www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(11): 2314-2320

www.thepharmajournal.com
Received: 01-09-2022
Accepted: 06-10-2022

Hemali Patel
M.V.Sc. Veterinary Medicine, Kamdhenu University, Anand, Gujarat, India

Neha Rao
Assistant Professor, Veterinary Clinical Complex, Kamdhenu University, Anand, Gujarat, India

Nitin R Patel
Scientist, KVK, AAU, Arnej, Ahmedabad, Gujarat, India

Nilesh Gohil
M.V.Sc. Veterinary Medicine, Kamdhenu University, Anand, Gujarat, India

Corresponding Author:
Hemali Patel
M.V.Sc. Veterinary Medicine, Kamdhenu University, Anand, Gujarat, India

Haemato-biochemical changes and therapeutic efficacy of adjuvant therapy on canine parvovirus gastroenteritis

Hemali Patel, Neha Rao, Nitin R Patel and Nilesh Gohil

Abstract
The study was conducted to access haemato-biochemical changes and to evaluate the efficacy of adjuvant therapy in CPV affected dogs. The clinical signs were anorexia, haemorrhagic diarrhoea, dehydration, dullness and vomition. Thirty two dogs were randomly selected based on clinical signs and the results of immune-chromatographic (IC) test and divided into 4 groups for therapeutic management, *viz.*, Group B, C, D and E, each of 8 animals, and a group of six healthy dogs (Group A) presented at Veterinary Clinical Complex for routine vaccination was kept as control. Group B dogs were treated with standard therapy. In groups C, D and E, along with standard therapy, honey, N-acetyl cysteine and Glutamine powder were given as adjuvant, respectively. Highly significant decrease in WBC count, lymphocytes, total protein and significant decrease in albumin, globulin, whereas neutrophils and creatinine were highly significantly increased and BUN was significantly increased in CPV infected dogs as compared to healthy dogs. The therapeutic efficacy based on haemato-biochemical parameters showed comparable findings between the different treatment protocols on day 5 as compared to values of healthy group. The recovery time was significantly less and recovery rate was highest in dogs treated with N-Acetyl Cysteine as adjuvant.

Keywords: CPV, clinical signs, haemato-biochemical changes, adjuvant therapy

1. Introduction
Dogs belong to the Canidae family of mammals. The scientific name dog is *Canis lupus familiaris* (Access Science Editor, 2014) [2]. Haemorrhagic gastroenteritis has a variety of causes. Canine parvovirus (CPV) is a well-known pathogen of dogs that is responsible for roughly 27 percent of canine diarrhoea cases. It causes high rate of mortality, particularly in pups under the age of six months (Sakulwira *et al.*, 2001) [28].
The severity of clinical symptoms varies depending on the animal's age, maternal immunity, immune response status and virus strain virulence (Awad, *et al.*, 2019) [5]. Symptoms of CPV-2 infection include acute haemorrhagic enteritis and myocarditis. Enteritis in dogs can accompany with fever, depression, loss of appetite, lethargy, vomiting and severe mucoid or bloody diarrhoea (Albaz *et al.*, 2015; Khare *et al.*, 2019) [3, 20].
Gastroenteritis was linked to a variety of haemato-biochemical alterations (Suresh *et al.*, 1994; Zafar *et al.*, 1999) [34, 38]. Haematological results included neutrophilia, lymphopenia and leucopenia. The majority of electrolyte abnormalities are caused by gastrointestinal diseases, with sodium, potassium, calcium and phosphorus being the most common. In CPV gastroenteritis, an increase in serum alanine aminotransferase, aspartate aminotransferase and alkaline phosphatase has been seen (Jacob *et al.*, 1980) [18].
Symptomatic and supportive therapy for CPV infection includes antiemetics, antibiotics, nutritional support, hydration therapy, antiviral medications and pain management. Fluid therapy with 5% dextrose saline or lactated Ringer's solution, depending on the severity of dehydration, is the line of therapy. If no therapy is given, the survival rate of sick dogs can be as low as 9 percent, but vigorous treatment can reduce mortality (Folitse *et al.*, 2017) [12].
Dogs are vaccinated with either attenuated or modified live vaccinations to prevent infection (Albaz *et al.*, 2015; Mylonakis *et al.*, 2016) [3, 24]. The primary CPV vaccination should be at the age of 6-8 weeks, then 2-4 weeks after the primary vaccination booster dose is recommended followed by every year revaccination (Ford *et al.*, 2017; Decaro *et al.*, 2020) [13, 10].

