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Full Recovery of a Cross-bred Cat from Bacterial Mycoplasmosis, Protozoan Babesiosis, and Other Co-current Diseases: A Case Report

(LAPORAN KASUS: PEMULIHAN PENUH DARI MIKOPLASMA BAKTERI, BABESIOSIS PROTOZOA, DAN PENYAKIT PENYERTA PADA KUCING PERANAKAN

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ABSTRACT

This report aimed to describe a diagnosis and treatment of feline mycoplasmosis that co-occurs with babesiosis and other diseases in a one-year-old male uncastrated mix-domestic cat. The patient was presented to the first clinic with pale, lethargy, and inappetence. After one week, the patient was presented to a second clinic due to the owner's inability to provide home treatment. Clinical examinations revealed pale to jaundiced mucous membranes, *caries dentis*, gingivitis, fur mite infestation, and flea infestation. Haematology revealed anaemia and thrombocytopenia. Blood chemistry showed increased alanine aminotransferase, total protein, and blood urea nitrogen. Ear native observation revealed ear mite infestation. Blood smear cytology revealed that the patient has intra-erythrocytic *Mycoplasma* and *Babesia* infections, so diagnoses of mycoplasmosis, babesiosis, fur mite infestation, flea infestation, ear mite infestation were made. The patient was hospitalised in both clinics for a total of 30 days. The treatments were doxycycline as anti-*Mycoplasma*/anti-*Babesia* treatment and supportive therapy such as infusion and blood supplement. Ectoparasiticides were also given to the patient to kill external parasites. Dental

scaling was applied to treat *caries dentis* and gingivitis. In conclusion, this study reported that the cat was fully recovered after the treatments and the patient was discharged from hospitalisation.

Keywords: feline mycoplasmosis, feline babesiosis, infectious diseases, vector-borne diseases

ABSTRAK

Laporan ini bertujuan untuk menjelaskan diagnosis dan pengobatan mikoplasmosis yang terjadi secara bersamaan dengan babesiosis dan penyakit lain pada kucing. Kucing peliharaan tersebut merupakan kucing peranakan, berjenis kelamin jantan, berumur satu tahun dan tidak dikebiri. Pasien dibawa ke klinik pertama kali dalam keadaan pucat, lesu dan tidak nafsu makan. Setelah satu minggu, pasien dibawa ke klinik kedua karena pemiliknya tidak mampu memberikan pera-watan di rumah. Pemeriksaan klinis menunjukkan selaput lendir pucat hingga kuning, terdapat karies gigi, radang gusi, infeksi tungau dan pinjal rambut. Hematologi menunjukkan anemia dan trombositopenia. Kimia darah menunjukkan peningkatan alanine aminotransferase, protein total dan nitrogen urea darah. Pengamatan terhadap telinga menunjukkan adanya infeksi tungau telinga. Sitologi apusan darah menun-jukkan bahwa pasien memiliki infeksi Mycoplasma intra-eritrosit dan Babesia, sehingga hewan kasus didiagnosis mengalami mikoplasmosis, babesiosis, infeksi tungau, infeksi tungau rambut dan infeksi tungau telinga. Pasien dirawat di kedua klinik selama total 30 hari. Perawatan yang diberikan adalah doksisiklin sebagai pengobatan antimikoplasma/ anti-babesia dan terapi suportif seperti infus dan suplemen darah. Pasien juga diberikan ektoparasitisida untuk membunuh parasit eksternal. Pembersihan karang gigi dilakukan untuk mengobati karies gigi dan radang gusi. Sebagai simpulannya, dapat dikemukakan bahwa studi kasus ini melaporkan bahwa kucing kasus pulih sepenuhnya setelah perawatan dan pasien dipulangkan dari rumah sakit.

Kata-kata kuci: mycoplasmosis kucing; babesio kucing; penyakit menular; penyaki yang ditularkan vector

INTRODUCTION

Owners keep cats as pets, best friends or even family members. Cat owners normally visit veterinarians for vaccination, spaying/neutering, diagnosis and treatment (Johnston *et al.*, 2017; Bir *et al.,* 2020). The more proper the diagnosis, the higher the possibility of the patients being appropriately treated (Khor *et al.*, 2021).

