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Hematological parameters and hypoglycemia in dogs with canine distemper virus and canine *parvovirus* infections: Study in veterinary clinics in Ho Chi Minh City, Viet Nam

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ABSTRACT

This study investigates hypoglycemic symptoms and physiological/ biochemical markers in dogs with parvovirus or distemper in Ho Chi Minh City. The survey of 10 cases of dogs with brown bloody diarrhea showed decreased red blood cell counts of 3.99 million/mm^3 (8/10 samples), decreased and increased white blood cell counts (4/10 and 4/10, respectively), and eight cases had extremely elevated AST. The AST, ALT, urea, and creatinine indexes rose in dogs exhibiting neurological symptoms; in contrast, the quantity of red and white blood cells dropped. Findings from the blood physiological index study of dogs infected with the parvovirus reveal that aberrant white blood cell indices (increased or decreased) were present in 50% of blood samples. According to survey results, of the 20 cases that tested positive for parvovirus, 14 cases (70%) had an increased AST index, while 4/20 (20%) had an increased ALT. Thirty cases (58.8%) of reduced blood sugar levels were found in a survey of fifty-one dogs who tested positive for the parvovirus and Carré. Of these, six cases had a minor fall in the blood sugar index, and twenty-four cases had a significant decrease.

1. INTRODUCTION

Carré disease or canine distemper was the most dangerous acute infectious disease in the first half of the 19th century, often occurring in puppies, spreading rapidly, and with a very high mortality rate. *Carré* disease was first reported in Europe in 1760 (Appel & Gillespie, 1972). The clinical symptoms and progression of the disease were first described in 1809 by Edward Jenner, and *Carré* virus was isolated in 1905. Carré disease occurs widely around the world, occurring in the US, Argentina, Brazil, Mexico, South Africa, and many countries in Europe, and most recently in Asian countries such as Thailand (Radtanakatikanon et al., 2013), Korea (An et al., 2008) and Viet Nam (Lan et al., 2009; Van Nguyen et al., 2017). The cause of Carré disease in dogs is the *Carré* virus (Canine distemper virus - CDV). CDV is a virus that infects lymph, mucosal, and nervous tissue, and is a member of the Morbillivirus genus of the Paramixoviridae family. *Carré* virus also causes disease in wild carnivores and tigers (Appel et al., 1994).

Parvovirus is a contagious disease in dogs, and unvaccinated dogs and puppies younger than 4 months are more susceptible to the disease. The virus affects the gastrointestinal tract in dogs and is transmitted when sick dogs have direct contact with healthy dogs or pathogens are present in feces, the environment, or humans. The virus can infect cages, food and water, collars, leads, or the hands and clothes of people in contact with sick dogs. Vaccines

can prevent this infection, but the mortality rate can be as high as 91% in untreated cases. Parvovirus CPV2 is a relatively new disease that emerged in the late 1970s. It was first recognized in 1978 and spread worldwide in one to two years.

Hypoglycemia is a condition that occurs when blood sugar levels are too low, leading to a lack of glucose for the body to function, and causing disorders in the body. This metabolic disorder can have a wide range of clinical signs, from abnormal behavior to life-threatening emergencies. Hypoglycemia can be caused by a number of physiological or pathological processes. The research results are very important in providing scientific data, supporting disease diagnosis based on changes in blood sugar indicators, physiology, blood biochemistry, and the time that animals get sick, contributing to reduced disease incidence and minimized economic losses caused by *Carré* disease and *Parvovirus*.

2. MATERIALS AND METHOD

2.1. Blood sampling

A survey was conducted on all dogs brought for examination and treatment in the period from April 2024 to September 2024 at Hong Loan Veterinary Clinic, Ho Chi Minh City.

Blood sampling process: first, blood is taken in the morning when the dog has not eaten or exercised. A specialized syringe takes about 1.5 ml of blood from the popliteal vein. If the blood sample is taken directly for cell counting, no additional anticoagulant is needed. However, if the sample needs to be preserved before analysis, an anticoagulant such as EDTA or sodium citrate can be used at a rate of 3%.

2.2. Survey of blood physiological indicators

Determine the number of red blood cells, white blood cells and hemoglobin content: After sampling, blood physiological parameters will be analyzed using a physiological index analyzer (BC-2800Vet-MINDRAY).