2. Materials and Methods

Total 32 dogs were randomly selected for therapeutic management based on clinical signs suggestive of canine parvoviral infection such as vomition, diarrhoea (haemorrhagic or non-haemorrhagic), weakness, inappetence, etc. and the results of immune-chromatographic (IC) test. These dogs were divided into 4 groups, *viz.*, Group B, C, D and E, each of 6 animals, and a group of six healthy dogs (Group A) presented at VCC for routine vaccination was kept as control. Group B dogs were treated with standard therapy that was ceftriaxone tazobactam @ 20 mg/kg OID I/V, metronidazole @ 20 mg/kg OID I/V, 5% DNS and RL according to % dehydration, ethamsylate @ 250-500 mg total dose OID I/V, vitamin B complex @ 1 ml total dose OID I/V, vitamin C @ 20 mg/kg OID I/V and ondansetron @ 0.5 mg/kg BW OID S/C. In groups C, D and E, along with standard therapy, honey @ 2 ml/kg b.wt., OID, P.O., N-acetyl cysteine (NAC) @ 70 mg/kg b.wt., OID, I/V and glutamine powder @ 0.5 gm/kg b.wt., OID, P.O. were given as adjuvant, respectively.

2.1 Clinical Examination

The clinical examination of dogs with haemorrhagic diarrhoea was carried out for rectal temperature, heart rate and respiratory rate.

2.2 Rapid Test for Canine Parvovirus Using Vet Cetera Rapid CPV Antigen Test Kit

The Vet Cetera Canine Parvovirus Rapid test is a lateral flow assay designed to detect Parvovirus infection without the use of a laboratory. The kit's swab was used to collect faeces from the rectum or previously ejected faecal samples. The swab was dipped in the diluent supplied with the assay and used to agitate the diluent to extract enough faecal sample and allowed to settle. Two to Three drops were poured into the sample hole on the test card using the provided dropper. The results were read in 5-10 minutes. The control line, denoted by the letter C, was always visible on the kit. If there was enough Canine Parvovirus antigen in the sample, a red test line, denoted as T, was visible.

2.3 Haemato-Biochemical Analysis

Five ml of blood was collected aseptically from recurrent tarsal vein of which 2 ml blood was transferred in sterile K3EDTA vacutainers for hematological analysis and 3 ml was transferred in sterile clot activator vial for separation of the serum for biochemical studies. Alterations in the values were observed by using auto analyzer.

Blood samples were aso collected from dogs of healthy control group as above on day 0 for haemato-biochemical analysis and comparing the findings with CPV positive dogs.

2.4 Therapeutic Management of Canine Parvovirus Enteritis

The therapeutic management of canine parvovirus gastroenteritis was carried out with standard therapies without (Group B) and with adjuvant therapies (Group C, D and E, Honey, NAC and Glutamine, respectively).

There were 4 groups of CPV positive dogs for therapeutic management and each of 8 dogs, A healthy control group A was having 6 dogs as shown in Table 1.