Diseases in cats include non-infectious and infectious diseases. Viral, bacterial, fungal and parasitic infections can cause infectious diseases. In addition to infectious diseases, the most common non-infectious diseases reported in cats are periodontal diseases, dental diseases, and obesity (O'Neill *et al.*, 2023)

Examples of infectious diseases in cats are mycoplasmosis, babesiosis, fur mite , ear mite and cat flea infection. The first two diseases are vector-borne diseases caused by a bacterial parasite (*Mycoplasma* sp.) (Jayanti *et al.* 2023) and apicomplexan protozoan parasite (*Babesia* sp.) (Birkenheuer 2021). Limited epidemiological studies and case reports of feline mycoplasmosis have been carried out in Indonesia (Jayanti *et al.*, 2023). However, a study reported the appearance of Candidatus *Mycoplasma haemominutum* in cats and their vectors (fleas) in Indonesia molecularly (Zarea *et al.*, 2022). In addition, there were scarce reports of feline babesiosis in Indonesia. A study in Southeast and East Asian countries has

reported the absence of *Babesia vogeli* infection in ticks collected from dogs and cats originating from several parts of Indonesia (Jakarta, Bogor and Yogyakarta) (Nguyen *et al.,* 2020). Besides, another study reported the absence of *Babesia gibsoni* from Indonesian dogs and cats from three similar locations (Jakarta, Bogor and Yogyakarta) (Colella *et al.,* 2020). However, Indonesia is considered an endemic country, as case reports and epidemiological studies reported the presence of babesiosis in dogs and cats (Hadi *et al.*, 2015).

In addition, ectoparasitic infections in cats, such as cat fleas, cat fur mites, and ear mites, can cause severe problems. These parasites can withdraw blood from their hosts and cause anaemia. Fleas (Order: Siphonaptera) are essential ectoparasites of cats worldwide. The most prevalent fleas found in cats are cat fleas or *Ctenocephalides felis* (Abdullah *et al.,* 2019). Ear mite infection caused by *Otodectes cynotis* is also common in cats and causes up to 80% of feline otitis externa. Ear mite infection is highly transmittable with direct contact with infected animals (Little and Duncan, 2021). *Lynxacarus radovskyi* (Lynxacarosis) or fur mite infection may show no symptoms at all; instead, their coats are dull, dry and dishevelled, with hairs that are easily epilated. The physical presence of the mite gives the coat a "peppered" appearance, and alopecia and pruritus have been reported in some cats in the past (Han *et al.,* 2016). This study reported a 1-year-old uncastrated male cat with co-occurrence of mycoplasmosis, babesiosis, *caries dentis*, gingivitis, ear mite, fur mite, and flea infections treated with doxycycline antibiotics, endectocide medicateons and dental scaling.

RESEARCH METHODS

Case Presentation

The study followed the principles of Good Clinical Practice (EMA 2000). The cat owner agreed that the patient's case should be reported as a scientific article. The owner agreed and allowed their animals to be treated and managed according to the treatment procedures in both veterinary clinics (March Animal Clinic and IPB University Veterinary Teaching Hospital).

Signalment: a male domestic shorthaired cat, 1-year-old, white and black colour, has not been vaccinated, weighs 2.8 kg, has not been castrated, and has blood type A. The patient was referred to March Animal Clinic on 3rd September 2023 for a blood transfusion due to inappetence and lethargy. Two previous haematology results (30th of August 2023 and 2nd of September 2023) brought by the owner revealed moderate macrocytic hypochromic, indicating regenerative anaemia, and thrombocytopenia (Table 1). Physical examination (3rd of September 2023) revealed inappetence, skin turgor < 2 seconds, pale mucous membrane, anorexia, fur mite infection (*Lynxacarus radovskyi*), no dehydration, good swallowing response, otitis with suppurative exudates, dry skin around the auricles, no vomit, no diarrhoea, no undulation of the abdominal cavity, and no pain observed during abdominal palpation. A blood smear examination (3rd of September 2023) revealed a rod-shaped organism (*Mycoplasma* sp.) in the periphery of erythrocytes (Figure 1). Thus, the patient was diagnosed with anaemia, fur mite infection, otitis externa and feline haemotropic mycoplasmosis.

The cat was hospitalised and the veterinarian gave doxycycline, red fermen-ted rice (*angkak*) and Ferro-B (Table 3). On the second day of hospitalisation, the pati-ent gained appetence. However, the pati-ent's pale mucous membrane was still observed until the last day of hospitalisation in March Animal Clinic. Anti-endo-ecto-treatment (0.4 mL combination of imida-cloprid 10% and moxidectin 1%) was given on 8th September 2023 (Table 3) for the diagnosis of fur mite. Another haematology examination on the 10th of September 2023 still showed anaemia due to low haemo-globin concentration, however, the platelet concentration improved and was slightly higher than normal or thrombocytosis (Table 1).

One day after being discharged from

March Animal Clinic on the 10th of September, 2023, the patient was admitted to the IPB University Veterinary Teaching Hospital (11th of September, 2023), and hospitalised due to the owner's inability to give the home-treatment medications prescribed. Further examinations at IPB University Veterinary Teaching Hospital included physical examination, blood smear analysis, haematology, and blood chemistry analysis. Initial symptoms showed during the first visit to IPB University Veterinary Teaching Hospital on the 11th of September 2023: fever, lethargy, and loss of appetite. The condition of the cat's fur is dull, with a body weight of 2.8 kg, an uncastrated male, and mix-domestic short hair. The heart rate was 152 beats per minute, while the respiratory rate was 48 times per minute. The temperature was normal (38.8 ºC), the colour of the mucous membrane was pale and jaundiced (Figure 1), the turgor was < 2 se conds, while the capillary refill time was > 2 seconds. *Caries dentis*, or dental plaque and gingivitis were also observed in the patient.

