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ORIGINAL RESEARCH

Causes and consequences of feline haemothorax: A retrospective case series

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Abstract

Background: The objective of this study was to describe the causes of haemothorax in cats, patient presentation and outcome.

Methods: This was a retrospective study based in a university teaching hospital. The electronic case records of cats presenting with a haemothorax between January 2005 and January 2023 were searched. Cases were categorised into 'trauma', 'neoplasia', 'coagulopathy' or 'other'. Signalment, physical examination, clinical pathology findings, concurrent injuries and diagnostic imaging findings were recorded. The median hospitalisation time was calculated, and survival to discharge was noted.

Results: Twenty-five cats were eligible for inclusion. Twenty cases of haemothorax were traumatic in origin, two were neoplastic, two were 'other' and one was coagulopathic. Increased respiratory rate ($n = 22$) and effort ($n = 20$) were common, and most patients were anaemic at presentation ($n = 16$). Common concurrent injuries included pulmonary contusions ($n = 15$) and pneumothorax ($n = 11$). The median hospitalisation time for the trauma cats was 5 days (range 1–15). Overall, 83.3% of the cases survived to discharge.

Limitations: The limitations of this study are related to its retrospective nature and the relatively small number of cats in the study population.

Conclusion: Haemothorax requiring a thoracocentesis in cats is rare, with trauma being the most likely cause. These patients tend to have concurrent injuries and require ongoing hospitalisation. Owners can be advised that the short-term outcome is generally favourable.

INTRODUCTION

In human medicine, haemothorax is defined as an effusion in the pleural cavity with a packed cell volume (PCV) of at least 25%–50% of that of the patient's peripheral blood.[1–3] In the veterinary literature, this is less well defined, although haemorrhagic effusion can be described as an effusion with more than 0.5–1 million/μL red blood cells with a measurable PCV (>1%).[4] Trauma and coagulopathy are the most commonly reported causes of haemothorax in the veterinary literature, although most studies have focused on dogs.[5–9] In contrast, the literature on cats is less extensive and consists mostly of case reports.[10–12] If a patient has sustained thoracic trauma, haemothorax is high in the index of suspicion of disease. In one human study, 6.3% of patients with trauma had concurrent haemothorax and/or pneumothorax; no other pleural effusion types were documented. It is therefore likely that grossly haemorrhagic fluid in a patient with a history of trauma is a haemothorax as opposed to other pleural effusion.[13]

A number of retrospective studies have characterised pleural effusion in cats, in which the reported proportion of cases with haemothorax is up to 10%.[3,14,15] However, details regarding the cause of the haemothorax in these studies are lacking. Canine haemothorax is reported more commonly, and although trauma is reported as a cause, neoplasia and coagulopathy are also frequently reported aetiologies.[5–9] In the human literature, haemothorax is caused by trauma, coagulopathy, neoplasia or iatrogenic causes. Clinical signs include worsening dyspnoea and signs of haemodynamic instability.[16]

Given the sparse data regarding feline haemothorax in the literature, this study aimed to describe the causes of haemothorax in cats, as well as the approach to diagnosis, clinical signs and survival to discharge of these patients, with the aim of aiding clinicians in their treatment of these cases and in their discussion with owners using evidence-based veterinary medicine.

METHODS

The electronic case records of a veterinary teaching hospital with both a referral and first opinion out-of-hours service were searched for any feline patients presenting with a haemothorax between January 2005 and January 2023. The search terms 'haemothorax' and 'hemothorax' were used. Cases were then manually reviewed by the same single operator and first marked if they were 'eligible' or 'non-eligible'. Any cases that were not clear were discussed with both authors for clarity. Cases were eligible if they had a diagnosis of haemothorax made at the hospital. This was defined as cases where thoracocentesis was performed and the attending clinician recorded a diagnosis of a haemothorax in their clinical notes. Cases were excluded if there was no thoracocentesis or no postmortem was performed. The eligible cases were reviewed and categorised into either 'trauma', 'neoplasia', 'coagulopathy' or 'other' as the cause of the haemothorax. The traumatic injury category was then subcategorised into road traffic accident, high-rise trauma or unwitnessed/unknown trauma. This was based on clinical, pathological and diagnostic imaging findings and clinical notes.