Table 1: Protocols for Therapeutic Management of Canine Parvovirus Enteritis (Duration of Treatment: 5 Days)

Treatment	Dose		Healthy dogs	CPV Positive Therapeutic Groups		
		Group A (n=6)	Group B (n=8)	Group C (n=8)	Group D (n=8)	Group E (n=8)
Ceftriaxone – tazobactam	20 mg/kg BW OID I/V	-----	✓	✓	✓	✓
Metronidazole	20 mg/kg BW OID I/V	-----	✓	✓	✓	✓
Ethamsylate	250-500 mg total dose OID I/V	-----	✓	✓	✓	✓
Vitamin B complex	1 ml total dose OID I/V	-----	✓	✓	✓	✓
Vitamin C	20 mg/kg BW I/V OID	-----	✓	✓	✓	✓
Ondansetron	0.5 mg/kg BW OID S/C	-----	✓	✓	✓	✓
Ringer's lactate + 5% DNS	Replacement fluid per 24 hrs as per % of dehydration I/V	-----	✓	✓	✓	✓
Honey	2 ml total dose BID on tongue	-----	-----	✓	-----	-----
N-acetyl cysteine (NAC)	70 mg/kg BW OID I/V	-----	-----	-----	✓	-----
Glutamine powder	0.5 gm/kg BW OID P.O.	-----	-----	-----	-----	✓

3. Results and Discussions

3.1 Clinical Examination (Rectal Temperature, Heart Rate and Respiration Rate)

The mean ± SE values of rectal temperature, heart rate and respiratory rate of groups A, B, C, D and E dogs depicted in Table 3. There was no significant ($p>0.05$) difference in rectal temperature of healthy dogs and CPV infected dogs. A similar finding was observed by Reddy (2013) [26], Mylonakis *et al.* (2016) [24], Hasan *et al.* (2017) [17] and Saravanan *et al.* (2020) [30]. The variation in the body temperature may be associated with increased temperature as a result of viremia in the early stages and subnormal temperature after severe fluid and electrolyte losses (Biswas *et al.*, 2005, Bastan *et al.*, 2013) [9, 6].

Table 2: Clinical parameters (Mean ± SE) of healthy and CPV affected dogs on day 0

Parameter s	Group A (Healthy) (N=6)	Group B (N=6)	Group C (N=6)	Group D (N=6)	Group E (N=6)	"p" value
Temperature (°F)	101.20±0.19	101.35±0.80	101.58±0.42	101.02±1.08	100.08±0.94	0.628
Heart rate/min**	88.17^{a}±1.01	104.17^{b}±2.71	104.17^{b}±2.71	100.33^{b}±3.36	98.17^{b}±2.83	0.001
Respiratory rate/min*	21.67^{a}±0.21	25.83^{b}±0.75	25.83^{b}±0.75	24.67^{b}±0.84	24.17^{b}±0.75	0.001

Mean with different superscripts (a, b) within the row differ significantly ($p<0.05$)

**$p<0.01$ = highly significant, *$p<0.05$ = significant

The heart rate in all CPV affected dogs were significantly (p<0.01) higher than in healthy control group A (Table 3). This indicated that tachycardia was observed in CPV infected dogs compared to healthy dogs. Similar results were observed by Bastan *et al.* (2013) [6], Bhat *et al.* (2013) [8] and Reddy (2013) [26]. Tachycardia observed in CPV affected dogs in this study might be due to the effect of catecholamine and other compensatory mechanisms of the heart to maintain oxygen supply to tissues as suggested by Saxena *et al.* (2006) [31].
The respiratory rate was significantly (p<0.01) higher in all CPV affected dogs than in healthy control group A (Table 3). It is in agreement with observations of Reddy (2013) [26].