The haematology examination in IPB University Veterinary Teaching Hospital on 18th September 2023 showed normal erythrocytes, haemoglobin and thrombocytes compared to previous results, even though the mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC), and red blood cell distribution width (RDW) values remained abnormal. The blood chemistry analysis on 18th September 2023 showed a slight increase in serum glutamic pyruvic transaminase (SGPT) or alanine aminotransferase (ALT), total protein (TP), and blood urea nitrogen (BUN) (Table 3). Blood smear examination on the 18th of September 2023, revealed *Babesia* sp., was found on the blood smear. Lastly, on the 27th of September, *Mycoplasma* sp., was found in a blood smear, but *Babesia* sp., was not found (Figure 3). An examination of the ear smear on the 18th of September 2023, revealed *Otodectes cynotis* (Figure 4).

Based on the anamnesis, physical examination, haematology, blood chemistry analysis, and blood smear examinations, the cat was diagnosed with mycoplasmosis concurrent with babesiosis, *caries dentis*, gingivitis, as well as ear mites, fur mite, and flea infections. Haemotropic mycoplasmosis was diagnosed based on a combination of the history of flea infection and, more importantly, the symptoms of moderate anaemia, lethargy, fever and jaundice in addition to the presence of *Mycoplasma* on the blood smear. The symptoms also supported the diagnosis of feline babesiosis in the presence of *Babesia* sp., during one of the blood smear examinations. In summary, the prognoses and treatments given to the patient are written in Table 2.

In this case study, doxycycline 10 mg/kg SID per oral for 28 days (the first 14 days were given in two regimens or 5 mg/kg BID) was given for co-infection by the bacterium (*Mycoplasma* sp.), and protozoan (*Babesia* sp.). Mycoplasmosis and babesiosis are both treated with doxycycline, with a dose of 10 mg/kg a day. In addition, intravenous infusion and blood-boosting supplements (Ferro B, red fermented rice, and Nutri-Plus Gel®) were given to improve erythrocytes and thrombocytes given to include. Ectoparasiticides (Advocate® and Broadline®) were given for ear mite infection, fur mite infection, and flea infection. Dental scaling was performed with an ultrasonic scaler for the patient in this patient for dental plaque or *caries dentis* and gingivitis. The condition of the patient before (Figure 5) and after (Figure 6) dental scaling was presented. The patient's condition improved, and after treatment, the patient's mucous membrane became rose pink from previously pale to jaundiced (Figure 7).

RESULT AND DISCUSSION

The clinical signs and clinical pathology results, including fever, lethargy, moderate anaemia, thrombocytopaenia and jaundice, were consistent with previous co-infection of feline babesiosis with other pathogens, including mycoplasmosis as reported by other studies (Penzhorn and Oosthuizen, 2020; Remesar *et al.*, 2022). Moderate anaemia observed occurred due to immune-mediated haemolysis caused by

Babesia infection and feline mycoplasmosis (Raimundo *et al.,* 2016; Almendros *et al.,* 2023; Strandberg *et al.,* 2023) and it also led to pale mucous membranes and jaundice that were also observed in the patient. Immune-mediated thrombocytopaenia was observed as reported in cats with *Babesia* infection (Almendros *et al.,* 2023). In addition, thrombocytopenia, and immune-mediated haemolytic anaemia are typical in cats infected by *Babesia* sp. (Birkenheuer 2021; Remesar *et al.,* 2022; Almendros *et al.,* 2023) or *Mycoplasma* sp. (Strandberg *et al.,* 2023).

The anaemia contracted by the patient showed regenerative anaemia that can occur due to secondary immune-mediated haemolytic anaemia due to erythrocytic parasites and bacteria, including *Babesia* sp. and *Mycoplasma* sp. Therefore, the examinations of peripheral blood smear for parasites and red blood cell morphological abnormalities observations, in addition to evaluating for underlying diseases, were carried out institute supportive therapy, including the infusion to restore circulating blood volume. However, cats who contracted feline babesiosis rarely showed fever, but it can occur in some cases (Rejimon *et al.,* 2022; Almendros *et al.,* 2023). *Babesia felis* infection in cats was reported as an afebrile. The fever observed in this patient may also have resulted from other organisms (Penzhorn and Oosthuizen, 2020). The patient also showed lethargy and weakness that may occur due to infection by *Babesia* and lethargy is one of the earliest and most prominent symptoms of the disease (Rejimon *et al.,* 2022; Remesar *et al.,* 2022).

