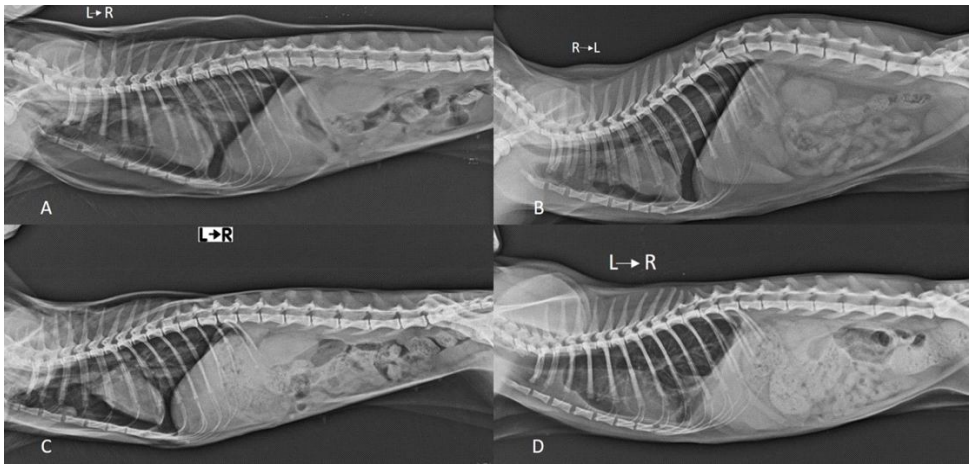
In the report by DeClue *et al*. (2011), for cats with sepsis induced by various microorganisms, clinicopathological abnormalities associated with sepsis include a high percentage of band cells, eosinopenia, hyponatremia, hypochloremia, hypoalbuminemia, hypocalcemia and hyperbilirubinemia. Hyponatremia and hypochloremia have been found in cats with non-infectious SIRS. Cats with sepsis have been reported to have a higher percentage of band cells and a lower plasma albumin concentration than cats with non-infectious SIRS, while cats with non-infectious SIRS have been reported to have a higher concentration of ALP (Comstedt *et al*., 2009; De Clue *et al*., 2011; Caserta *et al*., 2018; Gori *et al*., 2021). Band cell counting could not be performed in this study. However, there was a significant increase in ALP concentration. The increase in ALP concentration can of course be explained by the effect of liver.

It has been reported that early recognition of patients with systemic inflammatory response syndrome (SIRS) and sepsis is essential to optimize the patient's chance of survival (McGowan, 2015; Caserta *et al*., 2018; Sharp, 2018; Zhang *et al*., 2019). Early intervention is required to minimize further

Table 2: Mean±SD values of clinical variables in cats with traumatic SIRS (n=34).

Values	Reference interval	Mean value±Standard deviation
Temperature (°C)	38.1-39.2	38.48±0.60
Heart Rate (beats/min)	110-200	204.35±36.13
Respiratory rate (breaths/min)	20-30	64.29±39.30
WBCs ($\times10^3$ cell/L)	5.5-19.5	11.70±6.20
Neutrophils ($\times10^3$ cells/μL)	2.5-12.5	9.25±3.22
Lymphocytes ($\times10^3$ cells/μL)	1.5-7	2.20±0.65
Monocytes ($\times10^3$ cells/μL)	0-0.85	0.60±0.15
Eosinophils ($\times10^3$ cells/L)	0-1.5	0.70±0.25
Hct (%)	24-45	32.20±3.76
Glucose (mg/dL)	52-153	122.50±17.63
Urea nitrogen (mg/dL)	17-35	24.40±4.80
Creatinine (mg/dL)	0.5-2.2	1.00±0.36
Sodium (mEq/L)	149-159	149.50±0.15
Potassium (mEq/L)	3-4.7	3.90±1.12
Chloride (mEq/L)	114-122	118.22±3.60
Total CO_2 (mEq/L)	11-22	18.20±2.19
Albumin (g/dL)	2.6-4.2	3.80±0.28
Total proteins (g/dL)	6.4-8.8	7.80±1.20
Globulin (g/dL)	2.6-5.9	4.60±1.56
Total calcium (mg/dL)	8.6-10.7	9.00±0.82
Phosphorus (mg/dL)	2-5.3	4.20±1.35
Total bilirubin (mg/dL)	0-0.3	0.60±1.20
ALT (U/L)	18-77	110±12.20
ALP (U/L)	5-55	28.50±8.40

Reference values are taken as reported by DeCule *et al.* in (2011). To convert temperatures in celsius to fahrenheit, multiply by 9/5 and add 32.



In figures A, B, C, it is seen that the heart is displaced dorsally due to the effusion and effusion that develops due to thoracic trauma and a leaf-like appearance occurs in the lungs. In addition to these findings in Fig A, it is observed that subcutaneous emphysema occurs due to damage in the Thorax area. Fig D shows that the heart silhouette is distorted and leaf-like images occur in the lungs due to effusion resulting from thoracic trauma.

Fig 1: Some radiographic images of cases with thoracic trauma.

tissue ischemia, cellular damage and organ damage with developing SIRS. The primary goal of treatment consists of "rapid circulation support, appropriate antimicrobial selection and supportive measures" (McGowan, 2015; Zhang *et al*., 2019). Therefore, in our study, in addition to oxygen support in cats taken to the intensive care unit, intravenous fluid therapy was considered important. Since the patients are trauma patients, attention should be paid to the amount and speed of fluid administration in terms of pulmonary edema.

The prognosis for patients with SIRS is directly related to the type of underlying disease, the ability to correct the underlying disease process, and the patient's response to aggressive treatment and supportive care (Tello, 2003; Sharp, 2018). In our study, these conditions were met and the treatment was started. Especially radiographic and ultrasonographic examination is important in the evaluation of the lungs and kidneys. For these diseases, only blood findings may be limited. In addition, when the patients who developed acute respiratory distress syndrome and acute kidney failure were accepted as SIRS, there were no signs of these diseases, and it is remarkable that they developed later.

Due to the typical long hospital stay, intensive care unit, these patients require a significant financial commitment from their owners and, whatever the cause, SIRS has a high mortality rate. The most common causes of a condition that subsides even with aggressive treatment include cardiovascular collapse, persistent coagulation abnormalities, multiple organ dysfunction syndrome, and acute lung injury (Tello, 2003; Sharp, 2018). In our study, the survival rate was 20.58%, while the mortality was quite high (79.41%). Lung damage was confirmed radiologically in most cats who died. In fact, lung or thoracic problems should be expected in a traumatized patient.

Among the factors associated with a patient's survival, "early recognition of the SIRS/sepsis process, aggressive early fluid resuscitation, early appropriate antimicrobial use, identification and treatment of the underlying disease process, identification and treatment of anemia and coagulation disorders" have been reported (Tello, 2003; Brøchner and Toft, 2009; Sharp, 2018; Huo *et al*., 2021). The factors described above are the results of SIRS studies with sepsis, but the effect of these factors was confirmed in our study once again. The effect of A (Airway), B (Breathing), C (Circulation), D (Disability) steps in the trauma protocol should also be reminded.

CONCLUSION

As a result, in this study, it was determined that SIRS was seen at a rate of 22.66% in cats who were traumatized by falling from a height. Among these cats, the survival rate was very low (20.58%). SIRS should be considered in the evaluation of a traumatized patient.

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Additional informations

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Conflict of interest

There is no conflict of interest between the authors.

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