The following data were also recorded if available: signalment; physical examination findings on arrival at the hospital; PCV of peripheral blood on admission and the PCV of the pleural effusion; coagulation profile and platelet count; subjective assessment of volume of effusion noted on point of care ultrasound (POCUS); any other POCUS findings; whether thoracocentesis was used as a diagnostic tool or as a therapeutic requirement; presence of any concurrent injuries found on diagnostic imaging; and hospitalisation length and survival to discharge. The volume of pleural effusion was subjectively assessed by a clinician at the time of presentation, which is difficult to objectively compare between cases. Physical examination findings were defined as follows[17]: tachypnoea was diagnosed if the respiratory rate was equal to or greater than 40 breaths per minute, bradycardia was defined as a heart rate equal to or lower than 160 beats per minute (bpm) and tachycardia was defined as a heart rate equal to or greater than 220 bpm. Cats were deemed to have an elevated rectal temperature if it was greater than 39.2°C and to be hypothermic if it was lower than 38.1°C. Patients were defined as being severely anaemic when they had a PCV of less than 15%; if their PCV was between 16% and 24%, they were classified as moderately anaemic; and if their PCV was between 21% and 25%, they were classified as being mildly anaemic.[18]

Descriptive statistics were performed on the data. Age, respiratory rate, heart rate, temperature and PCV were assessed for normality using the Shapiro–Wilks test. The mean and standard deviation were calculated for parametric data, while the median and range were calculated for non-parametric data. The interquartile range (IQR) was further calculated for the non-parametric data in the trauma subgroup. All data processing and descriptive statistics were performed in the R environment (R core Team 2013).

RESULTS

In total, 49 cases required manual review, with 24 cases excluded because thoracocentesis was not performed and haemothorax was only suspected from imaging reports. Therefore, there were 25 cats that were diagnosed with haemothorax during the study period. Twenty of these cases were traumatic, one of which was dead on arrival and postmortem confirmed haemothorax secondary to trauma of unknown cause; therefore, this case was removed from the study. Two cases were neoplastic, two were categorised as other and one was coagulopathic. Overall, 20 cases survived to discharge out of 24 cases that were alive on arrival at the hospital (83.3%).

Trauma

Most of the cases were traumatic in origin (79.2%). Road traffic accident was confirmed in six cats, high-rise syndrome was confirmed in one cat and the remaining 13 cats sustained an unwitnessed trauma. Among the 19 traumatic cases that were alive at presentation, 11 cats were male and eight cats were female. The most common breed was the domestic short hair (n = 10); however, other breeds were also reported: Bengal (n = 3), British short hair (n = 1), Burmese (n = 1), domestic long hair (n = 1), Maine coon (n = 1), ragdoll (n = 1) and Russian blue (n = 1). The median age of patients was 15 months, with a range of 3–180 months and an IQR of 28.5 months.

The physical examination findings are summarised in Table 1. All but one cat that had sustained trauma had an increased respiratory rate (median: 60 bpm; range: 40–128 bpm; IQR: 11 bpm) and the other was 'within normal limits'. With regards to respiratory effort, 15 had increased respiratory effort (78.9%) and four had normal respiratory effort (21.1%). The mean temperature was 37.3°C (standard deviation [SD]: 1.9). Two patients were found to have an elevated temperature, six were hypothermic and three were normothermic. Temperature was not documented for eight cases. The mean heart rate was 192 bpm (SD: 34). Four patients were tachycardic on admission, nine had a normal heart rate and four were bradycardic. Heart rate was not documented for two patients.

The mean peripheral blood PCV on admission was 28.7% (SD: 7.51), and one patient did not have their

TABLE 1 Summary of the presentation of cats diagnosed with haemothorax ($n = 24$) between January 2005 and January 2023 at a university teaching hospital with both a first opinion and referral emergency service