Anaemia linked to *Babesia* sp. infection in felines is usually regenerative, hypochromic and macrocytic. In contrast, feline haemotropic *Mycoplasma* sp. infection can be asymptomatic or symptomatic (severe haemolytic anaemia), depending on the species and host specificity (Strandberg *et al.,* 2023). Thrombocytopenia can be caused by coagulopathy consumption or immune-mediated platelet degradation (Birkenheuer 2021). In addition, leukocytosis and increased liver enzymes can also occur in feline babesiosis (Remesar *et al.,* 2022). The blood chemistry results also supported the diagnosis of *Babesia* and *Mycoplasma* infection. Increased SGPT/ALT in the cat patient in this study can be caused by *Babesia* infection due to liver cell damage caused by hypoxia. This damage releases enzymes such as SGPT/ALT into the bloodstream (Baneth *et al.,* 2024). The patient showed increased total protein. This condition can be explained because cats with babesiosis often exhibit polyclonal gammopathy, - by an increase in the production of immune-globulins in response to infection. This condition leads to hypergammaglobupplinemia, contributing to the overall increase in total protein concentrations. Elevated BUN levels (34 mg/dL) in the cat patient indicate azotaemia, a condition characterrized by excessive nitrogen in the blood due to impaired kidney function (Baneth *et al.,* 2024). Azotaemia that co-occurs with anaemia is predictive of babesiosis in dogs (Kurnia *et al.,* 2023).

A blood smear test, or a blood cytological examination, was conducted to screen for bacterial or protozoan parasitic infections, including *Mycoplasma* sp. and *Babesia* sp. (Jayanti *et al.,* 2023; Strandberg *et al.,* 2023). A thin blood smear was prepared from the blood sample, smeared with Giemsa or Diff Quick™ stain, and observed cytologically. The diagnostic tools for blood bacterial infections by *Mycoplasma* sp. in cats can be carried out based on the visualisation of small, blue or pink-purple-staining rods, coccoid, and ring forms bacteria associated with erythrocytes on blood smears (Pekel and Duru, 2022). In mild to severe regenerative anaemia, the increased Howel-Jolly bodies and nucleated red blood cells (nRBCs) can be observed in felines infected by *Mycoplasma* sp. or cats with regenerative anaemia (Andrews 2008; Harvey 2017). Reports showed that the agent, *Mycoplasma* sp., can show mild to severe regenerative anaemia, as moderate anaemia is present in this case. Organisms are present <50% of the time on erythrocytes owing to cyclic parasitaemia (Andrews 2008). Mycoplasmosis should be

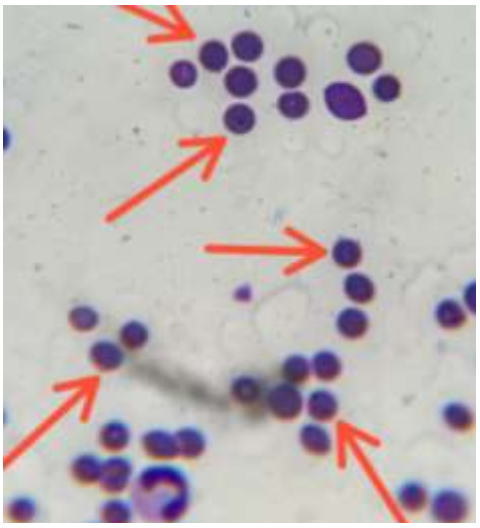

Figure 1. *Mycoplasma* sp. (red arrow) was detected in the blood smear using Diff Quick™ stain (3rd September 2023).

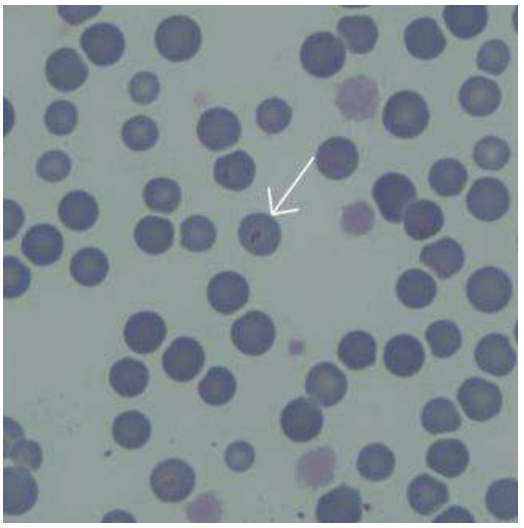

Figure 2. *Babesia* sp. (white arrow) was detected in the blood smear using Giemsa stain (18th of September 2023).