Fig 1: CPV affected dog with haemorrhagic diarrhoea

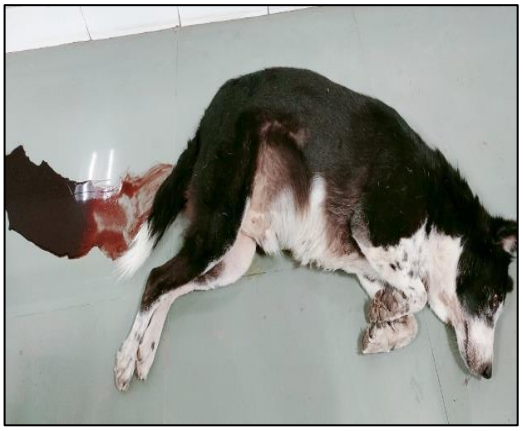

Fig 2: CPV affected dog with haemorrhagic diarrhoea

3.2 Diagnosis of Canine Parvovirus Gastroenteritis
3.2.1 Immunochromatographic Test
With the Vet Cetera rapid Ag test kit, faecal samples from 60 CPV suspected dogs were tested and 70.00% (42/60) dogs were found infected with CPV infection (Table 4). Since it is a speedy, simple, sensitive diagnostic test, immunochromatography based test kits have been used in several investigations to identify parvovirus from faecal samples of dogs. A similar result was observed by Hasan *et al.* (2017) [17], Bhargavi *et al.* (2017) [17], Navarro *et al.* (2020) [25], Tanwar *et al.* (2020) [35] and Shima *et al.* (2015) [32].

Table 3: Results of Vet Cetera rapid Antigen detection test kit for CPV

Vet Cetera rapid test kit		Percentage
Positive	42	70.00
Negative	18	30.00
Total	60	100

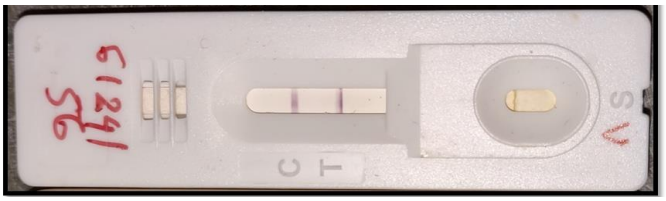

Fig 3: Rapid Ag test kit showing positive result for canine parvovirus infection

Fig 4: Rapid Ag test kit showing positive result for canine parvovirus infection

3.3 Haematological Changes in CPV Affected Dogs

Table 4: Haematological observations in healthy and canine parvovirus affected dogs on day 0 (Mean ± SE)

Parameters	Group A (Healthy dogs) (N=6)	CPV affected dogs (N=24)	"p" value
Hb (g/dl)	14.93±0.99	14.12±0.68	0.586
RBC (x106/µl)	7.15±0.47	7.20±0.29	0.941
WBC (x103/µl)	11.99±1.04	6.11±0.65**	0.000
Lymphocyte (%)	17.50±3.34	5.33±0.56**	0.000
Monocyte (%)	5.32±0.82	5.16±0.33	0.840
Neutrophils (%)	75.20±3.54	87.00±0.79**	0.000
Eosinophils (%)	1.57±0.44	1.88±0.30	0.628
Basophils (%)	0.42±0.12	0.63±0.09	0.259
PCV (%)	48.32±3.82	46.30±1.85	0.631
Platelets count (x103/µl)	320.00±25.48	354.29±38.29	0.695

**p<0.01 = highly significant.

The mean values of WBC and lymphocytes were highly significantly decreased (p<0.01) in CPV affected dogs in comparison to group A (healthy control group). Similar findings were reported by Salem (2014) [29], Wang (2019) [37], Saravanan *et al.* (2020) [30] and Harizan *et al* (2021) [16].
These findings might be due to the affinity of canine parvovirus for lymphocytes and lymphatic tissues. This discovery has received widespread acceptance and is ascribed to the death of haemopoietic progenitor cells of different leukocyte types, especially in the bone marrow, as well as in other lymphoproliferative organs such as the thymus, lymph nodes and spleen. This results in inadequate compensation for the massive demand for leukocytes in inflamed gastro intestinal tract (Goddard *et al.*, 2008) [15]. Due to their greater susceptibility to subsequent bacterial infections that can cause septicaemia, dogs with severe leukopenia have a higher mortality rate.
The mean value of neutrophils was highly significantly increased (p<0.01) in CPV affected dogs when comparison with healthy group A. Wang (2019) [37], Kataria *et al.* (2020) [19], Saravanan *et al.* (2020) [30] and Harizan *et al.* (2021) [16] reported similar findings. The neutrophilia observed might be due to secondary bacterial infections associated with parvoviral enteritis (Biswas *et al*, 2005) [9].
In the present study, the mean values of Hb, RBC, monocytes, eosinophils, basophils, PCV and platelet count in CPV affected dogs did not differ significantly (p>0.05) from

healthy dogs. These findings might be due to haemoconcentration as a result of dehydration (due to diarrhoea and vomition) in CPV affected dogs.

