International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(10): 93-98
www.biochemjournal.com
Received: 10-07-2025
Accepted: 13-08-2025

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Evaluation of haematological and biochemical parameters in different pathological conditions in dog

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i10b.5875

Abstract
The current study was carried out to aim to check the haematological and biochemical parameters in different clinical condition in dogs along with their associated prognosis. In the present study, 100 cases of dogs confirmed for different clinical conditions and 06 apparently healthy dogs, were subjected to estimation of various haematological parameters. All dogs were also subjected for estimation of various biochemical parameters using standard assay kits with the help of automatic serum biochemical analyzer. Among various clinical conditions recorded, the maximum cases of viral infection were recorded, followed by gastro-intestinal (GIT) disorders, pyometra, ascites, urinary tract infections (UTI), hepatic dysfunction, parasitic diseases, tumors and respiratory tract affections (RTI). The results shows hemoglobin levels significantly decreased in cases of parvovirus infection, respiratory tract infections, pyometra, ascites, hepatic dysfunction, and parasitic diseases. SGOT level significantly increased in cases of urinary tract infection (UTI), pyometra, and hepatic dysfunction. Creatinine level raised notably in UTI and hepatic dysfunction, while BUN levels significantly increased in UTI.

Keywords: UTI, GIT, SGOT level, Biochemical, Dog, Hematology

Introduction
Haematological and biochemical parameters serve as fundamental tools in veterinary diagnostics, offering critical insights into the physiological and pathological status of dogs. Haematology refers to the study of the numbers and morphology of the cellular elements of the blood and the use of these results in the diagnosis and monitoring of disease. Haemtological studies are useful in the diagnosis of many diseases as well as investigation of the extent of damage to blood. Haematological parameters are those parameters that are related to the blood and blood forming organs. The examination of blood for their constituents can provide important information for the diagnosis and prognosis of diseases in animals (Etim *et al*, 2014) [16].

Prognosis or mortality prediction by investigating different laboratory parameters is currently in demand in both human and veterinary medicine (Jitpean *et al* 2014) [21]. Hematology of infected dogs can help in giving an idea about the severity of infection and thus can guide in deciding the treatment protocol (Andrea *et al* 2017) [3]. Evaluating the leukogram, including a total white cell count, a differential cell count, absolute numbers of specific leukocytes and examination of morphology on a blood smear, can identify abnormalities that may suggest specific diseases such as a viral or bacterial infection or even a neoplastic process (Kaur, 2019) [23].

Although the diagnosis of a disease occasionally can be based solely on a complete blood cell (CBC) count, the hemogram may contribute valuable information in the diagnosis, surveillance, and formulation of a prognosis regarding the future progression of a disease in an individual (Roland, 2014) [37]. Hence, systematic measurement of haematological and biochemical parameters is cost-effective, minimally invasive, and broadly applicable. These changes help in early detection of disease, monitoring therapeutic response, prognosis and decision making concerning supportive care. For veterinary practitioners, integrating these laboratory findings with clinical signs and imaging provides a more complete picture and improves outcomes.

Materials and Methods

Experimental animals

This study was carried out on 100 dogs affected with different clinical conditions like pyometra, urinary tract infection, septicemia, parasitic diseases, respiratory tract infection, hepatic dysfunction, tumor, infectious wound etc. brought to Veterinary Clinical Complex (V.C.C), College of Veterinary Science & Animal Husbandry, Kamdhenu University, Junagadh. For establishing control values, apparently healthy six dogs who brought for routine check-up and vaccination were taken as control from VCC, K.U., Junagadh. The experimental protocol was approved by the Institutional Animal Ethics Committee (IAEC), College of Veterinary Science and Animal Husbandry, Kamdhenu University, Junagadh, Gujarat (Protocol no: KU-JVC-IAEC-SA-125-23; Dated: 16 /12/2023).