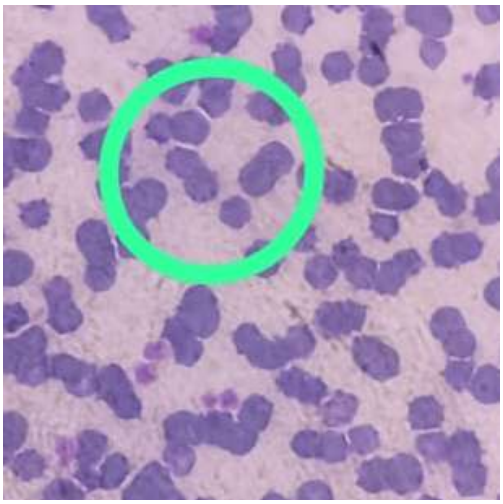

Figure 3. *Mycoplasma* sp. (Green circle) was observed using Giemsa stain (27th of September 2023).

Figure 4. *Otodectes cynotis* was observed from a native ear swab from the patient (18th of September 2023).

Figure 5. Gingivitis and *caries dentis* of the cat's left side before (left) and after (right) the dental scaling on 22nd of September 2023.

Figure 6. Gingivitis and *caries dentis* of the right side of the cat before (left) and after (right) the dental scaling on 22nd of September 2023

Figure 7 . Pale mucous membrane (left) and pink Rose mucous membrane (right) of the cat patient on the 22nd of September 2023 and 27th of September 2023, respectively.

considered a differential diagnosis in cats with fever and lymphadenopathy (Birkenheuer 2021; Travail and Peak, 2023). The patient was reported to contracted flea infection. As reported by other studies, one species of flea, *Ctenocephalides felis*, can transmit *Mycoplasma* worldwide (Raimundo *et al.*, 2016).

Light microscopy of peripheral blood smear using Giemsa stain was used in this study as a valid diagnostic of feline babesiosis. However, this study only reported in the genus, not until the species of *Babesia.* Blood smear cytology diagnostics for *Babesia* sp. infection can be carried out by observing the intraerythrocytic inclusion bodies of *Babesia* sp.. *Babesia* sp. inclusion bodies on the erythrocytes were observed as dot-shaped or circle-shaped trophozoites with a darker colour than the cytoplasmic area of the erythrocytes (Penzhorn and Oosthuizen, 2020). The species of *Babesia* were reported to infect cats are *B. cati*, *B. canis* sub-species *presentii, B. felis*, *B. microti*-like spp., *B. gibsoni* and *B. vogeli* (Rejimon *et al.*, 2022). Further molecular detection, such as PCR, is needed to determine species level and should be applied whenever possible. Babesiosis has been reported worldwide in domestic and wild cats, even though considered rare (Penzhorn and Oosthuizen, 2020). However, there is still no report on the molecular epidemiology of feline babesiosis in Indonesia. Even though clinical symptoms of feline babesiosis have been reported sporadically in various countries, scarce reports of feline babesiosis have been reported in Indonesia. In addition, more research is necessary to understand this organism and find the vector of feline babesiosis in the country.

Table 1. Patient´s Haematological Parameters

Parameter Measured	Examination Value 1 (30th August 2023)	Examination Value 2 (2nd of September 2023)	Examination Value 3 (10th September 2023)	Examination Value 4 (18th September 2023)	Reference Range (Thrall *et al.* 2012)	Unit
Haematology						
Erythrocytes	**1.89***	**1.67***	NA	5.18	4.6 – 10.0	10^6/µL
Haemoglobin	**3.9***	**3.7***	**6.0***	9.4	9.3 – 15.3	g/dL
Haematocrit	**18.5***	**16.7***	**16.8***	32	28.0 – 49.0	%
MCV	**97.8***	**99.5***	NA	**61.8***	39.0 – 52.0	fL
MCH	20.8	**22.2***	NA	18.1	13.0 – 21.0	pg
MCHC	**21.3***	**22.4***	35.7	**29.3***	30.0 – 38.0	g/dL
RDW	**11***	**11***	NA	**19.9***	14.0 – 18.0	%
Platelets	**29***	**26***	**551***	395	175 – 500	10^3/µL
Fibrinogen	NA	NA	267	NA	50 – 300	mg/dL
MPV	6.9	6.8	NA	11.8	5.0 – 11.8	fL
PDW	NA	NA	NA	15.3	0 – 50	%
PDW	**22.8***	15	NA	NA	10 – 18	fL
PCT	**0.02***	**0.018***	NA	0.466	0.1 – 0.5	%
Leucocytes	8.03	14.53	7.9	11.4	5.5 – 19.5	10^3/µL
Lymphocytes	3.0	3.9	NA	4.5	0.8 – 7.0	10^3/µL
Monocytes	0.66	0.93	NA	1.0	0.0 – 1.9	10^3/µL
Granulocytes	4.37	9.7	5.6	5.9	2.1 – 15.0	10^3/µL
Lymphocytes	37.4	26.8	NA	39.8	12.0 – 45.0	%
Monocytes	8.2	6.4	NA	8.4	2.0 – 9.0	%
Granulocytes	54.4	66.8	70.9	51.8	35.0 – 85.0	%
Eosinophiles	NA	NA	NA	3.5	0.0 – 10.0	%
P-LCR	**12.6***	13.6	NA	NA	13.0 – 43.0	%
L/M	NA	NA	2.3	NA	1.5 – 7.8	10^9/L
% L/M	NA	NA	29	NA	NA	%