	Cause of haemothorax			
	Trauma (n = 19)	**Neoplasia (n = 2)**	**Other (n = 2)**	**Coagulopathy (n = 1)**
Normal respiratory rate (<40 breaths per minute)	0	1	0	1
Tachypnoea (≥40 breaths per minute)	19	1	2	0
Increased respiratory effort	15	2	2	1
Normal respiratory effort	4	0	0	0
Hypothermia (<38.1°C)	6	1	1	1
Normothermia	3	1	0	0
Hyperthermia/pyrexia (≥39.2°C)	2	0	0	0
Bradycardia (<160 bpm)	3	0	0	0
Normal heart rate	10	2	2	1
Tachycardia (≥220 bpm)	4	0	0	0
Severe anaemia (<15%)	0	1	0	1
Moderate anaemia (16%–24%)	7	1	0	0
Mild anaemia (25%–30%)	5	0	1	0
Normal packed cell volume	6	0	1	0
Diagnostic thoracocentesis	14	2	1	0
Therapeutic thoracocentesis	5	0	2	1

PCV recorded in the clinical notes. Six patients had a normal PCV (33.3%), five patients were mildly anaemic (27.8%), seven were moderately anaemic (38.9%) and none was severely anaemic, as documented in Table 1. A coagulation panel was not performed on any of these cats. However, platelet count was performed in 10 patients, all of whom were considered adequate when assessed by a clinical pathologist.

The volume of effusion was subjectively assessed as moderate using POCUS in eight cases, a small volume in 10 cases and not specified in one case. A diagnostic thoracocentesis was performed on 14 patients (73.7%), whereas the remaining five patients required therapeutic thoracocentesis (26.3%). The PCV of the effusion was only recorded for five patients in this category.

Cats often presented with multiple concurrent injuries (Table 2) that were diagnosed on further imaging, the most prevalent being pneumothorax (11 cases) and pulmonary contusions (15 cases). POCUS was performed in 18 cases, radiographs were performed in 10 cases, computed tomography (CT) was performed in three cases and both radiographs and CT were performed in three cases. For those that underwent POCUS, six identified pneumothorax via loss of glide sign, nine noted B lines and one noted a shred sign. There was one POCUS examination where contusions were interpreted, but the findings were not further specified.

Seven cases required thoracic surgery, three of which also required extrathoracic surgery. Fifteen cases were referred, five of which presented to the first opinion out-of-hours of service. One of these cases was referred immediately to the referral service.

TABLE 2 Concurrent injuries in cats diagnosed with traumatic haemothorax ($n = 19$) between January 2005 and January 2023 at a university teaching hospital with both a first opinion and referral emergency service

Injury	**Number of cases**
Pulmonary contusions	15
Pneumothorax	11
Skull fracture	5
Rib fractures	5
Limb fracture	4
Ocular injury	4
Spinal fracture or injury	3
Pelvic fracture	3
Diaphragmatic rupture	2
Wounds	4
Abdominal wall rupture	2
Traumatic brain injury	1
Subcutaneous emphysema	1
Pneumoretroperitoneum	1
Pneumomediastinum	1

Sixteen of these cases survived to discharge, and one patient was euthanased within 24 hours of arrival due to financial constraints. One patient experienced respiratory arrest, became comatose, required mechanical ventilation and was subsequently euthanased on day 9. One patient was euthanased on day 14 due to deterioration of dyspnoea and suspected pulmonary parenchymal disease. The median length of hospital stay for those that survived was 5 days, ranging from 1 to 15 days (IQR: 5 days).

Neoplasia

Two cases of neoplasia were documented. One patient was a 6-year-old, female, neutered, Siberian cat. Her heart rate and temperature were within normal limits; however, there was increased respiratory rate and effort. Her PCV on admission was 24%. Her platelet count was adequate, and her coagulation profile was within normal limits. A diagnostic thoracocentesis revealed the PCV of the effusion to be 21%, and the volume of effusion noted on POCUS was mild to moderate. On POCUS, a mediastinal mass was also identified alongside enlarged sternal lymph nodes. Further imaging via CT confirmed this finding with associated metastases. Fine needle aspirate samples were taken, and she was diagnosed with mediastinal carcinoma with prescapular lymph node metastasis and pulmonary metastasis. She was in hospital for 1 day and survived to discharge but was discharged home on palliative care.

