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Comparative Efficacy of Imidocarb Dipropionate and Doxycycline, Clindamycin, Metronidazole Combination for the Treatment of Cytauxzoonosis in Domestic Cats

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ABSTRACT

Background: Cytauxzoonosis is an emerging and fatal disease of wild and domestic cats in India. Till date no chemotherapy has proved successful in achieving hundred percent survival. In this study we aimed to evaluate various therapeutic strategies to suggest an effective and safe drug combination for clinical management of domestic cats naturally affected cytauxzoonosis.

Methods: The domestic cats presented at VCC, Bihar Veterinary College, Patna, Bihar were screened on the basis of clinical symptoms of cytauxzoonosis irrespective of their age, sex or breed. The disease was confirmed by peripheral blood smear and Polymerase Chain Reaction test. Informed consent was taken from the cat owners before inclusion in this study. The confirmed cases were randomly divided into two treatment protocols, imidocarb dipropinate group (T-1) and doxycycline, clindamycin and metronidazole group (T-2). In group T1 imidocarb was given @ 3.5 mg/kg deep intramuscular which was repeated after 14 days. While cats in group T2 received doxycycline @10 mg/kg PO sid for 14 days, clindamycin @ 12.5mg/kg PO sid for 14 days and metronidazole benzoate@ 25 mg/kg PO sid for 7 days. A separate group of six healthy cats, negative for microscopic and molecular tests was taken as a control (T-3).

Result: It was found that both treatment protocols cleared erythro-parasitemia and brought clinical remission within 14 and 21 days of treatment in cats of group T1 and T2 respectively. However, improvement in morbidity and hemato-biochemical parameters were more rapid in imidocarb treated cats. No serious side effects or mortality could be recorded in cats that received the treatment protocols used in this study. But none of these treatment protocols could sterilize the infection and rendered the cats as carrier for life.

Key words: Clindamycin, Cytauxzoonosis, Domestic cat, Doxycycline, Imidocarb dipropionate, Metronidazole.

INTRODUCTION

Cytauxzoonosis is an emerging, tick-borne hemoparasitic disease of felidae family. It is caused by *Cytauxzoon* spp. which belong to the phylum Apicomplexa, class Sporozoasida, order Piroplasmida, family Theileriidae and genus Cytauxzoon. Feline cytauxzoonosis was first reported in Missouri, USA by Wagner in the year 1976. There are very few published reports of Cytauxzoonosis in domestic cats from India. Management of Cytauxzoonosis is generally difficult due to complex pathogenicity as well as refractory behaviour of the pathogen to chemotherapeutic agents. Prompt and comprehensive treatment is required for cytauxzoonosis because it is a rapidly progressive disease (Sherrill and Cohn, 2015). Several drugs with antiprotozoal property have been employed for therapy of clinically ill cats. It included buparvaquone, diamenazene aceturate, doxycycline, atovaquone, azithromycin, imidocarb *etc.* Paravaquone and buparavaquone, antiprotozoal drugs used successfully to treat bovine theileriosis, completely failed against experimentally induced cytauxzoonosis (Motzel and Wagner, 1990). Greene *et al.* (1999) successfully treated five of six naturally infected domestic cats in a trial using diminazene aceturate. Cohn *et al.* (2011) in their study found 60% survival in infected cats that were given the combination of atovaquone and azithromycin while it was mere 26% with imidocarb dipropionate. Presently, combination of atovaquone and azithromycin is considered standard for cytauxzoonosis treatment in cats.

Feline cytauxzoonosis on whole is less explored in India, especially when it comes to treatment aspect. The standard combination of atovaquone and azithromycin is still not 100% successful in achieving survival of ill cats.

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Further, atovaquone is an expensive drug and less used in veterinary sector in India. Thus, there is a need of alternative chemotherapy for treating cytauxzoonosis in domestic cats. Imidocarb is easily available drug and was previously used to successfully treat a single case of cytauxzoonosis affected cat in India (Halder and Gupta, 2021). Antimicrobials having antiprotozoal actions, such as clindamycin, doxycycline and metronidazole, were shown efficient against *Babesia* spp. in humans and dogs (Suzuki *et al.,* 2007). Almendros *et al.* (2020) reported the effective action of combination therapy using doxycycline, clindamycin and metronidazole, against *Babesia gibsoni* infection in dogs where atovaquone and azithromycin failed to eliminate the infection on a polymerase chain reaction (PCR) test. But there is no literature that documents the use of these drugs in feline babesiosis (Ayoob *et al.,* 2010). Hence a controlled study was designed to study the efficacy of triple drug combination and imidocarb dipropionate against feline piroplasmid Cytauxzoon organism.