Sample Collection

Dogs presented with the history of fever, vomiting, diarrhoea, breathing problems, excessive secretion, excretion, skin lesions, tumor, wound etc. were subjected for blood collection. A total 100 dog blood samples were collected from VCC, K.U., Junagadh. A two ml of venous blood was collected in a sterile K3 EDTA vacutainer for haematology parameters and 2 ml blood was collected in clot activator for analysis of different biochemical parameters

Ancillary Diagnosis Techniques

A disease diagnosis of various clinical condition was done by using different ancillary techniques like serum chemistry, rapid lateral flow assay (Immunochromatographic assay), urinalysis, cytology, histopathology and ultrasonography etc.

Haematological Evaluation

The hematological parameters were estimated by automated hematology analyzer (Abacus Vet 5, Diatron) available at the Department of Veterinary Pathology, Kamdhenu University, Junagadh.

Biochemical evaluation

The biochemical parameters were estimated using standard kits (Diatek kit) on automatic biochemistry analyzer (LW C 100, LANDWIND) at the Department of Veterinary Pathology, Kamdhenu University, Junagadh.

Statistical Analysis

All numerical data from this study are presented as mean ± standard error (S.E.). Statistical analyses of all data were carried out using GraphPad Prism 9.4.1. Kolmogorov-Smirnov test was used to evaluate the normality of data along with Bartlett's test to confirm the equal variance. Data with normal distribution and homogeneous variance were analyzed by parametric test by unpaired "t" test. The data that didn't have either normal distribution or equal variances were analyzed by Mann-witney test. The value of $p<0.05$ (*) was considered as statistically significant and $p<0.01$ (**), $p<0.005$ (***) and $p<0.001$ (****) was considered as highly statistically significant.

Results and Discussion

The different pathological conditions among the general disease conditions were the incidences that are recorded. Maximum cases of viral infection were noted (22), among the viral diseases maximum cases of canine distemper (CD) (14) and parvo viral infection (08), were recorded followed by gastro-intestinal (GIT) disorders (19), pyometra (15), ascites (12), urinary tract infections (UTI) (08), hepatic dysfunction (07), parasitic disease (07), and respiratory tract affections (RTI) (04) and tumor (06). Among the tumors, 03 cases of CTVT, 02 cases of mammary gland tumor and 01 squamous cell carcinoma.

The hematological value of dogs having canine distemper virus infection significantly increase TEC and insignificantly elevated TLC (25144.29±4506.05/µl) and absolute count of neutrophils (16847.86±3515.78/µl) in comparison to apparently healthy dogs. The non-significantly increase leukocytosis with neutrophilia showed in this study consist with the findings by Ezeibe and Udegbunam (2008) [17] and Salem (2014) [41] who reported leukopenia with neutropenia in canine distemper virus infected dogs.

The hematological value of dogs having parvo virus infection revealed significant higher HB ($p<0.01$), PCV ($p<0.01$), TEC ($p<0.005$) in comparison to the apparently healthy dogs. Although, TLC was high, hemoglobin and lymphocytes were reduced but the values did not reach the statistical significance. These findings were consistent with those reported by Bhargavi *et al*. (2017) [7]. Leukocytosis observed in this study might be attribute to the bacterial invasion of the damaged intestinal tract as opined by Rai *et al*. (1994) [35]. They stated that increased TLC in cases of canine parvo virus (CPV) enteritis may be due to the progression of disease. Reactive leukocytosis may result from myeloid hyperplasia, sample collection during the later stages of viremia rather than the initial stage, or secondary bacterial infections. The neutrophilia observed in this study aligns with findings associated with secondary bacterial complications in cases of parvoviral enteritis. (Bhargavi *et al*., 2017) [7]. During recovery from parvovirus infection, peripheral blood showing neutrophilia and hyperplasia of lymphoid, erythroid, and myeloid cells. (Shah *et al*., 2013) [46]. Anemia was found in this study may be due to the cytotoxic effects of the virus leading to myeloid and erythroid hypoplasia according to Roble *et al.* (2016) [36].

The elevated level of TLC value observed in this study aligns with the findings of Bhat *et al*. (2013) [8] and Sharma *et al*. (2008) [47]. The increase in neutrophils could be attributed to the immune system general reaction to bacterial infection and inflammatory processes in GIT (Berghoff and Steiner 2011) [6]. Thrombocytopenia may result from loss of blood through vomit and faeces, increased destruction and/or aggregation, reduced production and disseminating intravascular coagulation, these findings were consistent with those reported by Dash *et al*. (2017) [14].

