1. INTRODUCTION

Babesiosis is a parasitic infection caused by hemotropic protozoa of the genus *Babesia*, family Babesiidae, order Piroplasmida, within the phylum Apicomplexa. Newly recognised babesia with zoonotic potential continue to emerge around the world and the substantial economic impact of babesiosis on livestock and companion animals especially in the tropics and subtropics is ongoing (Collett, 2000; Kivaria et al., 2007).

Canine babesiosis is caused by tick transmitted apicomplexan parasites of *Babesia* species, which parasitize erythrocytes. Based on host specificity and morphology of the intraerythrocytic forms, canine piroplasms have been originally recognised belonging to two distinct species, the large (4–5 μm) *Babesia canis* and the small (1–2.5 μm) *B. gibsoni* (Foldvari et al., 2005).

*Babesia* are ubiquitous parasites with a world wide distribution. They generally have two classes of hosts, an invertebrate and a vertebrate host and the maintenance of *Babesia spp.* is dependent on both hosts. *Babesia spp.* are transmitted to dogs by a wide variety of Ixodid ticks including *Haemaphysalis longicornis*, *H. leachi*, *Rhipicephalus sanguineus* and *Dermacentor marginatus* (Shaw et al., 2001). Infection from blood transfusions (Stegeman et al., 2003), transplacental transmission (Fukumoto et al., 2005), and direct transmissions through bite wounds (Jefferies et al., 2007) have also been reported.

Babesiosis primarily affects erythrocytes leading to progressive anemia, but can involve multiple organs. Cases of canine babesiosis with a wide variation in severity of clinical signs occur ranging from a hyperacute, shock-associated, hemolytic crisis to an unapparent subclinical infection. Clinical manifestations of canine babesiosis vary with the species of the infectious agent, as well as with the age, immune status and concurrent infections of the affected dog. Lethargy is the most common symptom, followed by anorexia, pale mucous membranes, vomiting, amber to brown
urine, splenomegaly, jaundice, weight loss, tachycardia and tachypnea. Atypical cases showing ascites, gastrointestinal or neurological signs, peripheral edema and cardiopulmonary disease have also been reported (Lappin, 1997). A wide range of clinical signs has been reported for babesiosis, with the greatest severity in younger dogs, which may lead to the state of shock (Irwin and Hutchinson, 1991).

Babesiosis is classified as uncomplicated if the clinical changes are attributed directly to hemolytic anemia. Uncomplicated babesiosis is subclassified as mild (if anemia is mild to moderate) and severe (if anemia is life-threatening). Complicated cases are those with problems that are not directly attributable to acute hemolysis (Jacobson and Clark, 1994). Both *B. canis* and *B. gibsoni* can cause an acute hemolytic anemia with eventual potentially chronic babesiosis. The anemia is usually normochromic to hypochromic (Schetters *et al*., 1998; Taboada, 1998). Diagnosis of babesiosis is based on a combination of history, clinical findings and laboratory findings, especially size and morphological appearance of intra-erythrocytic forms in peripheral blood smears. Serial blood smears must be investigated early in the infection when the level of parasitemia in the host can be lower than 1 per cent.

Although the incidence of this infectious disease has been increasing, effective and crucial therapeutic modality is unavailable. Diminazene aceturate (Fowler *et al*., 1972), imidocarb dipropionate (Vial and Gorenflot, 2006), and phenamidine isethionate (Groves and Vanniasingham, 1970) have been previously reported to reduce parasitemia, but complete elimination of *B. gibsoni* (Asian genotype) from dogs is not reported (Boozer and Macintire, 2003, Birkenheuer *et al*., 2004). A decreased parasitemia level has been shown with doxycycline therapy @10 mg/kg b.wt. PO, BID, for 7-10 days (Ayoob *et al*., 2010). Various drugs like enrofloxacin, metronidazole, clindamycin and azithromycin, alone or in combination, have also been reported to be effective against the disease. However, relapses after administering some combinations of antibabesial drugs and the presence of drug-resistant *B. gibsoni* still pose significant challenges to veterinarians.
In view of the above, following objectives are proposed:

1. To study the epidemiological pattern of prevalent hemoprotezoa of dogs in and around Jabalpur.

2. To study the prognostic values of various hemato-biochemical alterations in uncomplicated and complicated babesiosis in dogs.

3. To evaluate the comparative therapeutic efficacy of different anti-babesial drugs in dogs.
2. REVIEW OF LITERATURE

Epidemiological pattern of hemoprotozoa

Oduye and Dipeolu (1976) examined the blood smears made from 500 dogs in Ibadan and reported that 26.0 and 20.2 per cent dogs were infected with *B. canis* and *B. gibsoni*, respectively.

Buoro *et al.* (1992) found 3.5 per cent incidence of *B. canis* in Kenya from 1978 to 1984. The disease did not present significant differences in the monthly incidence.

Cardoso and Serra-Freire (2001) conducted an epidemiological survey of *B. canis* and reported 20.75 and 24.70 per cent prevalence in Teresopolis and Silva Jardim of Rio de Janeiro State (Brazil), respectively.

Rodrigues *et al.* (2002) reported *B. canis* in 26.92 per cent of the total dogs studied between February 1999 and February 2000 at Minas Gerais, Brazil. Pups were found to be more affected than adults (43.47 and 23.07 per cent, respectively).

Chen and Huang (2003) stated that the overall prevalence of babesiosis was 1.75 per cent between January 1998 and December 1999 in Taiwan. The prevalence of *B. gibsoni* and *B. canis* infections was 1.56 and 0.19 per cent, respectively.

Bastos *et al.* (2004) conducted a retrospective study of clinical cases of babesiosis in dogs from March 1998 to September 2001 and reported *B. canis* in 42 per cent of the dogs infected with hemoparasites.

Sasaki *et al.* (2007) examined 400 dogs randomly from many parts of Nigeria and reported that 2.3 per cent were positive for babesiosis.

Gadahi *et al.* (2008) reported 5.00 per cent prevalence of *B. canis* in Hyderabad during the summer season. The prevalence in stray and pet dogs was recorded as 13.00 and 9.00 per cent, respectively. The highest percentage of infection (13.30 per cent) was recorded in the month of July. The adult dogs (14.70 per cent) were more commonly affected than pups (7.69 per cent). The percentage of infection was greater in females (18.6 per cent) than males (9.33 per cent).
Bashir et al. (2009) conducted the epidemiological studies on canine babesiosis in Lahore and reported 2.62 per cent prevalence of babesiosis. The male dogs were found to be more prone to disease than female dogs (3.39 vs. 1.32 per cent), whereas the incidence of disease was higher in younger dogs (6.90 per cent) than older age groups. Crossbreds were found to be more prone to the infection than purebreds.

Kumar et al. (2009) reported that *B. gibsoni* was identified in 84.90 per cent of the hemoprotozoa infected dogs in Chennai. It was at a higher prevalence during summer and winter. The highest infection was in adults (63.10 per cent) but evenly distributed amongst both sexes in all breeds of dogs.

Oh and Woo (2009) conducted a study to investigate the prevalence of *Babesia spp.* in dogs of South Korea and reported it to be 5.20 per cent.

Selvaraj et al. (2010) diagnosed babesiosis based on the clinical signs and demonstration of parasites within the RBCs and reported that 426 cases were positive for Babesia infection out of 4896 samples screened. Among the positive cases of *B. gibsoni*, 18 per cent were found to be less than one year old and 58 per cent of this pediatric population was less than three months old. The record of prevalence of babesiosis in different breeds of dogs showed that Non-descript dogs were found to be most commonly affected with an incidence of 20 per cent followed by spitz (12 per cent).

Vatsya et al. (2010) studied the incidence of blood parasites in dogs at Pantnagar (Uttarakhand) during 2001 to 2006. An overall incidence of 8.19 per cent was observed. Among hemoprotozoa infections *Hepatozoon canis* (1.29 per cent), *B. canis* and *B. gibsoni* (0.14 per cent per cent each) were reported. Highest incidence of blood parasites was recorded in the rainy season (11.37 per cent) followed by summer (7.82 per cent) and winter (5.10 per cent). Monthly blood examination revealed the highest positive cases in August (16.67 per cent), followed by July (12.73 per cent) and the least in November (2.08 per cent).
Wu et al. (2010) reported 6.3 per cent prevalence of *B. gibsoni* in Taipei, Taiwan.

Jumde et al. (2011) conducted a study on prevalence of hemoprotezoan infection in stray dogs, belonging to local breeds at Nagpur (Maharashtra) during September 2008 to November 2008. The overall prevalence observed during the study was 12.60 per cent. The prevalence of babesiosis, ehrlichiosis and hemobartonellosis was 8.00, 6.00 and 0.60 per cent, respectively.

Nalubamba et al. (2011) investigated the seasonal infection patterns and prevalence of canine babesiosis in Zambia. The dogs younger than 1 year age were more likely to be *Babesia spp.* positive followed by those between 2 and 5 years old. Seasonal trends indicated two peaks, one in the rainy season (November-March) and another in the cold dry season (June/July). Monthly prevalence rates of babesiosis ranged from 0 to 2.4 per cent in natural populations and from 0 to 28.6 per cent in laboratory specimens.

Sharma et al. (2011) collected the blood smears from dogs in and around Mathura (Uttar Pradesh) during January 2010 to August 2010 and reported the incidence of *B. canis* and *T. evansi* to be 4.90 and 3.80 per cent, respectively. Highest prevalence was observed in the monsoon months with no significant difference between breeds and sexes.

Wadhwa et al. (2011) reported 1.15 per cent incidence of canine babesiosis in Kangra Valley of Himachal Pradesh.

Adamu et al. (2012) stated that *Babesia spp.* was the most prevalent pathogen in Nigeria, present in 53 per cent of the dogs suffering from hemoprotezoa infection.

Singh et al. (2012) conducted study on 460 dogs at Ludhiana (Punjab) during the year 2010 and reported that examination of Giemsa stained peripheral blood smears exhibited 10.21 per cent hemoprotezoan comprising of *B. gibsoni* (8.26 per cent), *H. canis* (1.08 per cent), *B. canis* (0.65 per cent) and *T. evansi* (0.21 per cent). *B. gibsoni* infection was significantly higher (p<0.05) in male dogs.
Bhattacharjee and Sarmah (2013) reported 57.31 per cent prevalence of hemoprotozoa at Guwahati (Assam) during January 2009 to December 2010. A total of 7 species viz. *B. gibsoni* (47.16 per cent), *Ehrlichia platys* (8.49 per cent), *Dirofilaria immitis* (2.83 per cent), *E. canis* (2.12 per cent), *B. canis* (1.41 per cent), *Hepatozoon canis* (1.41 per cent) and *E. ewingii* (0.47 per cent) in single or mixed infections were recorded.

Das and Konar (2013) observed Giemsa stained peripheral blood smears of dogs in Kolkata (West Bengal) and reported a total of 47 cases of ehrlichiosis in dogs with babesiosis (8.51 per cent) and hepatozoonosis (6.38 per cent).

Halos et al. (2013) reported the overall annual incidence rate of clinical babesiosis to be 1.07 per cent in France.

Rene-Martellet et al. (2013) analysed the risk of infection according to age classes and reported significantly higher risk in dogs of less than 5 years age (OR = 1.39 [1.22; 1.60], p = 1.5 × 10\(^{-6}\)) compared to dogs more than 5 years old. Males were more affected than females (62 and 38 per cent, respectively).

Shrivastava and Shukla (2013) reported the prevalence of *Babesia* spp. as 6.93 per cent, in Jabalpur (Madhya Pradesh) during August 2010 to January 2011.

Adamu et al. (2014) documented the prevalence of *Babesia canis* as 2.8 per cent in Maiduguri, Nigeria.

Halos et al. (2014) evaluated the clinical occurrence of canine babesiosis in Western Europe and reported 0.7 per cent annual incidence amongst the investigated dog population.

Vairamuthu et al. (2014) conducted retrospective study of hemoprotozoan parasites affecting dogs in Chennai (Tamil Nadu) during 2006-2011 and reported that *B. gibsoni* was the most common hemoprotozoan infection accounting 56.65 per cent of the total cases, followed by *E. canis* (23.21 per cent), *H. canis* (11.23 per cent) and *B. canis* (5.54 per cent). A perceptible increase in the number of cases from 1404 in 2006, to 5693 in 2011 was also reported.
Uncomplicated and complicated babesiosis in dogs

Welzl et al. (2001) studied the systemic inflammatory response syndrome (SIRS) and multiple-organ dysfunction syndrome (MODS) in dogs with complicated babesiosis and reported that 87 per cent percent of cases were SIRS positive. Single organ damage was recorded in 52 per cent of the cases, while 48 per cent had MODS.

Mathe et al. (2006) summarized the clinical observations of Babesia canis infection of 63 dogs during one year period in Hungary. They found that most animals had babesiosis in the spring and autumn. Male animals appeared in higher numbers. Uncomplicated babesiosis was diagnosed in 32 cases. Lethargy, fever, splenomegaly, pallor, icterus, hemoglobinuria and presence of ticks were the most common observations. Thirty one animals demonstrated babesiosis with complications. Hepatopathy (44 per cent), pancreatitis (33 per cent), acute renal failure (ARF; 31 per cent) and disseminated intravascular coagulation (DIC; 24 per cent) were frequent complications, while immune-mediated hemolytic anemia (IMHA; 10 per cent), acute respiratory distress syndrome (ARDS; 6 per cent) and cerebral babesiosis (3 per cent) were rarely observed. There was a significant difference between the mean age of dogs having uncomplicated disease, babesiosis with a single complication and babesiosis with multiple complications (3.4, 4.8 and 8.6 years, respectively, p < 0.001). The recovery rate (78, 68 and 25 per cent, respectively, p = 0.005) and mortality rate (3, 21 and 67 per cent, respectively, p < 0.001) also tended to differ significantly in these groups.

Matijatko et al. (2009) retrospectively reviewed the records of 86 canine patients diagnosed with babesiosis, of which 10 had evidence of septic shock. Four patients had involvement of two organs, five had involvement of three organs, and one had involvement of four organs. The organ that was most frequently involved was the kidney (nine cases). Central nervous system dysfunction was the rarest complication noted (one case).

Crnogaj et al. (2010) examined 35 dogs infected with B. canis and clinically classified them into two groups, complicated (7 dogs) and uncomplicated (28 dogs). The noted complications were renal dysfunction, hepatic dysfunction, muscular involvement and acute respiratory distress syndrome in 5, 3, 2 and 1 cases, respectively.
Andoni et al. (2013) described the clinicopathological findings in dogs naturally infected with Babesia spp. and divided them in two groups with uncomplicated and complicated babesia. The duration of clinical signs ranged from 1 to 5 days prior to the arrival at the clinic. The main clinical signs were dehydration and anemia (79 per cent), apathy (74 per cent), anorexia or decrease appetite (70 per cent) and fever (68 per cent). The anemia was present in the dogs and classified as severe (13 per cent), mild (45 per cent), and moderate (52 per cent).

Daste et al. (2013) described a case of cerebral babesiosis and acute respiratory distress syndrome (ARDS) in a five year old male neutered Scottish Terrier dog referred for evaluation of progressive dyspnea and clinical signs suggestive of central neurological disease. Thoracic radiographs showed a diffuse and heavy interstitial/alveolar lung pattern. Babesiosis was diagnosed based on blood smear evaluation. Cerebral babesiosis and ARDS were confirmed at necropsy. Major pathological findings included erythrocyte aggregation in the lungs, liver, and brain.

**Hemato-biochemical alterations in canine babesiosis**

Abdullahi et al. (1990) studied hematological findings in 70 naturally occurring cases of B. canis infection in dogs and reported that anemia was of the regenerative type in all cases while neutrophilic leukocytosis was mainly observed in hyperacute cases.

Bansal et al. (1990) reported the hematological alterations in dogs after experimental infection with B. canis. Leukocytosis with neutrophilia was found in acute cases, while in the chronic stage leukocytosis was particularly due to lymphocytosis.

Conrad et al. (1991) reported anemia and thrombocytopenia as the most common alterations in B. gibsoni infection.

Vercammen et al. (1997) studied the hematological and biochemical parameters of dogs experimentally infected with B. Canis and reported development of a normocytic, normochromic anemia a few days after infection that became slightly hypochromic and macrocytic after 12 days and regenerative after 28 days. Five weeks after infection red blood cell
parameters returned to normal. Thrombocytopenia was present during the whole observation period of 12 weeks. Leukopenia due to neutropenia, lymphocytopenia and monocytopenia was irregularly observed. Most white blood cell parameters returned to normal after 11 weeks, but an eosinophilia developed from 7 weeks onwards. Moderate and temporary increases of bilirubin, aspartate transaminase and alanine transaminase during the first parasitaemic phase were observed. Prolonged hypoalbuminaemia was noticed until 5 weeks after infection.

Guelfi et al. (1998) performed hemograms in adult dogs with acute spontaneous babesiosis (B. canis). In dogs examined during first 24 hours, marked thrombocytopenia, eosinopenia and lymphopenia were observed and blood infection was often severe. In dogs examined later, thrombocytopenia and eosinopenia persisted. Lymphocytes and monocytes counts were normal or increased. Presence of lymphocytes with azurophilic granulations or with hyperbasophilic cytoplasm was also reported.

Meinkoth et al. (2002) studied the hematological alterations in dogs experimentally infected with B. gibsoni. All the dogs developed regenerative anemia and marked thrombocytopenia. Profound but transient neutropenia was detected in some dogs.

Chen and Huang (2003) studied the alterations in the hematobiochemical parameters in dogs suffering from babesiosis. Anemia (83.8 per cent) with regeneration (60.1 per cent), eosinopenia (59.3 per cent), monocytosis (27.0 per cent), leukocytosis (24.3 per cent), elevated ALT (37.5 per cent), hypoglycaemia (30.4 per cent) and elevated ALP (25.0 per cent) were the major abnormalities reported.

Hossain et al. (2003) studied hematological changes due to experimentally induced chronic babesiosis in splenectomized adult dogs and reported macrocytic normochromic anemia with polychromasia, anisocytosis and a marked increase in nucleated erythrocytes. Biochemical alterations included a significant increase \( (P<0.05) \) in mean total serum protein \( (8.27\pm2.37) \) and serum bilirubin \( (1.02\pm0.11) \).
Keller et al. (2004) conducted a study to determine the potential risk factors for hypoglycaemia in canine babesiosis. Hypoglycaemia (<60 mg/dL) was reported in 9 per cent of the cases. Sixteen dogs had severe hypoglycaemia (<40 mg/dl), of which 5 had glucose < 18 mg/dl. Risk factors for hypoglycaemia identified were collapsed state, severe anemia, icterus, age less than 6 months and vomiting.

Camacho et al. (2005) conducted a study on 58 dogs suffering from babesiosis and reported that affected dogs had a significant elevation of total proteins and globulin; and significantly lower levels of albumin. Among infected dogs, those presenting azotaemia had significantly lower concentrations of total proteins, albumin and globulins.

Furlanello et al. (2005) studied the clinicopathological findings of spontaneous canine babesiosis and reported that anemia was present in 74 per cent of the dogs and classified as mild (35 per cent), moderate (59 per cent) and severe (6 per cent). In all cases, the anemia was normocytic and normochromic. Seventy percent of dogs had hemolytic anemia and 30 per cent had non-hemolytic anemia. Leucopenia and neutropenia were observed in 69 ad 74 per cent of dogs, respectively. Leucocytosis, due to mature neutrophilia and lymphocytosis, was present in one dog. In all dogs thrombocytopenia was present. In the majority of cases, mild elevation of aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase (ALP), creatinekinase (CK) and total bilirubin were present.

Ulutas et al. (2005) reported a significantly higher C-reactive protein in naturally occurring babesiosis in dogs.

Zygner et al. (2007) evaluated the hematological changes in samples of blood obtained from 248 dogs naturally infected with large Babesia. The most common disorders in affected dogs were thrombocytopenia and anisocytosis. The count of erythrocytes below reference values was detected in 26.2 per cent of dogs and 31.4 per cent of affected animals presented hematocrit below the reference values. Hemoglobin concentration below the reference values was noted in 29 per cent of dogs, an increase of MCHC above normal values was detected in 21
per cent of the dogs and MCV below normal values was recognized in 2 per cent of dogs. In the study 60.5 per cent of dogs presented anisocytosis, 25 per cent poikilocytosis, 23.8 per cent polychromasia, 19.7 per cent hypochromia and 4.4 per cent erythroblastosis. Thrombocytopenia was detected in 99.5 per cent of dogs while 36.3 per cent of dogs had neutropenia, and 21.8 per cent presented a left shift, 14.9 per cent had the lymphocytosis and 7.2 per cent lymphopenia.

Maele et al. (2008) reported a case of canine babesiosis having a microcytic non-regenerative anemia, leukopenia and thrombocytopenia. Cytological evaluation of peripheral blood smear showed low numbers of spherocytes.

Koster et al. (2009) used C-reactive protein (CRP) as a predictive marker for risk of disease and to monitor the response to treatment in 75 dogs naturally infected with B. rossi. The concentration of CRP was determined by an automated human CRP Turbidometric Immunoassay, validated for use in dogs. There was no significant difference in mean CRP concentration between survivors (n=57), 107.5 ± 49.5 mg/L and non-survivors (n=11), 122.1 ± 64.6 mg/L at admission and using the exact logistic regression, adjusting for age and sex, there was no association with outcome (p = 0.53). Multiple regression analysis failed to show a significant relationship between admission CRP concentration and number of days of hospitalisation in the survivors, adjusting for age and sex (p=0.65). Similarly, no significant relationship was found between the magnitude of change in CRP concentration 24 hours after admission, and the number of days of hospitalisation in survivors (p=0.34).

Matijatko et al. (2009) reported the hematological alterations in 10 dogs suffering from babesiosis and presenting septic shock. Seven of them had a level of parasitaemia above 1 per cent, with the highest level being 20.2 per cent. Seven of the 10 dogs were anaemic and 3 dogs were leukopaenic. Thrombocytopenia and bilirubinaemia were present in nine dogs. Hypoglycaemia was noted in two dogs.
Fabisiak et al. (2010) studied the hematological abnormalities in 350 dogs affected with babesiosis. The most significant hematological abnormality in the course of the disease was thrombocytopenia, less severe abnormalities included anemia, leukopenias (both neutropenia and lymphopenia). Additionally, significant differences in PCV values between different age groups were observed, while TLC values differed significantly between German Shepherds and Mongrels.

Lobetti (2012) determined serum urea and creatinine concentrations and the derived urea:creatinine (UC) ratio in the dogs affected with babesiosis and compared with experimentally induced anemia and/or hemoglobinaemia. Serum urea concentration and the UC ratio were significantly greater in dogs with babesiosis.

Zygner et al. (2012) estimated the AST/ALT ratio in 182 dogs infected with *B. canis*. Amongst these 65 dogs had anemia and 68 were azotaemic. The differences in AST/ALT ratio between anaemic and non-anaemic dogs were statistically non significant, however, the comparison of AST/ALT ratio between azotaemic and non-azotaemic dogs revealed a significantly higher value of this index in azotaemic dogs.

Konto et al. (2014) reported significant (*p < 0.05*) rise in alkaline phosphatase and alanine transaminase values in infected dogs as compared with the control group. However, the mean values for creatinine and glucose of infected group were significantly lower than that of the control.

**Prognostic values of hemato-biochemical alterations in canine babesiosis**

Nel et al. (2004) studied the prognostic value of blood glucose and hematocrit in canine babesiosis. Serial glucose concentrations and hematocrit on admission were determined in 90 dogs with naturally occurring, severe or complicated canine babesiosis. These measurements were significantly associated with mortality and 22.2 per cent dogs had hypoglycemia (blood glucose concentration < 59.4 mg/dL).

Jacobson and Lobetti (2005) studied glucose concentrations in dogs with babesiosis. It deferred significantly between dogs that died and
those that survived. Three out of 5 dogs that died had hypoglycemia. Hypoglycemic dogs differed significantly from normoglycemic dogs with regard to percentage parasitemia.

Crnogaj et al. (2010) examined laboratory data of 35 dogs infected with *B. canis*. Levels of blood urea nitrogen, creatinine, total bilirubin, alanine transaminase and alkaline phosphatase were significantly increased in dogs with complicated versus uncomplicated babesiosis.