Imidocarb dipropionate is a carbanilide derivative, has antiprotozoal activity and is available only for veterinary use. Proposed mechanisms of action for imidocarb dipropionate are interference in utilisation or production of polyamines by parasites as found for *Trypanosoma brucei*, starvation of parasite resulting from blockage of inositol entry into parasite containing erythrocytes as found for Babesia organism and binding with nucleic acids of DNA of susceptible organisms causing damage to DNA to inhibit cellular repair and replication (Plumb, 2015). Doxycycline and clindamycin are thought to kill eukaryotic parasites by targeting ribosomes in the apicoplast (plastid) organelle where it inhibits prokaryotic-like translation (Okada *et al.,* 2020). Metronidazole on entering the target cell is reduced to unstable intermediates that interacts with bacterial or protozoal DNA, causing loss of helical DNA structure and breakage of strand. This inhibits nucleic acid synthesis leading to death of the cell (Weir and Le, 2023). Oral administration of metronidazole for longer than 7 days consecutively or total daily dosage greater than 50 mg/kg has the risk of causing neurotoxicity and disruption of DNA within peripheral mononuclear cells in cats. But these toxicities are reversible on discontinuation of the drug (Sekis *et al.,* 2009). The present study was undertaken to evaluate efficacy as well as any untoward effects (if any) in clinical cases of cytauxzoonosis in domestic cats.

MATERIALS AND METHODS

Study design and setting

The cat cases presented at the Veterinary Clinical Complex, Bihar Veterinary College, Patna were screened for cytauxzoonosis based on previously defined symptoms namely anorexia, vomition, fever, icterus, dyspnea, tachycardia, lethargy, dehydration, vocalization and diarrhoea. Further, the disease was confirmed by microscopic blood smear and PCR test. The study design was discussed with the owner of the animal and included in this study after obtaining their consent. Twelve affected cats were selected for clinical trial and were divided into two treatment groups T1 and T2 having 6 cats each. A control group T3 was made with six clinically healthy cats which gave negative microscopic and PCR test for cytauxzoonosis. Cats in T1 group received imidocarb dipropionate @ 3.5 mg/kg deep intramuscular two doses 14 days apart. Pheniramine maleate @1-2 mg/cat was administered intramuscular before imidocarb injection to tackle any adverse reactions of it. In group T2 triple drug combination of doxycycline @10 mg/kg PO sid for 14 days, clindamycin @ 12.5mg/kg PO sid for 14 days and metronidazole benzoate@ 25 mg/kg PO sid for 7 days. Supportive therapy with fluid, liver support and hematinic were common to all and given as per the condition of the case. The data on physiological parameters and hemato-biochemical findings were recorded on 0, 7, 14 and 21 days of treatment. Also, blood smear and PCR test was performed on all these days. Blood samples were collected from medial saphenous vein or cephalic vein in EDTA vial (1 ml) and plain vial (2 ml). Comparative efficacy of the two protocols in treatment of cytauxzoonosis in cats was based on clinical recovery, absence of piroplasm stage in blood smear examination and improvement in hemato-biochemical parameters.

Molecular analysis

Genomic DNA from clinically ill cats was isolated using 300 µL whole blood sample and HiPurA® SPP blood DNA isolation kit (HIMEDIA) following the manufacturer's instructions. The isolated DNA sample was stored at -20°C for further use. Molecular detection of piroplasms was carried out using a conventional PCR assay using the sense primer 5′CCAGCAGCCGCGGTAATT3′ and the antisense primer 5′CTTTCGCAGTAGTTYGTCTTAACAAATCT3′ that amplify a fragment of ~373 bp of the 18S rRNA gene (Diaz-Reganon *et al.,* 2017). PCR reactions were carried out in a final volume of 25 µL containing 12.5 µl of Taq PCR Master Mix (2 × Premix) containing Taq DNA Polymerase, optimized PCR buffer and dNTPs, 1.0 µl of each primer (Forward and Reverse), 2 µl of the DNA template and 8.5 µl nuclease free water.