The present findings of non-significant difference in mean values of Hb, PCV and RBCs in CPV affected and healthy dogs are in disagreement with Mohanta *et al.* (2018) [23], Kataria *et al.* (2020) [19], Harizan *et al.* (2021) [16] and Sulthana *et al.* (2015) [33], who reported significant drop in in these parameters in CPV affected dogs.

Similarly the non-significant difference in mean value of platelets count between healthy and CPV dogs contradicted the findings of thrombocytopenia in CPV affected dogs by Tatiana *et al.* (2013) [36], Amaravathi *et al.* (2016) [4], Roble *et al.* (2016) [27] and Kataria *et al.* (2020) [19].

3.4 Haematological Changes in CPV Treated Dogs (Day 5)

Table 5: Haematological changes in CPV affected dogs of groups B, C, D and E on day 5 of treatment in comparison to healthy group

Parameters	Group A (Healthy dogs) (N=6)	Group B (N=6)	Group C (N=6)	Group D (N=6)	Group E (N=6)	"P" value
Hb (g/dl)	14.93±0.99	13.28±1.13	12.98±1.15	12.55±1.05	12.38±1.21	0.843
RBC (x106/µl)	7.15±0.47	7.40±0.57	6.50±0.14	7.26±0.58	6.13±0.42	0.400
WBC(x103/µl)	11.99±1.04	18.72±3.05	9.99±0.89	12.88±1.37	12.73±3.84	0.389
Lymphocyte (%)	17.50±3.34	16.50±5.68	18.30±8.42	19.85±4.78	18.10±4.01	0.267
Monocyte (%)	5.32±0.82	5.93±1.37	5.48±0.50	4.18±0.98	6.18±0.82	0.498
Neutrophils (%)	75.20±3.54	76.42±5.23	59.43±7.99	74.58±4.36	74.15±4.73	0.242
Eosinophils (%)	1.57±0.44	0.80±0.47	1.07±0.46	1.02±0.33	1.00±0.38	0.916
Basophils (%)	0.42±0.12	0.37±0.16	0.48±0.21	0.35±0.10	0.34±0.12	0.927
PCV (%)	48.32±3.82	47.53±4.06	43.76±1.79	41.88±2.53	43.45±4.36	0.820
Platelets count (x103/µl)	320.00ab±25.48	509.50c±68.91	439.00bc±29.94	456.17bc±72.21	270.33a±26.59	0.011

Means with different superscripts (a, b) within the row differ significantly ($p<0.05$).
**$p<0.01$ = highly significant, *$p<0.05$ = significant

The mean values of only platelet counts were found to be significantly ($p<0.05$) higher in groups B, C and D in comparison to group E on day 5, through the later was statistically at par with healthy group A. The mean value of platelet counts in groups A, C, D had no significant ($p>0.05$) difference from each other on day 5 after treatment.

The mean values of Hb, RBC, WBC, lymphocytes, monocytes, eosinophils, neutrophils, basophils and PCV in groups B, C, D and E on day 5 after treatment were statistically similar and did not differ significantly ($p>0.05$) from healthy control group A. This is suggestive that all the treatments were having positive effect on haematological parameters on 5th day and all the dogs were in recovery stage.

