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# Hematological and Serum Chemistry of Canine Parvoviral Enteritis in Diverse Breeds of Dogs

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## Abstract

Canine Parvovirus enteritis (CPV-2) is a highly infectious viral disease occurring in puppies resulting in high mortality with a myriad of clinical signs, hematological and biochemical changes during the progression of the disease. This study investigated hematological and biochemical changes in 30 CPV-positive dogs in Ibadan, Nigeria. Severe non-regenerative anemia (35.71%) and leukopenia (22 cases) were prevalent. Thrombocytopenia was severe in 73.33% of cases. Further analysis revealed normocytic hypochromic anemia in 42.86%, microcytic hypochromic anemia in 28.57%, and leukopenia categorized as mild (5), moderate (12), or severe (5). Biochemical changes included hyperproteinemia (26.7%), hyperalbuminemia, hyperglobulinemia, and elevated liver enzymes in some cases. Renal dysfunction was evident in 16.7% of dogs with elevated creatinine. Significant differences ($p<0.05$) were observed between infected and healthy dogs. These findings underscore the critical impact of CPV on hematological and biochemical profiles, necessitating supportive care and emphasizing the crucial role of vaccination in disease prevention.

## Keywords

Biochemical Alterations, Canine Health, Canine Parvovirus, Hematology, Vaccination

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## Introduction

Canine parvovirus 2 (CPV-2) is a significant viral pathogen responsible for acute hemorrhagic enteritis and myocarditis in dogs. First identified in 1977, CPV-2 has established itself as a predominant enteric virus affecting canines globally, with a morbidity rate of 100% and mortality rates reaching up to 10% in treated cases, and potentially 90% if left untreated (Parrish and Kawaoka, 2010; Horecka *et al*., 2020). This highly contagious virus poses a severe threat to canine health (Chen *et al*., 2019) and manifests in three antigenic variants: a, b, and c, complicating both diagnosis and vaccination approaches (Fiorello *et al*., 2006). Upon infection, CPV-2 primarily targets the epithelial cells of the small intestine, disrupting vital functions such as nutrient absorption and barrier protection against fluid loss and bacterial invasion. While CPV-2 can infect dogs of any age, severe cases are most common in puppies aged between 6 weeks and 6 months, often leading to collapse due to myocarditis (Li *et al*., 2011). Improvements in vaccination and natural exposure have contributed to a decrease in myocarditis cases (Mylonakis *et al*., 2016). Interestingly, crossbred dogs generally exhibit lower susceptibility compared to certain purebreds like Doberman Pinschers, Rottweilers, Labradors, German Shepherds, and English Springer Spaniels, although exceptions exist for Toy Poodles and Cocker Spaniels (Chinchkar *et al*., 2006). Notably, some infected dogs may remain asymptomatic, serving as reservoirs for viral transmission to susceptible populations (Cho *et al*., 2004). Hematological evaluations are crucial for diagnosing and managing CPV-2 infections. Changes in blood parameters often precede clinical signs, enabling early detection, which is vital for initiating appropriate therapeutic interventions. Monitoring these parameters provides insights into the severity of the infection and aids veterinarians in determining the necessary medical interventions.

CPV-2 significantly impacts white blood cell counts, leading to leukopenia, characterized by a marked reduction in circulating leukocytes. This condition weakens the immune response, increasing susceptibility to secondary bacterial infections (Decaro *et al*., 2008). The virus selectively targets rapidly dividing cells, including those in the bone marrow, where leukocytes are produced. Concurrently, CPV-2 infections often result in thrombocytopenia, a decrease in platelet count that contributes to hemorrhagic signs such as bloody diarrhea and petechial hemorrhages (Decaro *et al*., 2005). The combination of bone marrow suppression and gastrointestinal bleeding leads to decreased erythrocyte production and increased destruction, resulting in anemia (Decaro *et al*., 2006). In CPV-2 cases, atypical lymphocytes and morphological changes in leukocytes, such as toxic granulations, may be observed (Decaro *et al*., 2008). A differential white blood cell count can reveal a decrease in lymphocytes, essential for immune function, and a left shift indicating an increased presence of immature neutrophils, suggesting an inflammatory response (Decaro *et al*., 2008). The total white blood cell count is a prognostic indicator; severely reduced counts correlate with poorer outcomes, as the immune system's capacity to combat the virus and secondary infections is compromised (Decaro *et al*., 2008). Biochemical markers are vital for assessing overall health and organ function in CPV-2 infections. These markers can indicate multi-organ damage, particularly in the gastrointestinal tract, liver, and kidneys. For

example, elevated alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels reflect hepatocellular injury and generalized tissue damage, respectively (Ender Dinçer *et al*., 2020; Ogbu *et al*., 2022). Additionally, increased blood urea nitrogen (BUN) and creatinine levels indicate impaired kidney function, often associated with dehydration and reduced glomerular filtration rates (Vandevelde and Zurbriggen, 2005; Decaro *et al*., 2013). Understanding these biochemical markers is crucial for guiding therapeutic strategies and assessing prognosis in CPV-2 infections.