The thermal cycling conditions consisted of an initial denaturation: 94°C for 3 min 35 cycles of 94°C for 30 s 64°C for 45 s 72°C for 30 s Final extension: 72°C for 7 min. All reactions were performed using an automated thermal cycler (BIO-RAD, T100). The amplicons were visualized under UV illumination in gel documentation system after electrophoresis of 10 µL of the reaction solution in a 2% agarose Gel.

Statistical analysis

The data obtained were statistically analysed by the IBM SPSS 29.0 standard version for Windows. Two-way ANOVA was used for comparing the mean values of the three treatment groups with the control group and within the groups on different days of assessment. Variables with $P \geq 0.05$ were considered as statistically "non-significant."

variables with P<0.05 were considered as statistically "significant".

RESULTS AND DISCUSSION

On microscopic blood smear examination both bipolar safety pin-like piroplasms (Fig 1) and round signet-ring shaped (Fig 2) were found in this study. Concentration of parasitaemia was graded mild in all the cases. The cats in the imidocarb group (T1) and triple drugs (T2) group became microscopically negative on day 21(Table 1). However, with both of these protocols PCR gave positive result (band of 373 bp, Fig 3) on all the days of assessment.

The body temperature, respiratory rate and heart rate (Table 2) were increased significantly (P<0.05) in both the groups on the day of presentation. Significant improvement was observed from 0 to 7th day reaching the normal level in both the treatment groups. The mean hemoglobin, haematocrit, TEC, platelet counts (Table 3) were significantly (P<0.05) lower from the control group on 0 day. The values increased significantly (P<0.05) from 0 to 14th day in imidocarb group while in triple drug group the increase was non-significant (P≥0.05). The mean total leukocyte count (TLC) (Table 3) did not show any significant changes (P≥0.05) in any of the treatment groups as compared to healthy control. However, mild leucocytosis and leukopenia were observed on referring to individual cases. Treatment brought non-significant changes in both the groups. The ALT activity (Table 4) were found to be significantly higher (P<0.05) in both the treatment groups from the healthy control on day 0. Significant decrease (P<0.05) in ALT was noted in imidocarb treated group from 0 to 14th day level. Triple drug combination also showed decrease but non-significantly. Mean total protein concentration (Table 4) was non-significantly (P≥0.05) lower in both the treatment groups as compared to healthy control on 0 day. The mean albumin concentration (Table 4) was significantly decreased (P<0.05) in both the treatment groups as compared to healthy control. Imidocarb significantly increased (P<0.05) albumin concentration on 14th day of treatment whereas triple drug did not show any significant (P≥0.05) improvement. There were no significant changes (P≥0.05) in mean total bilirubin values (Table 4) between and within groups. But there was considerable rise in two cats, one from each group that improved well with the treatment. One cat from group T1 had total bilirubin value 4.6 mg/dL on 0 day which lowered to 2.8, 1.5 and 0.9 mg/dL on 7th, 14th and 21st day of the treatment respectively (Fig 4 and 5). Similarly, total bilirubin level in a cat in group T2 improved from 4 mg/dL to 3, 1.4 and 1 mg/dL on 7th, 14th and 21st day of treatment respectively (Fig 6 and 7). However, effect of treatment could not be comprehended statistically on the mean bilirubin values. Blood Urea Nitrogen (BUN) and creatinine did not show significant alterations in affected cats of any of the group (Table 5).

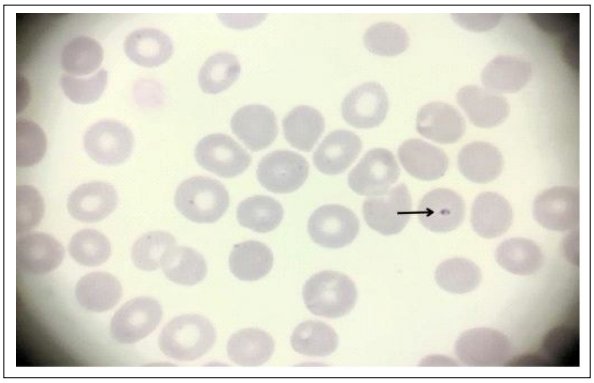

Fig 1: Microscopic view of bipolar safety-pin like intra-erythrocytic piroplasm of *Cytauxzoon* sp.