The second case was a 13-year-old, male, neutered, British short hair. His heart rate, respiratory rate and temperature were within normal limits; however, he did have increased respiratory effort. His PCV on admission was 13%, and a coagulation profile was not performed; however, his platelet count was adequate. The PCV of the effusion, which was obtained by diagnostic thoracocentesis, was 16%. An amount of 70 mL of effusion was drained via thoracocentesis. There were no other significant POCUS findings. However, a CT scan revealed a primary mass on the distal third of the right ninth rib. This mass was sampled using fine needle aspiration, which revealed spindle cell proliferation, but it was poorly cellular and therefore unable to determine aetiology. The owner opted for euthanasia due to the grave prognosis on his second day of hospitalisation.

Coagulopathy

There was one case with a suspected coagulopathy: a 4-month-old, male, entire, domestic short hair. He arrived with markedly increased respiratory effort, his heart rate was 160 bpm and he was hypothermic at 32.8°C. His PCV on admission was 12%, and the PCV of the effusion was 17%. The coagulation panel showed the prothrombin time to be above the readable level of the analyser (reference interval: 15–22s) and activated partial thromboplastin time to be 119s (reference interval: 65–119). The platelet count was adequate on smear evaluation. The pleural effusion was noted to be a large volume on POCUS and was drained via therapeutic thoracocentesis. The cat subsequently received an autotransfusion. Further imaging included a thoracic ultrasound showing an area in the cranial mediastinum considered most likely to represent thymic tissue (normal or involuting) with a thin rim of surrounding fluid. Supportive care, including vitamin K therapy and chest drain placement due to pleural fluid accumulation post-thoracocentesis, was then commenced. The cat was hospitalised for 5 days and discharged with a 3-week course of vitamin K. The presumptive diagnosis was rodenticide intoxication; however, the case was lost to subsequent follow-up.

Other

There were two cases of haemothorax that did not fit into the categories of trauma, neoplasia or coagulopathy. A 6-month-old, female, entire, domestic short hair was diagnosed with fibronecrotising pneumonia and pleuritis. She had an increased respiratory rate of 60 breaths per minute and increased respiratory effort on arrival with a normal heart rate, and her temperature was not recorded. Her PCV on admission was 23%, and her coagulation profile and platelet count were measured; both were within normal limits. The PCV of the effusion was 18%. This effusion was obtained via therapeutic thoracocentesis, and 63 mL of blood was drained via thoracocentesis. No further POCUS findings were observed, and a follow-up CT scan revealed a mass on the left caudal lung lobe. Subsequently, an intercostal thoracotomy was performed for removal of the mass, and histopathology revealed a severe, focally extensive, chronic, necrotising and fibrosing pneumonia with marked atelectasis and severe fibronecrotising pleuritis with negative culture. The cat was hospitalised for 7 days in total and survived to discharge.

The second case was a 3-year-old, male, neutered, domestic short hair with haemothorax of unknown cause. On arrival, he had an increased respiratory rate and effort, his heart rate was 160 bpm and he was hypothermic at 36.1°C. His PCV on admission was 27%, and the PCV of the effusion was 23%. The coagulation panel and platelet count were within normal limits. The effusion was noted to be a small volume on POCUS and was obtained via diagnostic thoracocentesis; no further POCUS findings were documented. Thoracic radiographs revealed an airgun pellet in the patient's axilla, but with no evidence of an external wound. This finding was thought to be incidental. The cat was in the hospital for 1 day and survived to discharge.

DISCUSSION

This study aimed to report the causes and outcomes of haemothorax in cats given the dearth of information in this area. The majority of feline haemothorax cases are traumatic in origin, and their survival to discharge is good (83.3%). It was interesting to note that of all cases of feline haemothorax reviewed at the institution, only one was suspected to be caused by an underlying coagulopathy. Previous case reports have shown various causes of feline haemothorax. These include high-rise syndrome, fat embolism secondary to trauma, parasitic infection with *Dirofiliaria* causing vessel trauma, coagulopathy and those of unknown

cause.[11,12,19,20] Canine haemothorax is reported more commonly, and although trauma is reported as a cause, neoplasia and coagulopathy are also frequently reported aetiologies.[5–9]

Most cats presented to the hospital with either increased respiratory effort or an increased respiratory rate. It can be normal to have 0.3 mL/kg of pleural effusion; however, an increased accumulation of fluid can cause respiratory signs.[5,15] Many of these cats presented after sustaining trauma. Their increased respiratory rate may have been a result of acute pain, stress or concurrent thoracic injuries (such as pulmonary contusions or pneumothorax) as well as the pleural fluid accumulation.[19] Four patients presented with tachycardia, which could have been due to blood loss-induced hypovolaemic shock, acute pain or stress at presentation. There were four patients that were bradycardic, and it is possible that these patients had either sustained significant head trauma or had been administered opioids prior to referral.[21,22] Sixteen patients presented with anaemia, which may account for other clinical signs of haemodynamic instability.