Note: NA = not available; MCV = mean corpuscular volume; MCH = mean corpuscular haemoglobin; MCHC = mean corpuscular haemoglobin concentration (MCHC); RDW = red cell distribution width; MPV = mean platelet volume; PDW = platelet distribution width; PCT = platelecrit; P-LCR = platelet large cell ratio; L/M = ratio of lymphocytes/monocytes; % L/M = percentage of ratio of lymphocytes/monocytes.

Table 2. Diagnosis or symptoms of the patient, the diagnostics used, prognosis, and treatment given

Diagnosis/Symptom	Date	Diagnostics	Prognosis	Treatment
March Animal Clinic (3rd of September 2023-10th of September 2023)				
1. Anaemia	03/09/2023	Haematology	Dubius	Ferro B ½ tab S.I.D. for 14 days; *angkak* (red fermented rice) ¼ cap S.I.D. for 14 days
2. Mycoplasmosis	03/09/2023	Blood smear	Dubius	Doxycycline 5 mg/kg B.I.D. for 14 days
3. Fur Mite Infestation	03/09/2023	Physical examination	Fausta	Spot On Advocate® Small Cat (< 4 kg), contains 0.4 ml (40 mg imidacloprid, 4 mg moxidectin)
4. *Caries dentis* and gingivitis	03/09/2023	Physical examination	Dubius	Delayed treatment due to unstable condition
5. Otitis externa	03/09/2023	Physical examination	Fausta	Ear cleaning
IPB University Veterinary Teaching Hospital (11th September 2023-2nd of October 2023)				
1. Anaemia	11/09/2023	Haematology	Dubius	Nutri-Plus Gel® (100 g contains proteins 1.1%, vitamin E 106 I.E, fer 8.8 mg, fat 30.8% vitamin B1 35 mg, Iodine: 8.8 mg, fibres 0.3%, vitamin B2 3.5 mg, manganese 17.6 mg, ash 0.8%, Vitamin B6 17.6 mg. magnesium: 7 mg, moisture: 15%, vitamin B12 35 µg, nicotinamide: 35 mg, vitamin A 17.635 IE, folic acid 3.5 mg, energy 18.7 MJ/kg ME, vitamin D3 882 IE, pantothenic acid: 35 mg) 5 cc S.I.D. (after Ferro B and fermented rice ended)
2. Babesiosis	18/09/2023	Blood smear	Dubius	Doxycycline 10 mg/kg S.I.D. for 14 days (continuing doxycycline from the previous clinic)
3. Cat flea infestation (*Ctenocephalides felis*)	30/09/2023	Physical examination	Fausta	Spot on Broadline® (fipronil, S-methoprene, eprinomectin, and praziquantel)
4. Ear mite infestation (*Otodectes cynotis*)		Microscopy	Fausta	Broadline®, ear cleaning, Otopain topical treatment
5. *Caries dentis* and gingivitis	11/09/2023	Physical examination	Dubius	*Dental Scaling*
6. Hepatitis	18/09/2023	Blood Chemistry	Dubius	Curcuma tablet

Table 3. Patient´s Blood Chemistry Parameters

Blood Chemistry	Examination Result	Normal Value in Cats (Thrall *et al.* 2012)	Unit
ALP	39	11 – 210	IU/L
SGPT/ALT	**153***	30 – 100	IU/L
SGOT/AST	9	14 – 38	IU/L
Total Protein	**8.9***	5.9 – 8.1	g/dL
Glucose	98	67 – 124	mg/dL
BUN	**34***	17 – 32	mg/dL
Creatinine	1	0.9 – 2.1	mg/dL

Note: ALP: Alkaline Phosphatase; SGPT/ALT: serum glutamic pyruvic transaminase/ alanine aminotransferase; SGOT/AST: serum glutamic-oxaloacetic transaminase/aspartaHte transaminase; BUN: blood urea nitrogen.