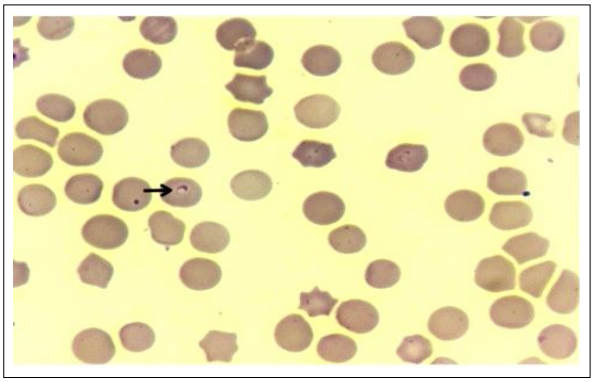

Fig 2: Microscopic view of signet-ring shaped intra-erythrocytic piroplasm of *Cytauxzoon* sp.

Both the treatment modalities appear safe for renal and hepatic function as there was no evidence of derailment in levels of renal and hepatic enzymes after treatment (Table 4 and 5). The safety of drugs in terms of pre and post administration effects on the physiological and behavioural factors of cats is presented in Table 6.

Recurrence of illness after a clinical recovery was reported with triple drug combination (after 45 days) in three of cats and in one of the imidocarb treated cat (after 60 days).

Imidocarb dipropionate and the combination of doxycycline, clindamycin and metronidazole gave negative

Table 1: Microscopic parasitaemia in treatment groups on 0, 7th, 14th and 21st day of observation.

Days	T1						T2					
0	+	+	+	+	+	+	+	+	+	+	+	+
7	+	+	-	-	-	+	+	-	+	+	+	-
14	-	-	-	-	-	-	+	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-

microscopic blood smear test in all cats on day 21. Thus, both were equally effective in terms of clearing erythro-parasitemia. However, both the drugs were not able to sterilise the infection of cytauxzoonosis giving positive PCR results. Thus, the cats once infected may recover from the clinical illness but remain to act as carrier. Harvey *et al.,* (2007) found that almost all cougars, bobcats and domestic cats recovering from acute *C. felis* infection continued to

Table 2: Mean ±SE of Body temperature, heart rate and respiratory rate in treatment and control groups on 0, 7th, 14th and 21st day of observation.

Vital parameters	Groups	0	7	14	21
Body temperature (°F)	T1	103.73^{by}±0.43	101.97^{ax}±0.23	101.72^{ax}±0.18	101.67^{ax}±0.17
	T2	104.10^{by}±0.50	102.20^{ax}±0.20	101.60^{ax}±0.24	101.63^{ax}±0.18
	T3	101.88^{a}±0.21	101.88^{a}±0.21	101.88^{a}±0.21	101.88^{a}±0.21
Heart rate (beats	T1	158.67^{by}±3.53	148.67^{ax}±1.91	146.67^{ax}±1.98	146.00^{ax}±1.71
per minute)	T2	156.67^{by}±5.51	146.67^{ax}±1.33	144.67^{ax}±1.23	147.33^{ax}±1.91
	T3	148.00^{a}±1.46	148.00^{a}±1.46	148.00^{a}±1.46	148.00^{a}±1.46
Respiratory rate	T1	44.00^{by}±2.31	33.67^{ax}±1.61	32.00^{ax}±1.03	32.00^{ax}±1.46
(breath per minute)	T2	43.33^{by}±3.17	33.33^{ax}±1.61	32.67^{ax}±0.84	32.67^{ax}±1.23
	T3	33.33^{a}±1.69	33.33^{a}±1.69	33.33^{a}±1.69	33.33^{a}±1.69

Mean with different superscripts in columns (x, y, z) and rows (a, b, c) differ significantly (P<0.05).

Table 3: Mean ±SE of haemoglobin, haematocrit, TEC, platelets and TLC. AST, total bilirubin, total protein and albumin in treatment and control groups on 0, 7th, 14th and 21st day of observation.