The temperature was not recorded in nine patients. In one record, it was explicitly stated that temperature was not taken due to patient instability. Cats presenting with increased respiratory effort can deteriorate rapidly, and patient stability and treatment should be prioritised.[23] Those with a low body temperature may have had a primary or secondary hypothermia; if they had sustained trauma and were unable to move, they could have been exposured to environmental temperatures. However, they may also have secondary hypothermia due to hypovolaemic shock.[24]

The majority of thoracocenteses performed were diagnostic; however, nearly half of all patients (45.8%) had a concurrent pneumothorax. In these cases, it is not clear whether a therapeutic thoracentesis was required for the effusion, the pneumothorax or both. It may also have been unclear to the attending veterinary surgeon, as pulmonary contusions were also present in 62.5% of cases, making it difficult to determine which pathology was causing the greatest degree of respiratory distress at the time. For those patients that had been referred ($n = 20$), it is possible that thoracocentesis had already been performed, meaning that, at the time of presentation, the volume of effusion was smaller than that initially identified. Only one patient, which was the patient with suspected rodenticide intoxication, required repeated thoracocentesis.

POCUS was a frequently used tool in the investigation of these cats and proved useful in identifying changes consistent with neoplasia (a mediastinal mass) in one cat. Many different clinicians have assessed these cats, resulting in likely variation in not only the subjective assessment of the effusion volume but also the ability to diagnose concurrent pathology. Radiography was performed in 10 cases, which can be helpful in diagnosing pulmonary contusions; however, some studies have shown that ultrasound is more sensitive than radiographs and CT for diagnosing canine contusions.[25] By comparison, in human medicine, CT is considered the gold standard.[22] Pneumothorax can also be diagnosed on either ultrasound or radiographs, with the decision-making process of which modality to use likely being influenced by finances and patient stability.[26] However, the topographical nature of CT can allow for a more detailed analysis of thoracic (and non-thoracic) pathology,[27] and this was performed in nine cases.

Canine haemothorax is most commonly caused by trauma; in one retrospective study that reviewed 235 cases of canine trauma, 18% presented with haemothorax.[28] However, coagulopathic causes are also well described, including anti-coagulant rodenticide intoxication and *Angiostrongylus vasorum* infection.[5,6,29–31] If non-coagulopathic in origin, the most likely cause of haemothorax in dogs is neoplasia.[1] Furthermore, in younger dogs, spontaneous thymic rupture can be an inciting cause.[9] *Dirofilaria immitis* has been detected in cats and can be a cause of haemothorax in other parts of Europe.[10,32]

Only one patient in the current study had an underlying coagulopathy that caused a haemothorax; however, it should be noted that a coagulation profile was only performed in three other cases where there was no obvious cause of bleeding, but in all other cases, clear evidence of the cause of the haemothorax was present. There are infrequent reports of anticoagulant rodenticide intoxication in cats in the veterinary literature.[33–36] None of these cases reported a haemothorax. Furthermore, in an experimental study in which 10 domestic shorthaired cats were fed a single oral dose of bromethalin, all cats developed neurological changes but did not show evidence of haemothorax.[37] It is interesting, therefore, to note that one cat in the current study was diagnosed with haemothorax secondary to anticoagulant rodenticide intoxication. Incidents of haemoabdomen in cats have been described in several studies; however, there are no confirmed cases where this was due to rodenticide toxicity. These cases were associated with trauma, surgical complications, neoplasia and coagulopathy of unknown origin.[38,39] Why cats are less likely to present with rodenticide toxicity is possibly due to two factors. First, cats have been domesticated for a shorter period of time than domestic dogs and still act and behave as specialist hunters; therefore, they are more attracted to live prey than leftover carcasses; they are not scavengers by nature, unlike dogs.[40] It is also possible that those more likely to be exposed to rodenticide toxicity are farm cats, and this population of cats is mostly kept outdoors and is less likely to be presented to a veterinarian if unwell, whether that be due to finances or the access to veterinary care in more rural areas.[41]