3.5 Serum Biochemical Changes in CPV Affected Dogs

Table 6: Serum biochemical profile of healthy and canine parvovirus affected dogs (Mean± SE)

Serum Parameters	Healthy dogs Group A (N=6)	CPV affected dogs (N=24)	"p" value
ALT (IU/L)	28.31±5.79	34.26±3.84	0.477
AST (IU/L)	20.68±3.43	31.84±6.52	0.408
Total protein (gm/dl)	5.24±0.07	4.98±0.18*	0.038
Albumin (gm/dl)	2.75±0.32	2.16±0.11*	0.033
Globulin (gm/dl)	3.48±0.34	2.70±0.16*	0.038
Creatinine (mg/dl)	0.70±0.06	0.89±0.05*	0.047
BUN (mg/dl)	5.74±2.80	17.58±2.20*	0.017
Blood glucose (mg/dl)	111.67±3.94	98.38±3.44	0.077

**$p<0.01$ = highly significant, *$p<0.05$ = significant

The mean values of serum total protein, albumin and globulin were significantly decreased ($p<0.05$) in CPV affected dogs in comparison to healthy dogs of group A. These findings were in agreement with Mallikarjun (2015) [22], Saravanan *et al.* (2020) [30], Harizan *et al.* (2021) [16] and Abdullaziz *et al.* (2022) [1]. These decreased values in CPV affected dogs might be due to leakage of serum protein through damaged capillaries of the villi of the intestine and less absorption through the damaged villi, anorexia and malabsorption leading to protein loss through the gastrointestinal tract (Macintire *et al.*, 1997) [21].

The mean values of serum creatinine and BUN were significantly increased ($p<0.05$) in CPV affected dogs in comparison to group A (healthy dogs). These findings were in agreement with Bhat *et al.* (2013) [8], Dogra and Sood (2016) [11], Bhargavi *et al.* (2017) [17] and Abdullaziz *et al.* (2022) [1]. Increased BUN might be due to reduced glomerular filtration rate or peripheral azotemia (Biswas *et al.*, 2005) [9]. Elevated BUN and creatinine are associated with hepatic hypoxia secondary to severe hypovolemia or due to the absorption of toxic substances due to loss of the gut barrier and also due to dehydration (Macintire *et al.*, 1997) [21].

The mean values of ALT and AST were apparently increased with reduced blood glucose in CPV affected dogs, but statistically they did not differ significantly ($p>0.05$) from group A (healthy control group).

3.6 Serum Biochemical Changes in CPV Affected Dogs after Treatment (Day 5)

In the present study, whole blood samples were collected from 24 dogs of groups B, C, D and E (n=6 each) on day 0 and 5th day of treatment for evaluation of serum biochemical parameters. The serum biochemistry values of groups B, C, D and E on day 5 after treatment were compared with healthy control group A. The detailed results are depicted in Table 8.

Table 7: Serum biochemical changes in CPV affected dog of groups B, C, D and Group E on day 5 of treatment and its comparison with healthy

control group

Serum Constituents	Healthy Dogs Group A (N=6)	CPV Treated Groups (n=6 each Group B	Group C	Group D	Group E	"p" value
ALT (IU/L)	28.31±5.79	37.24±8.82	39.88±8.46	22.26±2.16	24.91±2.53	0.224
AST (IU/L)	20.68±3.43	29.06±7.09	43.06±15.95	12.80±1.63	21.93±3.05	0.137
Total protein (gm/dl)	5.24±0.07	4.60±0.62	5.35±0.33	5.35±0.22	5.68±0.10	0.319
Creatinine (mg/dl)	0.70±0.06	0.72±0.07	0.81±0.32	0.64±0.06	0.62±0.07	0.905
Albumin (gm/dl)	2.75±0.32	2.32±0.41	2.84±0.20	2.58±0.12	2.74±0.17	0.684
Globulin (gm/dl)	3.48±0.34	2.38±0.29	2.51±0.29	2.78±0.25	2.94±0.18	0.635
BUN (mg/dl)	5.74^{a}±2.80	19.46^{b}±4.28	22.76^{b}±2.53	14.83^{b}±2.58	17.99^{b}±1.82	0.011
Blood Glucose (mg/dl)	113.0±3.49	100.00±7.60	97.17±4.71	103.33±5.79	97.83±8.60	0.404

Means with different superscripts (a, b) within the row differ significantly ($p<0.05$).
**$p<0.01$ = highly significant, *$p<0.05$ = significant.

