



**CLINICAL MANIFESTATIONS, LABORATORY AND DIAGNOSTIC IMAGING
FINDINGS OF FELINE UPPER RESPIRATORY AND PLEURAL
INFECTIONS**

By

SIM JUIN JIA

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the Degree of Master of
Veterinary Science**

August 2022

FPV 2022 24

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Veterinary Science

CLINICAL MANIFESTATIONS, LABORATORY AND DIAGNOSTIC IMAGING FINDINGS OF FELINE UPPER RESPIRATORY AND PLEURAL INFECTIONS

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August 2022

Chair : Associate Professor Dr. Lau Seng Fong, PhD
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Feline upper respiratory infection and feline pyothorax are common complaints in veterinary practice that can be caused by zoonotic bacteria. The study aimed to characterise clinical features, diagnostic imaging and laboratory findings in cats with upper respiratory tract infection and pyothorax, both retrospectively and prospectively. History, signalment and physical examination information of the cats were obtained. Laboratory findings including haematology, biochemistry, cytology, bacterial identification and diagnostic imaging findings were analysed. Additional virus testings for feline calicivirus, feline herpesvirus, feline coronavirus, feline leukaemia virus and feline immunodeficiency virus were conducted in the prospective study. Results showed that most cats had access to outdoors and were from multi-cat household. In both retrospective studies, common clinical signs such as sneezing, mucoid or mucopurulent nasal discharge and stertorous breathing were predominantly observed in cats with upper respiratory infection; while dyspnoea, harsh or dull lung sound and open mouth breathing were predominantly observed in cats with pyothorax. In the prospective study, nasal discharge, cough and stertor were commonly observed in cats with upper respiratory infection; while abdominal breathing, dehydration and inactivity were observed in cats with pyothorax. Hyperglobulinaemia and hyperproteinaemia were common clinicopathologic abnormalities observed in retrospective cases of feline upper respiratory infection and pyothorax. Additionally, monocytosis and leucocytosis were also common clinicopathologic abnormalities presented in retrospective cases of pyothorax cats. In the prospective study, the majority of the cats with upper respiratory infection or pyothorax had high antibody titres of feline herpesvirus and feline calicivirus, positive for feline coronavirus antibody, negative for feline leukaemia virus antigen and feline immunodeficiency virus. Diagnostic imaging of both retrospective and prospective studies revealed that fluid/soft tissue attenuated turbinates and sinuses were common in cats with upper respiratory infection; while pleural fluid, lung consolidation and obscured cardiac silhouette were common in cats with pyothorax. In retrospective studies, *Staphylococcus* spp.,

Pasteurella multocida and *Streptococcus* spp. were common in cats with upper respiratory infection; whereas, *Pasteurella multocida*, *Streptococcus* spp. and *Escherichia coli* were common in cats with pyothorax. In the prospective study, *Pasteurella multocida* was the most common bacterium in both upper respiratory infection and pyothorax cases. Beta-lactam group antimicrobials and doxycycline remained suitable choices of antimicrobial treatment in cases of feline upper respiratory infections while amoxicillin–clavulanate showed good antimicrobial susceptibility against aerobic bacteria isolated from the cases in the pyothorax study. The case outcomes of the cats were similar for both diseases. In the retrospective study of cats with feline upper respiratory infection, 15 cats (48.4%) recovered after treatment while 16 cats (51.6%) were dead or euthanised. Whereas, in the retrospective study of pyothorax cats, only 13 cats (46.4%) survived while 15 cats (53.6%) died at the point of re-evaluation. The study contributed to the understanding of feline upper respiratory infection and pyothorax in relation to clinical manifestations and diagnostic imaging features. Moreover, from the bacteria that were isolated, the study highlights the possible risk of zoonotic disease transmission from feline pets to human owners and emphasises the importance of disease prevention.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains Veterinar