Overall, 83.3% of patients in this population survived to discharge, the majority of these cases being associated with trauma. However, several cats needed prolonged hospitalisation, but this was due to their comorbidities secondary to the traumatic event rather than the haemothorax itself. Those that did not

survive to discharge had severe respiratory disease (two cases), poor prognosis due to underlying neoplasia or were euthanased due to financial constraints. None of the patients that suffered from trauma, neoplasia or other disease required repeated subsequent thoracocentesis for their haemothorax.

This study is consistent with other studies examining the survival to discharge in feline patients with trauma. For those that had sustained trauma of various causes, 11% did not survive to discharge.[42] For those that had experienced a high-rise trauma, 96.5% of cats survived.[19]

Limitations

The retrospective nature of the study means that not all information or clinical reasoning for case management was clearly explained and subjective assessments were reported that cannot be quantified, for example, mild or moderate pleural effusion. There were also several cases where the PCV of the effusion was not recorded, so the clinicians' description of haemothorax was relied upon. All the cases where PCV was not recorded were traumatic in origin. It is possible that, given the high clinical suspicion of haemothorax in these cases and a concurrent haemorrhagic-looking effusion obtained by thoracocentesis, the clinicians were confident of their diagnosis and felt that further fluid analysis was not required. PCV was recorded in the five non-traumatic cases; given the low incidence of haemothorax from non-traumatic events, analysis of the effusion is helpful in guiding clinicians in determining the underlying cause. It is likely that there were cases where a small volume of haemothorax was noted but no thoracocentesis was performed as it was not clinically indicated; therefore, these cases were not recorded. This could be thought to be more likely in trauma cases where concurrent physical examination and historical findings made the diagnosis clear; therefore, further investigation was not necessary. This, therefore, could mean that trauma cases, despite being the largest proportion of cases in this case series, could be underreported.

The cats that presented to the referral service may be the more severely affected cases and may not represent the more general population of cats with haemothorax, thus creating a degree of 'referral bias' within the study.[43] Furthermore, this patient population is semi-urban and may not reflect the feline population in more rural areas that perhaps have greater access to rodenticide. POCUS was performed on most of these patients. However, there were no standardised criteria to confirm the volume of effusion being small, moderate or large. Furthermore, the variability in clinicians' skill levels may have led to variation in POCUS reporting. Further studies could include follow-up of these patients to understand their long-term survival and quality of life. This was not performed in the current study due to the ethical framework limitations, and the aim was to better understand their presentation and short-term outcome.

CONCLUSION

The main presenting complaint in this sample of cats with haemothorax was tachypnoea and increased respiratory effort. Trauma was the most common cause, and these patients are likely to have a multitude of other injuries, most commonly pulmonary contusions. Overall, haemothorax is rare in cats, with only 25 confirmed cases over an 18-year period in a large multidisciplinary hospital with an out-of-hours emergency service. The outcome was favourable, with 83.3% of those presenting alive surviving to discharge.

AUTHOR CONTRIBUTIONS

Karen Humm conceived this study. Rachel Turner was responsible for the data collection and analysis. Both authors equally contributed to the writing of this paper.

CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

FUNDING INFORMATION

The authors received no specific funding for this work.

DATA AVAILABILITY STATEMENT

The data are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

This retrospective study required no specific ethical approval. All patient identification information was removed prior to data analysis.