The hematological value of dogs having pyometra revealed mean values Hb ($p<0.005$) and absolute count and percentage of neutrophils ($p<0.05$), to be significantly higher than the apparently healthy dogs while insignificantly lower lymphocytes % and higher TLC than the apparently healthy dogs. The reduced lymphocyte count may be attributed to elevated absolute neutrophil counts, likely resulting from severe suppurative uterine inflammation, endotoxaemia, or bacterial by-products. The anemia observed in these cases is attributed to decreased erythropoiesis, characteristic of anemia of chronic disease, potentially resulting from erythrocyte loss into the uterine

lumen or bone marrow suppression and red blood cell loss (Samantha *et al*., 2018) [42] these findings are also in line with those reported by Jena *et al.* (2013) [20].

The hematological value of dogs having ascites revealed insignificantly increased TLC and absolute count of neutrophils and significantly hemoglobin (p<0.05), PCV (p<0.05), TEC (p<0.01) and insignificantly reduced lymphocytes in comparison to apparently healthy dogs. The observed leukocytosis in this study may be stress-related, as noted by Pradeep *et al*. (2017) [33]. Similarly, Washabau (2010) [55] reported significant leukocytosis and neutrophilia in dogs with various hepatic conditions, including granulomatous hepatitis, cirrhosis, abscesses, and neoplasia. These results align with previous studies by Tantary *et al.* (2014) [49], Saravanan *et al.* (2014) [43], and Elhiblu *et al.* (2015) [15]. The observed decrease in hemoglobin is likely linked to liver dysfunction, as the liver helps in production of erythropoietin and other crucial factors for red blood cell production, and its impairment can lead to anemia. These findings were consistent with those of Tantary *et al*. (2014) [49], Saravanan *et al*. (2014) [43] and Elhiblu *et al*. (2015) [15]. The reduced Hb, PCV, TEC can be attributed to the chronic nature of this disease may be due to prolonging transient time of erythrocytes through the spleen could be due to dehydration caused by ascites which reduced portal blood flow (Phom *et al*., 2019) [32].

The hematological value of dogs having UTI cases revealed insignificant increase in TLC and neutrophils (p>0.05), whereas, reduced lymphocytes % were observed in comparison to the apparently healthy dogs. The increased TLC values in the present study align with previous findings of Punia *et al*. (2018) [34], Roopali (2018) [38] and Sarma and Kalita (2019) [44]. Additionally, neutrophilia in affected dogs consistent with the Mrudula *et al*. (2005) [29], Kralova *et al*. (2010) [25] and Thirunavukkarasu *et al.* (2010) [52]. Leucocytosis along with elevated neutrophil levels, may result from stress responses associated with cystitis and nephritis in dogs or as a defence mechanism against bacterial infections and noted minimal alterations in monocyte, basophil, and eosinophil counts in dogs with urinary tract infections as reported by Yogeshpriya *et al*. (2018) [57].

The hematological value of dogs having hepatic dysfunction revealed mean values of hemoglobin (p<0.01), lymphocytes (p<0.01), to be significantly lower than the apparently healthy dogs, while neutrophils (p<0.01), was significantly higher and TLC (>0.05) insignificantly higher than the apparently healthy dogs. Elhiblu *et al.* (2015) [15] reported similar findings, including decreased hemoglobin, elevated TLC, and neutrophil counts. Neutrophilic leukocytosis with left shift indicated a chronic inflammatory response in hepatitis. The anemia resulted from prolonged erythrocyte transit through the spleen, caused by decreased portal blood flow and/or red blood cell fragility due to elevated bile acid levels (Chikazawa *et al*. 2013, Elhiblu *et al*. 2015, Tantary *et al.* 2014) [12, 15, 49]. This study noted a minor, statistically nonsignificant increase in platelet count compared to healthy dogs, contradicting findings by Tantary *et al.* (2014) [49] and Elhiblu *et al.* (2015) [15].