MANIFESTASI KLINIKAL, PENEMUAN PENGIMEJIAN MAKMAL DAN DIAGNOSTIK JANGKITAN PERNAFASAN ATAS DAN PLEURAL KUCING

Oleh

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Jangkitan pernafasan atas kucing dan pyothorax kucing adalah aduan biasa dalam amalan veterinar yang boleh disebabkan oleh bakteria zoonosis. Kajian itu bertujuan untuk mencirikan sifat-sifat klinikal, pengimejan diagnostik dan penemuan makmal dalam kucing dengan jangkitan saluran pernafasan atas dan pyothorax secara retrospektif dan prospektif. Sejarah, latar belakang dan maklumat pemeriksaan fizikal kucing telah dikumpul. Penemuan makmal termasuk hematologi, biokimia, sitologi, pengecaman bakteria serta penemuan pengimejan diagnostik telah dianalisis. Ujian virus tambahan untuk *feline calicivirus*, *feline herpesvirus*, *feline coronavirus*, *feline leukemia virus* dan *feline immunodeficiency virus* telah dijalankan dalam kajian prospektif. Keputusan menunjukkan bahawa kebanyakan kucing mempunyai akses ke luar dan berasal dari rumah berbilang kucing. Dalam kedua-dua kajian retrospektif, tanda-tanda klinikal biasa seperti bersin, lendir hidung mukoid atau mukopurulen dan pernafasan berdengkus kebanyakannya diperhatikan pada kucing dengan jangkitan pernafasan atas; manakala sesak nafas, bunyi paru-paru yang keras atau kusam dan pernafasan mulut terbuka kebanyakannya diperhatikan pada kucing dengan pyothorax. Dalam kajian prospektif, lehan hidung, batuk dan dengkus biasanya diperhatikan pada kucing dengan jangkitan pernafasan atas; manakala pernafasan perut, dehidrasi dan ketidakaktifan diperhatikan pada kucing dengan pyothorax. Hiperoglobulinemia dan hiperproteinaemia adalah keabnormalan klinikopatologi biasa yang dapat diperhatikan dalam kes retrospektif jangkitan pernafasan atas kucing dan pyothorax. Selain itu, monositosis dan leukositosis juga merupakan keabnormalan klinikopatologi biasa yang ditunjukkan dalam kes retrospektif kucing pyothorax. Dalam kajian prospektif, majoriti kucing yang mengalami jangkitan pernafasan atas atau pyothorax mempunyai titer antibodi yang tinggi untuk *feline herpesvirus* dan *feline calicivirus*, positif untuk antibodi *feline coronavirus*, negatif untuk antigen *feline leukaemia virus* dan *feline immunodeficiency virus*. Pengimejan diagnostik kedua-dua kajian retrospektif dan prospektif mendedahkan bahawa turbinat dan sinus yang mempunyai intensiti tisu lembut/bendalir adalah perkara biasa pada

kucing dengan jangkitan pernafasan atas; manakala cecair pleura, konsolidasi paru-paru dan siluet jantung yang tidak jelas adalah perkara biasa pada kucing dengan pyothorax. Dalam kajian retrospektif, *Staphylococcus* spp., *Pasteurella multocida* dan *Streptococcus* spp. adalah biasa berlaku pada kucing dengan jangkitan pernafasan atas; manakala, *Pasteurella multocida*, *Streptococcus* spp. dan *Escherichia coli* adalah biasa berlaku pada kucing dengan pyothorax. Dalam kajian prospektif, *Pasteurella multocida* adalah bakteria yang paling biasa dalam kedua-dua jangkitan pernafasan atas dan kes pyothorax. Antimikrobial kumpulan beta-laktam dan doxycycline kekal sebagai pilihan rawatan antimikrobial yang sesuai dalam kes jangkitan pernafasan atas kucing manakala amoxicillin-clavulanate menunjukkan kerentanan antimikrob yang baik terhadap bakteria aerobik yang diasingkan dalam kes kajian pyothorax. Akibat kes kucing adalah serupa untuk kedua-dua penyakit. Dalam kajian retrospektif kucing dengan jangkitan pernafasan atas kucing, 15 kucing (48.4%) pulih selepas rawatan dan 16 kucing (51.6%) telah mati atau dimatikan. Manakala, dalam kajian retrospektif kucing pyothorax, hanya 13 kucing (46.4%) yang terselamat manakala 15 kucing (53.6%) mati pada titik penilaian semula. Kajian itu menyumbang kepada pemahaman tentang manifestasi klinikal dan ciri pengimejan diagnostik jangkitan pernafasan atas kucing dan pyothorax. Selain itu, daripada bakteria yang diasingkan, kajian itu menyerlahkan kemungkinan risiko penularan penyakit zoonosis daripada haiwan peliharaan kucing kepada pemilik manusia dan menekankan kepentingan pencegahan penyakit.

ACKNOWLEDGEMENTS

To begin with, I would like to thank all the people who have helped me and supported me in completing my work. First and foremost, I would like to express my sincere gratitude to my supervisor, Associate Professor Dr. Lau Seng Fong, for her dedication, selfless contribution, precious opinions, advice, and guidance, as well as her valuable support throughout the project. She not only guides me in doing my project, but she also reminds me that the purpose of doing research is to learn and experience, and from there, we will become a better person. I would like to thank my co-supervisors, Associate Professor Dr. Malaika Watanabe and Dr. Sharina Omar for their expertise and guidance throughout this research. During our discussions, their thoughts and insightful comments on my work have been very valuable for me. Their encouragement has helped me a lot in finishing my study.