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REFERENCES

1. Nakamura RK, Rozanski EA, Rush JE. Non-coagulopathic spontaneous hemothorax in dogs. J Vet Emerg Crit Care. 2008;18(3):292–97.
2. Beatty J, Barrs V. Pleural effusion in the cat. A practical approach to determining aetiology. J Feline Med Surg. 2010;12:693–707.
3. Davies C, Forrester S. Pleural effusion in cats: 82 cases (1987 to 1995). J Small Anim Pract. 1996;37(5):217–24.
4. Cornell University. Effusions. Available from: https://eclinpath.com/cytology/effusions-2/. Accessed 21 Apr 2024
5. Allerton F. Diagnosing and treating haemothorax in dogs and cats. In Pract. 2019;41(8):349–60.
6. Sasanelli M, Paradies P, Otranto D, Lia RP, De Caprariis D. Haemothorax associated with *Angiostrongylus vasorum* infection in a dog. J Small Anim Pract. 2008;49(8):417–20.
7. Stroope S, Walton R, Mochel JP, Yuan L, Enders B. Retrospective evaluation of clinical bleeding in dogs with anticoagulant rodenticide toxicity—a multi-center evaluation of 62 cases (2010–2020). Front Vet Sci. 2022;9:1–5.
8. Rutherford L, Stell A, Smith K, Kulendra N. Hemothorax in three dogs with intrathoracic extracardiac hemangiosarcoma. J Am Anim Hosp Assoc. 2016;52(5):325–29.
9. Stallwood J, Adamantos S, Allen S, Allerton F, Black V. Spontaneous haemothorax in juvenile dogs: a case series. BSAVA Congress Proc. 2019;24(1):530.