This study aims to analyze the impact of CPV-2 infection on the hematological profile and biochemical alterations, including liver enzymes and kidney function indicators, to guide clinicians in managing canine parvoviral enteritis. There is also a need to identify the effect of complete or incomplete vaccination on the hematological values in affected dogs. Understanding these clinical, hematological, and biochemical aspects is essential for developing targeted interventions and safeguarding public health by mitigating the virus's impact on dogs.

## Materials and Methods

### Study Area and Clinics

The study was conducted in Ibadan, the capital city of Oyo State, Nigeria, focusing on hospitals in the Ibadan Northwest local government area. This region is located at latitude 7.3775° N and longitude 3.9470° E. with cases submitted to Mokola State Veterinary Hospital (Mokola Roundabout), The City Veterinary Clinic (Ajibode Ojoo Road), and the Veterinary Teaching Hospital at the University of Ibadan.

### Sampling, Sample Collection, and Processing

The study involved 30 dogs of six different breeds from seven out of the 11 local government areas of Ibadan. The dogs were selected based on clinical history and a positive rapid antigen detection for Canine Parvovirus Type 2 (CPV-2). Clinical signs included anorexia, foul-smelling melena, diarrhea, vomiting, age under 1 year, and lethargy. Blood samples, sera, and fecal swabs were collected for hematology, serum chemistry, and polymerase chain reaction (PCR) detection. The samples were processed in the clinical pathology laboratory and the virology unit of the Veterinary Microbiology Department at the Faculty of Veterinary Medicine, University of Ibadan. Blood samples were collected from the cephalic vein of dogs. For hematological analysis, 2 ml of blood with EDTA was mixed to prevent clotting. For biochemical analysis, 3 ml of blood was allowed to clot, centrifuged, and the serum was refrigerated. CPV presence was confirmed using the Antigen Rapid® test kit. Blood smears were prepared for microscopic examination, and packed cell volume was measured via microhematocrit centrifugation. Serum chemistry analyses utilized Randox test kits, assessing ALT, AST, ALP, total protein, albumin, globulin, bilirubin, blood urea nitrogen, and creatinine levels.

Descriptive statistical analysis was conducted using SPSS version 23, focusing on the effects of CPV-2 on hematological and serum biochemical parameters. Statistical significance was determined using Student's t-test with a significance level of $p < 0.05$.

## Results

### Clinical Data of Parvovirus Infected Dog

The ages of the affected dogs ranged from 1 to 12 months, with a significant concentration of

cases among puppies aged 1 to 6 months, who accounted for 73% of the total. The sex distribution was fairly balanced, with males representing 53.3% (n=16) and females 46.7% (n=14), indicating no notable predisposition based on sex.

In terms of breed, German Shepherds (GSD) were the most commonly affected, comprising 40% (n=12) of the cases. Boerboels followed at 26.7% (n=8), while Rottweilers and mixed breeds each made up 13.3% (n=4). Eskimo breeds constituted 6.7% (n=2) of the infected population. A significant majority of the dogs (80%) had no vaccination history, while only 10% had received partial vaccinations (one or two shots) and a mere 3.3% had completed the full vaccination schedule. Common clinical signs observed included anorexia (93.3%), bloody feces (76.7%), vomiting (83.3%), and weight loss (90%), all of which are consistent with the gastrointestinal damage associated with CPV. Most dogs demonstrated anorexia and weight loss, with many also presenting bloody diarrhea and frequent vomiting. Additional signs included muscle weakness (46.7%), lethargy (63.3%), sunken eyes (40%), and foul-smelling feces (30%). Body temperatures varied from 37°C to 39.9°C, with some dogs experiencing hypothermia (13.3%) and pyrexia (23.3%), indicating a fever response to the infection.

The comprehensive hemogram results revealed the hematological impact of Canine Parvovirus (CPV) (Table 1). The mean packed cell volume (PCV) was 34.53%, with a median of 35% and a range of 14% to 60%, indicating varying degrees of anemia among the dogs. The average white blood cell (WBC) count was 3,935.5/µL, with a median of 3,800/µL and a range from 1,350/µL to 7,650/µL, reflecting leukopenia often seen in parvoviral infections due to suppressed bone marrow activity. Platelet counts varied significantly, averaging 104,500/µL, with a median of 96,000/µL and a range of 62,000/µL to 196,000/µL, indicating thrombocytopenia in many instances. Total protein levels had a mean of 7.23 g/dL, with a median of 7.5 g/dL and a range from 5.2 g/dL to 10.2 g/dL. Hemoglobin levels also showed variation, with a mean of 11.35 g/dL, a median of 11.0 g/dL, and a range from 4.3 g/dL to 20.0 g/dL.