**Therapeutic efficacy of different anti-babesial drugs**

Wulansari et al. (2003) reported that clindamycin therapy gradually reduced level of parasitemia and induced morphological changes that indicated degeneration of parasites in dogs with *B. gibsoni* infection. It also reduced the clinical symptoms characteristic of *Babesia* infection, including anemia, anorexia, and listlessness.

Suzuki et al. (2007) conducted a therapeutic study using clindamycin, metronidazole and doxycycline against canine babesiosis. The combination therapy successfully eliminated *B. gibsoni* in peripheral blood in 3 of 4 dogs, however the remaining dog showed obvious uncontrolled relapse after a temporary recovery.

Matsuu et al. (2008) evaluated *in vitro* growth inhibitory activities of various drugs against *B. gibsoni*, following establishment of a continuous culture isolate. They reported that no growth inhibitory effect was confirmed even at the maximum concentration of metronidazole, while doxycycline and clindamycin were found to be potent inhibitors of growth.

Lin and Huang (2010) evaluated efficacy of oral administration of a doxycycline-enrofloxacin-metronidazole combination with and without injections of diminazene diaceturate in the management of naturally occurring canine babesiosis caused by *B. gibsoni*. The overall efficacy of this combination of doxycycline-enrofloxacin-metronidazole in conjunction with and without administration of diminazene diaceturate was 85.7 per cent and 83.3 per cent, respectively; with a mean recovery time of 24.2 and 23.5 days, respectively.
Wadhwa et al. (2011) reported that two doses of diminazine aceturate @ 5 mg/kg b.wt. intramuscularly at 48 hr interval and supportive therapy including fluid administration, hematinics, liver tonic and multivitamins proved effective in 83 per cent cases of babesiosis in dogs.

Talukder et al. (2013) evaluated sensitivity of doxycycline against in vitro cultured B. gibsoni by real-time PCR. The culture of B. gibsoni was successfully continued and mean parasitemia was 4.63 per cent when in vitro drug sensitivity test was started. Morphological observation revealed that the number of parasites decreased per erythrocyte and line shaped parasites increased in erythrocytes with the increased concentration of doxycycline. Doxycycline effectively inhibited the growth of B. gibsoni in vitro.
3. MATERIALS AND METHODS

Place of work

The work was conducted in the Department of Veterinary Medicine, College of Veterinary Science & A.H., N.D.V.S.U., Jabalpur (Madhya Pradesh).

Location and features of the place

Jabalpur is located at 23°10′N 79°56′E and has an average elevation of 411 metres. It has a humid subtropical climate, typical of North-Central India.

Meteorological data

The data concerning temperature, rainfall and relative humidity from November 2012 to October 2013 were obtained from Department of Physics and Agricultural Meteorology, College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh).

Animals

For epidemiological study a total of 1680 dogs of either sex and various breeds were examined over a period of 12 months from November 2012 to October 2013. The samples were obtained from the dogs brought to the OPD Medicine (TVCC, College of Veterinary Science & A.H., Civil Lines, Jabalpur), State Veterinary Hospital (Omti, Jabalpur), Jabalpur Pet’s Hospital & Research Centre (Wright Town, Jabalpur), Jabalpur Dog Care Centre (Vijay Nagar, Jabalpur) and Getwell Dog Clinic (Cherital, Jabalpur). After confirmation of *Babesia spp.* infection by microscopic examination of blood smear stained with Leishman’s stain, dogs were selected for the therapeutic study.

Collection of samples

For epidemiological study blood samples were collected from cephalic or recurrent tarsal vein and smears were prepared on clean grease free glass slides. The smears were stained with Leishman’s stain as per standard procedure (Benjamin, 2001).
Collection of blood for therapeutic studies was done on day ‘0’ and subsequently on day ‘10’, ‘20’ and ‘30’ post treatment. Five ml blood was collected from cephalic or recurrent tarsal vein taking all aseptic precautions. From which 2 ml of blood was transferred in vial with anticoagulant (Heparin-1ml/10 ml blood) for hematological studies and 3 ml blood was transferred in sterile vial for separation of the serum for biochemical studies.

Parameters of the study

1. **History**

   Complete history of the case was recorded including age, sex, breed and duration of illness.

2. **Clinical examination**

   Recording of rectal temperature (°F), pulse rate (/min), respiration rate (/min) and examination of visible mucous membranes was done on day 0, 10, 20 and 30.

**Rectal temperature (°F)**

Rectal temperature was recorded by inserting the clinical thermometer in the rectum of animal in such a way that its bulb remained in direct contact with rectal mucosa for two minutes.

**Pulse rate (/min)**

Pulse rate was recorded by palpating the femoral artery during a period of one minute.

**Respiration rate (/min)**

Respiration Rate of animal was recorded by feeling the air movements at nostrils. Hand was placed in front of the nostrils and the air current was felt during a period of one minute.

3. **Hematological studies**

Hematological parameters including total erythrocyte count (TEC, millions/μl), hemoglobin (Hb, g/dl), packed cell volume (PCV, %), platelet count (thousands/μl), total leukocyte count (TLC, thousands/μl) and
differential leukocyte count (DLC, %) were evaluated following standard procedure (Benjamin, 2001).

4. Biochemical studies

The following biochemical parameters were determined in serum of animals. The analysis of serum for the following parameters was done on Blood Chemistry Semi Auto Analyzer.

(i) Alanine transaminase (ALT, U/L)
(ii) Aspartate transaminase (AST, U/L)
(iii) Alkaline phosphatase (ALP, U/L)
(iv) Creatine kinase (CK-MB, U/L)
(v) Bilirubin – total and direct (BIT and BID, mg/dl)
(vi) Total protein (TP, g/dl) and Albumin (g/dl)
(vii) Blood urea nitrogen (BUN, mg/dl)
(viii) Creatinine (CRE, mg/dl)
(ix) Blood Glucose (mg/dl)

Alanine Transaminase (ALT) and Aspartate Transaminase (AST)

Alanine transaminase and aspartate transaminase were analysed by the Erba Diagnostic kit using International federation of Clinical Chemistry Kinetic Method and activity was expressed as U/L.

Alkaline Phosphatase (ALP)

Alkaline phosphatase was analysed by Erba Diagnostic kit using Tris Carbonate Buffer kinetic method and activity was expressed as U/L.

Creatine Kinase (CK-MB)

Creatine kinase was analysed by the Erba Diagnostic kit using immunoinhibition method and activity was expressed as U/L.

Total and Direct Bilirubin (BIT & BID)

Total and direct bilirubin were analysed by Erba Diagnostic kit using Diazo method and values were expressed in terms of mg/dl.
Total Protein (TP)

Total protein was analysed by Erba Diagnostic kit using Biuret method and values were expressed in terms of g/dl.

Albumin (g/dl)

Albumin was analyzed by Erba Diagnostic kit using Biuret method and values were expressed in terms of g/dl.

Blood Urea Nitrogen (BUN)

Blood urea nitrogen was analysed by Erba Diagnostic kit using GLDH-Urease method and values were expressed as mg/dl.

Creatinine (CRE)

Creatinine was analysed by Erba Diagnostic kit using Modified Jaffé’s reaction and values were expressed as mg/dl.

Blood Glucose

Glucose estimation was done with the help of glucometer (Chauhan, 2003) immediately after collection of blood sample.

5. Criteria for diagnosis of complicated babesiosis in dogs

i. Systemic Inflammatory Response Syndrome (SIRS)

The case was considered positive for SIRS, if two or more of the following parameters were altered

1. Total Leukocyte Count <4000/μl or >12000/μl
2. Rectal Temperature <100°F or >103.5°F
   Or
   Heart Rate >120 beats/min
   Or
   Respiration Rate >20 breaths/min
   (Purvis and Kirby, 1994)
3. C-Reactive Protein (CRP, mg/L)
4. Tumour Necrosis Factor (TNF, pg/ml)

CRP and TNF were estimated using specific kits as per manufacturer’s instructions.
C-Reactive Protein (CRP)

A commercially available NycoCard CRP immunometric assay for human serum (Axis-Shield) was used to determine the CRP in dogs. The turbidometric immunoassay using human CRP kit has previously been validated for use in canine serum by Hansen et al. (2003) and Klenner et al. (2010). The NycoCard CRP was used for heterologous determination of CRP concentration (mg/L) in canine serum samples following manufacturer’s instructions using NycoCard Reader II.

Tumour Necrosis Factor α (TNF-α)

The TNF-α was determined in the serum using Dog Tumor Necrosis Factor α (TNF-α) ELISA Kit (Cusabio Biotech Co. Ltd.) which employs the quantitative sandwich enzyme immunoassay technique.

Contents of the kit

1. Assay plate pre-coated with antibody specific for TNF-α
2. Standard (Freeze dried)
3. Biotin-antibody
4. HRP-avidin
5. Biotin-antibody Diluent
6. HRP-avidin Diluent
7. Sample Diluent
8. Wash Buffer Concentrate
9. TMB Substrate
10. Stop Solution
11. Adhesive Strip (For 96 wells)

Reagent preparation

All reagents were brought to room temperature before reconstitution.
1. **Biotin-antibody (1x)**

   The vial was centrifuged before opening and a 100-fold dilution was made by adding 990 μl of Biotin-antibody diluent to 10 μl of Biotin-antibody.

2. **HRP-avidin (1x)**

   The vial was centrifuged before opening and a 100-fold dilution was made by adding 990 μl of HRP-avidin diluent to 10 μl of HRP-avidin.

3. **Wash buffer (1x)**

   The vial was gently shaken and 20 ml of wash buffer concentrate was mixed with distilled water to prepare a final volume of 500 ml of wash buffer.

4. **Standard**

   The standard vial was centrifuged at 6000 rpm for 30 seconds. The standard was reconstituted with 1.0 ml of sample diluent producing a stock solution of 10 ng/ml. The standard was mixed to ensure complete reconstitution and kept for a minimum of 15 minutes with gentle agitation prior to making dilutions. In each of six tubes (S₀-S₅), 250 μl of sample diluent was pipetted. A 2-fold dilution series was produced by adding 250 μl of stock solution to the tube S₅ followed by its serial dilution upto tube S₁. Each tube was mixed thoroughly before the next transfer. The undiluted standard served as the high standard (10 ng/ml), while sample diluent served as the zero standard (0 ng/ml).

**Assay procedure**

All the reagents and samples were brought to room temperature before use.

1. Equal volume (100 μl) of standard and sample was added per well and covered with the adhesive strip. It was incubated for 2 hours at 37°C.

2. The liquid of each well was removed and 100 μl of Biotin-antibody was added to each well. It was covered with a new adhesive strip and incubated for 1 hour at 37°C.
3. Each well was aspirated and washed, repeating the process two times for a total of three washes. Each well was washed by filling with wash buffer (200 μl) using a dispenser and allowed to stand for 2 minutes. After the last wash, any remaining wash buffer was removed by aspirating; the plate was inverted and blotted against clean paper towels.

4. HRP-avidin (100 μl) was added to each well and the microtiter plate was covered with a new adhesive strip. It was incubated for 1 hour at 37°C.

5. The aspiration/wash process was repeated for five times as in step 3.

6. TMB substrate (90 μl) was added to each well and incubated for 15-30 minutes at 37°C protecting it from light.

7. Finally 50μl of stop solution was added to each well, gently tapping the plate to ensure thorough mixing.

8. The intensity of the colour was measured at 450 nm within 5 minutes using a microplate reader and standard curve was created. The sample values were then read from the standard curve obtained.

i. **Multiple Organ Dysfunction Syndrome (MODS)**

Parameters considered for organ damage/dysfunction are as shown below. Where multiple criteria are present, only 1 has to be abnormal for the organ to be considered damaged as per Welzl et al. (2001).

<table>
<thead>
<tr>
<th>Organ</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>Alanine transaminase</td>
</tr>
<tr>
<td></td>
<td>Aspartate transaminase</td>
</tr>
<tr>
<td></td>
<td>Bilirubin –total and direct</td>
</tr>
<tr>
<td>Kidneys</td>
<td>Creatinine</td>
</tr>
<tr>
<td></td>
<td>Blood Urea Nitrogen</td>
</tr>
<tr>
<td>Muscle/Cardiovascular system</td>
<td>Creatine Kinase</td>
</tr>
</tbody>
</table>
**Lungs**  
Signs of pulmonary oedema on radiology/clinical examination

**CNS**  
Clinical signs of seizures, coma or abnormal behaviour

**Experimental design**

A total of sixty animals positive for babesiosis were placed into five groups T₁ to T₅. Each treatment group comprised twelve animals of which 4 were of hepatic complications, 4 of renal complications and 4 showing multiple organ dysfunction syndrome. Twelve apparently healthy animals were kept in control group. Animals were treated by the following drugs:

**Table 01: Drugs and dosage in different groups**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Group</th>
<th>No. of dogs</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control (Healthy)</td>
<td>12</td>
<td>----</td>
</tr>
<tr>
<td>2.</td>
<td>T₁</td>
<td>12</td>
<td>Diminazene aceturate (5 mg/kg, IM)</td>
</tr>
<tr>
<td>3.</td>
<td>T₂</td>
<td>12</td>
<td>Doxycycline (10 mg/kg, PO, BID) X 21 days</td>
</tr>
<tr>
<td>4.</td>
<td>T₃</td>
<td>12</td>
<td>Clindamycin (25 mg/kg, PO, BID) + Doxycycline (10 mg/kg, PO, BID) X 21 days</td>
</tr>
<tr>
<td>5.</td>
<td>T₄</td>
<td>12</td>
<td>Enrofloxacin (2 mg/kg, PO, BID) + Doxycycline (10 mg/kg, PO, BID) X 21 days</td>
</tr>
<tr>
<td>6.</td>
<td>T₅</td>
<td>12</td>
<td>Metronidazole (10 mg/kg, PO, BID) + Doxycycline (10 mg/kg, PO, BID) X 21 days</td>
</tr>
</tbody>
</table>

Supportive therapy including administration of fluids and electrolytes (Inj. Ringers Lactate 20-50 ml/kg b.wt. IV and/or Inj DNS 5% 20-50 ml/kg b.wt. IV), corticosteroids (Inj. Dexamethasone 0.5-1 mg/kg b.wt. q12-
24h IV), antacids (Inj. Ranitidine @ 0.5 mg/kg b.wt. BID I/M), antiemetics (Inj. Prochlorpromazene @ 0.5 mg/kg b.wt. BID I/M or Inj. Metoclopromide 0.2-0.5 mg/kg b.wt. BID IM) and diuretics (Inj. Furosemide 4 mg/kg b.wt. IV) were given according to the system involved and symptoms produced. Hematinics (containing Malt Extract I.P- 4.52, Calcium Gluconate I.P- 360 mg, Ferric Ammonium Cirtrate- 100 mg, Copper Sphate – 12 mg, Cobalt Chloride 1.5 mg, Cholecalfierrol I.P- 400 IU, Nicotinamide I.P- 45 mg, Biotin B.P- 75 mg, Folic Acid I.P- 1.5 mg and Cyanocobalamin I.P- 15 mcg in each 21 g @ 5-10 g daily PO for 30 days) and ectoparasiticidal drugs (Carbaryl 10% dusting powder or Amitraz 12.5% wash @ 2ml/litre of water) were given in all the treatment groups.

**Statistical analysis**

Statistical analysis for significance of difference in prevalence among various age groups, sex, breeds and months was done using Chi-Square test. The data of hemato-biochemical parameters were analysed using Mann-Whitney U Test and cut off values were obtained by use of ROC Curves Analysis, and Fisher’s exact test was employed to find out the prognostic values of the parameters. The alterations in hemato-biochemical parameters in treatment groups on different intervals were analysed using ANOVA and means were compared using Dunnett’s multiple comparisons test (Zar, 2011).
4. RESULTS

Present study was conducted on a total of 1680 dogs of different age, breed and sex brought to the OPD Medicine (TVCC, College of Veterinary Science & A.H., Jabalpur), State Veterinary Hospital (Omti, Jabalpur) and private veterinary clinics at Jabalpur.

Out of 1680 dogs, in 176 dogs babesiosis was confirmed by the presence of Babesia spp. on microscopic examination of blood smear. Following results were drawn from the study:

**Epidemiological pattern of prevalent hemoprotozoa of dogs in and around Jabalpur**

**Prevalence of hemoprotozoa**

The overall prevalence of hemoprotozoa during November 2012 to October 2013 was 10.60 per cent (178 out of 1680 dogs). The prevalence of Babesia spp. was 10.48 per cent *i.e.* 176 out of 1680 dogs, whereas Hepatozoon canis was reported in 2 dogs out of 1680 dogs showing 0.12 per cent prevalence (Table 02).

**Table 02: Prevalence of hemoprotozoa during November 2012 to October 2013**

<table>
<thead>
<tr>
<th>Hemoprotozoa</th>
<th>Total no. of dogs examined</th>
<th>No. of dogs found positive</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babesia spp.</td>
<td>1680</td>
<td>176</td>
<td>10.48%</td>
</tr>
<tr>
<td>Hepatozoon canis</td>
<td>2</td>
<td>0.12%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1680</td>
<td>178</td>
<td>10.60%</td>
</tr>
</tbody>
</table>

**Month wise prevalence of hemoprotozoa**

The meteorological data regarding Mean Air Temperature (°C), Mean Relative Humidity (%) and Total Rainfall (inch) of the area during November 2012 to October 2013 is presented in the table 03.
Table 03: Meteorological data of Jabalpur during November 2012 to October 2013

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean air temperature (°C)</th>
<th>Mean relative humidity (%)</th>
<th>Total rainfall (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 2012</td>
<td>20.35</td>
<td>61.00</td>
<td>00.00</td>
</tr>
<tr>
<td>Dec 2012</td>
<td>17.85</td>
<td>60.50</td>
<td>00.13</td>
</tr>
<tr>
<td>Jan 2013</td>
<td>15.10</td>
<td>61.50</td>
<td>00.00</td>
</tr>
<tr>
<td>Feb 2013</td>
<td>18.55</td>
<td>70.00</td>
<td>02.37</td>
</tr>
<tr>
<td>Mar 2013</td>
<td>22.60</td>
<td>56.50</td>
<td>01.31</td>
</tr>
<tr>
<td>Apr 2013</td>
<td>28.05</td>
<td>39.50</td>
<td>00.54</td>
</tr>
<tr>
<td>May 2013</td>
<td>33.55</td>
<td>23.50</td>
<td>00.00</td>
</tr>
<tr>
<td>Jun 2013</td>
<td>29.28</td>
<td>69.50</td>
<td>16.63</td>
</tr>
<tr>
<td>Jul 2013</td>
<td>26.75</td>
<td>86.50</td>
<td>24.17</td>
</tr>
<tr>
<td>Aug 2013</td>
<td>26.10</td>
<td>88.50</td>
<td>45.07</td>
</tr>
<tr>
<td>Sep 2013</td>
<td>27.50</td>
<td>78.00</td>
<td>05.92</td>
</tr>
<tr>
<td>Oct 2013</td>
<td>24.75</td>
<td>78.00</td>
<td>04.09</td>
</tr>
</tbody>
</table>

The month wise prevalence study of Babesia spp. revealed highest prevalence (18.18 per cent, 20 dogs out of 110 examined dogs) in the month of August 2013 followed by 16.67 per cent (24 dogs out of 144 examined dogs) in July 2013, 13.67 per cent (19 dogs out of 139 examined dogs) in June 2013, 12.93 per cent (19 dogs out of 147 examined dogs) in October 2013 and 12.78 per cent (17 dogs out of 133 examined dogs) in September 2013. Comparatively lower prevalence was reported in the months of November 2012 (10.96 per cent, 16 dogs out of 146 examined dogs), December 2012 (9.79 per cent, 14 dogs out of 143 examined dogs), January 2013 (8.69 per cent, 12 dogs out of 138 examined dogs), May 2013 (8.59 per cent, 11 dogs out of 128 examined dogs), April 2013 (6.71 per cent, 11 dogs out of 164 examined dogs) and February 2013 (5.41 per cent, 8 dogs out of
148 examined dogs). The lowest prevalence was reported in March 2013 i.e. 3.57 per cent (5 dogs out of 140 examined dogs). Significant variation (p<0.05) was noticed in the prevalence during different months (Table 04). Both the cases of *Hepatozoon canis* were reported in the month of July 2013.

**Table 04: Month wise prevalence of *Babesia* spp. during November 2012 to October 2013**

<table>
<thead>
<tr>
<th>Month</th>
<th>Total no. of dogs examined</th>
<th>Positive for <em>Babesia</em> spp.</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 2012</td>
<td>146</td>
<td>16</td>
<td>10.96</td>
</tr>
<tr>
<td>Dec 2012</td>
<td>143</td>
<td>14</td>
<td>09.79</td>
</tr>
<tr>
<td>Jan 2013</td>
<td>138</td>
<td>12</td>
<td>08.69</td>
</tr>
<tr>
<td>Feb 2013</td>
<td>148</td>
<td>08</td>
<td>05.41</td>
</tr>
<tr>
<td>Mar 2013</td>
<td>140</td>
<td>05</td>
<td>03.57</td>
</tr>
<tr>
<td>Apr 2013</td>
<td>164</td>
<td>11</td>
<td>06.71</td>
</tr>
<tr>
<td>May 2013</td>
<td>128</td>
<td>11</td>
<td>08.59</td>
</tr>
<tr>
<td>Jun 2013</td>
<td>139</td>
<td>19</td>
<td>13.67</td>
</tr>
<tr>
<td>Jul 2013</td>
<td>144</td>
<td>24</td>
<td>16.67</td>
</tr>
<tr>
<td>Aug 2013</td>
<td>110</td>
<td>20</td>
<td>18.18</td>
</tr>
<tr>
<td>Sep 2013</td>
<td>133</td>
<td>17</td>
<td>12.78</td>
</tr>
<tr>
<td>Oct 2013</td>
<td>147</td>
<td>19</td>
<td>12.93</td>
</tr>
<tr>
<td>Total</td>
<td>1680</td>
<td>176</td>
<td>10.48</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 30.77 \quad df = 11 \quad p = 0.0012 \]

**Age wise prevalence of *Babesia* spp.**

The age wise prevalence of babesiosis revealed highest prevalence (13.27 per cent, 41 dogs out of 309 examined dogs) in the 1-3 years age group, followed by 12.94 per cent prevalence in dogs of 5-7 years age (44 out of 340 examined dogs) and 12.92 per cent prevalence in 7-9 years age group (31 out of 240 examined dogs); However lower prevalence
was reported in the age groups of 3-5 years (7.95 per cent, 29 dogs out of 365 examined dogs), <1 year (7.32 per cent, 24 dogs out of 328 examined dogs) and more than 9 years (7.14 per cent, 7 dogs out of 98 examined dogs). The age wise prevalence showed significant variation (p<0.05) among the groups (Table 05). Out of two dogs found positive for *Hepatozoon canis* one case was reported in the age group of 1-3 years, while the other was reported in the 3-5 years age group.

**Table 05: Age wise prevalence of *Babesia* spp. during November 2012 to October 2013**

<table>
<thead>
<tr>
<th>Age group</th>
<th>No. of dogs examined</th>
<th>No. of dogs positive</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 year</td>
<td>328</td>
<td>24</td>
<td>07.32</td>
</tr>
<tr>
<td>1-3 Years</td>
<td>309</td>
<td>41</td>
<td>13.27</td>
</tr>
<tr>
<td>3-5 Years</td>
<td>365</td>
<td>29</td>
<td>07.95</td>
</tr>
<tr>
<td>5-7 Years</td>
<td>340</td>
<td>44</td>
<td>12.94</td>
</tr>
<tr>
<td>7-9 Years</td>
<td>240</td>
<td>31</td>
<td>12.92</td>
</tr>
<tr>
<td>&gt;9 Years</td>
<td>98</td>
<td>07</td>
<td>07.14</td>
</tr>
<tr>
<td>Total</td>
<td>1680</td>
<td>176</td>
<td>10.48</td>
</tr>
</tbody>
</table>

\[\chi^2 = 13.44 \quad df = 5 \quad p = 0.0196\]

**Sex wise prevalence of *Babesia* spp.**

Among 1680 dogs examined, the sex wise prevalence study revealed 14.77 per cent (104 out of 704 dogs) prevalence in females as compared with 7.38 per cent (72 out of 976 dogs) in males. Significant difference (p<0.05) was noticed in the prevalence of both sexes and relative risk analysis revealed that female dogs have two times higher risk of babesiosis as compared to male dogs (Table 06). *Hepatozoon canis* was reported in one male and one female dog.
Table 06: Sex wise prevalence of *Babesia* spp. during November 2012 to October 2013

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of dogs examined</th>
<th>No. of dogs positive</th>
<th>Prevalence (%)</th>
<th>Relative risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>704</td>
<td>104</td>
<td>14.77</td>
<td>2.00</td>
</tr>
<tr>
<td>Male</td>
<td>976</td>
<td>72</td>
<td>7.38</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1680</td>
<td>176</td>
<td>10.48</td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = 23.85$  df = 1   p < 0.0001

Breed wise prevalence of *Babesia* spp.