10. Biasato I, Tursi M, Zanet S, Longato E, Capucchio MT. Pulmonary artery dissection causing haemothorax in a cat: potential role of *Dirofilaria immitis* infection and literature review. J Vet Cardiol. 2017;19(1):82–87.
11. Sierra E, Rodríguez F, Herráez P, Fernández A, De Los Monteros AE. Post-traumatic fat embolism causing haemothorax in a cat. Vet Rec. 2007;161(5):170–72.
12. Dvornicky-Raymond Z, Lapsley J, Kanvier V, Mirance I, McDonaugh S, Hayes G. Auriculectomy or spontaneous thrombosis of the left auricle and a domestic shorthair cat. Can Vet J. 2009;50(11):1191–94.
13. Liman ST, Kuzucu A, Tastepe AI, Ulasan GN, Topcu S. Chest injury due to blunt trauma. Eur J Cardiothorac Surg. 2003;23(3):374–78.
14. König A, Hartmann K, Mueller RS, Wess G, Schulz BS. Retrospective analysis of pleural effusion in cats. J Feline Med Surg. 2019;21(12):1102–10.
15. Ruiz MD, Vessières F, Ragetly GR, Hernandez JL. Characterization of and factors associated with causes of pleural effusion in cats. J Am Vet Med Assoc. 2018;253(2):181–87.
16. Patrini D, Panagiotopoulos N, Pararajasingham J, Gvinianidze L, Iqbal Y, Lawrence DR. Etiology and management of spontaneous haemothorax. J Thorac Dis. 2015;7(3):520–26.
17. Silverstein, Deborah, Hopper K. Key critical care concepts. In: Small animal critical care medicine. 3rd ed. Elsevier—OHCE; 2022. p. 1–7.
18. EClinPath.com. Available from: https://eclinpath.com/hematology/anemia/. Cornell University. Accessed 21 Apr 2024.
19. Vnuk D, Pirkić B, Matičić D, Radišić B, Stejskal M, Babić T, et al. Feline high-rise syndrome: 119 cases (1998–2001). J Feline Med Surg. 2004;6(5):305–12.
20. Muri B, Schmierer P, Schwarz A, Sigrist N. Hyperfibrinolysis diagnosed with rotational thromboelastometry and treated with tranexamic acid in a dog with acute traumatic coagulopathy. Schweiz Arch Tierheilkd. 2018;160(4):227–33.
21. Kuo KW, Bacek LM, Taylor AR. Head trauma. Vet Clin North Am Small Anim Pract. 2018;48(1):111–28.
22. Lamont LA, Mathews KA. Opioids, Nonsteroidal Anti-inflammatories, and Analgesic Adjuvants. In: William J, Tranquilli John C, Thurmon Kurt A, editors. Grimm. Lumb & Jones' Veterinary Anaesthesia and Analgesia. 4th ed. Blackwell publishing; 2007. p. 241–72.
23. Linklater A. Recognition and intervention for feline respiratory emergencies. BSAVA Congress Proc. 2015;2015:257.
24. Oncken AK, Kirby R, Rudloff E. Hypothermia in critically ill dogs and cats. Compend Contin Educ Pract Vet. 2001;23(6):506–20.
25. Dicker SA, Lisciandro GR, Newell SM, Johnson JA. Diagnosis of pulmonary contusions with point-of-care lung ultrasonography and thoracic radiography compared to thoracic computed tomography in dogs with motor vehicle trauma: 29 cases (2017–2018). J Vet Emerg Crit Care. 2020;30(6):638–46.
26. Wang S, Ruan Z, Zhang J, Jin W. The value of pulmonary contusion volume measurement with three-dimensional computed tomography in predicting acute respiratory distress syndrome development. Ann Thorac Surg. 2011;92(6):1977–83.
27. Schild HH, Strunk H, Weber W, Stoerkel S, Doll G, Hein K, et al. Pulmonary contusion: CT vs plain radiograms. J Comput Assist Tomogr. 1989;13(3):417–20.
28. Lisciandro GR, Lagutchik MS, Mann KA, Voges AK, Fosgate GT, Tiller EG, et al. Evaluation of a thoracic focused assessment with sonography for trauma (TFAST) protocol to detect pneumothorax and concurrent thoracic injury in 145 traumatized dogs. J Vet Emerg Crit Care. 2008;18(3):258–69.
29. Benavides KL, Rozanski EA, Oura TJ. Lung lobe torsion in 35 dogs and 4 cats. Can Vet J. 2019;60(1):60–66.
30. Simpson SA, Syring R, Otto CM. Severe blunt trauma in dogs: 235 cases (1997–2003): retrospective study. J Vet Emerg Crit Care. 2009;19(6):588–602.
31. Mozzer LR, Lima WS. Rupture of the thoracic aorta associated with experimental *Angiostrongylus vasorum* infection in a dog. Parasite. 2012;19(2):189–91.
32. Pennisi MG, Tasker S, Hartmann K, Belák S, Addie D, Boucraut-Baralon C, et al. Dirofilarioses in cats: European guidelines from the ABCD on prevention and management. J Feline Med Surg. 2020;22(5):442–51.
33. DuVall MD, Murphy MJ, Ray AC, Reagor JC. Case studies on second-generation anticoagulant rodenticide toxicities in nontarget species. J Vet Diagn Invest. 1989;1(1):66–68.
34. Peterson EN, Kirby R, Sommer M, Bovee KC. Cholecalciferol rodenticide intoxication in a cat. J Am Vet Med Assoc. 1991;199(7):904–6.
35. Moore FM, Kudisch M, Richter K, Faggella A. Hypercalcemia associated with rodenticide poisoning in three cats. J Am Vet Med Assoc. 1988;193(9):1099–100.
36. Martin T, Johnson B. A suspected case of bromethalin toxicity in a domestic cat. Vet Hum Toxicol. 1989;31(3):239–40.
37. Dorman DC, Zachary JF, Buck WB. Neuropathologic findings of bromethalin toxicosis in the cat. Vet Pathol. 1992;29(2):139–44.
38. Cole LP, Humm K. Twelve autologous blood transfusions in eight cats with haemoperitoneum. J Feline Med Surg. 2019;21(6):481–87.
39. Bunnell N, Blong A, Kundu D, Mochel JP, Walton R. Blood product usage and factors associated with transfusions in cats with hemoperitoneum: 33 cases (2018–2022). Front Vet Sci. 2023;10:1–4.
40. Bradshaw JWS. The evolutionary basis for the feeding behavior of domestic dogs (*Canis familiaris*) and cats (*Felis catus*). Am Soc Nutrition. 2006;136:1927–31.
41. Hawes SM, Hupe TM, Winczewski J, Elting K, Arrington A, Newbury S, et al. Measuring changes in perceptions of access to pet support care in underserved communities. Front Vet Sci. 2021;8:1–14.
42. Hernon T, Gurney M, Gibson S. A retrospective study of feline trauma patients admitted to a referral centre. J Small Anim Pract. 2018;59(4):243–47.
43. Bartlett PC, Van Buren JW, Neterer M, Zhou C. Disease surveillance and referral bias in the veterinary medical database. Prev Vet Med. 2010;94(3–4):264–71.

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