**Table 1.** Hematological variation between vaccinated and unvaccinated CPV-2 positive dogs

| Parameter | Vaccinated (mean ± SD) | Non-vaccinated (mean ± SD) | t-value | p-value |
|---|---|---|---|---|
| PCV (%) | 39.2 ± 7.6 | 32.5 ± 6.8 | -2.34 | 0.024 |
| WBC (×10^3/µL) | 4.85 ± 1.6 | 3.15 ± 1.2 | 2.92 | 0.007 |
| `Platelet (×10^3/µL) | 127.5 ± 35.7 | 94.0 ± 28.3 | -2.51 | 0.016 |

Notably, 15 out of 30 dogs exhibited anemia ranging from mild to severe. Leukopenia was observed in 22 dogs, categorized as mild in five, moderate in 12, and severe in five. This condition was linked to neutropenia in seven cases, lymphopenia in four, and a combination in 11. Pancytopenia, characterized by anemia, leukopenia due to neutropenia, and thrombocytopenia, was seen in 13 dogs, while bicytopenia occurred in 14.

Severe thrombocytopenia affected 22 dogs (73.33%). Comparative statistical analysis indicated significant differences in hematological and biochemical parameters between vaccinated and non-vaccinated dogs. Vaccinated dogs had higher packed cell volume (PCV) (mean 39.2% vs. 32.5%, t = -2.34, p = 0.024) and platelet counts (mean 127,500/µL vs. 94,000/µL, t = -2.51, p = 0.016), alongside lower WBC counts (mean 4,850/µL vs. 3,150/µL, t = 2.92, p = 0.007) compared to their non-vaccinated counterparts.

Assessment of hepatic and renal function revealed significant abnormalities, indicating systemic involvement in CPV-infected dogs (Table 2). The mean total protein level was 6.73 g/dL, with a median of 6.5 g/dL and a range from 3.0 g/dL to 9.6 g/dL. Albumin levels averaged 2.83 g/dL, while globulin levels averaged 3.83 g/dL, resulting in an albumin to globulin ratio with a mean of 0.83. Elevated liver enzymes were noted, with aspartate aminotransferase (AST) averaging 14.33 µL, while alanine aminotransferase (ALT) levels averaged 90.67 µL. Kidney function tests indicated elevated blood urea nitrogen (BUN) levels, averaging 16.33 mg/dL, suggesting renal impairment in some dogs.

**Table 2.** Hepatic and renal parameters of vaccinated vs non-vaccinated dogs

| Parameter | Vaccinated (mean ± SD) | Non-vaccinated (mean ± SD) | t-value | p-value |
|---|---|---|---|---|
| ALT (µL) | 82.0 ± 15.7 | 97.5 ± 18.6 | 2.18 | 0.038 |
| BUN (mg/dL) | 13.9 ± 3.2 | 18.4 ± 4.7 | 2.67 | 0.011 |
| Creatinine (mg/dL) | 1.0 ± 0.3 | 1.3 ± 0.5 | 2.21 | 0.036 |

Overall, these findings underscore the importance of vaccination in alleviating the hematological, hepatic, and renal impacts of CPV infection. The significant differences in clinical parameters between vaccinated and non-vaccinated dogs emphasize the protective role of vaccination and the necessity for comprehensive vaccination programs to control the spread of CPV and mitigate its clinical severity.

## Discussion

Thirty dogs diagnosed with Canine Parvovirus (CPV) were presented from seven of the 11 local government areas (LGAs) in Ibadan to the Veterinary Teaching Hospital, Mokola State Veterinary Hospital, and The City Veterinary Clinic. The proximity of these clinics to the affected areas facilitated this process. The data collected offer valuable insights into the hematological and biochemical changes associated with CPV infection. The virus predominantly affects young dogs, particularly those between 1 and 6 months old, who accounted for 73% of the cases. Breeds such as German Shepherds, Boerboels, Rottweilers, and mixed breeds were significantly impacted, likely reflecting their common presence in the Ibadan region.