Determine the hematocrit index (Ht): Use a Wintrobe tube, a glass tube 10 cm long and 3 mm in diameter, graduated in centimeters. Aspirate the blood with a syringe with a long needle and put it into the Wintrobe tube to the zero mark. Centrifuge the Wintrobe tube at 3000 rpm for 30 minutes. After centrifugation, the red blood cells that settle will form a column. Determine the height of this red blood cell column by reading the Wintrobe tube's scale. The hematocrit value (Ht) is calculated by taking the average between the highest and lowest levels of the sedimented red blood cell column (Wintrobe, 2009).

Determine white blood cell formula: Prepare blood specimen: spread blood on glass slide, fix and stain by double staining method using dyes such as eosin and methylene blue. Observe the specimen under an optical microscope with a magnification of 1000 times. Classify and count white blood cells: conduct a random count of 100 white blood cells and classify different types of white blood cells. Calculate the white blood cell formula: based on the results of counting and classifying white blood cells, calculate the fraction ratio percent of each type of white blood cell to determine the white blood cell formula.

2.3. Blood sugar index survey

Take blood from dogs that tested positive for *Carré* disease and *Parvovirus*, when first brought to the clinic, and put it into a gray tube (containing anticoagulants Heparin and NaF). Assess liver and kidney function. Calculate X ± SE of biochemical and blood physiological indicators. Evaluate the fluctuations of blood physiological and biochemical indicators in dogs with clinical diseases compared to reference ranges.

2.4. Statistics and data processing

All collected data were processed using Microsoft Excel 2016® and Minitab 17.0 software. All data after processing for each monitoring indicator are expressed as the average plus standard deviation.

3. RESULTS AND DISCUSSION

3.1. The results of determining physiological and biochemical indexes of dog blood showed symptoms of diarrhea with blood and brown, fishy mucus

As a result of the survey, there were 10 cases of dogs with brown bloody diarrhea, and the test results were positive. Blood was taken from these dogs to measure physiological and biochemical indicators. The results are presented in Table 1.

Table 1. Physiological and biochemical indexes of blood in dogs with symptoms of brown and fishy diarrhea (n = 10)

Tracking Indicators	Reference range	Result	Observation range	X ± SE	Amount	Proportion (%)
Erythrocytes (million/mm^3)	5.50 – 8.50	Increase	-	-	-	-
		Decrease	3.52 – 5.00	3.99 ± 0.18	8	80.00
White blood cells (thousand/mm^3)	6.00 – 17.00	Increase	17.50 – 34.90	26.30 ± 4.29	4	40.00
		Decrease	4.90 – 5.60	5.18 ± 0.17	4	40.00
AST (U/L)	8.90 – 48.5	Increase	63.00 – 81.00	70.50 ± 2.07	8	80.00
		Decrease	-	-	-	-
ALT (U/L)	8.20 – 57.30	Increase	75.00 – 77.00	75.67 ± 0.67	3	30.00
		Decrease	-	-	-	-
UREA (mmol/L)	3.10 – 9.20	Increase	14.40 – 15.50	14.97 ± 0.16	6	60.00
		Decrease	2.17 – 3.09	2.63 ± 0.46	2	20.00
CREATININE (mmol/L)	44.30 – 138.40	Increase	140 – 150	146.67 ± 1.54	6	60.00
		Decrease	12.00 – 39.00	27.67 ± 8.09	3	30.00

Results from Table 1 show that most of the surveyed samples had reduced red blood cells, accounting for up to 80% of cases. During infection, white blood cell counts decrease to below normal levels (Goddard et al., 2008; Ling et al., 2012). Clinical manifestations include refusal to eat, weakness, and bloody diarrhea with brown and fishy mucus. In 10 cases tested, up to 8 cases had a very high AST (aspartate aminotransferase) index, indicating that heart function was seriously impaired. When heart function is impaired, blood flow to the kidneys is also reduced (normally the kidneys receive about 25% of blood flow). If the kidneys do not receive enough blood, kidney function will decline and waste will not be excreted, leading to an increase in the blood urea index. There were 6 cases (60%) with increased creatinine. Creatinine is filtered through the glomerulus, is not reabsorbed in the renal tubules, and is excreted through urine, so it is considered a good indicator of glomerular filtration function. When creatinine increases, it is a sign that kidney function has been impaired.

3.2. Results of determining physiological and biochemical indexes of blood in dogs with neurological symptoms

The survey results showed that 11 cases of dogs with neurological symptoms had their blood taken to test physiological and biochemical indicators in the blood. The results are presented in Table 2.