Special thanks to Ms. Krishnammah Kuppusamy, Mr. Mohd Azri Roslan, Ms. Nur Rabiataladawiyah Rosli and Dr. Muhammad Sabri Abdul Rahman from Bacteriology Laboratory, Faculty of Veterinary Medicine UPM for their assistance and guidance in bacterial culture and identification techniques. With their warm presence and kind personalities, it made the whole process of studying here fun and fulfilling.

I am also indebted to my beloved labmates, Ms. Zafirah Muhd, Dr. Waseem, Dr. Reza, Dr. Yusof, Dr. Lee Ting-Ying and my fellow BH housemates, Dr. Ng Lin Cieh, Ms. Loh Hui Yi, Ms. Toh Shu Xin, Mr. Chew Yung Kean and Ms. Lim Jia. I will cherish all the moments we spend together and hope that we can cross paths again in the future.

A special appreciation to my greatest inspiration, my father, Dr. Sim Hock Keat. I have always look up to him as a role model. I would also like to thank my mother and brother; without their unconditional support and love, I may not have the determination to face a lot of difficulties during my Master's study. Lastly, to everyone else who helped me directly or indirectly, a very big thank you.

I certify that a Thesis Examination Committee has met on 9 August 2022 to conduct the final examination of Sim Juin Jia on her thesis entitled "Clinical Manifestations, Laboratory and Diagnostic Imaging Findings of Feline Upper Respiratory and Pleural Infections" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Veterinary Science.

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LIST OF ABBREVIATIONS

%	Percentage
≤	Less than or equal
≥	More than or equal
®	Registered trademark
™	Trademark
°C	Degree Celsius
μl	Microlitre
μM	Micromolar
A:G	Albumin: globulin ratio
Ab	Antibody
ALP	Alkaline phosphatase
ALT	Alanine transaminase
AST	Aspartate transaminase
ATCC	American Type Culture Collection
BCS	Body condition score
bp	Base pair
CLSI	Clinical and Laboratory Standards Institute
CT	Computed tomography
CWCC	Complete white cell count
DICOM	Digital Imaging and Communications in Medicine
DNA	Deoxyribonucleic acid
FCV	Feline calicivirus
FeLV	Feline leukaemia virus

FHV	Feline herpesvirus
FHV-1	Feline herpesvirus- 1
FIV	Feline immunodeficiency virus
g/L	Gram per litre
GGT	Gamma glutamyl transferase
h	Hour
I	Intermediate
IU	International unit
IV	Intravenous
JPEG	Joint Photographic Experts Group
kg	Kilogram
L	Litre
LRTIs	Lower respiratory tract infections
mg	Milligram
min	Minutes
ml	Millilitre
MLST	Multilocus sequence typing
mmol/L	Millimolar per litre
MRSA	Methicillin-resistant <i>Staphylococcus aureus</i>
<i>n</i>	Number of cases
NaCl	Sodium chloride
PAR	Progressive atrophic rhinitis
PCR	Polymerase chain reaction
PCV	Packed cell volume

PO	Per oral
R	Resistant
RBC	Red blood cell
RL	Reference limit
RNA	Ribonucleic acid
rpm	Revolutions per minute
RT-PCR	Real-time polymerase chain reaction
s	Second
S	Susceptible
SD	Standard deviation
sp.	Species
spp.	Several species
SQ	Subcutaneous
STs	Sequence type(s)
TP	Total protein
URI	Upper respiratory infection
URT	Upper respiratory tract
URTD	Upper respiratory tract disease
USA	United States of America
WBC	White blood cell

CHAPTER 1

INTRODUCTION

1.1 Overview

Respiratory infection is still a common cause of morbidity and mortality in cats, despite the fact that there are many improved options for its prevention and treatment (Schulz et al., 2006). In general, the respiratory infections can be presented as infections of the upper respiratory tract and/or the lower respiratory tract (Foster & Martin, 2011; Litster et al., 2015).

Upper respiratory infection (URI) is most prevalent in stressful and crowded situations such as shelters, boarding facilities and multiple cat households. Clinical presentations of URI include sneezing, ocular discharge and nasal discharge (Pfaff, 2018). Common respiratory pathogens identified in cats with URI include feline herpesvirus (FHV), feline calicivirus (FCV), *Bordetella bronchiseptica*, *Chlamydia felis* and *Mycoplasma felis* (Litster et al., 2015).