CPV infection is often associated with various degrees of anemia, a finding consistent with previous research (Chinchkar *et al*., 2006; Castro *et al*., 2013; Shah *et al*., 2013; Dash *et al*., 2017; Andrea *et al*., 2017; Ogbu *et al*., 2022). In this group, 15 of the 30 dogs showed anemia that ranged from mild to severe, frequently

along with leukopenia and thrombocytopenia, indicating pancytopenia in 11 of the anemic dogs. Different types of anemia can occur, including normocytic hypochromic and microcytic hypochromic anemia. These conditions result from the virus's multifaceted effects, such as severe gastrointestinal damage leading to chronic blood loss and nutrient malabsorption, particularly iron, along with direct bone marrow suppression that disrupts red blood cell production. Additionally, chronic inflammation alters iron metabolism, further hindering red blood cell formation. Leukopenia was another significant finding, present in 22 out of 30 dogs, with varying degrees: mild (16.67%), moderate (40%), and severe (16.67%). This condition primarily stemmed from neutropenia, which was observed in 20 dogs (66.67%), either alone or in combination with lymphopenia. The presence of severe neutropenia (40%) indicates bone marrow suppression, which reduces the production of neutrophils and compromises the dogs' ability to fight secondary bacterial infections. Lymphopenia, noted in 12 dogs (40%), suggests immunosuppression, increasing vulnerability to opportunistic infections. Some dogs with normal white blood cell count also exhibited lymphopenia, highlighting its potential as a marker for the immune response to CPV. Biochemical analyses revealed hyperproteinemia in 26.7% of the dogs, likely due to dehydration from vomiting and diarrhea. Hyperalbuminemia and hyperglobulinemia in 20% of cases indicate an inflammatory response characterized by increased production of acute phase proteins and immunoglobulins. Elevated serum levels of AST (10%), ALT (6.7%), and ALP (3.3%) suggest liver involvement, possibly due to hypoxic injury from severe anemia or direct viral damage. Elevated serum creatinine (16.7%) points to potential renal impairment, likely resulting from dehydration or direct viral nephropathy. The clinical implications of CPV are particularly severe in younger, unvaccinated dogs. Symptoms such as bloody feces (76.7%), vomiting (83.3%), and anorexia (93.3%) are indicative of significant gastrointestinal damage. Notably, 80% of these dogs had no vaccination history, underscoring the urgent need for comprehensive vaccination programs.

In conclusion, the findings emphasize the critical role of vaccination in mitigating the hematological, hepatic, and renal effects of CPV infection. The marked differences in clinical parameters between vaccinated and non-vaccinated dogs reinforce the protective benefits of immunization and highlight the necessity for effective vaccination strategies to control CPV spread and reduce its clinical severity.

## Conclusion

This study emphasizes the significant clinical and laboratory effects of Canine Parvovirus (CPV) on young dogs, particularly breeds like German Shepherds, Boerboels, and Rottweilers. The findings suggest that veterinarians should be aware of breed susceptibility when diagnosing and managing CPV cases, as early intervention in these breeds is crucial for improving outcomes. Routine blood tests are essential for assessing common conditions such as anemia, leukopenia, and thrombocytopenia in CPV-infected dogs. These laboratory markers, combined with clinical signs, can serve as a cost-effective diagnostic tool within the Clinical Signs Laboratory Marker (CSLM) model (Akanbi *et al*., 2024, in press). The study advocates for robust

vaccination programs, highlighting that vaccination significantly mitigates the clinical severity of CPV, thereby protecting vulnerable canine populations. Effective treatment plans should focus on addressing dehydration, electrolyte imbalances, and potential liver and kidney issues. Supportive care, including fluid therapy and nutritional support, is vital for managing the systemic effects of the infection. Educating pet owners on the importance of early vaccination and prompt medical attention for susceptible breeds is crucial for controlling CPV spread and improving clinical outcomes. In summary, early diagnosis, supportive care, and preventive vaccination are essential for better health in at-risk canine populations.

## Approval of Ethical Commission

The ethical approval for this research study was given by the ACUREC of the University of Ibadan, Ibadan, Nigeria.

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## Author's Contribution

In the study, Dr. Olaifa O.S. was pivotal in the conceptualization of the study, developing the overall research framework and methodology. In addition, he supervised the project and coordinated administrative tasks while contributing significantly to the review and editing process of the manuscript.

Kolawole A.R. took the lead in conducting the investigation, handling formal analysis, and curating data. Akanbi O.B. was integral to the validation and formal analysis of the results, ensuring that the software tools were correctly implemented and resources were managed efficiently. He also played a key role in conceptualizing and helping to gather resources and funds for the study. His contributions extended to reviewing and editing the manuscript for clarity and coherence. Odita C.I. participated actively in managing data collection and ensuring accurate curation. She supported the drafting of the original manuscript and provided necessary resources for the study. Lastly, Taiwo V.O.'s leadership was evident in supervision and his substantial input in reviewing and editing the manuscript.

## Conflict of Interest

The authors declare that there are no conflicts of interest related to this study. No external financial support was received for conducting the research or preparing this manuscript. All aspects of the study, including data collection, analysis, and writing, were conducted independently by the authors.

## Data Availability Statement

The data supporting the findings of this study are available from the corresponding author, Olaifa O.S, upon reasonable request. The data include the raw hematological and serum chemistry data of the canine subjects involved in this research. Access to the data is restricted to ensure compliance with ethical standards and the privacy of the research subjects.

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