Table 2. Physiological and biochemical indexes of blood in dogs with neurological symptoms (n = 11)

Tracking Indicators	Reference range	Result	Observation range	X ± SE	Amount	Proportion (%)
Erythrocyte (million/mm^3)	5.50 – 8.50	Increase	-	-	-	-
		Decrease	3.62 – 4.40	3.95 ± 0.08	10	90.91
White blood cells (thousand/mm^3)	6.00 – 17.00	Increase	-	-	-	-
		Decrease	1.70 – 4.90	3.50 ± 0.36	11	100
AST (U/L)	8.90 – 48.5	Increase	96.00 – 116	106.89 ± 2.51	9	81.82
		Decrease	-	-	-	-
ALT (U/L)	8.20 – 57.30	Increase	84.00 – 88.00	85.5 ± 0.62	6	54.55
		Decrease	-	-	-	-
UREA (mmol/L)	3.10 – 9.20	Increase	16.21 – 17.60	16.96 ± 0.19	7	63.64
		Decrease	-	-	-	-
CREATININE (mmol/L)	44.30 – 138.40	Increase	176 – 220	198.67 ± 5.56	9	81.82
		Decrease	-	-	-	-

The results in Table 2 show that the physiological and biochemical indices in the blood of dogs with neurological symptoms had significant changes. Specifically, AST, ALT, urea, and creatinine indexes all increased. There were 9 cases with increased AST up to 116 U/L (accounting for

81.82%), and 6 cases of increased ALT (accounting for 54.55%). In contrast, the number of red blood cells and white blood cells decreased. All blood samples (100%) showed leukopenia, in some cases, down to a minimum of 1.70 thousand/mm^3. More than 90% (90.91%) of the samples recorded decreased red blood cells. These signs reflect serious deterioration of blood cell, bone marrow, heart, liver and kidney function. The cause is exhaustion and malnutrition in dogs with late-stage *Carré* disease. Increased urea and creatinine can be due to heart failure, gastrointestinal bleeding, dehydration and salt loss, leading to impaired blood flow to the kidneys, causing kidney failure. This can also lead to urea poisoning, causing the dog to fall into a coma. The results of this study, the indicators, as well as the signs and symptoms, are similar to the studies reported by (Castro et al., 2007; Goddard et al., 2008; Kalli et al., 2010; Sykes, 2014).

3.3. Results of determining blood physiological index of dogs infected with *Parvovirus*

Survey results showed that 10 blood samples had white blood cell counts within the normal physiological range. The results are presented in Table 3.

The results in Table 3 show that 50% of blood samples had abnormal white blood cell indices (increased or decreased). The main cause of co-infection in dogs is the simultaneous action of two different agents - viruses that reduce the number of white blood cells and bacteria that increase the number of white blood cells. This causes the hematopoietic organs to not function ormally and leads to changes in the number of white blood cells. Survey results show that dogs aged 2 - 6 months have a very high risk of graft infection. This result is similar to the report of Tion et al. (2018). Test results of 20 samples showed neutrophils: 6 samples increased (30%), 4 samples decreased (20%); Leukemic lymphoma: 6 samples increased (30%), 4 samples decreased (20%); Monocytes: 10 samples increased (50%), 2 samples decreased. This shows an imbalance in the number of white blood cells, reflecting graft infection in dogs.

Table 3. Blood physiological indexes of dogs with *Parvovirus* (n=20)

Tracking Indicators	Reference range	Result	Amount	Proportion (%)
Erythrocyte (million/mm^3)	5.5 – 8.5	Increase	-	-
		Decrease	14	70.00
Hematocrit (%)	37 – 55	Increase	-	-
		Decrease	14	70.00
White blood cells (thousand/mm^3)	6.0 – 17	Increase	2	10.00
		Decrease	8	40.00
Neutrophil (%)	60 – 75	Increase	6	30.00
		Decrease	4	20.00
Lymphocyte (%)	12 – 30	Increase	6	30.00
		Decrease	4	20.00
Monocyte (%)	3 – 10	Increase	10	50.00
		Decrease	2	10.00

3.4. Results of determining blood biochemical indexes of dogs infected with *Parvovirus*

Survey results showed that among 20 cases positive for *Parvovirus*, 14 cases (accounting for 70%) had elevated AST index. The results are presented in Table 4.