Blood parameters	Groups	0	7	14	21	P value
Haemoglobin (g/dL)	T1	7.40^{ax}±0.79	8.92^{axy}±0.84	10.30^{ay}±0.62	10.67^{by}±0.57	0.016
	T2	8.80^{ax}±0.62	$9.38a^{x}$±0.57	9.95^{ax}±0.46	10.27^{ax}±0.44	0.245
	T3	13.20^{b}±0.46	13.20^{b}±0.46	13.20^{b}±0.46	13.20^{b}±0.46	
Haematocrit (%)	T1	22.82^{ax}±2.34	26.47^{axy}±2.60	30.67^{axy}±1.96	32.10^{by}±1.72	0.027
	T2	26.40^{ax}±1.79	28.25^{axy}±1.71	29.75^{axy}±1.29	30.88^{ay}±1.33	0.238
	T3	38.62^{b}±1.48	38.62^{b}±1.48	38.62^{b}±1.48	38.62^{b}±1.48	
TEC ($\times 10^6$ /µl)	T1	4.60^{ax}±0.59	5.60^{axy}±0.66	6.58^{abxy}±0.41	6.78^{ay}±0.39	0.028
	T2	5.38^{ax}±0.53	5.93^{abx}±0.45	6.38^{abx}±0.30	6.62^{ax}±0.30	0.178
	T3	7.93^{b}±0.17	7.93^{b}±0.17	7.93^{b}±0.17	7.93^{b}±0.17	
Platelets count	T1	135.33^{ax}±14.66	175.83^{abxy}±17.44	215.83^{by}±23.11	219.67^{by}±21.61	0.020
($\times 10^3$/µl)	T2	146.83^{ax}±28.05	167.17^{ax}±31.76	190.67^{ax}±30.08	193.33^{ax}±29.04	0.660
	T3	265.33^{b}±31.00	265.33^{b}±31.00	265.33^{b}±31.00	265.33^{b}±31.00	
TLC ($\times 10^3$ /µl)	T1	13.16^{ax}±2.14	12.77^{ax}±1.97	12.42^{ax}±1.75	12.38^{ax}±1.59	0.990
	T2	12.93^{ax}±3.31	12.32^{ax}±3.01	11.82^{ax}±2.61	11.70^{ax}±2.45	1.000
	T3	10.65^{a}±1.24	10.65^{a}±1.24	10.65^{a}±1.24	10.65^{a}±1.24	

Mean with different superscripts in columns (x, y, z) and rows (a, b, c) differ significantly (P<0.05).

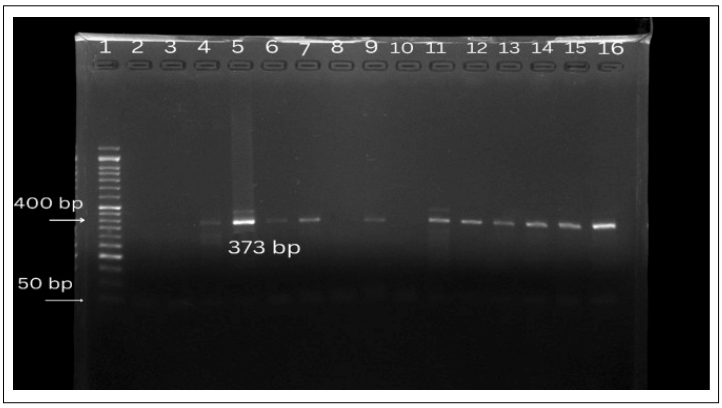

Fig 3: Gel electrophoresis image showing an amplicon of 373 bp of 18S rRNA gene of *Cytauxzoon* sp., where lane 1 shows ladder of 50 bp, lane 2 shows negative control, lane 3, 8 and 10 are negative samples and 4, 5, 6, 7, 9, 11, 12, 13, 14, 15 and 16 are positive samples.

be parasitaemic for life. However, Carli *et al.,* (2014) thoroughly studied cytauxzoonosis infection in a free-ranging cat with multiple evaluations post-treatment with doxycycline and imidocarb dipropionate and it gave negative PCR result on all these days.

Elevated body temperature, respiratory rate and heart rate was consistent with the findings of Cohn *et al.,* (2011). The remission of these vital parameters to normal on 7th day was parallel in both groups. It could be attributed to antipyretic treatment and lowered infection.

Mild to moderate anemic state of infected cats was due to immune mediated erythro-phagocytosis and was also reported in previous studies (Carli *et al.,* 2022).

Thrombocytopenia as evidenced in present and other studies (Alho *et al.,* 2016) is believed to be due to DIC and inflammation led coagulation (Conner *et al.,* 2015).