During the study the dogs of different breeds were examined for babesiosis including Spitz, German Shepherd, Labrador, Samoyed, Pug, Dalmatian, Daschund, Doberman, Pomeranian, Lhasa Apso, Great Dane, Boxer, Rottweiler and Saint Bernard along with Non-descript dogs. The maximum prevalence was noticed in German Shepherd breed *i.e.* 15.47 per cent (43 out of 278 examined dogs) followed by Samoyed, Pug, Non-descript, Spitz, Doberman, Daschund, Labrador and Dalmatian in which prevalence was found to be 15.25, 12.50, 10.94, 10.13, 6.25, 5.56, 4.78 and 4.55 per cent, respectively. There was significant variation (p<0.05) in the prevalence of babesiosis in various breeds (Table 07). Both the dogs found positive for *Hepatozoon canis* were non-descript.
Table 07: Breed wise prevalence of *Babesia spp.* during November 2012 to October 2013

<table>
<thead>
<tr>
<th>Breed of dogs</th>
<th>No. of dogs examined</th>
<th>No. of dogs positive</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-descript</td>
<td>576</td>
<td>63</td>
<td>10.94</td>
</tr>
<tr>
<td>Spitz</td>
<td>316</td>
<td>32</td>
<td>10.13</td>
</tr>
<tr>
<td>German Shepherd</td>
<td>278</td>
<td>43</td>
<td>15.47</td>
</tr>
<tr>
<td>Labrador</td>
<td>293</td>
<td>14</td>
<td>04.78</td>
</tr>
<tr>
<td>Samoyed</td>
<td>118</td>
<td>18</td>
<td>15.25</td>
</tr>
<tr>
<td>Pug</td>
<td>24</td>
<td>03</td>
<td>12.50</td>
</tr>
<tr>
<td>Dalmatian</td>
<td>22</td>
<td>01</td>
<td>04.55</td>
</tr>
<tr>
<td>Daschund</td>
<td>18</td>
<td>01</td>
<td>05.56</td>
</tr>
<tr>
<td>Doberman</td>
<td>16</td>
<td>01</td>
<td>06.25</td>
</tr>
<tr>
<td>Pomeranian</td>
<td>04</td>
<td>00</td>
<td>00.00</td>
</tr>
<tr>
<td>Lhasa Apso</td>
<td>04</td>
<td>00</td>
<td>00.00</td>
</tr>
<tr>
<td>Great Dane</td>
<td>03</td>
<td>00</td>
<td>00.00</td>
</tr>
<tr>
<td>Boxer</td>
<td>03</td>
<td>00</td>
<td>00.00</td>
</tr>
<tr>
<td>Rottweiler</td>
<td>03</td>
<td>00</td>
<td>00.00</td>
</tr>
<tr>
<td>Saint Bernard</td>
<td>02</td>
<td>00</td>
<td>00.00</td>
</tr>
<tr>
<td>Total</td>
<td>1680</td>
<td>176</td>
<td>10.48</td>
</tr>
</tbody>
</table>

\( \chi^2 = 24.49 \quad df = 14 \quad p = 0.0399 \)

**Recovery rate and case fatality rate in babesiosis**

In the present study the recovery rate of uncomplicated babesiosis was found to be 83.05 per cent (49 out of 59 dogs), while it was 71.79 per cent (84 out of 117 dogs) in complicated cases. The case fatality rate was 16.95 per cent (10 out of 59 dogs) and 28.21 per cent (33 out of 117 dogs) in uncomplicated and complicated babesiosis, respectively (Table 08).
### Table 08: Recovery rate and case fatality rate in uncomplicated and complicated babesiosis

<table>
<thead>
<tr>
<th>Type of babesiosis</th>
<th>No. of dogs</th>
<th>Recovery Rate</th>
<th>Case Fatality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. of dogs recovered</td>
<td>%</td>
</tr>
<tr>
<td>Uncomplicated</td>
<td>59</td>
<td>49</td>
<td>83.05</td>
</tr>
<tr>
<td>Complicated</td>
<td>117</td>
<td>84</td>
<td>71.79</td>
</tr>
</tbody>
</table>

**Uncomplicated and complicated babesiosis in dogs**

The cases positive for babesiosis were divided into two groups *i.e.* complicated and uncomplicated babesiosis. Out of 176 dogs positive for babesiosis 117 dogs (66.48 per cent) fulfilled the criteria of complicated babesiosis while 59 dogs (33.52 per cent) were suffering from uncomplicated babesiosis. Out of 117 dogs suffering from complicated babesiosis, 58 dogs had single organ complications while 59 dogs (50.43 per cent) were reported to have MODS. Among the dogs suffering from single organ complications, hepatic complications and renal complications were reported in 30 (25.64 per cent) and 28 (23.93 per cent) dogs, respectively. Out of 59 dogs suffering from MODS, hepatic and renal complications were reported in 29 dogs (49.15 per cent), while 9 dogs (15.25 per cent) had liver, kidneys and muscle involvement. Liver, kidneys and lungs were found to be affected in 10 cases (16.95 per cent), while CNS involvement in addition to hepatic and renal affection was reported in 5 cases (8.47 per cent). Six dogs (10.15 per cent) had complications due to affections of liver, kidneys, muscles and lungs (Table 09).
Table 09: Involvement of organs and type of babesiosis in dogs (n=176)

<table>
<thead>
<tr>
<th>Type of babesiosis and organs involved</th>
<th>No. of dogs affected</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncomplicated</td>
<td>59</td>
<td>33.52</td>
</tr>
<tr>
<td>Complicated</td>
<td>117</td>
<td>66.48</td>
</tr>
<tr>
<td>Liver</td>
<td>30</td>
<td>25.64</td>
</tr>
<tr>
<td>Kidneys</td>
<td>28</td>
<td>23.93</td>
</tr>
<tr>
<td>MODS</td>
<td>59</td>
<td>50.43</td>
</tr>
<tr>
<td>Liver+Kidneys</td>
<td>29</td>
<td>49.15</td>
</tr>
<tr>
<td>Liver+Kidneys+Muscles</td>
<td>09</td>
<td>15.25</td>
</tr>
<tr>
<td>Liver+Kidneys+Lungs</td>
<td>10</td>
<td>16.95</td>
</tr>
<tr>
<td>Liver+Kidneys+CNS</td>
<td>05</td>
<td>08.47</td>
</tr>
<tr>
<td>Liver+Kidneys+Muscles+Lungs</td>
<td>06</td>
<td>10.17</td>
</tr>
</tbody>
</table>

Systemic inflammatory response syndrome was observed in 19.88 per cent dogs (35 out of 176 dogs). The mean total leukocyte count in the affected dogs was 18.98±3.65 thousands/μl. The mean rectal temperature, heart rate and respiration rate were 103.60±2.74 °F, 136.50±3.49 /min and 26.33±2.04 /min, respectively. In the affected animals the mean concentrations of C-reactive protein and tumor necrosis factor α were 109.68±9.47 mg/L and 3.96±0.54 pg/ml, respectively (Table 10).

Table 10: Systemic inflammatory response syndrome in dogs affected with babesiosis

<table>
<thead>
<tr>
<th>No. of dogs examined</th>
<th>No. of dogs affected</th>
<th>Percentage</th>
<th>Parameters</th>
<th>Mean±SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>176</td>
<td>35</td>
<td>19.88</td>
<td>Total leukocyte count (thousands/μl)</td>
<td>18.98±3.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rectal temperature (°F)</td>
<td>103.60±2.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Heart rate (/min)</td>
<td>136.50±3.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Respiration rate (/min)</td>
<td>26.33±2.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C-reactive protein (mg/L)</td>
<td>109.68±9.47</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tumor necrosis factor α (pg/ml)</td>
<td>3.96±0.54</td>
</tr>
</tbody>
</table>
Clinical signs in uncomplicated babesiosis of dogs

In the present study physical examination of the dogs suffering from uncomplicated babesiosis revealed an increased rectal temperature (>102.5 °F) in 89.83 per cent of the cases, while 8.47 per cent of the dogs had decreased rectal temperature (<99.5 °F). The rectal temperature within the normal range (99.5-102.5 °F) was recorded in one dog. There was increased pulse rate (>120/min) in 76.27 per cent of the cases while normal pulse rate (80-120/min) was found in 16.95 per cent dogs. Four dogs (6.78 per cent) were reported to have decreased pulse rate (<80/min). An increase in the respiration rate (>35/min) was recorded in 86.44 per cent of the dogs while normal (10-35/min) and decreased respiration rates (<10/min) were recorded in 11.86 per cent and 1.70 per cent cases, respectively (Table 11).

The clinical examination of the cases of uncomplicated babesiosis revealed anorexia, lethargy, presence of ticks, hemoglobinuria, pallor, vomiting and icterus in 89.83, 81.36, 71.19, 40.68, 18.64, 16.95 and 8.47 per cent of the cases, respectively. Pale mucous membranes were reported in 91.53 per cent of the cases while 8.47 per cent dogs had pink mucous membranes (Table 11).
Table 11: Clinical signs in uncomplicated babesiosis (n=59)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>No. of animals</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rectal temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;102.5 °F</td>
<td>53</td>
<td>89.83</td>
</tr>
<tr>
<td></td>
<td>99.5-102.5 °F</td>
<td>1</td>
<td>1.70</td>
</tr>
<tr>
<td></td>
<td>&lt;99.5 °F</td>
<td>5</td>
<td>8.47</td>
</tr>
<tr>
<td>2.</td>
<td>Pulse rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;120/min</td>
<td>45</td>
<td>76.27</td>
</tr>
<tr>
<td></td>
<td>80-120/min</td>
<td>10</td>
<td>16.95</td>
</tr>
<tr>
<td></td>
<td>&lt;80/min</td>
<td>4</td>
<td>6.78</td>
</tr>
<tr>
<td>3.</td>
<td>Respiration rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;35 /min</td>
<td>51</td>
<td>86.44</td>
</tr>
<tr>
<td></td>
<td>10-35/min</td>
<td>7</td>
<td>11.86</td>
</tr>
<tr>
<td></td>
<td>&lt;10/min</td>
<td>1</td>
<td>1.70</td>
</tr>
<tr>
<td>4.</td>
<td>Anorexia</td>
<td>53</td>
<td>89.83</td>
</tr>
<tr>
<td>5.</td>
<td>Lethargy</td>
<td>48</td>
<td>81.36</td>
</tr>
<tr>
<td>6.</td>
<td>Presence of ticks</td>
<td>42</td>
<td>71.19</td>
</tr>
<tr>
<td>7.</td>
<td>Hemoglobinuria</td>
<td>24</td>
<td>40.68</td>
</tr>
<tr>
<td>8.</td>
<td>Pallor</td>
<td>11</td>
<td>18.64</td>
</tr>
<tr>
<td>9.</td>
<td>Vomiting</td>
<td>10</td>
<td>16.95</td>
</tr>
<tr>
<td>10.</td>
<td>Icterus</td>
<td>5</td>
<td>8.47</td>
</tr>
<tr>
<td>11.</td>
<td>Colour of mucous membrane</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pink</td>
<td>5</td>
<td>8.47</td>
</tr>
<tr>
<td></td>
<td>Pale</td>
<td>54</td>
<td>91.53</td>
</tr>
</tbody>
</table>
Clinical signs in complicated babesiosis of dogs

The physical examination of the dogs suffering from complicated babesiosis revealed an increased rectal temperature (>102.5 °F) in 30.77 per cent of the cases, while 34.19 per cent of the dogs had the rectal temperature within the normal range (99.5-102.5 °F). Decreased rectal temperature (<99.5 °F) was recorded in 35.04 per cent of the cases. An increase in pulse rate (>120/min) was found in 27.35 per cent of the cases while normal pulse rate (80-120/min) was found in 35.90 per cent dogs. Decreased pulse rate (<80/min) was recorded in 36.75 per cent of the dogs. Increased respiration rate (>35/min) was recorded in 30.77 per cent of the dogs while normal (10-35/min) and decreased respiration rates (<10/min) were recorded in 32.48 per cent and 36.75 per cent cases, respectively (Table 12).

In the present study, history and clinical examination of the cases of complicated babesiosis revealed lethargy, anorexia, presence of ticks, vomiting, diarrhoea, pallor and edema in 91.45, 78.63, 73.50, 66.67, 58.97, 52.14 and 26.50 per cent of the cases, respectively. Ocular/nasal discharge, respiratory distress, moist cough, icterus, ataxia and seizures were reported in 16.24, 13.68, 12.82, 11.97, 4.27 and 4.27 per cent of dogs, respectively. Congested mucous membranes were reported in 32.48 per cent of the cases while 67.52 per cent dogs had pale mucous membranes (Table 12).
Table 12: Clinical signs in complicated babesiosis (n=117)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>No. of animals</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rectal temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;102.5 °F</td>
<td>36</td>
<td>30.77</td>
</tr>
<tr>
<td></td>
<td>99.5-102.5 °F</td>
<td>40</td>
<td>34.19</td>
</tr>
<tr>
<td></td>
<td>&lt;99.5 °F</td>
<td>41</td>
<td>35.04</td>
</tr>
<tr>
<td>2.</td>
<td>Pulse rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;120/min</td>
<td>32</td>
<td>27.35</td>
</tr>
<tr>
<td></td>
<td>80-120/min</td>
<td>42</td>
<td>35.90</td>
</tr>
<tr>
<td></td>
<td>&lt;80/min</td>
<td>43</td>
<td>36.75</td>
</tr>
<tr>
<td>3.</td>
<td>Respiration rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;35 /min</td>
<td>36</td>
<td>30.77</td>
</tr>
<tr>
<td></td>
<td>10-35/min</td>
<td>38</td>
<td>32.48</td>
</tr>
<tr>
<td></td>
<td>&lt;10/min</td>
<td>43</td>
<td>36.75</td>
</tr>
<tr>
<td>4.</td>
<td>Lethargy</td>
<td>107</td>
<td>91.45</td>
</tr>
<tr>
<td>5.</td>
<td>Anorexia</td>
<td>92</td>
<td>78.63</td>
</tr>
<tr>
<td>6.</td>
<td>Presence of ticks</td>
<td>86</td>
<td>73.50</td>
</tr>
<tr>
<td>7.</td>
<td>Vomiting</td>
<td>78</td>
<td>66.67</td>
</tr>
<tr>
<td>8.</td>
<td>Diarrhoea</td>
<td>69</td>
<td>58.97</td>
</tr>
<tr>
<td>9.</td>
<td>Pallor</td>
<td>61</td>
<td>52.14</td>
</tr>
<tr>
<td>10.</td>
<td>Edema</td>
<td>31</td>
<td>26.50</td>
</tr>
<tr>
<td>12.</td>
<td>Respiratory distress</td>
<td>16</td>
<td>13.68</td>
</tr>
<tr>
<td>13.</td>
<td>Moist cough</td>
<td>15</td>
<td>12.82</td>
</tr>
<tr>
<td>14.</td>
<td>Icterus</td>
<td>14</td>
<td>11.97</td>
</tr>
<tr>
<td>15.</td>
<td>Ataxia</td>
<td>5</td>
<td>4.27</td>
</tr>
<tr>
<td>16.</td>
<td>Seizures</td>
<td>5</td>
<td>4.27</td>
</tr>
<tr>
<td>17.</td>
<td>Colour of mucous membrane</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Congested</td>
<td>38</td>
<td>32.48</td>
</tr>
<tr>
<td></td>
<td>Pale</td>
<td>79</td>
<td>67.52</td>
</tr>
</tbody>
</table>
Prognostic values of various hemato-biochemical alterations in uncomplicated babesiosis

**Total erythrocyte count (TEC)**

In uncomplicated babesiosis the TEC (Mean±SE) of survivors was 3.48±0.87 millions/µl while in non survivors it was 1.87±0.37 millions/µl. The median values in survivors and non survivors were 3.55 millions/µl and 1.83 millions/µl, respectively and differed significantly (p<0.0001). The cut off value 2.41 millions/µl was obtained (Table 13).

**Table 13: Total erythrocyte count (millions/µl) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>3.48±0.87</td>
<td>1.87±0.37</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>3.55</td>
<td>1.83</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>5.59</td>
<td>2.36</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>1.98</td>
<td>1.32</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td></td>
<td>2.41</td>
<td></td>
</tr>
</tbody>
</table>

**Hemoglobin concentration (Hb)**

The hemoglobin concentration (Mean±SE) in survivors and non survivors were 6.64±1.08 g/dl and 4.64±0.68 g/dl, respectively; while the median values were 6.40 g/dl and 4.60 g/dl, respectively. The median values differed significantly (p<0.0001) and the cut off value 5.42 g/dl was obtained (Table 14).

**Table 14: Hemoglobin concentration (g/dl) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>6.64±1.08</td>
<td>4.64±0.68</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>6.40</td>
<td>4.60</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>8.80</td>
<td>5.60</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>5.20</td>
<td>3.60</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>5.42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Packed cell volume (PCV)

In the cases of uncomplicated babesiosis the PCV (Mean±SE) of survivors was 18.95±4.48 per cent while in non survivors it was 15.59±3.87 per cent. The median values in survivors and non survivors were 16.88 per cent and 14.96 per cent, respectively and differed significantly (p<0.0001). The cut off value 17.52 per cent was obtained (Table 15).

Table 15: Packed cell volume (%) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>18.95±4.48</td>
<td>15.59±3.87</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>16.88</td>
<td>14.96</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>27.68</td>
<td>21.61</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>14.23</td>
<td>10.68</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>17.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total leukocyte count (TLC)

In uncomplicated babesiosis the TLC (Mean±SE) of survivors was 16.39±1.09 thousands/µl while in non survivors it was 20.63±5.77 thousands/µl. The median values in survivors and non survivors were 16.35 thousands/µl and 16.65 thousands/µl, respectively (Table 16) and did not differ significantly (p=0.087).

Table 16: Total leukocyte count (thousands/µl) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>16.39±1.09</td>
<td>20.63±5.77</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>16.35</td>
<td>16.65</td>
<td>p=0.087</td>
</tr>
<tr>
<td>Maximum</td>
<td>18.45</td>
<td>29.87</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>14.25</td>
<td>15.45</td>
<td></td>
</tr>
</tbody>
</table>
Platelet count

The platelet values (Mean±SE) in survivors and non survivors were 48.22±4.29 thousands/μl and 24.13±6.86 thousands/μl, respectively; while the median values were 48.33 thousands/μl and 25.20 thousands/μl, respectively. The median values differed significantly (p<0.0001) and the cut off value 39.16 thousands/μl was obtained (Table 17).

Table 17: Platelet count (U/l) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>48.22±4.29</td>
<td>24.13±6.86</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>48.33</td>
<td>25.20</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>59.67</td>
<td>37.54</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>33.78</td>
<td>16.34</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>39.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Differential leukocyte count (DLC)

Neutrophil

In uncomplicated babesiosis neutrophil percent (Mean±SE) of survivors was 66.67±0.50 per cent while in non survivors it was 65.50±0.70 per cent. The median values in survivors and non survivors were 66 and 65 per cent, respectively (Table 18) and did not differ significantly (p=0.239).

Table 18: Neutrophil (%) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>66.67±0.50</td>
<td>65.50±0.70</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>66</td>
<td>65</td>
<td>p=0.239</td>
</tr>
<tr>
<td>Maximum</td>
<td>73</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>59</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>
Lymphocyte

The lymphocyte percent (Mean±SE) in survivors and non survivors were 27.33±2.10 and 28.50±1.01 per cent, respectively; while the median values were 27 and 28 per cent, respectively (Table 19) and did not differ significantly (p=0.541).

**Table 19: Lymphocyte (%) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>27.33±2.10</td>
<td>28.50±1.01</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>27</td>
<td>28</td>
<td>p=0.541</td>
</tr>
<tr>
<td>Maximum</td>
<td>34</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>20</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Monocyte

In the cases of uncomplicated babesiosis the monocyte count (Mean±SE) of survivors was 3.33±0.50 per cent while in non survivors it was 3.67±0.70 per cent. The median values in survivors and non survivors were 3.00 and 4.00 per cent, respectively (Table 20) and did not differ significantly (p=0.140).

**Table 20: Monocyte (%) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>3.33±0.50</td>
<td>3.67±0.70</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>3</td>
<td>4</td>
<td>p=0.140</td>
</tr>
<tr>
<td>Maximum</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
**Eosinophil**

In uncomplicated babesiosis the eosinophil count (Mean±SE) of survivors was 4.00±0.52 per cent while in non survivors it was 3.00±0.40 per cent. The median values in survivors and non survivors were 4.00 and 3.00 per cent, respectively (Table 21) and did not differ significantly (p=0.216).

**Table 21: Eosinophil (%) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>4.00±0.52</td>
<td>3.00±0.40</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>4</td>
<td>3</td>
<td>p=0.216</td>
</tr>
<tr>
<td>Maximum</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Alanine transaminase (ALT)**

The ALT values (Mean±SE) in survivors and non survivors were 46.47±5.12 U/L and 50.05±8.62 U/L, respectively; while the median values were 46.59 U/L and 49.52 U/L, respectively (Table 22). The median values did not differ significantly (p=0.117).

**Table 22: Alanine transaminase (U/L) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>46.47±5.12</td>
<td>50.05±8.62</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>46.59</td>
<td>49.52</td>
<td>p=0.117</td>
</tr>
<tr>
<td>Maximum</td>
<td>59.67</td>
<td>62.57</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>33.22</td>
<td>31.20</td>
<td></td>
</tr>
</tbody>
</table>
Aspartate transaminase (AST)
The Mean±SE and median values of AST in survivors were 73.44±6.07 U/L and 73.56 U/L, respectively, while in non survivors it were 71.07±5.09 U/L and 69.41 U/L, respectively (Table 23). The median values did not differ significantly (p=0.20).

Table 23 : Aspartate transaminase (U/L) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>73.44±6.07</td>
<td>71.07±5.09</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>73.56</td>
<td>69.41</td>
<td>p=0.20</td>
</tr>
<tr>
<td>Maximum</td>
<td>82.48</td>
<td>81.83</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>59.95</td>
<td>65.48</td>
<td></td>
</tr>
</tbody>
</table>

Alkaline phosphatase (ALP)
The ALP (Mean±SE) in survivors was 104.34±3.01 U/L while in non survivors it was 109.58±5.43 U/L. The median values were 98.37 U/L and 105.98 U/L in survivors and non survivors, respectively (Table 24), and did not differ significantly (p=0.289).

Table 24 : Alkaline phosphatase (U/L) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>104.34±3.01</td>
<td>109.58±5.43</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>98.37</td>
<td>105.98</td>
<td>p=0.289</td>
</tr>
<tr>
<td>Maximum</td>
<td>154.33</td>
<td>137.59</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>67.49</td>
<td>89.44</td>
<td></td>
</tr>
</tbody>
</table>
Creatine kinase (CK)

The CK values (Mean±SE) in survivors and non survivors were 82.85±2.21 U/L and 85.95±4.61 U/L, respectively; while the median values were 80.28 U/L and 85.11 U/L, respectively (Table 25). The median values did not differ significantly (p=0.952).