Table 4. Blood biochemical indexes of dogs with *Parvovirus* (n=20)

Tracking Indicators	Reference range	Result	Amount	Proportion (%)
AST (U/L)	8.9 – 48.5	Increase	14	70.00
		Decrease	-	-
ALT (U/L)	8.2 – 57.3	Increase	4	20.00
		Decrease	-	-
UREA (mmol/L)	3.1 – 9.2	Increase	4	20.00
		Decrease	4	20.00
CREATININE (mmol/L)	44.3–138.4	Increase	-	-
		Decrease	8	40.00

The results in Table 4 show that, unlike AST, only 4/20 (20%) of dogs with diarrhea caused by *parvovirus* had increased ALT. ALT is abundant in liver cells, so ALT quantification is useful in diagnosing liver necrosis. AST and ALT have the same concentration in liver cells but are distributed differently: AST is in the cytoplasm and mitochondria while ALT is only in the cytoplasm. The half-life of ALT is longer than AST (47 hours compared to 17 hours), so ALT increases when there is damage at the liver cell level, not to the extent of mitochondrial damage. Of the 20 samples, 2 samples had both ALT and AST increased. Among them, 1 sample of ALT > AST, 1 sample AST > ALT. In addition, 4/20 samples (20%) had decreased blood urea, and 8/20 samples (40%) had decreased blood creatinine. This finding aligns with the results of Hoan and Hue (2020), which showed that infected with canine *Parvovirus* had AST (61.75 U/L) and ALT (64.77 U/L) enzyme levels and urea (14.03 mmol/L) increased, in case of creatinine (35.87 mmol/L), blood sugar level (4.26 mmol/L) reserve decreased in comparison with the healthy dogs; Hai et al. (2021) also demonstrated an increase in liver enzymes (AST: 64,00 ± 7,32 U/L, ALT: 110,14 ± 7,76 U/L).

3.5. Compare physiological and biochemical indicators of healthy dogs with those of dogs with *Carré* disease

Of the 25 cases with positive test results for *Carré* disease, 10 animals with characteristic symptoms of the disease were selected. The results of counting the number of red blood cells, the number of white blood cells, and the ratio of different types of white blood cells using a hematometer are presented in Table 5.

Table 5. Some blood physiological indices of dogs with *Carré* disease (n=10)

Tracking Indicators	Reference range	Result	Observation range	Mean ± SE	Amount	Proportion (%)
Erythrocyte (million/mm^3)	5.5-8.5	Decrease	4.05-5.4	4.76 ± 0.17	10	100
Hematocrit (%)	37-55	Decrease	31.5-35	33.42 ± 0.38	10	100
White blood cells (thousand/mm^3)	6.0 -17.0	Decrease	4-5.8	5.12 ± 0.19	10	100
Neutrophil (%)	60 – 75	Increase Decrease	58-77	64.3 ± 2.1	2 2	20 20
Lymphocyte (%)	12 – 30	Increase	15-32	25.65 ± 1.84	2	20
Monocyte (%)	3 – 10	Decrease	2-6	3.81 ± 0.4	2	20

The average number of red blood cells and white blood cells only reached 4.76 million/mm^3 and 5.12 thousand/mm^3. Reduced red blood cell count may be due to conditions such as blood loss, diarrhea with high fever in pneumonia. The total number of white blood cells has decreased low compared to normal physiological parameters proving that the virus has strongly attacked hematopoietic organs, destroying white blood cells. The observation is relatively consistent with the observation of Ezeibe and Udegbunam (2008) about leukopenia infected with canine distemper virus. We recorded all 10 blood test samples with quantity decrease of white blood cells. In 10 cases of white blood cell formula surveys, the main changes were in neutrophils, lymphocytes, and monocytes, affecting the dog's resistance. Effective treatment of *Carré* disease depends greatly on the resistance of the sick dog itself and above all the care and concern of the owner. The nearly study in Iran also stated that a significant number of dogs may die if they develop a distemper virus despite treatment, the distemper fatality rate was 69.57% (32/46) (Mousafarkhani et al., 2023).

3.6. Blood sugar indexes in dogs infected with *Carré* and *Parvovirus* diseases

The results of a survey of 51 dogs with positive test results for *Carré* and *Parvovirus* showed that there were 30 cases of reduced blood sugar levels when infected with *Carré* and *Parvovirus*. The results are presented in Table 6.