In the current case, *Mycoplasma* sp. and *Babesia* sp. co-infection were treated with doxycycline 5 mg/kg PO BID for two weeks and continued with doxycycline 10 mg/kg PO SID for two weeks. Even though enrofloxacin 5 mg/kg PO SID can be used to treat haemotropic mycoplasma, no studies have reported this for treating *Babesia* sp. infection. In addition, the *Babesia* sp. Infection was diagnosed in the second blood smear examination (10^{th} September 2023). Therefore, doxycycline was first chosen for *Mycoplasma* sp. infection and then for treating the co-current *Babesia* sp. infection. Blood transfusion is indicative of severe cases of feline haemotropic *Mycoplasma* sp. infection. However, the cat in the current case contracted moderate anaemia. Thus, blood transfusion is an option, not compulsory. A previous report showed that recovered cats stay carriers once the haematocrit returns to normal but seldom experience a clinical illness relapse (Andrews 2008). Doxycycline used in this study was first chosen for *Mycoplasma* sp. infection. However, two weeks after the first *Mycoplasma* sp. detection, a blood smear - *Babesia* sp. Only a few reports of doxycycline was used as the agent for feline babesiosis (Kumar *et al*., 2008). However, monotherapy of doxycycline (10 mg/kg/day per oral) or in combination with other medicine was applied to treat canine babesiosis in dogs (Adaszek *et al.*, 2018).

The present study also reported the presence of fur mites in the cat. The current study also reported flea infection. This study reported the successful treatment of monotherapy of doxycycline for both mycoplasmosis and babesiosis. The suspected source of this cat patient's *Mycoplasma* sp. Transmission route was the cat flea vector present in this patient. In addition, even though during the physical examinations, tick presence cannot be observed, the patient had a high probability of being bitten by ticks since the cat is not routinely treated against both ectoparasites and endoparasites, lives in a multi-cat household, and has access to the outdoors in a rural region. Several studies have found that *Babesia microti* can also be found in cat fleas (*C. felis*), and dog fleas (*C. canis*) (Kamani *et al.,* 2018). These results suggested that these fleas have the potential to be *Babesia* vectors. Further investigation is required to resolve the ecology of flea-borne disease transmission cycles. In general, research on fleas' ability to transmit tick-borne infections and the possibility of tick-flea co-feeding may be worthwhile to pursue, as other studies reported that *B. microti* cannot be found in cats infected by *B. microti* (Kamani *et al.*, 2018).

Feline haemotropic mycoplasmosis can cause fatal haemolytic anaemia in several mammalian species, including the domestic cat, which carries feline infectious anaemia (Barker 2019). The co-occurrence of these pathogens and other immunosuppressive illnesses can increase host susceptibility (Remesar *et al.,* 2022). The transmission of feline haemotropic mycoplasmosis from

infected fleas into cats is still questionable. However, some experts think that *Mycoplasma* sp. transmission from the fleas can occur while the cats chew the infected fleas or ingest the flea's excrement, not while the fleas withdraw the cat's blood. However, *Mycoplasma* was transferred from the cats to the fleas while they withdrew the infected cats' blood. Other experts cannot rule out the possibility of *Mycoplasma* transmission between cats living in multi-cat households (Bergmann *et al.* ,2017). Generally, the prevalence of *Mycoplasma* infection is higher in the tropics since the weather supports the development of arthropods as vectors (Do *et al.*, 2021; Jayanti *et al.*, 2023). This study, however, reported the co-infection of feline mycoplasmosis and feline babesiosis in a mix-domestic cat and supported the phenomenon of co-infection by vector-borne diseases (*Babesia* sp. and *Mycoplasma* sp.) as well as other diseases. Previous studies have reported the co-occurrence of babesiosis and mycoplasmosis in cats (Wulansari *et al.*, 2014; Do *et al.*, 2021). The co-infection in this study and other studies raises the veterinarians' and authorities' awareness of vector-borne diseases in Bogor, Indonesia. Pathogen co-infection, in addition, can change the host's sensitivity to other infections and, consequently, impair the host's immune response.

In this study, doxycycline was given for co-current mycoplasmosis and babesiosis in the cat patient. Doxycycline is a broad-spectrum antibacterial with antiprotozoal activity. Doxycycline with a dose of 5 mg/kg orally BID or 10 mg/kg SID for 3 to 4½ weeks was recommended as the initial treatment for feline mycoplasmosis (Tasker *et al.*, 2018; Travail and Peak, 2023). Besides, doxycycline at 5 mg/kg BID or 10 mg/kg SID for 21 days can be used to treat canine babesiosis (Adaszek *et al.*, 2018). This study reported successful treatment of monotherapy or doxycycline *Babesia* sp. and *Mycoplasma* sp. co-infection. Despite the patient's physical examination finding no ticks, Indonesia is known to be an endemic place for babesiosis. After treatment of doxycycline, on the 27th of September 2023, *Babesia* sp. cannot be detected even though *Mycoplasma* sp. presence is persistent. Nevertheless, it is usually not possible to completely eradicate *Mycoplasma* sp. from the patient, and the animals end up as lifelong carriers (Strandberg *et al.*, 2023).

