

Prevalence and characteristics of feline pleural effusion in Khon Kaen, Thailand: A 2024–2025 study

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Abstract

Pleural effusion (PE) is a life-threatening condition in cats that can cause severe respiratory compromise. Identification of the underlying etiology is essential for prognosis and treatment planning. This study investigated the prevalence and characteristics of diseases associated with feline pleural effusion in northeastern Thailand. Medical records of cats diagnosed with pleural effusion at the Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Khon Kaen University, Thailand, between January 2024 and January 2025 were retrospectively reviewed. Cases lacking a complete diagnostic workup were excluded. Diagnoses were confirmed using cytology or histopathology for neoplasia, echocardiography for heart disease, polymerase chain reaction (PCR) for feline infectious peritonitis (FIP), and pleural fluid analysis for pyothorax. Of 86 cats initially identified, 72 met the inclusion criteria. The most common etiologies were FIP (30.5%, n=22), lymphoma (27.7%, n=20), heart disease (22.2%, n=16), and pyothorax (18.1%, n=13) and trauma (1.38%, n=1). Cats with pyothorax (1.8 ± 1.2 years) and FIP (2.5 ± 2.0 years) were significantly younger than cats with lymphoma (4.2 ± 4.4 years) and heart disease (5.3 ± 4.3 years) ($P < 0.05$). Restrictive cardiomyopathy was the most common cardiac disorder (43.8%) among cats with heart disease. Bacterial culture was positive in only 23.1% of pyothorax cases. FIP was the leading cause of feline pleural effusion in this population, followed by lymphoma, heart disease, and pyothorax. These findings suggest regional differences in disease epidemiology and emphasize the importance of comprehensive diagnostic evaluation in cats with pleural effusion.

Keywords: FIP, lymphoma, pyothorax, restrictive cardiomyopathy

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Introduction

Pleural effusion (PE) is a life-threatening condition in cats, characterized by the abnormal accumulation of fluid in the pleural space, resulting from an underlying disease disrupting normal homeostatic mechanisms within the thorax (Ruiz *et al.*, 2018; Hung *et al.*, 2022). In a healthy cat, the pleural space contains only a small volume of fluid, approximately 0.3 mL/kg, which lubricates the visceral and parietal pleura (Ruiz *et al.*, 2018). The accumulation of pathological fluid can eventually lead to pulmonary atelectasis and hypoventilation (Beatty and Barrs, 2010). Cats with PE often present with severe respiratory compromise or distress, necessitating immediate and careful stabilization. Globally, feline pleural effusion is most commonly attributed to congestive heart failure, neoplastic diseases, pyothorax, and feline infectious peritonitis (Beatty and Barrs, 2010). However, the relative prevalence of these underlying etiologies varies significantly across geographic regions and clinical populations. While several retrospective studies have characterized feline pleural effusion in Europe, Australia, and North America (Ruiz *et al.*, 2018; Hung *et al.*, 2022; Johnson *et al.*, 2023), epidemiological data from Thailand remain limited, with only a single recent study conducted in the metropolitan area of Bangkok (Hla, 2021). Determining the underlying cause of the effusion is critical for accurate prognostication and for guiding therapeutic management (Beatty and Barrs, 2010; Hung *et al.*, 2022). To date, no studies have evaluated the prevalence and characteristics of feline pleural effusion in northeastern Thailand. Therefore, this study aimed to characterize the prevalence of underlying etiologies of pleural effusion in cats by retrospectively reviewing all feline cases presented to our hospital during the 2024-2025 period in the Khon Kaen area of Thailand.

Materials and Methods

Study sampling: This retrospective study included cats presented to the Veterinary Teaching Hospital (VTH), Faculty of Veterinary Medicine, Khon Kaen University, Thailand, from January 2024 to January 2025. The cases were identified by searching the hospital's radiography reports for the keyword "pleural effusion."

Medical records: Electronic medical records were retrospectively reviewed to determine the final diagnosis for all enrolled cats. Exclusion criteria required removal of subjects lacking a comprehensive diagnostic investigation or those whose owners declined a complete diagnostic workup. Confirmation of each disease category followed specific predefined diagnostic criteria:

Neoplasia: A definitive diagnosis required histopathological examination of a tissue biopsy or cytological analysis of relevant aspirates or fluids to confirm malignancy.

Heart disease: Diagnosis was based solely on a complete echocardiographic examination, which identified the specific structural and functional cardiac abnormality.