There is no uniform pattern in shift of leukocyte count in present work similar to previous studies. Moghaddam *et al.,* (2020) found leukocytosis, indicative of acute infection. Naidenko *et al.,* (2022) reported leukopenia indicating

Fig 4: Pre-treatment cat with icteric pinna and conjunctiva.

Fig 5: Post-treatment cat with normal pinna and conjunctiva.

Table 4: Mean ±SE of ALT, total bilirubin, total protein and albumin in treatment and control groups on 0, 7th, 14th and 21st day of observation.

Blood parameters	Groups	0	7	14	21	P value
ALT (U/L)	T1	86.50^{by}±6.66	76.17^{abxy}±5.58	67.00^{abx}±2.84	62.50^{abx}±2.39	0.009
	T2	89.83^{bx}±6.49	82.83^{bx}±6.25	75.53^{bx}±4.68	71.43^{bx}±4.47	0.126
	T3	59.00^{a}±1.15	59.00^{a}±1.15	59.00^{a}±1.15	59.00^{a}±1.15	
Total bilirubin (mg/dL)	T1	1.55^{ax}±0.62	0.96^{ax}±0.37	0.59^{ax}±0.19	0.40^{ax}±0.11	0.180
	T2	1.60^{ax}±0.61	1.10^{ax}±0.47	0.70^{ax}±0.26	0.49^{ax}±0.16	0.273
	T3	0.25^{a}±0.03	0.25^{a}±0.03	0.25^{a}±0.03	0.25^{a}±0.03	
Total protein (g/dL)	T1	6.86^{ax}±0.08	6.98^{ax}±0.07	7.07^{ax}±0.07	7.15^{ax}±0.06	0.018
	T2	6.92^{ax}±0.12	7.07^{ax}±0.10	7.08^{ax}±0.09	7.17^{ax}±0.07	0.327
	T3	7.18^{a}±0.07	7.18^{a}±0.07	7.18^{a}±0.07	7.18^{a}±0.07	
Albumin (g/dL)	T1	2.70^{ax}±0.12	2.96^{axy}±0.06	3.12^{ay}±0.07	3.15^{ay}±0.04	0.003
	T2	2.85^{abx}±0.18	3.00^{abx}±0.08	3.15^{abx}±0.06	3.17^{ax}±0.05	0.165
	T3	3.28^{b}±0.08	3.28^{b}±0.08	3.28^{b}±0.08	3.28^{b}±0.08	

Mean with different superscripts in columns (x, y, z) and rows (a, b, c) differ significantly (P<0.05).

chronic infection. While Carli *et al.* (2022) did not find any significant changes in total leucocyte, neutrophil and lymphocyte counts in their case-control study.

Higher liver enzyme activity in infected cats was alike reports of Alho *et al.,* (2016) and Nentwig *et al.,* (2018). This signifies hepatic damage that could be both hypoxic (due to anemia) and infarctive (due to occlusion of blood vessels by parasite distended mononuclear cells).

Hyperbilirubinemia was detected but not an obvious finding in the present study. Such variation can also be concluded from the findings of Carli *et al.,* (2022) who found the total bilirubin level within the normal range in the infected cats while Cohn *et al.,* (2020) reported hyperbilirubinemia.

Low mean albumin concentration was also observed by Moghaddam *et al.,* (2020) similar to present study. Vasculitis, liver dysfunction and protein losing nephropathy and enteropathy are the possible causes for hypoproteinemia and hypoalbuminemia (Frontera-Acevedo *et al.,* 2013).

Imidocarb dipropionate gave significant result in improving the hemato-biochemical parameters within 21 days of treatment. However triple drug combination showed non-significant improvement during this period. Thus, triple drug had slower action than imidocarb in normalising the hemato-biochemical alterations. Due to the lengthy protocol of triple drug combination, there could be possibility of discontinuation of the treatment by the owners once the symptoms resolved. Besides, complaint of mild diarrhoea was given in many cases under this treatment protocol. But overall no serious side effects or mortality could be recorded in cats that received any of the treatment protocols.