The hematological value of dogs having parasitic disease revealed significantly reduced hemoglobin (p<0.01), while insignificant increase TLC and neutrophils within normal range. The decreased hemoglobin (Hb) levels in dogs Vojta *et al.* (2012) [53], Sakina *et al.* (2012) [40] indicated by reduced Hb content, may result from the deteriorated health condition due to reduced food intake, systemic illness, toxaemia, septicaemia, and secondary bacterial infections caused by mites. Additionally, chronic parasitic diseases can trigger generalized inflammation and leukocytosis due to prolonged antigenic stimulation, as reported by Janus *et al.* (2014) [19].

The haematology of different cases of neoplasms revealed statistically significant increase in TLC (p<0.05), while insignificantly increase neutrophil percentage and absolute count lymphocytes and absolute count eosinophil along with statistically non-significant decrease in values of hemoglobin in comparison to apparently healthy animals. Anaemia and leukocytosis as the most common clinicopathologic features in lymphoma reported by Kayar *et al*. (2018) [24]. Thangapandiyan *et al*. (2013) [51] found anemia to be the most common abnormality in lymphoma, typically indicating chronic disease, but also potentially linked to hemolysis, bone marrow issues or cytokine-mediated disruptions in erythrocyte production. Leukocytosis often accompanied lymphoma, reflecting tumor-related inflammation.

The decreased hemoglobin and increased total leukocyte and neutrophil counts align with Kumar *et al.* (2017) [26] these findings were indicative of suggesting an inflammatory response and potential bacterial infection in tumor-affected dogs.

The hematology of different cases of respiratory tract affections revealed significantly lower HB (p<0.05), while insignificant increase in TLC and neutrophils and decreased lymphocytes, while, insignificantly lower monocytes were observed when compared to apparently healthy dogs. Significant elevation in white blood cell count was noted, consistent with the findings of Šoltésová *et al.* (2015) [48]. Leukocytosis along with neutrophilia were reported by Ning *et al*. (2016) [30] in children with community-acquired pneumonia and in goat with caprine mycoplasmal pneumonia by Mondal *et al.* (2004) [28]. Additionally, Mondal *et al.* (2004) [28] observed anemia in goats, which similar with the findings of this study. The neutrophilia showed may be attributed to the more demand for neutrophils to support phagocytic activity in response to the presence of foreign proteins in the system (Mondal *et al.*, 2004) [28].

Serum biochemical analysis in 22 cases of viral diseases revealed non-significant increased AST and SGPT when significantly elevated ALP (p<0.005). Shah *et al*. (2013) also reported elevated AST and ALP [46]. Amravathi *et al.* (2016) [2] reported increased SGPT level whereas Buragohain *et al.* (2017) [11] reported SGPT level within normal range with rise in ALP and AST. Increased AST might be due to involvement of liver (Grigonis *et al.*, 2002) [18]. Elevated ALP could result from hepatic hypoxia due to severe hypovolemia or toxic substance absorption following gut barrier disruption. (Shah *et al*., 2013) [46].

Serum biochemical analysis in nineteen cases of GIT disorders revealed non-significantly elevated AST, and reduced albumin along with significantly increase ALP (p<0.005) in comparison to apparently healthy dogs. These observations were consistent with findings by Arora *et al.* (2018) [4]. Reduced albumin and increase AST in gastroenteritis infected dogs may be due to liver involvement and severe protein losing enteropathy due to intestinal haemorrhage or intestinal villi damage (Grigonis

et al., 2002) [18]. Increase level of AST also found by Dash *et al*. (2017) [14].

Serum biochemical analysis in fifteen cases of pyometra revealed significantly increase ALP (p<0.05) and nonsignificantly increase AST in comparison to apparently healthy dogs. The elevated AST and ALP levels are consistent with findings from multiple studies (Shah *et al.*, 2016, Sahoo *et al.*, 2012) [45, 39] and increased level of ALP in affected animals than the apparently healthy dogs reported by Samantha *et al.* (2018) [42]. This indicate that toxemia resulting from pyometra may impair liver enzyme synthesis and cause damage of hepatic membrane (Bigliardi *et al*., 2004) [9]. Elevated AST and ALP levels may result from hepatocellular damage caused by septicemia, impaired hepatic circulation, cellular hypoxia in dehydrated animals, and intrahepatic cholestasis.