Table 25: Creatine kinase (U/l) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>82.85±2.21</td>
<td>85.95±4.61</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>80.28</td>
<td>85.11</td>
<td>p=0.952</td>
</tr>
<tr>
<td>Maximum</td>
<td>118.58</td>
<td>109.45</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>61.68</td>
<td>64.56</td>
<td></td>
</tr>
</tbody>
</table>

Bilirubin- total (BIT)

The BIT (Mean±SE) in survivors was 2.27±0.70 mg/dl; while in non survivors it was 3.78±0.83 mg/dl. The median values were 2.13 mg/dl and 3.92 mg/dl in survivors and non survivors, respectively, and differed significantly (p<0.0001). The cut off value 2.68 mg/dl was obtained (Table 26).

Table 26: Bilirubin-total (mg/dl) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>2.27±0.70</td>
<td>3.78±0.83</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>2.13</td>
<td>3.92</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>4.11</td>
<td>4.79</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>1.10</td>
<td>2.27</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>2.68</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bilirubin- direct (BID)

In uncomplicated babesiosis the BID (Mean±SE) in survivors was 0.19±0.05 mg/dl; while in non survivors it was 0.22±0.07 mg/dl. The median values were 0.16 mg/dl and 0.21 mg/dl in survivors and non survivors, respectively (Table 27), and did not differ significantly (p=0.531).

Table 27: Bilirubin-direct (mg/dl) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>0.19±0.05</td>
<td>0.22±0.07</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.16</td>
<td>0.21</td>
<td>p=0.531</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.24</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.09</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

Total protein (TP)

The TP values (Mean±SE) in survivors and non survivors were 5.01±0.72 g/dl and 5.47±1.01g/dl, respectively; while the median values were 5.10 g/dl and 5.43 g/dl, respectively (Table 28). The median values did not differ significantly (p=0.129).

Table 28: Total protein (g/dl) in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>5.01±0.72</td>
<td>5.47±1.01</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>5.10</td>
<td>5.43</td>
<td>p=0.129</td>
</tr>
<tr>
<td>Maximum</td>
<td>6.54</td>
<td>6.78</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>3.45</td>
<td>3.58</td>
<td></td>
</tr>
</tbody>
</table>
**Albumin**

The albumin (Mean±SE) in survivors was 3.91±0.89 g/dl; while in non survivors it was 4.13±0.47 g/dl. The median values were 4.12 g/dl and 4.11 g/dl in survivors and non survivors, respectively (Table 29), and did not differ significantly (p=0.716).

**Table 29: Albumin (g/dl) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>3.91±0.89</td>
<td>4.13±0.47</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>4.12</td>
<td>4.11</td>
<td>p=0.716</td>
</tr>
<tr>
<td>Maximum</td>
<td>5.32</td>
<td>4.98</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>2.13</td>
<td>3.35</td>
<td></td>
</tr>
</tbody>
</table>

**Blood urea nitrogen (BUN)**

The BUN values (Mean±SE) in survivors and non survivors were 16.48±1.19 mg/dl and 16.56±0.89 mg/dl, respectively; while the median values were 16.25 mg/dl and 16.35 mg/dl, respectively (Table 30). The median values did not differ significantly (p=0.832).

**Table 30: Blood urea nitrogen (mg/dl) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>16.48±1.19</td>
<td>16.56±0.89</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>16.25</td>
<td>16.35</td>
<td>p=0.832</td>
</tr>
<tr>
<td>Maximum</td>
<td>18.66</td>
<td>18.35</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>13.68</td>
<td>15.56</td>
<td></td>
</tr>
</tbody>
</table>
Creatinine

The value of creatinine (Mean±SE) in survivors was 1.15±0.29 mg/dl; while in non survivors it was 1.16±0.40 mg/dl. The median values were 1.13 mg/dl and 1.06 mg/dl in survivors and non survivors, respectively (Table 31), and did not differ significantly (p=0.538).

**Table 31: Creatinine (mg/dl) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>1.15±0.29</td>
<td>1.16±0.40</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>1.13</td>
<td>1.06</td>
<td>p=0.538</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.89</td>
<td>1.99</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.36</td>
<td>0.67</td>
<td></td>
</tr>
</tbody>
</table>

Blood glucose

The blood glucose values (Mean±SE) in survivors and non survivors were 62.34±1.93 mg/dl and 47.90±4.49 mg/dl, respectively; while the median values were 62.39 mg/dl and 46.79 mg/dl, respectively. The median values differed significantly (p=0.001) and the cut off value 54.51 mg/dl was obtained (Table 32).

**Table 32: Blood glucose (mg/dl) in uncomplicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=49)</th>
<th>Non survivors (n=10)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>62.34±1.93</td>
<td>47.90±4.49</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>62.39</td>
<td>46.79</td>
<td>p=0.001</td>
</tr>
<tr>
<td>Maximum</td>
<td>87.24</td>
<td>59.67</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>33.21</td>
<td>43.78</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>54.51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Prognostic indicators in uncomplicated babesiosis

Based on estimation of hemato-biochemical parameters in uncomplicated babesiosis the total erythrocyte count, hemoglobin, packed cell volume, platelet count, bilirubin-total and glucose were reported to affect the outcome of the disease. Further statistical analysis using Fisher’s Exact Test revealed that all the above mentioned factors except packed cell volume, significantly affected the prognosis (Table 33).

Table 33: Prognostic indicators in uncomplicated babesiosis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Level</th>
<th>Score</th>
<th>Survivors</th>
<th>Non-survivors</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total erythrocyte count</td>
<td>2.41-5.50 millions/μl</td>
<td>-</td>
<td>45</td>
<td>0</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&lt;2.41 millions/μl</td>
<td>-</td>
<td>4</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin concentration</td>
<td>5.42-12 g/dl</td>
<td>-</td>
<td>40</td>
<td>1</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&lt;5.42 g/dl</td>
<td>-</td>
<td>9</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Platelet count</td>
<td>39.16-145 thousands/μl</td>
<td>-</td>
<td>48</td>
<td>0</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&lt;39.16 thousands/μl</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Bilirubin-total</td>
<td>0.55-2.68 mg/dl</td>
<td>+</td>
<td>12</td>
<td>9</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&gt;2.68 mg/dl</td>
<td>++</td>
<td>37</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Blood glucose</td>
<td>54.51-80 mg/dl</td>
<td>-</td>
<td>32</td>
<td>1</td>
<td>p=0.003</td>
</tr>
<tr>
<td></td>
<td>&lt;54.51 mg/dl</td>
<td>-</td>
<td>17</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
Prognostic values of various hemato-biochemical alterations in complicated babesiosis

Total erythrocyte count (TEC)

In complicated babesiosis the TEC (Mean±SE) of survivors was 3.82±0.09 millions/\(\mu\)l while in non survivors it was 2.74±0.08 millions/\(\mu\)l. The median values in survivors and non survivors were 3.63 millions/\(\mu\)l and 2.67 millions/\(\mu\)l, respectively and differed significantly (p<0.0001). The cut off value 3.22 millions/\(\mu\)l was obtained (Table 34).

Table 34: Total erythrocyte count (millions/\(\mu\)l) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>3.82±0.09</td>
<td>2.74±0.08</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>3.63</td>
<td>2.67</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>5.55</td>
<td>3.50</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>2.16</td>
<td>1.67</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>3.22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hemoglobin concentration (Hb)

The hemoglobin concentration (Mean±SE) in survivors and non survivors were 6.90±0.13 g/dl and 5.33±0.18 g/dl, respectively; while the median values were 6.60 g/dl and 5.40 g/dl, respectively. The median values differed significantly (p<0.0001) and the cut off value 5.80 g/dl was obtained (Table 35).

Table 35: Hemoglobin concentration (g/dl) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>6.90±0.13</td>
<td>5.33±0.18</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>6.60</td>
<td>5.40</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>8.80</td>
<td>7.80</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>4.80</td>
<td>3.60</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>5.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Packed cell volume (PCV)**

In the cases of complicated babesiosis the PCV (Mean±SE) of survivors was 27.40±0.28 per cent while in non survivors it was 20.19±0.74 per cent. The median values in survivors and non survivors were 26.88 and 19.95 per cent, respectively and differed significantly (p<0.0001). The cut off value 24.52 per cent was obtained (Table 36).

**Table 36: Packed cell volume (%) in complicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>27.40±0.28</td>
<td>20.19±0.74</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>26.88</td>
<td>19.95</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>35.47</td>
<td>28.54</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>22.36</td>
<td>11.45</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>24.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Platelet count**

The platelet count (Mean±SE) in survivors and non survivors were 68.41±1.98 and 28.63±1.28 thousands/μl, respectively; while the median values were 74.71 and 26.39 thousands/μl, respectively. The median values differed significantly (p<0.0001) and the cut off value 38.45 thousands/μl was obtained (Table 37).

**Table 37: Platelet count (thousands/μl) in complicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>68.41±1.98</td>
<td>28.63±1.28</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>74.71</td>
<td>26.39</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>99.48</td>
<td>48.25</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>42.37</td>
<td>16.25</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>38.45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Total leukocyte count (TLC)

In complicated babesiosis the TLC (Mean±SE) of survivors was 15.58±2.05 thousands/µl while in non survivors it was 16.18±2.54 thousands/µl. The median values in survivors and non survivors were 15.36 thousands/µl and 16.34 thousands/µl, respectively (Table 38) and did not differ significantly (p=0.069).

Table 38: Total leukocyte count (thousands/µl) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>15.58±2.05</td>
<td>16.18±2.54</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>15.36</td>
<td>16.34</td>
<td>p=0.069</td>
</tr>
<tr>
<td>Maximum</td>
<td>19.87</td>
<td>20.55</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>12.26</td>
<td>13.11</td>
<td></td>
</tr>
</tbody>
</table>

Differential leukocyte count (DLC)

Neutrophil

In complicated babesiosis neutrophil percent (Mean±SE) of survivors was 64.50±1.01 per cent while in non survivors it was 65.33±0.50 per cent. The median values in survivors and non survivors were 64 and 65 per cent, respectively (Table 39) and did not differ significantly (p=0.075).

Table 39: Neutrophil (%) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>64.50±1.01</td>
<td>65.33±0.50</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>64</td>
<td>65</td>
<td>p=0.075</td>
</tr>
<tr>
<td>Maximum</td>
<td>68</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>60</td>
<td>62</td>
<td></td>
</tr>
</tbody>
</table>
Lymphocyte

The lymphocyte percent (Mean±SE) in survivors and non survivors were 28.33±0.90 and 27.67±0.70 per cent, respectively; while the median values were 28 and 27 per cent, respectively (Table 40) and did not differ significantly (p=0.09).

Table 40: Lymphocyte (%) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>28.33±0.90</td>
<td>27.67±0.70</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>28</td>
<td>27</td>
<td>p=0.09</td>
</tr>
<tr>
<td>Maximum</td>
<td>32</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>24</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Monocyte

In the cases of complicated babesiosis the monocyte percent (Mean±SE) of survivors was 4.33±0.67 per cent while in non survivors it was 3.67±0.80 per cent. The median values in survivors and non survivors were 4.00 per cent and 4.00 per cent, respectively (Table 41) and did not differ significantly (p=0.149).

Table 41: Monocyte (%) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>4.33±0.67</td>
<td>3.67±0.80</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>4</td>
<td>4</td>
<td>p=0.149</td>
</tr>
<tr>
<td>Maximum</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Eosinophil

In complicated babesiosis the eosinophil percent (Mean±SE) of survivors was 3.67±0.90 per cent while in non survivors it was 4.33±0.70 per cent. The median values in survivors and non survivors were 4.00 and 4.00 per cent, respectively (Table 42) and did not differ significantly (p=0.367).

Table 42: Eosinophil (%) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>3.67±0.90</td>
<td>4.33±0.70</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>4</td>
<td>4</td>
<td>p=0.367</td>
</tr>
<tr>
<td>Maximum</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Alanine transaminase (ALT)

The ALT values (Mean±SE) in survivors and non survivors were 68.48±2.07 U/L and 85.03±3.61 U/L, respectively; while the median values were 74.39 U/L and 80.38 U/L, respectively. The median values differed significantly (p=0.0007) and the cut off value of 76.24 U/L was obtained (Table 43).

Table 43: Alanine transaminase (U/L) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>68.48±2.07</td>
<td>85.03±3.61</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>74.39</td>
<td>80.38</td>
<td>p=0.0007</td>
</tr>
<tr>
<td>Maximum</td>
<td>108.34</td>
<td>127.38</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>40.31</td>
<td>41.23</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>76.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Aspartate transaminase (AST)

The Mean±SE and median values of AST in survivors were 76.38±1.10 U/L and 76.89 U/L, respectively, while in non survivors it were 75.74±0.82 U/L and 75.63 U/L, respectively (Table 44). The median values did not differ significantly (p=0.7459).

Table 44: Aspartate transaminase (U/L) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>76.38±1.10</td>
<td>75.74±0.82</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>76.89</td>
<td>75.63</td>
<td>p=0.7459</td>
</tr>
<tr>
<td>Maximum</td>
<td>101.23</td>
<td>82.13</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>60.25</td>
<td>67.45</td>
<td></td>
</tr>
</tbody>
</table>

Alkaline phosphatase (ALP)

The ALP (Mean±SE) in survivors was 123.01±2.28 U/L; while in non survivors it was 218.42±6.71 U/L. The median values were 124.45 U/L and 228.36 U/L in survivors and non survivors, respectively, and differed significantly (p<0.0001). The cut off value 211.25 U/L was obtained (Table 45).

Table 45: Alkaline phosphatase (U/L) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>123.01±2.28</td>
<td>218.42±6.71</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>124.45</td>
<td>228.36</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>208.39</td>
<td>250.34</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>96.56</td>
<td>101.23</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>211.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Creatine kinase (CK)

The CK values (Mean±SE) in survivors and non survivors were 101.70±3.44 U/L and 215.79±3.61 U/L, respectively; while the median values were 99.65 U/L and 105.66 U/L, respectively. The median values differed significantly (p<0.0001) and the cut off value 139.50 U/L was obtained (Table 46).

Table 46: Creatine Kinase (U/L) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>101.70±3.44</td>
<td>215.79±3.61</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>99.65</td>
<td>105.66</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>247.86</td>
<td>511.98</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>43.24</td>
<td>89.45</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>139.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bilirubin- total (BIT)

The BIT (Mean±SE) in survivors was 1.11±0.06 mg/dl; while in non survivors it was 1.33±0.05 mg/dl. The median values were 0.98 mg/dl and 1.22 mg/dl in survivors and non survivors, respectively, and differed significantly (p=0.0256). The cut off value 1.19 mg/dl was obtained (Table 47).

Table 47: Bilirubin total (mg/dl) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>1.11±0.06</td>
<td>1.33±0.05</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.98</td>
<td>1.22</td>
<td>p=0.0256</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.99</td>
<td>1.98</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.38</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>1.19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bilirubin- direct (BID)

In complicated babesiosis the BID (Mean±SE) in survivors was 0.20±0.07 mg/dl; while in non survivors it was 0.24±0.06 mg/dl. The median values were 0.19 mg/dl and 0.22 mg/dl in survivors and non survivors, respectively (Table 48), and did not differ significantly (p=0.092).

**Table 48: Bilirubin direct (U/l) in complicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>0.20±0.07</td>
<td>0.24±0.06</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.19</td>
<td>0.22</td>
<td>p=0.092</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.26</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.11</td>
<td>0.14</td>
<td></td>
</tr>
</tbody>
</table>

Total protein (TP)

The TP values (Mean±SE) in survivors and non survivors were 4.88±0.12 g/dl and 3.56±0.13 g/dl, respectively; while the median values were 5.05 U/l and 3.45 g/dl, respectively. The median values differed significantly (p<0.0001) and the cut off value 3.67 g/dl was obtained (Table 49).

**Table 49: Total protein (g/dl) in complicated babesiosis**

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>4.88±0.12</td>
<td>3.56±0.13</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>5.05</td>
<td>3.45</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>7.75</td>
<td>4.87</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>2.21</td>
<td>2.27</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>3.67</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Albumin

The albumin (Mean±SE) in survivors was 2.01±0.96 g/dl; while in non survivors it was 1.97±0.67 g/dl. The median values were 2.03 g/dl and 1.96 g/dl in survivors and non survivors, respectively (Table 50), and did not differ significantly (p=0.541).

Table 50: Albumin (g/dl) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>2.01±0.96</td>
<td>1.97±0.67</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>2.03</td>
<td>1.96</td>
<td>p=0.541</td>
</tr>
<tr>
<td>Maximum</td>
<td>2.86</td>
<td>2.49</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>1.04</td>
<td>1.10</td>
<td></td>
</tr>
</tbody>
</table>

Blood Urea Nitrogen

The BUN values (Mean±SE) in survivors and non survivors were 16.16±0.69 mg/dl and 29.60±2.08 mg/dl, respectively; while the median values were 15.68 mg/dl and 28.35 mg/dl, respectively. The median values differed significantly (p<0.0001) and the cut off value 26.37 mg/dl was obtained (Table 51).

Table 51: Blood urea nitrogen (mg/dl) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>16.16±0.69</td>
<td>29.60±2.08</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>15.68</td>
<td>28.35</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>36.21</td>
<td>48.25</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>8.49</td>
<td>7.98</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>26.37</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Creatinine

The creatinine (Mean±SE) in survivors was 2.19±0.10 mg/dl; while in non survivors it was 3.77±0.22 mg/dl. The median values were 2.35 mg/dl and 3.65 mg/dl in survivors and non survivors, respectively, and differed significantly (p<0.0001). The cut off value 3.12 mg/dl was obtained (Table 52).

Table 52: Creatinine (mg/dl) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>2.19±0.10</td>
<td>3.77±0.22</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>2.35</td>
<td>3.65</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.67</td>
<td>6.32</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>0.55</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>3.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Blood glucose

The blood glucose values (Mean±SE) in survivors and non survivors were 61.14±0.99 mg/dl and 48.84±0.58 mg/dl, respectively; while the median values were 65.47 mg/dl and 49.44 mg/dl, respectively. The median values differed significantly (p<0.0001) and the cut off value 54.38 mg/dl was obtained (Table 53).

Table 53: Blood glucose (mg/dl) in complicated babesiosis

<table>
<thead>
<tr>
<th>Value</th>
<th>Survivors (n=84)</th>
<th>Non survivors (n=33)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SE</td>
<td>61.14±0.99</td>
<td>48.84±0.58</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>65.47</td>
<td>49.44</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>Maximum</td>
<td>73.29</td>
<td>54.38</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>40.12</td>
<td>42.37</td>
<td></td>
</tr>
<tr>
<td>Cut off value</td>
<td>54.38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Prognostic indicators in complicated babesiosis

Estimation of hemato-biochemical parameters in complicated babesiosis revealed that the total erythrocyte count, hemoglobin, packed cell volume, platelet count, alanine transaminase, alkaline phosphatase, serum bilirubin, total protein, creatine kinase, blood urea nitrogen, creatinine and blood glucose significantly affect the prognosis of the disease (Table 54).

Table 54: Prognostic indicators in complicated babesiosis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Level</th>
<th>Score</th>
<th>Survivors</th>
<th>Non-survivors</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total erythrocyte count</td>
<td>&lt;5.50 millions/µl</td>
<td>-</td>
<td>62</td>
<td>5</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&lt;3.22 millions/µl</td>
<td>- -</td>
<td>22</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin concentration</td>
<td>&lt;12 g/dl</td>
<td>-</td>
<td>65</td>
<td>7</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&lt;5.80 g/dl</td>
<td>- -</td>
<td>19</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Packed cell volume</td>
<td>38-24.52%</td>
<td>-</td>
<td>81</td>
<td>6</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&lt;24.52%</td>
<td>- -</td>
<td>3</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Platelet count</td>
<td>&lt;145 thousands/µl</td>
<td>-</td>
<td>84</td>
<td>3</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&lt;38.45 thousands/µl</td>
<td>- -</td>
<td>0</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Alanine transaminase</td>
<td>Upto 48.20 U/L</td>
<td>Normal</td>
<td>28</td>
<td>3</td>
<td>p=0.0061</td>
</tr>
<tr>
<td></td>
<td>48.20-76.24 U/L</td>
<td>+</td>
<td>8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;76.24 U/L</td>
<td>++</td>
<td>48</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>Reference Range</td>
<td>Normal</td>
<td>Abnormality</td>
<td>p Value</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------</td>
<td>---------</td>
<td>-------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Alkaline phosphatise</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 105.50 U/L</td>
<td></td>
<td>26</td>
<td>2</td>
<td>p&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>105.50-211.25 U/L</td>
<td></td>
<td>55</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 211.25 U/L</td>
<td></td>
<td>3</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bilirubin-total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 0.55 mg/dl</td>
<td></td>
<td>28</td>
<td>0</td>
<td>p&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>0.55-1.19 mg/dl</td>
<td></td>
<td>7</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 1.19 mg/dl</td>
<td></td>
<td>49</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.65-3.67 g/dl</td>
<td></td>
<td>-</td>
<td>70</td>
<td>12</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>&lt; 3.67 g/dl</td>
<td></td>
<td>-</td>
<td>14</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td><strong>Creatine kinase</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 139.50 U/L</td>
<td></td>
<td>4</td>
<td>11</td>
<td>p=0.0001</td>
<td></td>
</tr>
<tr>
<td>&gt; 139.50 U/L</td>
<td></td>
<td>80</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Blood urea nitrogen</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 16 mg/dl</td>
<td></td>
<td>31</td>
<td>3</td>
<td>p&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>16-26.37 mg/dl</td>
<td></td>
<td>41</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 26.37 mg/dl</td>
<td></td>
<td>12</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Creatinine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1.10 mg/dl</td>
<td></td>
<td>31</td>
<td>3</td>
<td>p&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>1.10-3.12 mg/dl</td>
<td></td>
<td>37</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 3.12 mg/dl</td>
<td></td>
<td>16</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Blood glucose</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 54.51 mg/dl</td>
<td></td>
<td>-</td>
<td>62</td>
<td>1</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>&lt; 54.51 mg/dl</td>
<td></td>
<td>-</td>
<td>22</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>
Evaluation of comparative therapeutic efficacy of different anti-babesial drugs in complicated babesiosis of dogs

**Group T₁ (Diminazene Aceturate)**

In the group T₁, 5 out of 12 dogs died during the treatment; however, in the remaining 7 dogs degree of parasitemia reduced on day 10 post treatment. None of the dogs showed parasitemia on day 20 and 30 post treatment (Table 55).

**Table 55: Degree of parasitemia at different intervals in group T₁**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hepatic Complications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>+++</td>
<td>+</td>
<td>Died</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>++</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Renal Complications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>++</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Multiple Organ Dysfunction Syndrome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>++</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In 8 dogs clinical improvement was noticed on day 10 post treatment, of which 1 dog died later on. On day 30 post treatment all the 7 survivor dogs showed complete clinical recovery (Table 56).