Kier and Greene (1998) claimed a 50% survival rate using imidocarb in cats suffering from naturally occurring cytauxzoonosis. Cohn *et al.,* (2011) in their study found mere 26% survival in cats that were treated with imidocarb dipropionate. In a case report of cytauxzoonosis in a kitten

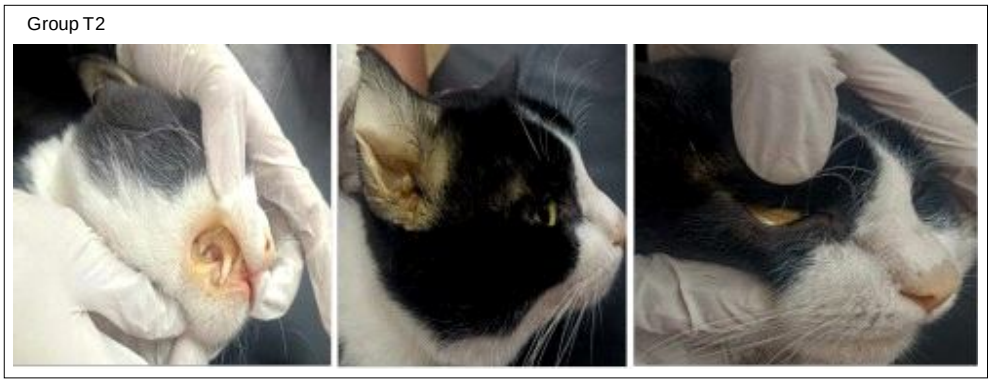

Fig 6: Pre-treatment cat showing icteric gingiva, pinna and mucus membrane.

Fig 7: Post-treatment cat showing normal gingiva, pinna and mucus membrane.

Table 5: Mean ±SE of blood urea nitrogen (BUN) and Creatinine in treatment and control groups on 0, 7, 14 and 21 days of observation.

Blood parameters	Groups	0	7	14	21	P value
BUN (mg/dL)	T1	28.08^{ax}±3.40	26.17^{ax}±3.50	24.17^{ax}±3.12	22.50^{ax}±2.36	0.720
	T2	26.17^{ax}±2.48	24.75^{ax}±1.94	23.50^{ax}±1.63	22.50^{ax}±1.59	0.662
	T3	22.60^{a}±1.01	22.60^{a}±1.01	22.60^{a}±1.01	22.60^{a}±1.01	
Creatinine(mg/dL)	T1	1.01^{ax}±0.09	1.00^{ax}±0.07	1.01^{ax}±0.05	0.93^{ax}±0.04	0.971
	T2	1.03^{ax}±0.11	1.02^{ax}±0.08	1.02^{ax}±0.09	0.98^{ax}±0.04	0.991
	T3	1.06^{a}±0.06	1.06^{a}±0.06	1.06^{a}±0.06	1.06^{a}±0.06	

Mean with different superscripts in columns (x, y, z) and rows (a, b, c) differ significantly (P<0.05).

Table 6: Safety evaluation of both the treatment protocols in Cytauxzoon affected cats.

Parameter	Observation after Drug administration			
	Group T1		Group T2	
	Pretreatment	Post treatment	Pretreatment	Post treatment
Motor activity	+	+++	++	+++
Respiration	+++	+	++	+
Pain and distress	++	+	++	++
Postural abnormality	-	-	-	-
Pupil size of eye	+	++	+	++
Lacrimation	++	-	+	-
Reflexes (Pinna, Corneal *etc.*)	+	++	+	++
Reactivity to sound and touch	+	++	+	++
Salivation	-	++	-	++
Diarrhoea	-	-	-	+
Behaviour (Aggression/Stereotype)	-	+	-	-
Mortality	-	-	-	-

from India treatment was attempted using doxycycline but the kitten collapsed ultimately (Varshney *et al.,* 2009). The severely affected cats that died during the treatment duration was excluded from the present study. Thus, we could not conclude the efficacy in terms of survival percentage. Recurrence of illness in few cats from both the groups could be either new infection or recrudescence of previously lowered infection with the treatment.

CONCLUSION

Imidocarb dipropionate as well as combination of doxycycline, clindamycin and metronidazole combination brought clinical remission. However, improvement in morbidity and hemato-biochemical parameters were more rapid in imidocarb treated cats. No serious side effects or mortality could be recorded in cats that received the treatment protocols used in this study. But none of these treatment protocols could sterilize the infection and rendered the cats as carrier for life.

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Ethics approval

The experimental protocol was approved by institutional animal ethical committee, Bihar Animal Science University, India (vide letter no- F.26-1/2022-23/DR).

Conflict of interest

The authors have no relevant financial or non-financial interests to disclose.

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