From the results in Table 6, it can be seen that the number of dogs with a decreased blood sugar index when infected with *Carré* and *Parvovirus* was 30. (58.8%), there were 6 cases of slightly decreased blood sugar index, and there were 24 cases with a strong decrease in the blood sugar index; 18 cases had normal blood sugar index, accounting for 35.2% and 3 cases had increased blood sugar index, accounting for 6%. A A slight decrease in blood sugar index occurs in dogs in the early stages of

Carré and *Parvo* disease due to not eating for 1 to 2 days, vomiting, and food that is not adequate in nutritional value. The blood sugar index drops sharply when sick dogs stop eating for a long time, vomit and have frequent loose bloody stools. Typical symptoms include vomiting and diarrhea, which can range from mucous to bloody (Prittie, 2004; Lamm & Rezabek, 2008; Touihri et al., 2009). *Parvovirus* canine tends to attack rapidly dividing cells in the intestinal tract, lymphoid tissue, and bone marrow, leading to bloody diarrhea, vomiting, severe leukopenia, and immunodeficiency (Hoskins, 1997). Dogs infected with *Carré* and *Parvovirus* may develop hypoglycemia, the main cause of which is usually related to the effects of the virus on liver cells, strong damage to the immune system and effects on insulin production or the mechanism that regulates the body's level of insulin. The number of red blood cells is an important index to evaluate the blood's ability to carry oxygen. Infectious diseases such as *Carré* and *Parvovirus* can affect the production and distribution of red blood cells, leading to a reduced red blood cell count. Platelet counts can decrease in inflammatory diseases such as *Carre*'s disease and *Parvovirus*, causing anemia due to blood loss. Hematocrit (Ht) and Hemoglobin (Hb) are measures of the blood's ability to transport oxygen. In infections by *Carré* and *Parvovirus*, decreased Ht and Hb reflect blood loss and anemia. There were 3 cases with increased blood sugar index, accounting for 6%. Dogs infected with diseases such as *Carré* and *Parvovirus* can show fluctuations in blood sugar levels, including hyperglycemia in some dogs. The main causes include stress and physical reactions: dogs infected with these diseases often have to endure a large amount of physiological and emotional stress. Hormones such as cortisol and adrenaline caused by stress can lead to hyperglycemia. About inflammation and an immune response: *Carré* and *Parvovirus* diseases cause severe inflammation. A strong immune response and damage to the body can cause the liver to increase glucose production and the tissues to decrease glucose use. Fluctuations in blood sugar balance: some dogs with these diseases may experience fluctuations in blood sugar balance due to factors such as excess insulin or reduced ability to effectively consume insulin (Castro et al., 2007; Goddard et al., 2008; Kalli et al., 2010). Although hyperglycemia is not a common presentation in *Carré* and *Parvovirus* infections, it can occur in some special cases.

Table 6. Reduced blood sugar index in 30 dogs infected with *Carré* and *Parvovirus*

TT	Normal glucose content (mmol/L)	Glucose index in sick dogs (mmol/L)	Result	TT	Glucose content normal (mmol/L)	Glucose index in sick dogs (mmol/L)	Result
1	3.3 – 6.2	3.26	Mitigate	16	3.3 – 6.2	2.50	Plummeting
2		3.23		17		2.48	
3		3.17		18		2.46	
4		3.12		19		2.44	
5		3.08		20		2.31	
6		3.04		21		2.30	
7		2.99	Plummeting	22		2.27	
8		2.83		23		2.24	
9		2.76		24		2.22	
10		2.66		25		2.16	
11		2.62		26		2.11	
12		2.60		27		2.10	
13		2.57		28		1.53	
14		2.57		29		1.46	
15		2.55		30		1.42	

4. CONCLUSION

The survey of 10 cases of dogs with brown bloody diarrhea showed decreased red blood cells, decreased and increased white blood cells, and eight cases had extremely elevated AST. The AST, ALT, urea, and creatinine indexes rose in dogs exhibiting neurological symptoms. Most of the *Carré* disease survey samples had reduced red and white blood cells. In most of the samples of dogs infected with *Parvovirus*, red blood cells, white blood cells, and hematocrit all tended to decrease, while AST and ALT indexes all tended to increase. More than 50%

of dogs testing positive for *Carré* disease and *Parvovirus* had reduced blood sugar levels.

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REFERENCES

An, D.-J., Kim, T.-Y., Song, D.-S., Kang, B.-K., & Park, B.-K. (2008). An immunochromatography assay for rapid antemortem diagnosis of dogs suspected to have canine distemper. *Journal of Virological Methods*, *147*(2), 244-249.

Appel, M. J., Yates, R. A., Foley, G. L., Bernstein, J. J., Santinelli, S., Spelman, L. H., . . . Barr, M. (1994). Canine distemper epizootic in lions, tigers, and leopards in North America. *Journal of Veterinary Diagnostic Investigation*, *6*(3), 277-288.