**Table 56: Clinical improvement at different intervals in group T1**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatic Complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+</td>
<td>Died</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renal Complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>++</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple Organ Dysfunction Syndrome</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The hematological estimations showed that marked increase was noticed in TEC, Hb, PCV and platelet count on day 20 post treatment, and on day 30 post treatment all the hematological parameters returned to the normal range as compared with the control group (Table 57).
Table 57: Hematological parameters at different intervals in group T₁

<table>
<thead>
<tr>
<th>Parameter</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Erythrocyte Count (millions/µl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₁</td>
<td>3.45&lt;sup&gt;c&lt;/sup&gt; ±0.20</td>
<td>3.69&lt;sup&gt;c&lt;/sup&gt; ±0.19</td>
<td>4.51&lt;sup&gt;b&lt;/sup&gt; ±0.23</td>
<td>5.50&lt;sup&gt;a&lt;/sup&gt; ±0.32</td>
<td>5.54&lt;sup&gt;a&lt;/sup&gt; ±0.39</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>3.47&lt;sup&gt;c&lt;/sup&gt; ±0.44</td>
<td>3.68&lt;sup&gt;c&lt;/sup&gt; ±0.12</td>
<td>4.38&lt;sup&gt;b&lt;/sup&gt; ±0.23</td>
<td>5.68&lt;sup&gt;a&lt;/sup&gt; ±0.13</td>
<td>5.54&lt;sup&gt;a&lt;/sup&gt; ±0.39</td>
</tr>
<tr>
<td>2. Renal</td>
<td>3.68&lt;sup&gt;b&lt;/sup&gt; ±0.42</td>
<td>3.91&lt;sup&gt;b&lt;/sup&gt; ±0.55</td>
<td>5.25&lt;sup&gt;a&lt;/sup&gt; ±0.24</td>
<td>5.65&lt;sup&gt;a&lt;/sup&gt; ±0.34</td>
<td>5.54&lt;sup&gt;a&lt;/sup&gt; ±0.39</td>
</tr>
<tr>
<td>3. MODS</td>
<td>3.22±0.20</td>
<td>3.41±0.09</td>
<td>4.27±0.42</td>
<td>5.14±0.22</td>
<td>5.54±0.39</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₁</td>
<td>8.01&lt;sup&gt;c&lt;/sup&gt; ±0.41</td>
<td>8.49&lt;sup&gt;b&lt;/sup&gt; ±0.20</td>
<td>10.17&lt;sup&gt;a&lt;/sup&gt; ±0.38</td>
<td>11.06&lt;sup&gt;a&lt;/sup&gt; ±0.61</td>
<td>11.82&lt;sup&gt;a&lt;/sup&gt; ±0.23</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>8.37&lt;sup&gt;c&lt;/sup&gt; ±0.28</td>
<td>8.86&lt;sup&gt;b&lt;/sup&gt; ±0.19</td>
<td>10.90&lt;sup&gt;a&lt;/sup&gt; ±0.73</td>
<td>11.10&lt;sup&gt;a&lt;/sup&gt; ±0.94</td>
<td>11.82&lt;sup&gt;a&lt;/sup&gt; ±0.23</td>
</tr>
<tr>
<td>2. Renal</td>
<td>8.13&lt;sup&gt;b&lt;/sup&gt; ±0.49</td>
<td>8.45&lt;sup&gt;b&lt;/sup&gt; ±0.58</td>
<td>9.81&lt;sup&gt;a&lt;/sup&gt; ±0.91</td>
<td>11.70&lt;sup&gt;a&lt;/sup&gt; ±0.84</td>
<td>11.82&lt;sup&gt;a&lt;/sup&gt; ±0.23</td>
</tr>
<tr>
<td>3. MODS</td>
<td>7.35±0.87</td>
<td>8.09±0.35</td>
<td>9.91±0.62</td>
<td>11.91±0.47</td>
<td>11.82±0.23</td>
</tr>
<tr>
<td>Packed Cell Volume (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₁</td>
<td>26.90&lt;sup&gt;b&lt;/sup&gt; ±2.31</td>
<td>32.36&lt;sup&gt;b&lt;/sup&gt; ±2.17</td>
<td>37.80&lt;sup&gt;a&lt;/sup&gt; ±0.98</td>
<td>39.12&lt;sup&gt;a&lt;/sup&gt; ±0.63</td>
<td>39.05±0.12</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>25.35&lt;sup&gt;b&lt;/sup&gt; ±1.96</td>
<td>30.98&lt;sup&gt;b&lt;/sup&gt; ±0.56</td>
<td>35.74&lt;sup&gt;b&lt;/sup&gt; ±1.25</td>
<td>39.19&lt;sup&gt;a&lt;/sup&gt; ±1.87</td>
<td>39.05±0.12</td>
</tr>
<tr>
<td>2. Renal</td>
<td>27.89&lt;sup&gt;b&lt;/sup&gt; ±2.01</td>
<td>32.41&lt;sup&gt;b&lt;/sup&gt; ±1.95</td>
<td>38.86&lt;sup&gt;a&lt;/sup&gt; ±0.97</td>
<td>39.49&lt;sup&gt;a&lt;/sup&gt; ±1.79</td>
<td>39.05±0.12</td>
</tr>
<tr>
<td>3. MODS</td>
<td>29.41&lt;sup&gt;b&lt;/sup&gt; ±2.47</td>
<td>33.07&lt;sup&gt;b&lt;/sup&gt; ±1.47</td>
<td>37.71&lt;sup&gt;a&lt;/sup&gt; ±1.61</td>
<td>40.17±0.87</td>
<td>39.05±0.12</td>
</tr>
<tr>
<td>Platelet (thousands/µl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₁</td>
<td>67.45&lt;sup&gt;b&lt;/sup&gt; ±4.13</td>
<td>76.13&lt;sup&gt;b&lt;/sup&gt; ±4.19</td>
<td>104.63&lt;sup&gt;a&lt;/sup&gt; ±4.09</td>
<td>135.87±2.32</td>
<td>144.96±4.34</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>76.40&lt;sup&gt;b&lt;/sup&gt; ±1.67</td>
<td>83.29&lt;sup&gt;b&lt;/sup&gt; ±3.17</td>
<td>104.91&lt;sup&gt;a&lt;/sup&gt; ±2.33</td>
<td>144.91±1.79</td>
<td>144.96±4.34</td>
</tr>
<tr>
<td>2. Renal</td>
<td>68.69&lt;sup&gt;b&lt;/sup&gt; ±2.57</td>
<td>78.50&lt;sup&gt;b&lt;/sup&gt; ±2.54</td>
<td>114.75&lt;sup&gt;a&lt;/sup&gt; ±2.97</td>
<td>135.97±2.79</td>
<td>144.96±4.34</td>
</tr>
<tr>
<td>3. MODS</td>
<td>58.07&lt;sup&gt;b&lt;/sup&gt; ±7.31</td>
<td>68.74&lt;sup&gt;b&lt;/sup&gt; ±2.58</td>
<td>94.47&lt;sup&gt;a&lt;/sup&gt; ±1.69</td>
<td>127.73±3.07</td>
<td>144.96±4.34</td>
</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett's multiple comparison test, p<0.05)
The biochemical estimations showed all the parameters returned to normal range on day 30 post treatment in the survivor dogs of the group as compared with the control group (Table 58).

**Table 58: Biochemical parameters at different intervals in group T₁**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alanine Transaminase (U/L)</strong></td>
<td>T₁</td>
<td>73.20 ±6.41</td>
<td>76.43 ±3.65</td>
<td>66.39 ±1.99</td>
<td>50.61 ±2.35</td>
<td>46.09 ±2.19</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>79.18 ±3.28</td>
<td>83.45 ±1.39</td>
<td>79.10 ±1.09</td>
<td>50.19 ±3.12</td>
<td>46.09 ±2.19</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>46.12 ±0.19</td>
<td>61.34 ±3.41</td>
<td>48.37 ±2.85</td>
<td>48.03 ±2.03</td>
<td>46.09 ±2.19</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>88.37 ±5.17</td>
<td>78.28 ±3.01</td>
<td>69.71 ±1.45</td>
<td>49.38 ±3.84</td>
<td>46.09 ±2.19</td>
</tr>
<tr>
<td><strong>Alkaline phosphatase (U/L)</strong></td>
<td>T₁</td>
<td>120.39 ±4.98</td>
<td>137.33 ±1.98</td>
<td>129.46 ±1.56</td>
<td>105.81 ±3.04</td>
<td>104.85 ±0.73</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>134.63 ±3.02</td>
<td>142.17 ±2.81</td>
<td>136.41 ±1.06</td>
<td>106.19 ±1.15</td>
<td>104.85 ±0.73</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>100.96 ±2.17</td>
<td>129.51 ±2.51</td>
<td>122.06 ±1.68</td>
<td>101.53 ±1.68</td>
<td>104.85 ±0.73</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>126.25 ±3.19</td>
<td>140.37 ±1.95</td>
<td>131.10 ±3.01</td>
<td>108.11 ±2.53</td>
<td>104.85 ±0.73</td>
</tr>
<tr>
<td><strong>Creatine Kinase (U/L)</strong></td>
<td>T₁</td>
<td>108.82 ±3.05</td>
<td>107.83 ±3.19</td>
<td>108.71 ±4.92</td>
<td>104.18 ±3.19</td>
<td>100.16 ±4.24</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>106.29 ±2.41</td>
<td>105.94 ±2.04</td>
<td>106.31 ±3.17</td>
<td>102.19 ±4.14</td>
<td>100.16 ±4.24</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>110.10 ±4.03</td>
<td>108.63 ±5.51</td>
<td>105.90 ±2.59</td>
<td>103.69 ±3.13</td>
<td>100.16 ±4.24</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>104.43 ±3.99</td>
<td>109.39 ±3.02</td>
<td>109.81 ±3.92</td>
<td>108.53 ±5.03</td>
<td>100.16 ±4.24</td>
</tr>
<tr>
<td><strong>Bilirubin-Total (mg/dl)</strong></td>
<td>T₁</td>
<td>1.48 ±0.21</td>
<td>1.21 ±0.16</td>
<td>0.57 ±0.03</td>
<td>0.58 ±0.10</td>
<td>0.55 ±0.09</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>1.38 ±0.19</td>
<td>1.04 ±0.20</td>
<td>0.53 ±0.15</td>
<td>0.54 ±0.11</td>
<td>0.55 ±0.09</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>0.57 ±0.16</td>
<td>0.55 ±0.11</td>
<td>0.54 ±0.14</td>
<td>0.56 ±0.09</td>
<td>0.55 ±0.09</td>
</tr>
<tr>
<td>3.</td>
<td>MODS</td>
<td>1.87&lt;sup&gt;a&lt;/sup&gt;±0.96</td>
<td>1.31&lt;sup&gt;a&lt;/sup&gt;±0.13</td>
<td>0.58&lt;sup&gt;b&lt;/sup&gt;±0.30</td>
<td>0.57&lt;sup&gt;b&lt;/sup&gt;±0.17</td>
<td>0.55&lt;sup&gt;b&lt;/sup&gt;±0.09</td>
</tr>
<tr>
<td>Total Protein (g/dl)</td>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>4.89&lt;sup&gt;b&lt;/sup&gt;±0.31</td>
<td>4.02&lt;sup&gt;b&lt;/sup&gt;±0.97</td>
<td>5.21&lt;sup&gt;a&lt;/sup&gt;±0.51</td>
<td>5.28&lt;sup&gt;a&lt;/sup&gt;±0.16</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt;±0.30</td>
</tr>
<tr>
<td>1.</td>
<td>Hepatic</td>
<td>4.21&lt;sup&gt;b&lt;/sup&gt;±0.46</td>
<td>4.01&lt;sup&gt;b&lt;/sup&gt;±0.91</td>
<td>5.29&lt;sup&gt;a&lt;/sup&gt;±0.16</td>
<td>5.35&lt;sup&gt;a&lt;/sup&gt;±0.49</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt;±0.30</td>
</tr>
<tr>
<td>2.</td>
<td>Renal</td>
<td>5.03&lt;sup&gt;b&lt;/sup&gt;±0.37</td>
<td>3.95&lt;sup&gt;b&lt;/sup&gt;±0.89</td>
<td>4.95&lt;sup&gt;a&lt;/sup&gt;±0.74</td>
<td>5.23&lt;sup&gt;a&lt;/sup&gt;±0.70</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt;±0.30</td>
</tr>
<tr>
<td>3.</td>
<td>MODS</td>
<td>4.73&lt;sup&gt;b&lt;/sup&gt;±1.20</td>
<td>4.08&lt;sup&gt;b&lt;/sup&gt;±1.07</td>
<td>5.02&lt;sup&gt;a&lt;/sup&gt;±0.73</td>
<td>5.36&lt;sup&gt;a&lt;/sup&gt;±0.19</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt;±0.30</td>
</tr>
<tr>
<td>Blood Urea Nitrogen (mg/dl)</td>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>23.61&lt;sup&gt;a&lt;/sup&gt;±2.18</td>
<td>24.38&lt;sup&gt;a&lt;/sup&gt;±1.45</td>
<td>20.11&lt;sup&gt;b&lt;/sup&gt;±1.93</td>
<td>17.16&lt;sup&gt;b&lt;/sup&gt;±0.85</td>
<td>16.35&lt;sup&gt;b&lt;/sup&gt;±0.45</td>
</tr>
<tr>
<td>1.</td>
<td>Hepatic</td>
<td>17.02&lt;sup&gt;b&lt;/sup&gt;±0.44</td>
<td>19.34&lt;sup&gt;b&lt;/sup&gt;±1.95</td>
<td>19.16&lt;sup&gt;a&lt;/sup&gt;±1.14</td>
<td>16.40&lt;sup&gt;a&lt;/sup&gt;±1.61</td>
<td>16.35&lt;sup&gt;a&lt;/sup&gt;±0.45</td>
</tr>
<tr>
<td>2.</td>
<td>Renal</td>
<td>30.19&lt;sup&gt;a&lt;/sup&gt;±1.05</td>
<td>29.19&lt;sup&gt;a&lt;/sup&gt;±2.11</td>
<td>22.01&lt;sup&gt;b&lt;/sup&gt;±0.43</td>
<td>18.07&lt;sup&gt;b&lt;/sup&gt;±0.53</td>
<td>16.35&lt;sup&gt;b&lt;/sup&gt;±0.45</td>
</tr>
<tr>
<td>3.</td>
<td>MODS</td>
<td>22.97&lt;sup&gt;b&lt;/sup&gt;±1.04</td>
<td>25.61&lt;sup&gt;b&lt;/sup&gt;±1.94</td>
<td>19.98&lt;sup&gt;a&lt;/sup&gt;±1.64</td>
<td>17.21&lt;sup&gt;a&lt;/sup&gt;±0.53</td>
<td>16.35&lt;sup&gt;a&lt;/sup&gt;±0.45</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>1.83&lt;sup&gt;a&lt;/sup&gt;±0.04</td>
<td>1.30&lt;sup&gt;b&lt;/sup&gt;±0.32</td>
<td>1.07&lt;sup&gt;b&lt;/sup&gt;±0.21</td>
<td>0.99&lt;sup&gt;b&lt;/sup&gt;±0.05</td>
<td>1.08&lt;sup&gt;b&lt;/sup&gt;±0.05</td>
</tr>
<tr>
<td>1.</td>
<td>Hepatic</td>
<td>1.02&lt;sup&gt;b&lt;/sup&gt;±0.11</td>
<td>0.89&lt;sup&gt;b&lt;/sup&gt;±0.09</td>
<td>0.93&lt;sup&gt;b&lt;/sup&gt;±0.16</td>
<td>1.07&lt;sup&gt;b&lt;/sup&gt;±0.13</td>
<td>1.08&lt;sup&gt;b&lt;/sup&gt;±0.05</td>
</tr>
<tr>
<td>2.</td>
<td>Renal</td>
<td>1.91&lt;sup&gt;a&lt;/sup&gt;±0.09</td>
<td>1.30&lt;sup&gt;a&lt;/sup&gt;±0.13</td>
<td>1.08&lt;sup&gt;b&lt;/sup&gt;±0.09</td>
<td>1.04&lt;sup&gt;b&lt;/sup&gt;±0.06</td>
<td>1.08&lt;sup&gt;b&lt;/sup&gt;±0.05</td>
</tr>
<tr>
<td>3.</td>
<td>MODS</td>
<td>2.71&lt;sup&gt;a&lt;/sup&gt;±0.06</td>
<td>1.45&lt;sup&gt;b&lt;/sup&gt;±0.11</td>
<td>1.09&lt;sup&gt;b&lt;/sup&gt;±0.08</td>
<td>1.01&lt;sup&gt;b&lt;/sup&gt;±0.14</td>
<td>1.08&lt;sup&gt;b&lt;/sup&gt;±0.05</td>
</tr>
<tr>
<td>Blood glucose (mg/dl)</td>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>66.81&lt;sup&gt;b&lt;/sup&gt;±1.19</td>
<td>81.74&lt;sup&gt;a&lt;/sup&gt;±1.71</td>
<td>83.21&lt;sup&gt;a&lt;/sup&gt;±2.94</td>
<td>86.09&lt;sup&gt;a&lt;/sup&gt;±1.31</td>
<td>86.43&lt;sup&gt;a&lt;/sup&gt;±2.62</td>
</tr>
<tr>
<td>1.</td>
<td>Hepatic</td>
<td>63.32&lt;sup&gt;b&lt;/sup&gt;±1.06</td>
<td>82.58&lt;sup&gt;a&lt;/sup&gt;±1.76</td>
<td>84.19&lt;sup&gt;a&lt;/sup&gt;±1.04</td>
<td>86.74&lt;sup&gt;a&lt;/sup&gt;±3.42</td>
<td>86.43&lt;sup&gt;a&lt;/sup&gt;±2.62</td>
</tr>
<tr>
<td>2.</td>
<td>Renal</td>
<td>69.64&lt;sup&gt;b&lt;/sup&gt;±1.81</td>
<td>80.41&lt;sup&gt;a&lt;/sup&gt;±2.19</td>
<td>85.71&lt;sup&gt;a&lt;/sup&gt;±3.27</td>
<td>85.93&lt;sup&gt;a&lt;/sup&gt;±2.18</td>
<td>86.43&lt;sup&gt;a&lt;/sup&gt;±2.62</td>
</tr>
<tr>
<td>3.</td>
<td>MODS</td>
<td>64.61&lt;sup&gt;b&lt;/sup&gt;±0.69</td>
<td>83.27&lt;sup&gt;a&lt;/sup&gt;±3.55</td>
<td>81.80&lt;sup&gt;a&lt;/sup&gt;±2.32</td>
<td>87.49&lt;sup&gt;a&lt;/sup&gt;±1.06</td>
<td>86.43&lt;sup&gt;a&lt;/sup&gt;±2.62</td>
</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett's multiple comparison test, p<0.05)
**Group T₂ (Doxycycline)**

In the group T₂, 3 out of 12 dogs died during the treatment; However, in the remaining 9 dogs degree of parasitemia reduced on day 10 post treatment. None of the dogs showed parasitemia on day 30 post treatment (Table 59).

**Table 59: Degree of parasitemia at different intervals in group T₂**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatic Complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>++</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renal Complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>+</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple Organ Dysfunction Syndrome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>++</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In 9 dogs clinical improvement was noticed on day 10 post treatment and on day 30 post treatment all the survivor dogs showed complete clinical recovery (Table 60).
Table 60: Clinical improvement at different intervals in group T₂

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hepatic Complications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Renal Complications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Multiple Organ Dysfunction Syndrome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The hematological estimations showed gradual increase in TEC, Hb, PCV and platelet count on day 10 and 20 post treatment, and on day 30 post treatment all the parameters returned to the normal range as compared with the control group (Table 61).
Table 61: Hematological parameters at different intervals in group T2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Erythrocyte Count (millions/μl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>3.55±0.22</td>
<td>3.53±0.21</td>
<td>4.86±0.20</td>
<td>5.27±0.32</td>
<td>5.54±0.39</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>3.09±0.28</td>
<td>3.24±0.17</td>
<td>4.91±0.33</td>
<td>4.94±0.70</td>
<td>5.54±0.39</td>
</tr>
<tr>
<td>2. Renal</td>
<td>3.60±0.47</td>
<td>3.58±0.54</td>
<td>4.57±0.67</td>
<td>5.40±0.78</td>
<td>5.54±0.39</td>
</tr>
<tr>
<td>3. MODS</td>
<td>3.97±0.31</td>
<td>3.74±0.39</td>
<td>4.87±0.19</td>
<td>5.47±0.27</td>
<td>5.54±0.39</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>7.85±0.22</td>
<td>9.29±0.20</td>
<td>10.38±0.19</td>
<td>11.42±0.30</td>
<td>11.82±0.23</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>8.01±0.14</td>
<td>9.40±0.61</td>
<td>10.30±1.03</td>
<td>11.48±0.52</td>
<td>11.82±0.23</td>
</tr>
<tr>
<td>2. Renal</td>
<td>7.70±0.42</td>
<td>9.30±0.71</td>
<td>11.28±0.35</td>
<td>10.98±0.61</td>
<td>11.82±0.23</td>
</tr>
<tr>
<td>3. MODS</td>
<td>7.87±0.31</td>
<td>9.18±0.32</td>
<td>9.82±0.19</td>
<td>11.87±0.52</td>
<td>11.82±0.23</td>
</tr>
<tr>
<td>Packed Cell Volume (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>27.53±0.75</td>
<td>31.29±1.02</td>
<td>36.48±0.56</td>
<td>39.58±0.53</td>
<td>39.05±0.12</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>27.81±0.14</td>
<td>32.61±0.31</td>
<td>37.73±0.17</td>
<td>40.08±1.25</td>
<td>39.05±0.12</td>
</tr>
<tr>
<td>2. Renal</td>
<td>25.53±0.94</td>
<td>30.32±1.48</td>
<td>35.90±0.32</td>
<td>37.92±1.53</td>
<td>39.05±0.12</td>
</tr>
<tr>
<td>3. MODS</td>
<td>29.35±0.63</td>
<td>31.72±1.34</td>
<td>37.11±0.26</td>
<td>39.16±0.61</td>
<td>39.05±0.12</td>
</tr>
<tr>
<td>Platelet (thousands/μl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>67.19±5.77</td>
<td>75.89±3.88</td>
<td>123.71±1.41</td>
<td>128.77±1.94</td>
<td>144.96±4.34</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>79.13±2.75</td>
<td>87.53±2.63</td>
<td>126.06±1.56</td>
<td>134.72±2.45</td>
<td>144.96±4.34</td>
</tr>
<tr>
<td>2. Renal</td>
<td>68.55±1.67</td>
<td>75.33±2.53</td>
<td>121.23±2.73</td>
<td>122.35±1.53</td>
<td>144.96±4.34</td>
</tr>
<tr>
<td>3. MODS</td>
<td>55.47±1.36</td>
<td>63.23±3.65</td>
<td>122.07±2.01</td>
<td>128.08±2.54</td>
<td>144.96±4.34</td>
</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett’s multiple comparison test, p<0.05)
The biochemical estimations showed all the parameters returned to normal range on day 30 post treatment in the survivor dogs of the group as compared with the control group (Table 62).