Pleural infection, also known as pyothorax, is a condition where septic purulent exudate is accumulated in the pleural cavity. Clinical signs of feline pyothorax include dyspnoea, muffled heart sounds or abnormal lung sounds upon auscultation (Gorris et al., 2017). Polymicrobial infections consisting of obligate anaerobes (such as *Clostridium* spp., *Fusobacterium* spp., *Bacteroides* spp.) and/or facultative aerobic bacteria (which include *Pasteurella* spp. and *Actinomyces* spp.) are often associated with feline pyothorax, whereas around 20% of cases are caused by non-oropharyngeal bacteria (Barrs et al., 2005).

1.2 Problem statements and justification

Feline respiratory infections are one of the common diseases presented in veterinary clinics. The diagnosis of feline respiratory infection is often challenging. The correlation of clinical manifestation, aetiology and evidence of diagnostic imaging in cases of feline respiratory infection has yet to be demonstrated. Furthermore, URI and pleural infection are two important respiratory diseases in cats. There are limited established studies documenting the clinical manifestations (in terms of clinical signs and blood analysis) and diagnostic imaging findings (in terms of skull computed tomography of the skull and radiography of the thorax) of feline URI and pleural infection respectively.

Bacterial agents isolated from feline respiratory tract disease are reported to have zoonotic potential (Day et al., 2012). There is a need to identify the bacteria

involved in cats with respiratory infections in Malaysia to assist in the treatment and management of the diseases. The risk of zoonotic disease transmission from cats may arise as most Malaysian cat owners keep an average of two to three cats as pets, with some having more than 10 cats per household (Alashraf et al., 2019; Sivagurunathans et al., 2018). Hence, understanding this disease in local settings is of crucial importance due to its public health concern, as cats appear to be the most common companion animals in Malaysia.

This study gives us a better understanding of the clinical manifestation, diagnostic features and bacterial agents of feline URI and pleural infection. The study may improve our understanding of feline URI and pleural infection, increasing the chances of successful diagnosis and treatment outcomes for future feline patients. Furthermore, the study highlights the potential risk of zoonotic disease transmission to human cat owners from the cat population and emphasizes the importance of the prevention of zoonotic diseases.

1.3 Objectives of the study

The overall objective of my research was to characterize feline URI and pleural infection. The following specific objectives have been pursued throughout the research:

1. To retrospectively characterize the clinical manifestations, laboratory and computed tomography findings in cats with URI.
2. To retrospectively characterize the clinical manifestations, laboratory and radiographic findings in cats with pleural infection.
3. To prospectively characterize the clinical manifestations, laboratory and diagnostic imaging findings in cats with URI and pleural infection.

1.4 Organisation of the thesis

This section presents the layout of the thesis and the contents of each chapter as follows:

Chapter one provided an overview of feline URI and pleural infections, problem statements, justifications, objectives and the organisation of the thesis.

Chapter two provided the general introduction of this thesis with an overview of different aspects of feline URI and pleural infections, such as disease background, prevalence, aetiology, diagnosis and treatment.

Chapter three described a retrospective study characterizing the clinical manifestations, laboratory and computed tomography findings in cats with URI that were referred to the University Veterinary Hospital, Universiti Putra Malaysia from 2016 to 2020. Results on haematology, serum biochemistry, cytological examination of nasal flush samples and antimicrobial susceptibility profile were analysed.

Chapter four described a retrospective study on cats with pleural infections that were referred to University Veterinary Hospital, Universiti Putra Malaysia from 2013 to 2020 according to the same aspects as in Chapter three. Results on haematology, serum biochemistry, cytological examination of pleural fluid samples and an antimicrobial susceptibility profile were also analysed.

Chapter five described a prospective study of feline URI and pleural infections cases from March 2020 to September 2021 from University Veterinary Hospital, Selangor and two veterinary clinics in Seri Kembangan and Kota Damansara, respectively. Prospectively, the study focused on characterizing the clinical manifestations, laboratory and diagnostic imaging findings in cases of feline URI and pleural infections. The laboratory investigation in this study only focused on bacterial identification and additional investigations of the viral status (feline herpesvirus, feline calicivirus, feline coronavirus, feline leukaemia virus, feline immunodeficiency virus) of feline URI and pleural infections.

Chapter six summarized the conclusions from the studies in Chapters three, four and five. With the results and discussions in previous chapters, the recommendations for further investigations or actions for future work are mentioned.

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