In this study, periodontal therapy or dental scaling was given for supragingival plaque and tartar. However, removal of the subgingival plaque can cause advanced periodontal diseases and detached gingival disease, openly through flap surgery with a curette to remove subgingival plaque after gingival flap elevation. Periodontal therapy controls microbiological periodontal disease by eliminating bacterial biofilm, calculus and toxins from periodontally afflicted root surfaces (Elseddawy 2023). Dental scaling, in this study, however, was carried out after the condition of the patient was safe for anaesthesia administration, as the patient has the possibility of fatal diseases due to *Babesia* sp. infection and *Mycoplasma* sp. Infection. Anaesthetic inductions with ketamine (10 mg/kg body weight, intravenous) and in combination with acepromazine (0.1 mg/kg body weight, intravenously) as premedication were given to the patient (Robertson *et al.*, 2018).

Oral and dental care are necessary for preserving animals' good health and quality of life. Untreated oral and dental problems can cause discomfort and diseases locally and systemically (Elseddawy 2023). The pathology of the oral cavity in cats can be infectious, neoplastic, traumatic, immune-mediated, congenital and others. The main problem of the oral cavity is inflamed periodontium. The clinical terms of an active process in periodontal disease include periodontitis and gingivitis. Bacterial plaque gingivitis can be eliminated as a preventable and reversible disease by removing the bacteria above or below the gingival margin. The calculus (or bacterial plaque or *caries dentis*) calcified by saliva minerals is relatively non-pathogenic and irritant (Bellows *et al.*, 2019).

In this case study, ear mites (*Otodectes cynotis*), cat fleas (*C. felis*), and cat fur mites (*L. radovskyi*) infection were treated

with spot-on Advocate® (10% imidacloprid + 1% moxidectin) on 8th September 2023 (Han *et al.*, 2016; Han *et al.*, 2019; Campos *et al.*, 2020; Little and Cortinas, 2021). In addition, after three weeks apart (29th September 2023), a spot on Broadline® (fipronil 74.7 mg, S-methoprene 90 mg, praziquantel 3.6 mg, and eprinomectin 74.7 mg) was also given for similar indications (Baker *et al.*, 2014; Beugnet *et al.*, 2014). Due to the possibility of otitis externa and dry ear with co-current bacterial infection observed in the patient, ear drop formulations that in each 1 mL consist of polymyxin B sulphate 10,000 IU, neomycin sulphate 5 mg, fludrocortisone acetate 1 mg, and lidocaine HCl 40 mg. Topical treatment with polymyxin B sulphate and neomycin sulphate was given to kill the bacteria, lidocaine was given for relieve the pain and fludrocortisone acetate was for inflammation. Blood-boosting supplements were provided to support the formation of cat red blood cells because both *Babesia* and *Mycoplasma* can cause red blood cell lysis.

Within minutes of their arrival, *C. felis* will start feeding on their host's blood, and most of them will finish their blood meal within an hour (Otranto *et al.*, 2021). In addition to their blood-feeding behaviour to their hosts, *C. felis* can transmit flea-borne diseases, namely bartonellosis, rickettsiosis, mycoplasmosis and dipylidiosis (Abdullah *et al.*, 2019; Huang *et al.*, 2021). Endectoparasiticide medications can prevent and treat flea infection and transmission of flea-borne diseases (Otranto *et al.*, 2021). In addition to cat flea infection, ear mite infection caused by *O. cynotis* is common in cats. Clinical signs of cats infected with ear mites include pruritus, head tilt, head shaking, circling and sometimes pinna-pedal reflex. Some of the recommended treatments for ear mite infections are otic formulations of ivermectin, otic formulations of milbe-mycin oxime (Little and Duncan, 2021), spot-on-formulations of selamectin or spot-on-formulations of 10% imidacloprid + 1% moxidectin, once or twice 30 days apart (Yang and Huang, 2016). Infected animals, especially cats, may become malnourished or exhibit neurological symptoms without treatment (Little andcDuncan 2021). This study reported full recovery of a 1-year-old uncastrated male cat with co-occurrence of mycoplasmosis, babesiosis, *caries dentis*, gingivitis, ear mite, fur mite, and flea infections treated with doxycycline anti-biotics, endectocide medications, and dental scaling.

CONCLUSION

In conclusion, this study reported the presence of feline mycoplasmosis and babesiosis in a cat patient with the co-current diseases of ectoparasitic infections, *caries dentis,* and gingivitis. Doxycycline can be used as anti-*Mycoplasma*/anti-*Babesia* treatment in the patient, in addition to supportive therapy such as infusion and blood supplements. Dental scaling was applied to the patient to treat *caries dentis* and gingivitis.

SUGGESTION

This study suggested employing ectoparasiticides to kill external parasites already on the animal's body and newly acquired parasites and prevent re-infection by ectoparasites. In addition, ectoparasiticides can be applied to avoid diseases transmitted by ectoparasite vectors, including feline babesiosis and mycoplasmosis. The treatments given to the patient are considered successful.

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