**Table 62: Biochemical parameters at different intervals in group T₂**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alanine Transaminase (U/L)</strong></td>
<td>T₂</td>
<td>71.12ᵇ</td>
<td>73.90ᵃ</td>
<td>63.57ᶜ</td>
<td>52.96ᵈ</td>
<td>46.09ᵈ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±7.23</td>
<td>±2.25</td>
<td>±3.43</td>
<td>±1.99</td>
<td>±2.19</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>77.23ᵃ</td>
<td>79.10ᵃ</td>
<td>70.03ᵃ</td>
<td>57.63ᵇ</td>
<td>46.09ᵇ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.86</td>
<td>±1.64</td>
<td>±2.64</td>
<td>±2.72</td>
<td>±2.19</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>46.05ᵇ</td>
<td>68.04ᵃ</td>
<td>56.52ᵇ</td>
<td>46.35ᵇ</td>
<td>46.09ᵇ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.25</td>
<td>±1.52</td>
<td>±1.31</td>
<td>±1.26</td>
<td>±2.19</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>91.73ᵃ</td>
<td>80.38ᵇ</td>
<td>63.92ᶜ</td>
<td>53.55ᵈ</td>
<td>46.09ᵈ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.45</td>
<td>±2.32</td>
<td>±0.61</td>
<td>±2.63</td>
<td>±2.19</td>
</tr>
<tr>
<td><strong>Alkaline phosphatase (U/L)</strong></td>
<td>T₂</td>
<td>117.43ᵇ</td>
<td>135.83ᵃ</td>
<td>136.56ᵃ</td>
<td>104.79ᶜ</td>
<td>104.85ᶜ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±5.15</td>
<td>±2.68</td>
<td>±3.07</td>
<td>±2.18</td>
<td>±0.73</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>129.25ᵃ</td>
<td>139.24ᵃ</td>
<td>144.13ᵃ</td>
<td>104.63ᵇ</td>
<td>104.85ᵇ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.65</td>
<td>±2.04</td>
<td>±1.05</td>
<td>±1.64</td>
<td>±0.73</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>104.96ᵇ</td>
<td>131.24ᵃ</td>
<td>128.54ᵇ</td>
<td>103.24ᵇ</td>
<td>104.85ᵇ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.57</td>
<td>±1.33</td>
<td>±3.52</td>
<td>±2.47</td>
<td>±0.73</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>128.73ᵃ</td>
<td>136.02ᵃ</td>
<td>136.72ᵃ</td>
<td>106.06ᵇ</td>
<td>104.85ᵇ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.05</td>
<td>±1.54</td>
<td>±1.64</td>
<td>±2.42</td>
<td>±0.73</td>
</tr>
<tr>
<td><strong>Creatine Kinase (U/L)</strong></td>
<td>T₂</td>
<td>103.51ᵇ</td>
<td>106.19</td>
<td>103.77</td>
<td>105.48</td>
<td>100.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.64</td>
<td>±2.43</td>
<td>±3.06</td>
<td>±3.19</td>
<td>±4.24</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>102.21ᵇ</td>
<td>109.51</td>
<td>103.34</td>
<td>107.13</td>
<td>100.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.05</td>
<td>±2.24</td>
<td>±1.04</td>
<td>±2.10</td>
<td>±4.24</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>100.32ᵇ</td>
<td>106.64</td>
<td>105.42</td>
<td>105.62</td>
<td>100.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.54</td>
<td>±1.45</td>
<td>±1.76</td>
<td>±1.94</td>
<td>±4.24</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>107.45ᵇ</td>
<td>103.51</td>
<td>101.72</td>
<td>103.36</td>
<td>100.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±4.02</td>
<td>±2.01</td>
<td>±1.44</td>
<td>±2.05</td>
<td>±4.24</td>
</tr>
<tr>
<td><strong>Bilirubin-Total (mg/dl)</strong></td>
<td>T₂</td>
<td>1.25ᵃ</td>
<td>1.10ᵇ</td>
<td>0.52ᵇ</td>
<td>0.54ᵇ</td>
<td>0.55ᵇ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.19</td>
<td>±0.16</td>
<td>±0.03</td>
<td>±0.04</td>
<td>±0.09</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>1.31ᵇ</td>
<td>1.41ᵃ</td>
<td>0.55ᵇ</td>
<td>0.49ᵇ</td>
<td>0.55ᵇ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.08</td>
<td>±0.12</td>
<td>±0.08</td>
<td>±0.06</td>
<td>±0.09</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>0.53</td>
<td>0.60</td>
<td>0.53</td>
<td>0.53</td>
<td>0.55ᵇ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.16</td>
<td>±0.10</td>
<td>±0.04</td>
<td>±0.04</td>
<td>±0.09</td>
</tr>
<tr>
<td>Component</td>
<td>Group</td>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
<td>1. Hepatic</td>
<td>2. Renal</td>
<td>3. MODS</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------</td>
<td>---------------</td>
<td>------------</td>
<td>----------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>Total Protein (g/dl)</td>
<td></td>
<td>4.50&lt;sup&gt;b&lt;/sup&gt; ±0.22</td>
<td>3.70&lt;sup&gt;b&lt;/sup&gt; ±0.94</td>
<td>5.17&lt;sup&gt;a&lt;/sup&gt; ±0.35</td>
<td>5.32&lt;sup&gt;a&lt;/sup&gt; ±0.07</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt; ±0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.51&lt;sup&gt;b&lt;/sup&gt; ±0.43</td>
<td>3.44&lt;sup&gt;b&lt;/sup&gt; ±0.19</td>
<td>5.22&lt;sup&gt;a&lt;/sup&gt; ±0.23</td>
<td>5.39&lt;sup&gt;a&lt;/sup&gt; ±0.13</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt; ±0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.40&lt;sup&gt;b&lt;/sup&gt; ±0.34</td>
<td>4.05&lt;sup&gt;b&lt;/sup&gt; ±0.62</td>
<td>5.12&lt;sup&gt;a&lt;/sup&gt; ±0.35</td>
<td>5.33&lt;sup&gt;a&lt;/sup&gt; ±0.41</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt; ±0.30</td>
</tr>
<tr>
<td>Blood Urea Nitrogen (mg/dl)</td>
<td></td>
<td>4.61&lt;sup&gt;b&lt;/sup&gt; ±1.02</td>
<td>3.71&lt;sup&gt;b&lt;/sup&gt; ±0.42</td>
<td>5.17&lt;sup&gt;a&lt;/sup&gt; ±0.73</td>
<td>5.25&lt;sup&gt;a&lt;/sup&gt; ±0.31</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt; ±0.30</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td></td>
<td>20.86&lt;sup&gt;a&lt;/sup&gt; ±1.94</td>
<td>22.38&lt;sup&gt;a&lt;/sup&gt; ±1.50</td>
<td>19.81&lt;sup&gt;b&lt;/sup&gt; ±1.49</td>
<td>18.30&lt;sup&gt;b&lt;/sup&gt; ±1.38</td>
<td>16.35&lt;sup&gt;b&lt;/sup&gt; ±0.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17.05 ±0.12</td>
<td>20.31 ±2.43</td>
<td>21.29 ±2.41</td>
<td>19.62 ±1.32</td>
<td>16.35 ±0.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30.12 ±1.32</td>
<td>24.16 ±0.41</td>
<td>19.65 ±0.24</td>
<td>17.41 ±0.31</td>
<td>16.35 ±0.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.91 ±0.24</td>
<td>22.14 ±1.31</td>
<td>18.22 ±1.21</td>
<td>18.42 ±1.02</td>
<td>16.35 ±0.45</td>
</tr>
<tr>
<td>Blood glucose (mg/dl)</td>
<td></td>
<td>1.54±0.24</td>
<td>0.99±0.18</td>
<td>0.97±0.10</td>
<td>0.96±0.20</td>
<td>1.08±0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.96±0.02</td>
<td>0.50±0.21</td>
<td>0.90±0.03</td>
<td>1.06±0.30</td>
<td>1.08±0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.49±0.10</td>
<td>1.42±0.13</td>
<td>1.10±0.05</td>
<td>0.93±0.07</td>
<td>1.08±0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.10±0.31</td>
<td>0.99±0.05</td>
<td>0.98±0.04</td>
<td>0.91±0.09</td>
<td>1.08±0.05</td>
</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett’s multiple comparison test, p<0.05)
Group T₃ (Clindamycin+Doxycycline)

In the group T₃, degree of parasitemia gradually reduced on day 10 and 20 post treatment in all the dogs. None of the dogs showed parasitemia on day 30 post treatment (Table 63).

Table 63: Degree of parasitemia at different intervals in group T₃

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatic Complications</td>
<td>1.</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>+++</td>
<td>++</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Renal Complications</td>
<td>1.</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Multiple Organ Dysfunction Syndrome</td>
<td>1.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>+++</td>
<td>++</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

In all the dogs clinical improvement was noticed on day 10 post treatment and on day 30 post treatment all the survivor dogs showed complete clinical recovery (Table 64).
Table 64: Clinical improvement at different intervals in group T<sub>3</sub>

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatic Complications</td>
<td>1.</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Renal Complications</td>
<td>1.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Multiple Organ Dysfunction Syndrome</td>
<td>1.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
</tbody>
</table>

The hematological estimations showed gradual increase in TEC, Hb, PCV and platelet count on day 10 and 20 post treatment, and on day 30 post treatment all the parameters returned to the normal range as compared with the control group (Table 65).
Table 65: Hematological parameters at different intervals in group T\textsubscript{3}

<table>
<thead>
<tr>
<th>Parameter</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Erythrocyte Count</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(millions/μl)</td>
<td>T\textsubscript{3}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>3.56\textsuperscript{c} ±0.54</td>
<td>3.71\textsuperscript{c} ±0.22</td>
<td>4.18\textsuperscript{b} ±0.85</td>
<td>5.39\textsuperscript{a} ±0.53</td>
<td>5.54\textsuperscript{a} ±0.39</td>
</tr>
<tr>
<td>2. Renal</td>
<td>3.67\textsuperscript{b} ±0.72</td>
<td>3.80\textsuperscript{b} ±0.41</td>
<td>5.01\textsuperscript{a} ±0.25</td>
<td>5.60\textsuperscript{a} ±0.45</td>
<td>5.54\textsuperscript{a} ±0.39</td>
</tr>
<tr>
<td>3. MODS</td>
<td>3.15\textsuperscript{c} ±0.64</td>
<td>3.63\textsuperscript{c} ±0.49</td>
<td>4.31\textsuperscript{b} ±0.24</td>
<td>5.47\textsuperscript{a} ±0.24</td>
<td>5.54\textsuperscript{a} ±0.39</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>T\textsubscript{3}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.07\textsuperscript{b} ±0.62</td>
<td>8.39\textsuperscript{b} ±0.09</td>
<td>10.11\textsuperscript{a} ±0.11</td>
<td>11.30\textsuperscript{a} ±0.18</td>
<td>11.82\textsuperscript{a} ±0.23</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>8.29\textsuperscript{b} ±0.35</td>
<td>8.67\textsuperscript{b} ±0.11</td>
<td>10.73\textsuperscript{b} ±0.24</td>
<td>11.60\textsuperscript{a} ±0.64</td>
<td>11.82\textsuperscript{a} ±0.23</td>
</tr>
<tr>
<td>2. Renal</td>
<td>8.10\textsuperscript{b} ±0.75</td>
<td>8.35\textsuperscript{b} ±0.23</td>
<td>10.21\textsuperscript{b} ±0.46</td>
<td>11.21\textsuperscript{a} ±0.12</td>
<td>11.82\textsuperscript{a} ±0.23</td>
</tr>
<tr>
<td>3. MODS</td>
<td>7.68\textsuperscript{b} ±0.82</td>
<td>8.01\textsuperscript{b} ±0.44</td>
<td>9.98\textsuperscript{a} ±0.12</td>
<td>11.02\textsuperscript{a} ±0.42</td>
<td>11.82\textsuperscript{a} ±0.23</td>
</tr>
<tr>
<td>Packed Cell Volume (%)</td>
<td>T\textsubscript{3}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.87\textsuperscript{b} ±2.34</td>
<td>31.60\textsuperscript{b} ±1.99</td>
<td>38.21\textsuperscript{b} ±0.37</td>
<td>40.24\textsuperscript{a} ±0.98</td>
<td>39.05\textsuperscript{a} ±0.12</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>25.23\textsuperscript{b} ±1.54</td>
<td>30.81\textsuperscript{b} ±0.73</td>
<td>37.32\textsuperscript{b} ±1.25</td>
<td>41.10\textsuperscript{a} ±1.93</td>
<td>39.05\textsuperscript{a} ±0.12</td>
</tr>
<tr>
<td>2. Renal</td>
<td>27.38\textsuperscript{b} ±2.18</td>
<td>32.19\textsuperscript{b} ±2.04</td>
<td>37.42\textsuperscript{b} ±0.75</td>
<td>39.69\textsuperscript{a} ±1.89</td>
<td>39.05\textsuperscript{a} ±0.12</td>
</tr>
<tr>
<td>3. MODS</td>
<td>23.21\textsuperscript{b} ±2.47</td>
<td>33.17\textsuperscript{b} ±1.72</td>
<td>39.43\textsuperscript{b} ±1.91</td>
<td>40.01\textsuperscript{a} ±0.94</td>
<td>39.05\textsuperscript{a} ±0.12</td>
</tr>
<tr>
<td>Platelet (thousands/μl)</td>
<td>T\textsubscript{3}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>69.31\textsuperscript{b} ±3.67</td>
<td>79.32\textsuperscript{b} ±4.76</td>
<td>125.88\textsuperscript{a} ±6.09</td>
<td>149.32\textsuperscript{a} ±3.46</td>
<td>144.96\textsuperscript{a} ±4.34</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>78.10\textsuperscript{b} ±3.87</td>
<td>85.78\textsuperscript{b} ±4.03</td>
<td>134.13\textsuperscript{a} ±3.39</td>
<td>148.27\textsuperscript{a} ±2.63</td>
<td>144.96\textsuperscript{a} ±4.34</td>
</tr>
<tr>
<td>2. Renal</td>
<td>68.78\textsuperscript{b} ±1.99</td>
<td>78.11\textsuperscript{b} ±4.57</td>
<td>124.67\textsuperscript{a} ±3.17</td>
<td>155.17\textsuperscript{a} ±3.29</td>
<td>144.96\textsuperscript{a} ±4.34</td>
</tr>
<tr>
<td>3. MODS</td>
<td>59.12\textsuperscript{b} ±5.17</td>
<td>67.79\textsuperscript{b} ±2.93</td>
<td>114.72\textsuperscript{a} ±3.20</td>
<td>137.32\textsuperscript{a} ±2.09</td>
<td>144.96\textsuperscript{a} ±4.34</td>
</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett’s multiple comparison test, p<0.05)
The biochemical estimations showed all the parameters returned to normal range on day 30 post treatment in the survivor dogs of the group as compared with the control group (Table 66).

**Table 66: Biochemical parameters at different intervals in group T₃**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alanine Transaminase (U/L)</strong></td>
<td>T₃</td>
<td>75.09 b</td>
<td>78.43 a</td>
<td>70.39 c</td>
<td>51.15 d</td>
<td>46.09 d</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±5.13</td>
<td>±2.65</td>
<td>±1.99</td>
<td>±2.52</td>
<td>±2.19</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>79.80 a</td>
<td>85.51 a</td>
<td>74.32 a</td>
<td>54.78 b</td>
<td>46.09 b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.94</td>
<td>±1.44</td>
<td>±1.09</td>
<td>±4.20</td>
<td>±2.19</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>48.23 b</td>
<td>56.42 a</td>
<td>49.47 b</td>
<td>48.32 b</td>
<td>46.09 b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.19</td>
<td>±3.39</td>
<td>±2.85</td>
<td>±2.11</td>
<td>±2.19</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>71.47 a</td>
<td>80.48 b</td>
<td>76.71 c</td>
<td>50.18 d</td>
<td>46.09 d</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±6.04</td>
<td>±2.81</td>
<td>±1.45</td>
<td>±1.84</td>
<td>±2.19</td>
</tr>
<tr>
<td><strong>Alkaline phosphatase (U/L)</strong></td>
<td>T₃</td>
<td>122.16 b</td>
<td>128.64 a</td>
<td>114.61 a</td>
<td>108.21 c</td>
<td>104.85 c</td>
</tr>
<tr>
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<td>±2.02</td>
<td>±3.25</td>
<td>±1.12</td>
<td>±0.73</td>
</tr>
<tr>
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<td>123.31 a</td>
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</tr>
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<td>104.13 a</td>
<td>103.86 b</td>
<td>104.85 b</td>
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<td>±0.73</td>
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<td></td>
<td>118.87 a</td>
<td>129.14 a</td>
<td>115.87 a</td>
<td>112.35 b</td>
<td>104.85 b</td>
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<td>±2.43</td>
<td>±4.13</td>
<td>±3.09</td>
<td>±0.73</td>
</tr>
<tr>
<td><strong>Creatine Kinase (U/L)</strong></td>
<td>T₃</td>
<td>103.29</td>
<td>104.83</td>
<td>108.31</td>
<td>103.28</td>
<td>100.16</td>
</tr>
<tr>
<td></td>
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<td>±3.57</td>
<td>±4.92</td>
<td>±3.94</td>
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<td>99.94</td>
<td>107.11</td>
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<td>±2.45</td>
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<td>111.63</td>
<td>105.40</td>
<td>103.19</td>
<td>100.16</td>
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<td>±4.24</td>
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<td>100.39</td>
<td>109.11</td>
<td>106.53</td>
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</tr>
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<td>±1.13</td>
<td>±3.14</td>
<td>±4.03</td>
<td>±4.24</td>
</tr>
<tr>
<td><strong>Bilirubin-Total (mg/dl)</strong></td>
<td>T₃</td>
<td>1.35 a</td>
<td>1.23 a</td>
<td>0.67 b</td>
<td>0.58 b</td>
<td>0.55 b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.52</td>
<td>±0.46</td>
<td>±0.63</td>
<td>±0.13</td>
<td>±0.09</td>
</tr>
<tr>
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<td>1.48 a</td>
<td>1.24 a</td>
<td>0.63 b</td>
<td>0.57 b</td>
<td>0.55 b</td>
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<tr>
<td></td>
<td></td>
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<td>±0.20</td>
<td>±0.15</td>
<td>±0.11</td>
<td>±0.09</td>
</tr>
<tr>
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<td>0.87 b</td>
<td>0.65 b</td>
<td>0.55 b</td>
<td>0.56 b</td>
<td>0.55 b</td>
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<td></td>
<td>±0.16</td>
<td>±0.11</td>
<td>±0.14</td>
<td>±0.09</td>
<td>±0.09</td>
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<tr>
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<td>Total Protein (g/dl)</td>
<td>Blood Urea Nitrogen (mg/dl)</td>
<td>Creatinine (mg/dl)</td>
<td>Blood glucose (mg/dl)</td>
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<tr>
<td>----------------</td>
<td>----------------------</td>
<td>-----------------------------</td>
<td>-------------------</td>
<td>----------------------</td>
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<tr>
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<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. MODS</td>
<td>1.67&lt;sup&gt;a&lt;/sup&gt; ±0.96</td>
<td>4.59&lt;sup&gt;b&lt;/sup&gt; ±0.21</td>
<td>1.79&lt;sup&gt;a&lt;/sup&gt; ±0.09</td>
<td>65.34&lt;sup&gt;b&lt;/sup&gt; ±1.31</td>
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</tr>
<tr>
<td></td>
<td>1.35&lt;sup&gt;a&lt;/sup&gt; ±0.13</td>
<td>4.52&lt;sup&gt;b&lt;/sup&gt; ±0.37</td>
<td>1.32&lt;sup&gt;b&lt;/sup&gt; ±0.12</td>
<td>82.45&lt;sup&gt;a&lt;/sup&gt; ±1.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.72&lt;sup&gt;b&lt;/sup&gt; ±0.30</td>
<td>5.29&lt;sup&gt;a&lt;/sup&gt; ±0.51</td>
<td>1.01&lt;sup&gt;b&lt;/sup&gt; ±0.11</td>
<td>84.10&lt;sup&gt;a&lt;/sup&gt; ±1.51</td>
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<td>0.59&lt;sup&gt;b&lt;/sup&gt; ±0.17</td>
<td>5.39&lt;sup&gt;a&lt;/sup&gt; ±0.16</td>
<td>0.95&lt;sup&gt;b&lt;/sup&gt; ±0.15</td>
<td>85.99&lt;sup&gt;a&lt;/sup&gt; ±1.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.55&lt;sup&gt;b&lt;/sup&gt; ±0.09</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt; ±0.30</td>
<td>1.08&lt;sup&gt;b&lt;/sup&gt; ±0.05</td>
<td>86.43&lt;sup&gt;a&lt;/sup&gt; ±2.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>4.34&lt;sup&gt;b&lt;/sup&gt; ±0.46</td>
<td>4.01&lt;sup&gt;b&lt;/sup&gt; ±0.91</td>
<td>1.08 ±0.17</td>
<td>63.21&lt;sup&gt;b&lt;/sup&gt; ±1.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.01&lt;sup&gt;b&lt;/sup&gt; ±0.91</td>
<td>5.19&lt;sup&gt;a&lt;/sup&gt; ±0.16</td>
<td>0.92 ±0.19</td>
<td>82.33&lt;sup&gt;a&lt;/sup&gt; ±1.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.01&lt;sup&gt;b&lt;/sup&gt; ±0.91</td>
<td>5.34&lt;sup&gt;a&lt;/sup&gt; ±0.49</td>
<td>0.99 ±0.16</td>
<td>84.21&lt;sup&gt;a&lt;/sup&gt; ±1.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.01&lt;sup&gt;b&lt;/sup&gt; ±0.91</td>
<td>5.45&lt;sup&gt;a&lt;/sup&gt; ±0.70</td>
<td>1.03 ±0.11</td>
<td>86.04&lt;sup&gt;a&lt;/sup&gt; ±3.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Renal</td>
<td>5.01&lt;sup&gt;b&lt;/sup&gt; ±0.37</td>
<td>4.95&lt;sup&gt;b&lt;/sup&gt; ±0.89</td>
<td>1.07 ±0.06</td>
<td>69.38&lt;sup&gt;b&lt;/sup&gt; ±0.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.95&lt;sup&gt;b&lt;/sup&gt; ±0.89</td>
<td>5.34&lt;sup&gt;a&lt;/sup&gt; ±0.74</td>
<td>1.07 ±0.02</td>
<td>86.94&lt;sup&gt;a&lt;/sup&gt; ±1.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.95&lt;sup&gt;b&lt;/sup&gt; ±0.89</td>
<td>5.45&lt;sup&gt;a&lt;/sup&gt; ±0.70</td>
<td>1.08 ±0.05</td>
<td>83.43&lt;sup&gt;a&lt;/sup&gt; ±2.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. MODS</td>
<td>4.29&lt;sup&gt;b&lt;/sup&gt; ±1.20</td>
<td>4.08&lt;sup&gt;b&lt;/sup&gt; ±1.07</td>
<td>1.03 ±0.02</td>
<td>64.98&lt;sup&gt;b&lt;/sup&gt; ±0.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.08&lt;sup&gt;b&lt;/sup&gt; ±1.07</td>
<td>5.22&lt;sup&gt;a&lt;/sup&gt; ±0.73</td>
<td>0.91 ±0.24</td>
<td>83.93&lt;sup&gt;a&lt;/sup&gt; ±1.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.08&lt;sup&gt;b&lt;/sup&gt; ±1.07</td>
<td>5.38&lt;sup&gt;a&lt;/sup&gt; ±0.19</td>
<td>1.08 ±0.05</td>
<td>82.94&lt;sup&gt;a&lt;/sup&gt; ±1.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.08&lt;sup&gt;b&lt;/sup&gt; ±1.07</td>
<td>5.48&lt;sup&gt;a&lt;/sup&gt; ±0.30</td>
<td></td>
<td>87.49&lt;sup&gt;a&lt;/sup&gt; ±1.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.08&lt;sup&gt;b&lt;/sup&gt; ±1.07</td>
<td></td>
<td></td>
<td>86.43&lt;sup&gt;a&lt;/sup&gt; ±2.62</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett’s multiple comparison test, p<0.05)
Group T₄ (Enrofloxacin+Doxycycline)

In the group T₄, 1 out of 12 dogs died during the treatment; however, in the remaining 11 dogs degree of parasitemia reduced on day 10 and 20 post treatment. None of the dogs showed parasitemia on day 30 post treatment (Table 67).