Feline Infectious Peritonitis (FIP): Diagnosis was established based on a combination of characteristic clinical presentation, effusional properties consistent with FIP (viscous, yellow-tinted exudate with high total protein), and positive detection of feline coronavirus (FCoV) RNA in pleural fluid via quantitative real-time reverse transcription PCR.

Pyothorax: Diagnosis was defined by cytological evidence of purulent inflammation, characterized by abundant degenerate neutrophils with or without intracellular bacteria. To avoid misclassification, cases were confirmed as pyothorax only after negative cytological/histopathology evaluations for neoplasia and negative PCR results for FCoV.

Statistical analysis: Descriptive statistics were used to summarize demographic characteristics and key study variables. Group comparisons were performed using one-way Analysis of Variance (ANOVA) to assess differences in mean values among the study groups. Following a significant ANOVA result, Duncan's multiple range test was employed for post hoc pairwise comparisons to determine the specific groups exhibiting statistically significant differences. Statistical analyses were conducted using SPSS.

Animal ethics statement: The experimental protocol was approved by Animal Care and Use Center of Khon Kaen University (IACUC-KKU ©-44/69). All procedures were conducted in accordance with the institution's animal welfare guidelines.

Results

Of 86 cats initially identified with pleural effusion, 14 cats were excluded due to incomplete diagnostic workups or because the owner declined further investigation, leaving 72 cats for analysis. The most common diagnoses were FIP (30.5%, n=22), neoplasia (27.7%, n=20), heart disease (22.2%, n=16), pyothorax (18.1%, n=13), and trauma (1.38%, n=1). All neoplasia cases were lymphoma.

Retrospective analysis revealed notable demographic differences among the four primary disease groups. Cats with pyothorax were the youngest cohort (mean age: 1.8 years) and were predominantly male (61.5%). This group was significantly younger than cats with lymphoma or heart disease. Cats with FIP were also young (mean age: 2.5 years) but were predominantly female (59.0%). In contrast, cats with lymphoma (mean age: 4.2 years; 55.0% male) and heart disease (mean age: 5.3 years; 56.2% female) represented older cohorts. Mean body weight was similar across all groups, ranging from 2.9 to 3.2 kg, indicating that body weight was not strongly associated with disease category (Table 1).

Table 1 Shows the age, weight, and sex distribution of the cats in each major disease category.

Disease	Mean age $\pm$ SD	Mean weight $\pm$ SD	Male	Female
Pyothorax	1.8 ^A $\pm$ 1.2	2.9 $\pm$ 1.0	61.5%	38.4%
FIP	2.5 ^A $\pm$ 2.0	2.9 $\pm$ 0.9	40.9%	59.0%
Lymphoma	4.2 ^{A, B} $\pm$ 4.4	3.0 $\pm$ 0.6	55.0%	45.0%
Heart disease	5.3 ^B $\pm$ 4.3	3.2 $\pm$ 1.1	43.4%	56.2%

Means with different superscripts are significantly different ($P < 0.05$), as determined by Duncan's multiple range test.

Among the 16 cats diagnosed with heart disease, restrictive cardiomyopathy (RCM) was the most prevalent condition, accounting for nearly half of the cases (43.8%, 7/16), followed by hypertrophic cardiomyopathy (HCM) at 18.8% (3/16). Several other cardiac abnormalities were identified at a frequency of 6.3% of cases (1/16) each, including tricuspid insufficiency, pulmonic stenosis, tricuspid valve mass, arrhythmogenic right ventricular cardiomyopathy, and bi-atrial enlargement secondary to sepsis (myocarditis).

Within the pyothorax group (n=13), bacterial culture yielded positive results in only three cats (23.1%; 3/13). The cultured isolates were *Streptococcus agalactiae*, *Pasteurella canis*, and gram-positive bacilli. The remaining 10 cats (76.9%) showed no bacterial growth.

Discussion

This retrospective study of cats presented to the VTH, Khon Kaen University characterizes the underlying etiologies of PE within this specific patient population in northeastern Thailand. A total of 72 cats with pleural effusion FIP was the most prevalent underlying etiology (30.5%), followed by lymphoma (27.7%), heart disease (22.2%), and pyothorax (18.1%). Our findings reveal distinct epidemiological differences when compared to international literature, where congestive heart failure typically predominates, accounting for 40.8% to 53.4% of cases in Western and Australian populations (Ruiz *et al.*, 2018; Hung *et al.*, 2022). Conversely, FIP rates in those modern international reports ranged from merely 1.4% to 3.2% (Ruiz *et al.*, 2018; Hung *et al.*, 2022).