Amongst the serum biochemical profile evaluated, the mean values of BUN were significantly increased ($p<0.05$) in groups B, C, D and E in comparison to group A (healthy dogs) on day 5 after treatment. This increased BUN might be due to reduced glomerular filtration rate or peripheral azotemia (Biswas *et al.*, 2005) [9]. The mean values of AST, ALT, Total protein, Creatinine, Albumin, Globulin and Blood glucose were non-significantly ($p>0.005$) different between groups A, B, C, D and E on day 5 after treatment, the values of ALT, AST, TP were apparently higher and globulin lower in treated groups on day 5 as compared to values of healthy control group A (Table 4.18).

3.7 Clinical Efficacy of Different Treatment on Canine Parvovirus Infection

With each passing day of treatment, the clinical signs eventually reduced. In groups B, C and E, out of 8 dogs each, 6 (75.00%) dogs were recovered and mortality was noted in 2 (25.00%) dogs. In group D, all 8 (100%) dogs were recovered and no mortality was observed. Data in Table 8 indicate that Group D was having faster recovery without mortality as compared to Groups B, C and E. Majority of cases 15 (46.88%) recovered on day 5 of treatment followed by 15.62% recovery each on day 4 and day 3 (3 cases each) and 3.12% on day 2, which indicates that efficacy of therapy improved successively with the duration of treatment.

Table 8: Summary of clinical improvement after multiple treatments of canine parvovirus gastroenteritis

Treatment group	No. of dogs	Recovery time (days)	Recovery rate (%)
Group A	Healthy dogs		
Group B	8	5.00^{x}±0.00	75.00% (6/8)
Group C	8	4.67^{x}±0.21	75.00% (6/8)
Group D	8	3.13^{y}±0.23	100.0% (8/8)
Group E	8	4.83^{x}±0.17	75.00% (6/8)

Treatment found significant at 1% and 5% level of significance CD (Critical Difference) at $p<0.01$ = 0.779, CD at $p<0.05$ = 0.573.
Means with different superscript (x, y) within the column differ significantly ($p<0.01$).

All the dogs in different treatment groups showed improvement on the 5th day of treatment as compared to 0 day.

The dogs in group B the clinical recovery was recorded in 75.00% (6/8) dogs in this group, and average recovery time was 5.00±0.00 days.

The dogs in group C the clinical recovery was recorded in 75.00% (6/8) dogs in this group and the average recovery time was 4.67±0.21 days. There was increase in blood glucose level in dogs of group C on day 5 as compared to day 0, because honey facilitates absorption of sugar and starch. It is also having anti-bacterial, anti-inflammatory properties and also contains vitamins, minerals and antioxidants.

The dogs in group D the clinical recovery was recorded in 100% (8/8) dogs in this group, with the average recovery time of 3.125±0.23 days. These findings are comparable to those of Gaykwad *et al.* (2018) [14] and Kataria *et al.* (2020) [19]. N-acetyl cysteine is a powerful antioxidant, with improved glutathione S-transferase (GST) activity and decreased nitrite plus nitrate and malondialdehyde concentration. N-acetyl cysteine represents a potential additional treatment option that could be considered to improve the health condition and minimize the duration of hospitalization of CPV affected dogs. However supportive treatment alone failed to ameliorate oxidative stress in the infected dogs.

The dogs in group E the clinical recovery in 75.00% (6/8) dogs with the recovery time of 4.83±0.17 days. Glutamine plays a key role in the maintenance of integrity of GI mucosal barrier, preventing bacterial translocation and facilitating absorption of nutrients and electrolytes from GI tract. Although the CPV affected dogs had tendency of vomition, they were not able to take glutamine powder orally. So, any oral medication is not recommended in CPV affected dogs due to vomition.

Prolonged recovery time was observed in group B dogs which were treated with standard therapy without any adjuvant therapy. In Group C and E there was no significant ($p>0.05$) reduction in recovery time as compared to group B. Group D showed highly significant ($p<0.01$) reduction in recovery time as compared to group B, C and E. These results suggested that adjuvant therapy along with standard therapy helps to reduce the recovery time and improvement in recovery rate. So, such therapies are recommended in dogs affected with CPV infection.