Appel, M. J. G., & Gillespie, J. H. (1972). *Canine Distemper*. Virus. Virology Monographs. New York: Springer Verlag. *11*.

Castro, T., Miranda, S., Labarthe, N., Silva, L., & Cubel Garcia, R. (2007). Clinical and epidemiological aspects of canine parvovirus (CPV) enteritis in the State of Rio de Janeiro: 1995-2004. *Arquivo brasileiro de medicina veterinária e zootecnia*, *59*, 333-339.

Ezeibe, M. C. O. & Udegbunam, R. I. (2008). Haematology of dogs infected with canine distemper virus. *Sokoto J Vet Sci.*, 7(2), 31–33.

Goddard, A., Leisewitz, A., Christopher, M., Duncan, N., & Becker, P. (2008). Prognostic usefulness of blood leukocyte changes in canine parvoviral enteritis. *Journal of Veterinary Internal Medicine*, *22*(2), 309-316.

Hoan T. D., & Hue G. T. (2020). Several clinical signs and hematological parameters in canine *Parvovirus* infection. *Veterinary sciences and techniques*, 27(8), 50-61.

Hai V. V., Dao B. T.A., Nga B. T. T., & Phan L. V. (2021). Some physiological and biochemical indicators of blood in dogs suffering from diarrhea caused by canine *Parvovirus*. *Veterinary Sciences and Techniques*, *28*(4), 27-32.

Hoskins, J. (1997). Update on canine parvoviral enteritis.

Kalli, I., Leontides, L. S., Mylonakis, M. E., Adamama-Moraitou, K., Rallis, T., & Koutinas, A. F. (2010). Factors affecting the occurrence, duration of hospitalization and final outcome in canine *parvovirus* infection. *Research in Veterinary Science*, *89*(2), 174-178.

Mousafarkhani, F., Sarchahi A. A., Mohebalian, H., Khoshnegah, J., & Arbabi, M. (2023). Prevalence of canine distemper in dogs referred to Veterinary Hospital of Ferdowsi University of Mashhad, Mashhad, Iran. *Vet Res Forum.*, *14*(3), 153–160.

Lamm, C. G., & Rezabek, G. B. (2008). *Parvovirus* infection in domestic companion animals. *Veterinary Clinics of North America: Small Animal Practice*, *38*(4), 837-850.

Lan, N. T., Yamaguchi, R., Kien, T. T., Hirai, T., Hidaka, Y., & Nam, N. H. (2009). First isolation and characterization of canine distemper virus in Vietnam with the immunohistochemical examination of the dog. *Journal of Veterinary Medical Science*, *71*(2), 155-162.

Ling, M., Norris, J. M., Kelman, M., & Ward, M. P. (2012). Risk factors for death from canine parvoviral-related disease in Australia. *Veterinary Microbiology*, *158*(3-4), 280-290.

Prittie, J. (2004). Canine *parvovirus* enteritis: a review of diagnosis, management, and prevention. *Journal of Veterinary Emergency and Critical Care*, *14*(3), 167-176.

Radtanakatikanon, A., Keawcharoen, J., taya Charoenvisal, N., Poovorawan, Y., Prompetchara, E., Yamaguchi, R., & Techangamsuwan, S. (2013). Genotypic lineages and restriction fragment length polymorphism of canine distemper virus isolates in Thailand. *Veterinary Microbiology*, *166*(1-2), 76-83.

Sykes, J. E. (2014). Canine *parvovirus* infections and other viral enteritides. *Canine and Feline Infectious Diseases*, 141.

Tion, M., Fotina, H., & Saganuwan, A. (2018). A retrospective study of Canine *parvovirus* in Private veterinary clinic 'Health', Sumy Region, Ukraine (2015–2018). *Journal for Veterinary Medicine, Biotechnology and Biosafety*, *4*(3), 5-9.

Touihri, L., Bouzid, I., Daoud, R., Desario, C., El Goulli, A. F., Decaro, N., . . . Bahloul, C. (2009). Molecular characterization of canine *parvovirus*-2 variants circulating in Tunisia. *Virus Genes*, *38*, 249-258.

Van Nguyen, D., Suzuki, J., Minami, S., Yonemitsu, K., Nagata, N., Kuwata, R., . . . Maeda, K. (2017). Isolation and phylogenetic analysis of canine distemper virus among domestic dogs in Vietnam. *Journal of Veterinary Medical Science*, *79*(1), 123-127.

Wintrobe, M. M. (2009). *Wintrobe's clinical hematology* (Vol. 1, 12th ed). Lippincott Williams & Wilkins