**Table 67: Degree of parasitemia at different intervals in group T₄**

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatic Complications</td>
<td>1.</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Renal Complications</td>
<td>1.</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Multiple Organ Dysfunction Syndrome</td>
<td>1.</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td>+++</td>
<td>Died</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In 11 dogs clinical improvement was noticed on day 10 post treatment and on day 30 post treatment all the survivor dogs showed complete clinical recovery (Table 68).
Table 68: Clinical improvement at different intervals in group T₄

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatic Complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
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</tr>
<tr>
<td>Renal Complications</td>
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</tr>
<tr>
<td>1.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
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</tr>
<tr>
<td>Multiple Organ Dysfunction Syndrome</td>
<td>1.</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>2.</td>
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<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Died</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The hematological estimations showed gradual increase in TEC, Hb, PCV and platelet count on day 10 and 20 post treatment, and on day 30 post treatment all the parameters returned to the normal range as compared with the control group (Table 69).
Table 69: Hematological parameters at different intervals in group T₄

<table>
<thead>
<tr>
<th>Parameter</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Erythrocyte Count (millions/µl)</td>
<td>T₄</td>
<td>3.51ᵇ</td>
<td>3.55ᵇ</td>
<td>4.56ᵃ</td>
<td>5.45ᵃ</td>
</tr>
<tr>
<td></td>
<td>±0.12</td>
<td>±0.31</td>
<td>±0.60</td>
<td>±0.12</td>
<td>±0.39</td>
</tr>
<tr>
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<td>3.09ᵇ</td>
<td>3.22ᵇ</td>
<td>4.99ᵃ</td>
<td>5.49ᵃ</td>
</tr>
<tr>
<td></td>
<td>±0.28</td>
<td>±0.37</td>
<td>±0.31</td>
<td>±0.10</td>
<td>±0.39</td>
</tr>
<tr>
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<td>3.63ᵇ</td>
<td>3.59ᵇ</td>
<td>4.76ᵃ</td>
<td>5.43ᵃ</td>
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<tr>
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<td>±0.17</td>
<td>±0.18</td>
<td>±0.39</td>
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<td>3. MODS</td>
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<td>3.72ᵇ</td>
<td>4.47ᵃ</td>
<td>5.47ᵃ</td>
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<tr>
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<td>±0.13</td>
<td>±0.59</td>
<td>±0.23</td>
<td>±0.70</td>
<td>±0.39</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>T₄</td>
<td>7.99ᵇ</td>
<td>9.18ᵇ</td>
<td>10.42ᵃ</td>
<td>11.76ᵃ</td>
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<tr>
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<td>±0.22</td>
<td>±0.16</td>
<td>±0.30</td>
<td>±0.11</td>
<td>±0.23</td>
</tr>
<tr>
<td></td>
<td>1. Hepatic</td>
<td>8.40ᵇ</td>
<td>9.57ᵇ</td>
<td>9.92ᵇ</td>
<td>11.08ᵃ</td>
</tr>
<tr>
<td></td>
<td>±0.21</td>
<td>±0.36</td>
<td>±0.24</td>
<td>±0.40</td>
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<td>8.95ᵇ</td>
<td>10.88ᵃ</td>
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<td>±0.47</td>
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<td>±0.71</td>
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<td></td>
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<td>8.15ᵇ</td>
<td>9.45ᵇ</td>
<td>10.27ᵃ</td>
<td>11.71ᵃ</td>
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<td>±0.32</td>
<td>±0.55</td>
<td>±0.23</td>
</tr>
<tr>
<td>Packed Cell Volume (%)</td>
<td>T₄</td>
<td>26.59ᵇ</td>
<td>31.97ᵇ</td>
<td>38.18ᵃ</td>
<td>39.80ᵃ</td>
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<td></td>
<td>±0.75</td>
<td>±2.08</td>
<td>±0.61</td>
<td>±0.36</td>
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<tr>
<td></td>
<td>1. Hepatic</td>
<td>26.03ᵇ</td>
<td>30.12ᵇ</td>
<td>35.27ᵇ</td>
<td>38.06ᵃ</td>
</tr>
<tr>
<td></td>
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<td>±0.39</td>
<td>±0.98</td>
<td>±1.01</td>
<td>±0.12</td>
</tr>
<tr>
<td></td>
<td>2. Renal</td>
<td>26.34ᵇ</td>
<td>29.43ᵇ</td>
<td>34.78ᵇ</td>
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<td>±0.56</td>
<td>±0.38</td>
<td>±0.12</td>
</tr>
<tr>
<td>Platelet (thousands/µl)</td>
<td>T₄</td>
<td>66.51ᵇ</td>
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<td>139.98ᵃ</td>
</tr>
<tr>
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<td>±3.91</td>
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<td>89.75ᵇ</td>
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<td>±3.46</td>
<td>±3.01</td>
<td>±4.34</td>
</tr>
<tr>
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<td>74.53ᵇ</td>
<td>122.82ᵃ</td>
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<td>±3.43</td>
<td>±2.94</td>
<td>±2.92</td>
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<td>3. MODS</td>
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<td>127.38ᵃ</td>
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<td>±1.79</td>
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</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett’s multiple comparison test, p<0.05)
The biochemical estimations showed all the parameters returned to normal range on day 30 post treatment in the survivor dogs of the group as compared with the control group (Table 70).

Table 70: Biochemical parameters at different intervals in group T₄

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alanine Transaminase (U/L)</td>
<td>T₄</td>
<td>71.29ᵇ</td>
<td>74.16ᵇ</td>
<td>69.83ᶜ</td>
<td>53.11ᵈ</td>
<td>46.09ᵈ</td>
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<td></td>
<td>±7.23</td>
<td>±1.52</td>
<td>±2.11</td>
<td>±1.92</td>
<td>±2.19</td>
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<td>78.70ᵃ</td>
<td>74.40ᵃ</td>
<td>56.56ᵇ</td>
<td>46.09ᵇ</td>
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<tr>
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<td></td>
<td>±4.98</td>
<td>±3.31</td>
<td>±3.20</td>
<td>±2.25</td>
<td>±2.19</td>
</tr>
<tr>
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<td>67.00ᵇ</td>
<td>51.75ᵇ</td>
<td>47.13ᵇ</td>
<td>46.09ᵇ</td>
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<tr>
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<td>±0.90</td>
<td>±1.17</td>
<td>±1.05</td>
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<td>78.28ᵇ</td>
<td>68.49ᶜ</td>
<td>57.13ᵈ</td>
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<td>±3.33</td>
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<td>±3.11</td>
<td>±2.19</td>
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<td>103.93ᶜ</td>
<td>104.85ᶜ</td>
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<td>±1.78</td>
<td>±1.99</td>
<td>±1.98</td>
<td>±0.73</td>
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<td>140.88ᵃ</td>
<td>142.57ᵃ</td>
<td>104.56ᵇ</td>
<td>104.85ᵇ</td>
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<td>±1.70</td>
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<td>±0.73</td>
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<td>128.03ᵇ</td>
<td>126.95ᵇ</td>
<td>100.72ᵇ</td>
<td>104.85ᵇ</td>
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<td>±2.53</td>
<td>±3.86</td>
<td>±2.32</td>
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<td>143.36ᵃ</td>
<td>110.46ᵇ</td>
<td>104.85ᵇ</td>
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<td>±2.50</td>
<td>±4.99</td>
<td>±0.73</td>
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<tr>
<td>Creatine Kinase (U/L)</td>
<td>T₄</td>
<td>105.31ᵇ</td>
<td>107.23ᵇ</td>
<td>100.72ᵇ</td>
<td>102.76ᵇ</td>
<td>100.16ᵇ</td>
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<td>±2.76</td>
<td>±1.98</td>
<td>±1.19</td>
<td>±4.24</td>
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<td>104.72ᵇ</td>
<td>108.45ᵇ</td>
<td>101.93ᵇ</td>
<td>103.71ᶜ</td>
<td>100.16ᵇ</td>
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<td>±2.73</td>
<td>±2.34</td>
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<td>103.16ᵇ</td>
<td>104.69ᵇ</td>
<td>101.86ᵇ</td>
<td>100.16ᵇ</td>
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<td>±2.95</td>
<td>±3.45</td>
<td>±2.61</td>
<td>±4.24</td>
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<td>111.29ᵇ</td>
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<td>107.33ᵇ</td>
<td>100.16ᵇ</td>
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<td>±2.82</td>
<td>±2.39</td>
<td>±4.10</td>
<td>±4.24</td>
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<td>Bilirubin-Total (mg/dl)</td>
<td>T₄</td>
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<td>1.23ᵃ</td>
<td>0.56ᵇ</td>
<td>0.57ᵇ</td>
<td>0.55ᵇ</td>
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<td>±0.09</td>
<td>±0.04</td>
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<td>1.53ᵇ</td>
<td>1.44ᵇ</td>
<td>0.52ᵇ</td>
<td>0.47ᵇ</td>
<td>0.55ᵇ</td>
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<td>±0.25</td>
<td>±0.20</td>
<td>±0.05</td>
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<td>0.59ᵇ</td>
<td>0.55ᵇ</td>
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<td>±0.05</td>
<td>±0.07</td>
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<tr>
<td>Total Protein (g/dl)</td>
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<td>5.48±0.30</td>
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<td>1. Hepatic</td>
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<td>4.94±0.93</td>
<td>3.45±1.02</td>
<td>5.02±0.93</td>
<td>5.43±0.50</td>
<td>5.48±0.30</td>
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<td>4.51±1.51</td>
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<td>5.48±0.30</td>
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<tr>
<td>Blood Urea Nitrogen (mg/dl)</td>
<td>21.95±1.78</td>
<td>22.86±1.71</td>
<td>18.98±3.37</td>
<td>17.42±1.27</td>
<td>16.35±0.45</td>
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</tr>
<tr>
<td>T4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>16.95±0.25</td>
<td>19.19±3.03</td>
<td>20.64±3.37</td>
<td>20.36±3.61</td>
<td>16.35±0.45</td>
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<td>2. Renal</td>
<td>29.20±2.46</td>
<td>26.56±0.51</td>
<td>19.55±0.67</td>
<td>16.40±0.50</td>
<td>16.35±0.45</td>
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<td>3. MODS</td>
<td>16.42±0.49</td>
<td>20.01±3.41</td>
<td>19.34±4.03</td>
<td>18.78±4.14</td>
<td>16.35±0.45</td>
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<td>Creatinine (mg/dl)</td>
<td>1.68±0.42</td>
<td>1.09±0.08</td>
<td>0.99±0.11</td>
<td>1.05±0.31</td>
<td>1.08±0.05</td>
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<td>T4</td>
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<td></td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>0.95±0.08</td>
<td>0.84±0.04</td>
<td>0.89±0.06</td>
<td>1.01±0.23</td>
<td>1.08±0.05</td>
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<td>2.58±0.27</td>
<td>1.51±0.23</td>
<td>1.02±0.10</td>
<td>0.99±0.04</td>
<td>1.08±0.05</td>
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<td>3. MODS</td>
<td>1.38±0.20</td>
<td>0.96±0.09</td>
<td>1.09±0.08</td>
<td>0.94±0.10</td>
<td>1.08±0.05</td>
<td></td>
</tr>
<tr>
<td>Blood glucose (mg/dl)</td>
<td>63.97±2.13</td>
<td>81.97±1.99</td>
<td>86.36±3.09</td>
<td>87.13±2.10</td>
<td>86.43±2.62</td>
<td></td>
</tr>
<tr>
<td>T4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>64.93±3.76</td>
<td>80.27±2.25</td>
<td>86.11±1.04</td>
<td>84.75±3.61</td>
<td>86.43±2.62</td>
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</tr>
<tr>
<td>2. Renal</td>
<td>68.81±4.36</td>
<td>80.81±1.79</td>
<td>86.23±3.27</td>
<td>84.91±1.15</td>
<td>86.43±2.62</td>
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</tr>
<tr>
<td>3. MODS</td>
<td>58.17±0.49</td>
<td>84.70±1.18</td>
<td>86.36±2.32</td>
<td>88.29±1.97</td>
<td>86.43±2.62</td>
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</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett’s multiple comparison test, p<0.05)
Group T₅ (Metronidazole+Doxycycline)

In the group T₅, 1 out of 12 dogs died during the treatment; however, in the remaining 11 survivor dogs degree of parasitemia reduced on day 10 and 20 post treatment. None of the dogs showed parasitemia on day 30 post treatment (Table 71).

Table 71: Degree of parasitemia at different intervals in group T₅

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
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<tbody>
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<td></td>
<td></td>
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</tr>
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<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>2.</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>4.</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Renal Complications</td>
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<td></td>
</tr>
<tr>
<td>1.</td>
<td>++</td>
<td>-</td>
<td>-</td>
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<tr>
<td>2.</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>-</td>
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<tr>
<td>3.</td>
<td>++</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>++</td>
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<td>-</td>
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<td>Multiple Organ Dysfunction Syndrome</td>
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<td>++</td>
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<td>+</td>
<td>-</td>
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<tr>
<td>2.</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>++</td>
<td>Died</td>
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</tr>
</tbody>
</table>

In 11 dogs clinical improvement was noticed on day 10 post treatment and on day 30 post treatment all the survivor dogs showed complete clinical recovery (Table 72).
Table 72: Clinical improvement at different intervals in group T₅

<table>
<thead>
<tr>
<th>Complications</th>
<th>Animal</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
</tr>
</thead>
<tbody>
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<td>Hepatic Complications</td>
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<td>+++</td>
<td>+++</td>
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<td>2.</td>
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<td>Renal Complications</td>
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</tr>
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</tr>
<tr>
<td>2.</td>
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<tr>
<td>3.</td>
<td>++</td>
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<tr>
<td>4.</td>
<td>+</td>
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<tr>
<td>Multiple Organ Dysfunction Syndrome</td>
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<tr>
<td>1.</td>
<td>+</td>
<td>++</td>
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<td>++</td>
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<td>4.</td>
<td>Died</td>
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</tbody>
</table>

The hematological estimations showed gradual increase in TEC, Hb, PCV and platelet count on day 10 and 20 post treatment, and on day 30 post treatment all the parameters returned to the normal range as compared with the control group (Table 73).
**Table 73: Hematological parameters at different intervals in group T5**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Erythrocyte Count (millions/µl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>3.37b ±0.24</td>
<td>3.48b ±0.19</td>
<td>4.69a ±0.09</td>
<td>5.38a ±0.29</td>
<td>5.54a ±0.39</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>3.52b ±0.09</td>
<td>3.66b ±0.26</td>
<td>4.82a ±0.15</td>
<td>5.06a ±0.27</td>
<td>5.54a ±0.39</td>
</tr>
<tr>
<td>2. Renal</td>
<td>3.23b ±0.38</td>
<td>3.38b ±0.67</td>
<td>4.67a ±0.16</td>
<td>5.55a ±0.31</td>
<td>5.54a ±0.39</td>
</tr>
<tr>
<td>3. MODS</td>
<td>3.49b ±0.17</td>
<td>3.57b ±0.19</td>
<td>4.43a ±0.26</td>
<td>5.46a ±0.73</td>
<td>5.54a ±0.39</td>
</tr>
<tr>
<td><strong>Hemoglobin (g/dl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>8.10b ±0.31</td>
<td>9.10b ±0.40</td>
<td>10.89a ±0.01</td>
<td>11.73a ±0.61</td>
<td>11.82a ±0.23</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>8.19b ±0.68</td>
<td>9.28b ±0.16</td>
<td>10.90b ±0.31</td>
<td>11.72a ±0.68</td>
<td>11.82a ±0.23</td>
</tr>
<tr>
<td>2. Renal</td>
<td>8.35b ±0.43</td>
<td>9.06b ±0.36</td>
<td>10.81a ±0.98</td>
<td>11.75a ±0.26</td>
<td>11.82a ±0.23</td>
</tr>
<tr>
<td>3. MODS</td>
<td>7.96b ±0.23</td>
<td>8.95b ±0.19</td>
<td>10.88a ±0.28</td>
<td>11.68a ±0.33</td>
<td>11.82a ±0.23</td>
</tr>
<tr>
<td><strong>Packed Cell Volume (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>28.96b ±0.29</td>
<td>33.68b ±2.31</td>
<td>39.34a ±0.87</td>
<td>39.12a ±0.43</td>
<td>39.05a ±0.12</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>27.29b ±0.48</td>
<td>31.25b ±1.64</td>
<td>40.29a ±0.96</td>
<td>39.43b ±1.45</td>
<td>39.05a ±0.12</td>
</tr>
<tr>
<td>2. Renal</td>
<td>29.11b ±1.05</td>
<td>32.48b ±0.97</td>
<td>38.12a ±2.54</td>
<td>38.11a ±2.01</td>
<td>39.05a ±0.12</td>
</tr>
<tr>
<td>3. MODS</td>
<td>28.36b ±2.63</td>
<td>35.06b ±2.02</td>
<td>38.96a ±1.76</td>
<td>39.26a ±1.40</td>
<td>39.05a ±0.12</td>
</tr>
<tr>
<td><strong>Platelet (thousands/µl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>68.14b ±3.14</td>
<td>74.12b ±1.73</td>
<td>124.14a ±2.98</td>
<td>138.13a ±1.34</td>
<td>144.96a ±4.34</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td>72.16b ±4.17</td>
<td>84.06b ±3.19</td>
<td>117.43a ±1.65</td>
<td>140.64b ±2.78</td>
<td>144.96a ±4.34</td>
</tr>
<tr>
<td>2. Renal</td>
<td>70.27b ±3.96</td>
<td>72.63b ±1.73</td>
<td>124.71a ±2.85</td>
<td>143.14b ±3.07</td>
<td>144.96a ±4.34</td>
</tr>
<tr>
<td>3. MODS</td>
<td>61.38b ±5.05</td>
<td>71.35b ±2.95</td>
<td>128.95a ±3.77</td>
<td>134.60a ±4.07</td>
<td>144.96a ±4.34</td>
</tr>
</tbody>
</table>

Different superscripts in a row indicate a significant difference (Dunnett’s multiple comparison test, p<0.05)
The biochemical estimations showed all the parameters returned to normal range on day 30 post treatment in the survivor dogs of the group as compared with the control group (Table 74).

Table 74: Biochemical parameters at different intervals in group T₅

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>0 Day</th>
<th>10 Day</th>
<th>20 Day</th>
<th>30 Day</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alanine Transaminase (U/L)</strong></td>
<td>T₅</td>
<td>74.01ᵇ ±5.13</td>
<td>73.06ᵃ ±1.98</td>
<td>62.74ᵇ ±2.19</td>
<td>51.92ᶜ ±0.89</td>
<td>46.09ᵇ ±2.19</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>76.29ᵃ ±3.41</td>
<td>79.39ᵇ ±2.49</td>
<td>68.11ᵃ ±1.98</td>
<td>58.92ᵇ ±1.65</td>
<td>46.09ᵇ ±2.19</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>47.84ᵇ ±2.10</td>
<td>53.16ᵃ ±0.93</td>
<td>49.24ᵇ ±0.98</td>
<td>44.28ᵇ ±1.04</td>
<td>46.09ᵇ ±2.19</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>99.41ᵃ ±1.54</td>
<td>97.28ᵇ ±2.01</td>
<td>64.29ᶜ ±1.94</td>
<td>52.72ᵈ ±2.12</td>
<td>46.09ᵈ ±2.19</td>
</tr>
<tr>
<td><strong>Alkaline phosphatase (U/L)</strong></td>
<td>T₅</td>
<td>119.87ᵇ ±5.15</td>
<td>129.11ᵃ ±2.07</td>
<td>116.43ᵇ ±1.98</td>
<td>106.19ᶜ ±1.43</td>
<td>104.85ᶜ ±0.73</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>141.93ᵃ ±2.01</td>
<td>132.75ᵇ ±2.97</td>
<td>129.44ᵃ ±2.04</td>
<td>109.24ᵇ ±3.72</td>
<td>104.85ᵇ ±0.73</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>100.81ᵇ ±5.08</td>
<td>126.38ᵃ ±1.98</td>
<td>104.27ᵇ ±2.15</td>
<td>103.41ᵇ ±1.95</td>
<td>104.85ᵇ ±0.73</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>121.34ᵃ ±1.07</td>
<td>129.38ᵇ ±3.02</td>
<td>118.38ᵃ ±3.96</td>
<td>107.15ᵇ ±2.75</td>
<td>104.85ᵇ ±0.73</td>
</tr>
<tr>
<td><strong>Creatine Kinase (U/L)</strong></td>
<td>T₅</td>
<td>102.19 ±1.87</td>
<td>104.32 ±1.34</td>
<td>102.47 ±1.09</td>
<td>103.18 ±1.73</td>
<td>100.16 ±4.24</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>103.28 ±1.43</td>
<td>102.94 ±0.93</td>
<td>102.06 ±1.43</td>
<td>101.09 ±2.37</td>
<td>100.16 ±4.24</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>100.32 ±1.95</td>
<td>102.64 ±0.38</td>
<td>104.32 ±2.31</td>
<td>103.51 ±1.95</td>
<td>100.16 ±4.24</td>
</tr>
<tr>
<td>3. MODS</td>
<td></td>
<td>102.09 ±3.21</td>
<td>106.04 ±3.65</td>
<td>100.14 ±1.04</td>
<td>105.22 ±3.45</td>
<td>100.16 ±4.24</td>
</tr>
<tr>
<td><strong>Bilirubin-Total (mg/dl)</strong></td>
<td>T₅</td>
<td>1.39ᵃ ±0.23</td>
<td>1.02ᵃ ±0.11</td>
<td>0.55ᵇ ±0.13</td>
<td>0.56ᵇ ±0.09</td>
<td>0.55ᵇ ±0.09</td>
</tr>
<tr>
<td>1. Hepatic</td>
<td></td>
<td>1.52ᵃ ±0.19</td>
<td>1.24ᵃ ±0.20</td>
<td>0.58ᵇ ±0.13</td>
<td>0.54ᵇ ±0.15</td>
<td>0.55ᵇ ±0.09</td>
</tr>
<tr>
<td>2. Renal</td>
<td></td>
<td>0.56 ±0.11</td>
<td>0.55 ±0.09</td>
<td>0.55 ±0.28</td>
<td>0.58 ±0.10</td>
<td>0.55ᵇ ±0.09</td>
</tr>
</tbody>
</table>
### Table 1: Hemodynamic and Metabolic Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T&lt;sub&gt;5&lt;/sub&gt;</th>
<th>1. Hepatic</th>
<th>2. Renal</th>
<th>3. MODS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Protein (g/dl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.63&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.91&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.27&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.42&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>±0.26</td>
<td>±0.41</td>
<td>±0.45</td>
<td>±0.13</td>
</tr>
<tr>
<td><strong>Blood Urea Nitrogen (mg/dl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.92&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16.39&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>±2.76</td>
<td>±2.01</td>
<td>±3.01</td>
<td>±2.75</td>
</tr>
<tr>
<td><strong>Creatinine (mg/dl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.71&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.98&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.99&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.09&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>±0.36</td>
<td>±0.23</td>
<td>±0.11</td>
<td>±0.08</td>
</tr>
<tr>
<td><strong>Blood glucose (mg/dl)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>65.19&lt;sup&gt;b&lt;/sup&gt;</td>
<td>83.72&lt;sup&gt;a&lt;/sup&gt;</td>
<td>87.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>85.74&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>±3.21</td>
<td>±2.51</td>
<td>±2.63</td>
<td>±1.98</td>
</tr>
<tr>
<td><strong>Different superscripts in a row indicate a significant difference (Dunnett’s multiple comparison test, p&lt;0.05)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. DISCUSSION

Babesiosis is a hemotropic protozoa infection caused by tick transmitted apicomplexan parasites of *Babesia* species. Newly recognised babesia with zoonotic potential continues to emerge around the world and the substantial economic impact of babesiosis on livestock and companion animals especially in the tropics and subtropics is ongoing. *Babesia* are ubiquitous parasites with a worldwide distribution. The parasites are transmitted to dogs by a wide variety of Ixodid ticks. Infections from blood transfusions, transplacental transmission, and direct transmissions through bite wounds have also been reported. The present study was planned to study the epidemiological pattern of prevalent hemoprotozoa of dogs in and around Jabalpur, to study the prognostic values of various hematobiochemical alterations in uncomplicated and complicated babesiosis in dogs and to evaluate the comparative therapeutic efficacy of different anti-babesial drugs in dogs.

A total of 1680 dogs brought to the OPD Medicine (TVCC, College of Veterinary Science & A.H., Jabalpur), State Veterinary Hospital (Omti, Jabalpur), and private clinics of Jabalpur were examined during November 2012 to October 2013. After confirmation of *Babesia* sp. infection by microscopic examination of blood smear stained with Leishman’s stain, dogs were selected for the study. Age, sex, breed, history and clinical signs of each dog were recorded. Hemato-biochemical estimation was conducted on day 0 pre treatment and 10, 20 and 30 days post treatment in the affected dogs, and also in the control group of animals. To assess the therapeutic efficacy of drugs, 60 dogs having complicated babesiosis were divided into 5 groups (T<sub>1</sub>–T<sub>5</sub>). Each treatment group comprised of twelve animals of which 4 were of hepatic complications, 4 of renal complications and 4 showing multiple organ dysfunction syndrome. The dogs in the groups T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> were treated with diminazene aceturate (5 mg/kg, IM), doxycycline (10 mg/kg, PO, BID) X 21 days, clindamycin (25 mg/kg, PO, BID) + doxycycline (10 mg/kg, PO, BID) X 21 days, enrofloxacin (2 mg/kg, PO, BID) + doxycycline (10 mg/kg, PO, BID) X 21 days and metronidazole (10 mg/kg, PO, BID) + doxycycline (10 mg/kg, PO, BID) X 21 days, respectively.
In the present investigation the overall prevalence of hemoprotezoa during November 2012 to October 2013 was 10.60 per cent. Similar findings were reported by Vatsya et al. (2010), Jumde et al. (2011) and Singh et al. (2012) who reported 8.19, 12.60 and 10.21 per cent incidence of hemoprotezoa in Pantnagar, Nagpur and Mathura, respectively. A relatively higher prevalence (57.31%) was reported at Guwahati by Bhattacharjee and Samrah (2013). The prevalence of Babesia sp. in Jabalpur was 10.48 per cent; earlier workers (Jumde et al., 2011 and Singh et al., 2012) have also described similar findings. In this study Hepatozoon canis was reported in 0.12 per cent of the dogs; a higher prevalence (1.08% and 1.41%) was reported by Singh et al. (2012) and Bhattacharjee and Samrah (2013). The month wise prevalence study of Babesia sp. revealed highest prevalence (18.18%) in the month of August 2013 followed by 16.67 per cent in July 2013 and 13.67 per cent in June 2013. Earlier Nalubamba et al. (2011) and Sharma et al. (2011) have reported similar findings in rainy season at Zambia and Mathura, respectively. Thuo et al., (2014) reported a high incidence of babesiosis in wet season and stated that warm and humid season played a key role in the occurrence and spread of the disease. The prevalence differences at various places are attributed to the presence of favourable climate for the vectors, activity of ectoparasites, and maintenance of dogs in hygienic and tick free place.