The overall distribution of disease etiologies in our study aligns generally with a previous study conducted in Bangkok, Thailand (Hla, 2021), where infectious and neoplastic etiologies accounted for a substantial proportion of pleural effusion cases. However, the proportion of FIP cases in Khon Kaen (30.5%) was noticeably higher than that observed in Bangkok (17.3%). This disparity likely reflects geographic variations in cat housing, density, and management practices between metropolitan Bangkok and northeastern Thailand, as well as potential differences in regional viral strain virulence.

International studies have historically reported much lower rates of FIP-associated pleural effusion, typically ranging from 1.4% to 13% (Creighton and Wilkins, 1975; Gruffydd-Jones and Flecknell, 1987; Davies and Forrester, 1996; Zoia *et al.*, 2009; Ruiz *et al.*, 2018; Hung *et al.*, 2022;), making our observed proportion of 30.5% in the Khon Kaen population notably high. A study from Munich, Germany (Hirschberger *et al.*, 1999) reported a high FIP rate of

25% with comparable etiological patterns to those found in Thailand. However, that study classified all cases of aseptic serositis as FIP without specifying confirmation criteria, which may have led to an overestimation of their FIP prevalence. This high prevalence could be attributed to regional variations in viral virulence, differences in population structure (such as multi-cat households), environmental factors, or the enhanced accessibility and sensitivity of modern diagnostic tools compared to those used in older studies.

In this study, the bacterial culture success rate for the pyothorax cohort was remarkably low at 23% (3/13) compared to the 89.6% (26/29) reported by Johnson *et al.* (2023). This discrepancy in culture sensitivity between laboratories may be caused by several factors related to sample handling, transport, and pathogen characteristics. Variations in transport time, storage conditions, and the use of appropriate anaerobic transport media can influence bacterial viability, particularly for fastidious or anaerobic organisms commonly associated with pyothorax. Additionally, laboratories may use different culture techniques, media types, and incubation conditions, which can affect the detection of slow-growing or nutritionally demanding bacteria. The sensitivity of culture methods also varies among laboratories, and some may be better equipped to recover mixed or low-abundance organisms.

Among non-infectious causes, RCM was the most prevalent cardiac condition in our cohort (43.8%), followed by HCM (18.8%). Consistent with previous literature, all neoplastic effusions in this study were diagnosed as lymphoma. Although feline leukemia virus (FeLV) is a well-established primary driver of feline lymphoma, historical limitations and missing medical records prevented us from confirming FeLV status for all affected cats. Consequently, a direct causal link between FeLV infection and lymphoma development could not be established in this cohort.

Several limitations should be considered when interpreting the findings of this study. First, the retrospective design relied on the accuracy and completeness of medical records, which may have resulted in missing or inconsistent data. Second, this was a single-center study conducted at a tertiary veterinary teaching hospital, and therefore referral bias may have influenced the distribution of etiologies, as more severe or complex cases are more likely to be referred. In addition, cases lacking complete diagnostic investigations were excluded from analysis, which may have introduced selection bias and affected the reported prevalence of specific disease categories. Finally, the low bacterial culture positivity rate observed in pyothorax cases limited the ability to characterize the bacterial spectrum associated with this

condition and may have resulted from factors related to sample collection, transport, storage, or laboratory methodologies. Future multicenter prospective studies using standardized diagnostic protocols would help validate and expand upon the reported findings.

In conclusion, feline infectious peritonitis and lymphoma were the primary causes of feline pleural effusion in northeastern Thailand, contrasting with international reports where cardiac disease predominates. Younger cats were significantly more likely to present with pyothorax or FIP, whereas older cats were more frequently affected by lymphoma and heart disease. These findings underscore the critical role of geographic and demographic factors in disease distribution and emphasize the necessity of a thorough, multimodal diagnostic approach for cats presenting with pleural effusion in clinical practice.

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Declaration of artificial intelligence use: The authors used an artificial intelligence (AI)-assisted language tool solely for grammar checking and language editing of the manuscript. The AI tool was not used for data collection, data analysis, interpretation of results, or generation of scientific content.

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