Serum biochemical analysis in eight cases of ascites revealed insignificant elevated AST, along with significantly reduced total protein (p<0.01) and albumin (p<0.01) in comparison to apparently healthy dogs. The reduction in total protein and albumin levels observed in ascitic dogs may due to liver's central role in synthesizing major plasma proteins, along with its involvement in the degradation and synthesis of other proteins, which liver disease can significantly impact (Webster, 2005) [56]. Ascites increases the distribution of albumin, leading to reduced blood albumin levels, thereby lowering plasma osmotic pressure and worsening the ascitic condition. (Saravanan *et al*. (2014)) [43].

Serum biochemical analysis in nine cases of UTI revealed significantly increase AST (p<0.001), ALP (p<0.01), BUN (p<0.001), and creatinine (p<0.001), in comparison to apparently healthy dogs. And elevated level BUN and creatinine in all urinary tract infected cases comparison to apparently healthy dogs were found by Sarma and Kalita (2019) [44].

Serum biochemical examination in seven cases of hepatic dysfunction revealed significantly increase in total bilirubin, direct bilirubin, indirect bilirubin, AST, SGPT and ALP while, total protein level was reduced in comparison to apparently healthy dogs. These observations were in consistent with Tantary *et al.*, (2014) [49].

The increased level of ALP was significantly higher in the infected dogs. These abnormalities are likely due to hemolysis and damage to hepatic cells, aligning with findings with studies by Wadhwa *et al*. (2011) [54]. An Elevated ALP level may due to damage or abnormal function of biliary system (Crnogaj *et al*., 2010) [13]. Increased activities of AST and SGPT were likely due to release of these enzymes from the damaged hepatic parenchymal cells with necrosis or altered membrane permeability which indicate hepatic dysfunction (Kumar and Kumar 2018) [27].

Serum biochemical analysis of six cases of neoplasms revealed nonsignificant increased level of AST, SGPT while significantly increased ALP (p<0.01) in comparison to apparently healthy dogs. Levels of SGPT, AST, and ALP observed in this study aligned with findings by Behera *et al*. (2012) [5], Birhan, & Chanie (2015) [10] and Kumar *et al*. (2017) [26]. Albanese *et al.* (2006) [1] reported normal total protein, BUN, and serum creatinine levels in dogs with transmissible venereal tumors (TVT). Serum biochemical parameters in cases of mammary tumors did not exhibit any deviations from the reference range (Kumar *et al.*, 2017) [26].

Blood serum biochemistry indicated significantly elevated levels of ALKP, AST, GGT, and BUN activity in dogs diagnosed with malignant lymphoma (Kayar *et al*., 2018) [24].

Serum biochemical analysis in four cases of respiratory tract infections revealed significantly increased ALP (p<0.005) and non-significantly reduced total protein and albumin in comparison to apparently healthy dogs. Similar finding of decreased serum proteins was also reported by Mondal *et al*. (2004) [28] in goats with mycoplasma pneumonia which may be due to consumption of serum proteins by mycoplasma organisms for their growth.

Conclusions

Hemoglobin levels significantly decreased in cases of parvovirus infection, respiratory tract infections, pyometra, ascites, hepatic dysfunction, and parasitic diseases. Absolute neutrophilia observed in cases of pyometra, tumors, and hepatic dysfunction with a leukemoid reaction observed in pyometra. SGOT level significantly increased in cases of urinary tract infection (UTI), pyometra, and hepatic dysfunction. Creatinine level raised notably in UTI and hepatic dysfunction, while BUN levels significantly increased in UTI. Total protein levels significantly decreased in ascites and hepatic dysfunction, while ALP levels significantly increased in all conditions.

Acknowledgement

The authors thanks to all staff of Department of Veterinary Pathology and Veterinary Clinical Complex, Kamdhenu University, Junagadh for their support during the study.

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