The age wise prevalence of babesiosis revealed highest prevalence (13.27%) in the 1-3 years age group, followed by 12.94 per cent prevalence in dogs of 5-7 years age and 12.92 per cent prevalence in 7-9 years age group; However, lower prevalence was reported in the dogs of <1 year age (7.32%). This observation was in accordance with the findings of Gadahi et al. (2008) in Hyderabad, Kumar et al. (2009) in Chennai and Jalali et al. (2013) in Iran, who reported higher prevalence in adults; whereas, Rodrigues et al. (2002) at Minas Gerais, Brazil, Bashir et al. (2009) in Lahore and Nalubamba et al. (2011) in Zambia reported higher prevalence in pups. Bashir et al. (2009) stated that babesiosis can infect dogs of all ages, although most infected dogs are less than three years old. On the other hand, the older dogs are also prone to babesia infection and are predisposed for
babesial complications. In protozoan infections, most of the neonates of chronically infected mothers show a high degree of immunity to the homologous parasites compared to those born of normal mothers (Palmer, 1978). Shitta and James-Rugu (2013) reported higher prevalence of babesiosis in young dogs associated with the fact that young dogs are agile and move about indiscriminately where they come in contact with the tick vector of *B. canis*. Another possible reason was found to be the habit of playing on the grasses around by the young animals where they pick up a waiting tick ready to attach itself to a scavenging host.

The sex wise prevalence study revealed 14.77 per cent prevalence in females as compared with 7.38 per cent in males. Thus the female dogs had two times higher risk of babesiosis as compared to male dogs. The finding is in accordance with Gadahi *et al.* (2008) in Hyderabad and Konto *et al.* (2014); However, Bashir *et al.* (2009) in Lahore reported higher prevalence in males as compared to females. Kumar *et al.* (2009) in Chennai reported non significant difference amongst sex. This spread of transmission might be due to the fact that female dogs usually form a sedentary habit while nursing their offspring; as a result, they easily get infested by ticks (Konto *et al.*, 2014). Moreover, periodical stress during pregnancy, poor health status and immunity during pregnancy and lactation may contribute to the development of the disease.

During the study the maximum prevalence was noticed in German Shepherd breed *i.e.* 15.47% per cent followed by Samoyed, Pug, Non-descript and Spitz dogs in which prevalence was found to be 15.25, 12.50, 10.94 and 10.13 percent, respectively. Kumar *et al.* (2009) in Chennai reported a higher incidence of babesiosis in hairy breed dogs, which may be due to more tick infestation and difficulties during tick control in hairy breeds because of their long hair coat.

In this study complicated babesiosis was reported in 66.48 per cent of dogs positive for babesiosis while 33.52 per cent dogs were suffering from uncomplicated babesiosis. Out of 117 dogs suffering from complicated babesiosis, 58 dogs had single organ complications while 59 dogs (50.43%) were reported to have multiple organ dysfunction syndrome (MODS). Among
the dogs suffering from single organ complications, hepatic complications and renal complications were reported in 25.64 and 23.93 per cent dogs, respectively. Systemic inflammatory response syndrome (SIRS) was observed in 19.88 per cent dogs. Welzl et al. (2001) reported that many atypical signs or complications can develop in animals with babesiosis, which can not be directly explained by hemolysis but appear to be the result of the host inflammatory response. The resultant tissue damage probably causes the release of cytokines, which support widespread inflammation and additional damage to multiple organs. MODS complications resulting from SIRS have been acute renal failure, hepatopathy, immune-mediated hemolysis, pulmonary edema, rhabdomyolysis and cerebral dysfunction.

In the present study physical examination of the dogs suffering from uncomplicated babesiosis revealed an increased rectal temperature (>102.5 °F) in 89.83 per cent of the cases, while 8.47 per cent of the dogs had decreased rectal temperature (<99.5 °F). The rectal temperature within the normal range (99.5-102.5 °F) was recorded in one dog. There was increased pulse rate (>120/min) in 76.27 per cent of the cases while normal pulse rate (80-120/min) was found in 16.95 per cent dogs. In 6.78 per cent cases decreased pulse rate (<80/min) was observed. An increase in the respiration rate (>35/min) was recorded in 86.44 per cent of the dogs while normal (10-35/min) and decreased respiration rates (<10/min) were recorded in 11.86 and 1.70 per cent cases, respectively. In complicated babesiosis increased rectal temperature in 30.77 per cent of the cases, while 34.19 per cent of the dogs had the rectal temperature within the normal range. Decreased rectal temperature was recorded in 35.04 per cent of the cases. An increase in pulse rate was found in 27.35 per cent of the cases while normal pulse rate was found in 35.90 per cent dogs. Decreased pulse rate was recorded in 36.75 per cent of the dogs. Increased respiration rate was recorded in 30.77 per cent of the dogs while normal and decreased respiration rates were recorded in 32.48 and 36.75 per cent cases, respectively. Konto et al. (2014) reported a significant rise in all the vital parameters including the rectal temperature, pulse and respiration rate in canine babesiosis.
The history and clinical examination of the cases of uncomplicated babesiosis revealed anorexia, lethargy, presence of ticks, hemoglobinuria, pallor, vomiting and icterus in 89.83, 81.36, 71.19, 40.68, 18.64, 16.95 and 8.47 per cent of the cases, respectively. Pale mucous membranes were reported in 91.53 per cent of the cases while 8.47 per cent dogs had pink mucous membranes. In complicated babesiosis lethargy, anorexia, presence of ticks, vomiting, diarrhea, pallor and edema were reported in 91.45, 78.63, 73.50, 66.67, 58.97, 52.14 and 26.50 per cent of the cases respectively. Ocular/nasal discharge, respiratory distress, moist cough, icterus, ataxia and seizures were reported in 16.24, 13.68, 12.82, 11.97, 4.27 and 4.27 per cent of dogs respectively. Congested mucous membranes were reported in 32.48 per cent of the cases while 67.52 per cent dogs had pale mucous membranes. Konto et al. (2014) reported similar findings and stated that the major clinical signs were associated with intravascular hemolysis of the red blood cells in circulation, resulting in anaemia depicted as the pallor of mucous membrane of the mouth and eyelid. The sudden change in appetite and lethargy may be due to fever, which develops as a result of the presence of parasites in the circulating blood as foreign bodies thereby triggering the release of vasoactive amines like cytokines.

Based on estimation of hemato-biochemical parameters in uncomplicated babesiosis decreased total erythrocyte count, hemoglobin concentration, platelet count and blood glucose, and increased bilirubin-total were reported to affect the outcome of the disease. In complicated babesiosis in addition to the above parameters increased alanine transaminase, alkaline phosphatase, creatine kinase, blood urea nitrogen and creatinine, and decreased total protein significantly affected the prognosis of the disease. Decreased blood glucose levels and hematocrit has previously been described to affect the outcome of disease (Nel et al., 2004; Jacobson and Lobetti, 2005). Crnogaj et al. (2010) stated that levels of blood urea nitrogen concentration, creatinine, bilirubin-total, alanine transaminase and alkaline phosphatase were significantly increased in dogs with complicated versus uncomplicated babesiosis.
In the dogs affected with babesiosis total erythrocyte count, hemoglobin and packed cell volume were significantly decreased, indicating anaemia. Similar findings have previously been reported by Abdullahi et al. (1990), Bansal et al. (1990), Conrad et al. (1991), Vercammen et al. (1997), Wozniak et al. (1997), Guelfi et al. (1998), Birkenheuer et al. (1999), Meinkoth et al. (2002), Duh et al. (2004), Rafaj et al. (2007), Maele et al. (2008), Fabisiak et al. (2010) and Selvaraj et al. (2010). Profound anaemia results from the hemolysis due to multiplication of the organism in peripheral vessels. Following attachment of an infected tick, trophozoites of Babesia sp. are released into the blood, infecting erythrocytes. Within the erythrocytes, the parasite multiplies by binary fission, an asexual form of schizogony. Hemolytic anaemia is the result of direct erythrocyte injury caused by the parasites and also by immune-mediated mechanisms. Parasitemia results in osmotically fragile erythrocytes, hemolysis, and subsequent anemia. Induction of serum hemolytic factors, increased erythrophagocytic activity of macrophages, and damage induced by the secondary immune system after formation of antierythrocyte membrane antibodies are also important to the pathogenesis. Serum from infected dogs inhibits erythrocyte 5′-nucleosidase, which can lead to the accumulation of cyclic nucleotides and may contribute to erythrocyte damage. Oxidative stress is another possible cause of damage to erythrocytes that also results in increased susceptibility to phagocytosis. Increased production of superoxide has been demonstrated in erythrocytes infected with B. gibsoni, which may relate to oxidative damage from lipid peroxidation. Increased urinary methemoglobinemia levels have been found in dogs with naturally occurring B. canis infections. Lipid peroxidation occurring during Babesia infection increases rigidity of parasitized and nonparasitized erythrocytes and slows their passage through capillary beds. Soluble parasite proteases activate the kallikrein system and induce fibrinogen-like protein (FLP) formation. The FLPS make erythrocytes more “sticky,” leading to additional erythrocytes sludging in the capillaries. Vascular stasis from sludging of parasitized cells and erythrocyte stroma within capillary beds is thought to contribute to the acute anemia and many of the other potential clinical signs. The most severe sludging appears to occur in the central nervous system and muscles.
Thrombocytopenia was observed in both uncomplicated and complicated babesiosis. The finding is similar to those reported by Conrad et al. (1991), Vercammen et al. (1997), Wozniak et al. (1997), Guelfi et al. (1998), Birkenheuer et al. (1999), Meinkoth et al. (2002), Duh et al. (2004), Maele et al. (2008), Matijatko et al. (2009) and Fabisiak et al. (2010). Thrombocytopenia is observed in many cases of babesiosis and may relate to immune or coagulatory consumption of platelets from hemolytic or vascular injury. Thrombocytopenia is common, especially in dogs infected with B. gibsoni (Taboada and Lobetti, 2006).

The levels of alanine transaminase and alkaline phosphatase were significantly higher in the affected animals, which is in accordance with the observations of Vercammen et al. (1997), Rafaj et al. (2007) and Crnogaj et al. (2010). This change may be attributed to the hemolysis and cellular damage to the hepatic cells. There was significant increase in bilirubin-total. The finding was in accordance with Vercammen et al. (1997), Hossain et al. (2003), Furlanello et al. (2005), Rafaj et al. (2007), Matijatko et al. (2009) and Crnogaj et al. (2010). This change may be attributed to the hemolysis and cellular damage to splenic and hepatic cells. The creatine kinase was increased in complicated babesiosis, Furlanello et al. (2005) reported similar finding in babesiosis in dogs. It is an indicator of muscle damage in complicated babesiosis (Konto et al., 2014).

There was a significant increase in the blood urea nitrogen and creatinine in the affected animals, previously Crnogaj et al. (2010) has also reported elevated blood urea nitrogen and creatinine level in the affected animals. An elevated serum urea alone is an unreliable indicator of renal insufficiency in animals with babesiosis, as a disproportionate rise in urea (compared with creatinine) has been related to catabolism of lysed erythrocytes. In this study, significant decrease in the blood glucose level was observed. Similar findings were reported by Keller et al. (2004), Nel et al. (2004) and Matijatko et al. (2009). The lower levels may be associated with starvation and hepatic dysfunction.

The concentration of total protein in the affected animals decreased significantly as in complicated; however, Hossain et al. (2003) and
Camacho *et al.* (2005) reported increased levels of total plasma protein in babesiosis. Konto *et al.* (2014) reported decreased levels of total protein associated with anorexia, malabsorption, hepatopathy and blood loss. There is a decrease in plasma proteins as a result of an increased intravascular hemolysis of red blood cells, this pressure decreases and fluid starts to accumulate in the tissue spaces. On the other hand, the liver can not synthesize these plasma proteins without certain amino acids which can only be achieved by dietary intake. With anorexia and mal-absorption, there is insufficient intake of these amino acids resulting to malnutrition. Parasites may also create malnutrition in canines resulting to emaciation.

The therapeutic study revealed that all the drugs under study could clear the *Babesia sp.* infections from the affected dogs, however, based on the earlier clinical improvement, lowered degree of parasitemia and higher survival rate clindamycin+doxycycline was considered as the most efficacious antibabesial therapy in the complicated babesiosis; followed by metronidazole+doxycycline, enrofloxacin+doxycycline, diminazene aceturate and doxycycline therapy.

Clindamycin is a semisynthetic derivative of lyncomycin. The *in vitro* activities of clindamycin against *B. divergens* were demonstrated with an IC50 value of 2200–3400 mg/l, which corresponds to 4.36–6.73 mM. Wulansari *et al.* (2003) reported the effectiveness of clindamycin for the treatment of babesiosis in dogs experimentally infected with *B. gibsoni* as the drug reduced parasitemia levels and induced morphological changes that indicated degeneration of parasites (e.g., segmentation; size reduction; localization in the cell limbic and/or torn state of the nucleus; and swelling, decrease, or disappearance of the cytoplasm) in the majority of dogs.

Talukder *et al.* (2013) evaluated doxycycline sensitivity against *in vitro* cultured *B. gibsoni* by real-time PCR and parasitemia and found that doxycycline was effective against *B. gibsoni* infection. The activity of doxycycline against *B. divergens* and *B. canis* has been recognized *in vivo* (Vercammen *et al.*, 1997). Metronidazole is a nitroimidazole compound reported to be used as part of therapy in babesiosis (Fowler *et al.*, 1972; Suzuki *et al.*, 2007); However, Matsuu *et al.* (2008) did not observe its activity.
against *B. gibsoni* in the continuous culturing of the organism. Recently Kline (2013) filed a patent application stating that metronidazole is the redox drug which treats life stages and forms of *Babesia* that are not susceptible to other drugs.

Enrofloxacin is a synthetic antibacterial agent from the class of the fluoroquinolone carboxylic acid derivatives. In this study it was found that doxycycline+enrofloxacin combination was effective in the treatment of complicated babesiosis. Similarly, Lin and Huang (2010) recorded the overall efficacy of the combination of doxycycline-enrofloxacin-metronidazole to be 83.30 per cent in dogs suffering from babesiosis. Diminazene aceturate, belongs to the group of aromatic diamidines, which are DNA minor groove-binding ligands that interfere with the DNA biosynthesis and aerobic glycolysis of pathogens. In Babesia spp., *in vitro* activities against *B. divergens* has been observed. The IC50 against *B. gibsoni* was approximately 10 times higher than that against *B. divergens*. Hepato-toxicity in the dog has also been reported after single dose of 3.5 mg/kg b.wt. but pre-existing liver disease could not be excluded as a contributing factor (Opping, 1969). Suzuki *et al.* (2007) reported apparent cure of *B. gibsoni* in 3 out of 4 experimental dogs that had not responded to repeated diminazine treatment, with a combination of clindamycin, metronidazole and doxycycline. Clindamycin has been shown to be effective against human babesiosis; however, it is suggested that treatment with clindamycin alone is not enough to eliminate the clinical symptoms and *Babesia* in blood. Therefore other therapies, in addition to clindamycin are necessary to obtain a satisfactory anti-babesial effect. Although a complete elimination of *B. gibsoni* from infected dogs has not been reported on each drug, it seems that the additive or synergistic effect could be expected if these drugs are used in combinations. In the present study additive effects of combinations of the therapeutic agents have proved to be efficacious for the treatment of complicated canine babesiosis.
6. SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

6.1 Summary

The present work was planned to study the epidemiological pattern of prevalent hemoprotozoa of dogs in and around Jabalpur, to study the prognostic values of various hemato-biochemical alterations in uncomplicated and complicated babesiosis in dogs and to evaluate the comparative therapeutic efficacy of different anti-babesial drugs in dogs.

The proposed work was conducted on a total of 1680 dogs brought to the OPD Medicine (TVCC, College of Veterinary Science & A.H., Jabalpur), State Veterinary Hospital (Omti, Jabalpur), and private clinics of Jabalpur were examined during November 2012 to October 2013. After confirmation of Babesia sp. infection by microscopic examination of blood smear stained with Leishman’s stain, dogs were selected for the study. Age, sex, breed, history and clinical signs of each dog were recorded. Five ml blood was collected from cephalic or recurrent tarsal vein taking all aseptic precautions. For the therapeutic studies blood samples were collected on day ‘0’ and subsequently on day ‘10’, ‘20’ and ‘30’ post treatment. Estimations of the hematological parameters including total erythrocyte count (TEC, millions/μl), hemoglobin (Hb, g/dl), packed cell volume (PCV, %), platelet count (thousands/μl), total leukocyte count (TLC, thousands/μl) and differential leucocyte count (DLC, %) were done following standard procedures. The biochemical parameters including alanine transaminase (ALT, U/L), aspartate transaminase (AST, U/L), alkaline phosphatase (ALP, U/L), creatine kinase (CK-MB, U/L), bilirubin –total and direct (BIT and BID, mg/dl), total protein (TP, g/dl) and albumin (g/dl), blood urea nitrogen (BUN, mg/dl), creatinine (CRE, mg/dl) and blood glucose (mg/dl) were determined in serum of animals.

To assess the therapeutic efficacy of drugs, 60 dogs having complicated babesiosis were divided into 5 groups (T₁–T₅). Each treatment group comprised of twelve animals of which 4 were of hepatic complications, 4 of renal complications and 4 showing multiple organ dysfunction syndrome.
The dogs in the groups $T_1$, $T_2$, $T_3$, $T_4$ and $T_5$ were treated with diminazene aceturate (5 mg/kg, IM), doxycycline (10 mg/kg, PO, BID) $\times$ 21 days, clindamycin (25 mg/kg, PO, BID) + doxycycline (10 mg/kg, PO, BID) $\times$ 21 days, enrofloxacin (2 mg/kg, PO, BID) + doxycycline (10 mg/kg, PO, BID) $\times$ 21 days and metronidazole (10 mg/kg, PO, BID) + doxycycline (10 mg/kg, PO, BID) $\times$ 21 days, respectively.

The overall prevalence of hemoprotozoa during November 2012 to October 2013 was 10.60 percent. The prevalence of *Babesia* sp. was 10.48 per cent, whereas *Hepatozoon canis* was showed 0.12 per cent prevalence. Out of 176 dogs positive for babesiosis 117 dogs (66.48%) fulfilled the criteria of complicated babesiosis while 59 dogs (33.52%) were suffering from uncomplicated babesiosis.

The month wise prevalence study of *Babesia* spp. revealed highest prevalence (18.18 per cent) in the month of August 2013 followed by 16.67 per cent in July 2013, 13.67 per cent in June 2013, 12.93 per cent in October 2013 and 12.78 per cent in September 2013. Comparatively lower prevalence was reported in the months of November 2012 (10.96 per cent), December 2012 (9.79 per cent), January 2013 (8.69 per cent), May 2013 (8.59 per cent), April 2013 (6.71 per cent) and February 2013 (5.41 per cent). The lowest prevalence was reported in March 2013 i.e. 3.57 per cent. The age wise prevalence of babesiosis revealed highest prevalence (13.27 per cent) in the 1-3 years age group, followed by 12.94 per cent prevalence in dogs of 5-7 years age and 12.92 per cent prevalence in 7-9 years age group. Among 1680 dogs examined, the sex wise prevalence study revealed 14.77 per cent prevalence in females as compared with 7.38 per cent in males. The maximum prevalence was noticed in German Shepherd breed i.e. 15.47 per cent followed by Samoyed, Pug and Non-descript in which prevalence was found to be 15.25, 12.50 and 10.94, respectively. There was significant variation (p<0.05) in the prevalence of babesiosis during different months and in different age groups, sex and breeds.

In the present study the recovery rate of uncomplicated babesiosis was found to be 83.05 per cent, while it was 71.79 per cent in complicated cases. The case fatality rate was 16.95 per cent and 28.21 per
cent in uncomplicated and complicated babesiosis, respectively. The cases positive for babesiosis were divided into two groups i.e. complicated and uncomplicated babesiosis. Out of 176 dogs positive for babesiosis 117 dogs (66.48 per cent) fulfilled the criteria of complicated babesiosis while 59 dogs (33.52 per cent) were suffering from uncomplicated babesiosis. Out of 117 dogs suffering from complicated babesiosis, 58 dogs had single organ complications while 59 dogs (50.43 per cent) were reported to have MODS. Among the dogs suffering from single organ complications, hepatic complications and renal complications were reported in 30 (25.64 per cent) and 28 (23.93 per cent) dogs, respectively. Out of 59 dogs suffering from MODS, hepatic and renal complications were reported in 29 dogs (49.15 per cent), while 9 dogs (15.25 per cent) had liver, kidneys and muscle involvement. Liver, kidneys and lungs were found to be affected in 10 cases (16.95 per cent), while CNS involvement in addition to hepatic and renal affection was reported in 5 cases (8.47 per cent). Six dogs (10.15 per cent) had complications due to affections of liver, kidneys, muscles and lungs. Systemic inflammatory response syndrome was observed in 19.88 per cent dogs (35 out of 176 dogs).

Based on estimation of hemato-biochemical parameters in uncomplicated babesiosis the total erythrocyte count, hemoglobin concentration, platelet count, bilirubin-total and blood glucose were reported to affect the outcome of the disease. In complicated babesiosis total erythrocyte count, hemoglobin concentration, packed cell volume, platelet count, alanine transaminase, alkaline phosphatase, bilirubin-total, total protein, creatine kinase, blood urea nitrogen, creatinine and blood glucose significantly affected the prognosis of the disease.

The therapeutic study revealed that all the drugs under study could clear the babesia sp. infections from the affected dogs, however, based on the earlier clinical improvement, lowered degree of parasitemia and higher survival rate in group t3 clindamycin+doxycycline was considered as the most efficacious antibabesial therapy in the complicated babesiosis; followed by metronidazole+doxycycline, enrofloxacin+doxycycline, diminazene aceturate and doxycycline therapy.
6.2 Conclusions

1. The overall prevalence of hemoprotozoa in Jabalpur was 10.60 per cent and Babesia sp. was the most prevalent hemoprotozoa having 10.48 per cent prevalence.

2. Based on estimation of hemato-biochemical parameters in uncomplicated babesiosis the total erythrocyte count, hemoglobin concentration, platelet count, bilirubin-total and blood glucose significantly affected the outcome of the disease.

3. In complicated babesiosis total erythrocyte count, hemoglobin concentration, packed cell volume, platelet count, alanine transaminase, alkaline phosphatase, bilirubin-total, total protein, creatine kinase, blood urea nitrogen, creatinine and blood glucose significantly affected the prognosis of the disease.

4. Clindamycin + doxycycline therapy proved to be the effective antibabesial treatment for complicated babesiosis based on clinical improvement, lowered degree of parasitemia and higher survival rate, followed by metronidazole + doxycycline and enrofloxacin + doxycycline therapy.
6.3 Suggestions for further work

1. Study on efficacy of anti-babesial drugs by testing the clearance of parasite DNA from peripheral blood and necropsy obtained tissues using validated PCR should be undertaken.

2. Study of effect of blood transfusion in the uncomplicated and complicated babesiosis of dogs is further needed.

3. Development of vaccine for prevention of babesiosis in dogs is urgently required.
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