Among the adjuvant therapies, N-acetyl cysteine @ 70 mg/kg BW OID I/V took less recovery time with the highest recovery rate, so it can be recommended as an adjuvant along with standard therapy for treatment of CPV affected dogs.

4. Conclusions

The canine parvovirus infected dogs showed a highly significant decrease in WBC count, lymphocytes, total protein and significant decrease in albumin, globulin, whereas neutrophils and creatinine were highly significantly increased and BUN was significantly increased in CPV infected dogs as compared to healthy dogs.

All the dogs in various treatment groups showed improvement in haematology and serum biochemistry on the 5th day of treatment as compared to 0 day values. The therapeutic efficacy based on haemato-biochemical parameters showed

comparable findings between the different treatment protocols on day 5 as compared to values of healthy group.

The recovery time was significantly less (3.12±0.23 days) and recovery rate was 100% (8/8) in dogs that were treated with N-Acetyl Cysteine as adjuvant therapy as compared to other treatment groups. So, N-Acetyl Cysteine (NAC) @ 70 mg/kg BW OID I/V along with standard thray can be suggested as adjuvant therapy in the treatment of canine parvovirus gastroenteritis.

5. Acknowledgement

Authors thanking the Dean of the College and Professor & Head of Department of Veterinary Medicine, College of Veterinary science and Animal Husbandry, Kamdhenu University, Anand.

6. References

1. Abdullaziz I, Aly M, & Elshahawy, I. Clinical, haemato-biochemical alterations with acute phase response in canine parvoviral enteritis. Damanhour Journal of Veterinary Sciences. 2022;7(1):23-27.
2. Access Science Editors. Dog domestication. Access Science; c2014; Retrived on July 21, 2021, from https://doi.org/10.1036/1097-8542.
3. Albaz A, Sayed-Ahmed M, Younis E, Khodier M. Investigation of the antiviral effect of acyclovir on canine parvovirus infection. Pharmacy Pharmacology International Journal. 2015;2(2):14.
4. Amaravathi M, Kumar B, Reddy C, Jyosthna Devi, S. Clinico haemato biochemical changes in canine parvoviral infection. International Journal of Advanced Multidisciplinary Research. 2016;3(3):31-33.
5. Awad R, Safwat AH. Successful treatment of canine parvovirus infection in naturally infectedpuppies. Asian Journal of Scientific Research. 2019;12(3):308-315.
6. Bastan I, Kurtdede A, Ozen D. Prognostic usefulness of some parameters in dogs with canine parvovirus. Ankara Universtiy Veterinary Fakültesi Dergisi. 2013;60(1):53-58.
7. Bhargavi M, Sobhamani B, Kumari NK, Shrilatha C. Diagnostic aspects and haematobiochemical changes associated with canine parvpoviral enteritis in dogs. International Journal of Current Microbiology and Applied Sciences. 2017;6(11):3357-3364.
8. Bhat AA, Wadhwa DR, & Khan MA. Therapeutic management of canine parvo viral (CPV) gastroenteritis. Veterinary Practice. 2013;14:96-97.
9. Biswas S, Chakravorty D, Pradhan NR. Clinical & haematobiochemical changes in parvovirus infection in dogs. Indian Journal of Veterinary Medicine. 2005;25(1):16-18.
10. Decaro N, Buonavoglia C, Barrs VR. Canine parvovirus vaccination and immunizationn failures: are we far from disease eradication. Veterinary Microbiology. 2020;247:108-760.
11. Dogra S & Sood NK. Haemato-biochemical alterations in canine parvovirus infection. Indian Journal of Veterinary Pathology. 2016;40:266-268.
12. Folitse RD, Kodie DO, Amemor E, Dei D, Tasiame W, Burimuah V *et al*. Detection of canine parvovirus antigen in dogs in Kumasi, Ghana. African Journal of Infectious Disease. 2017;12(1):28-32.
13. Ford RB, Larson LJ, McClure KD, Schultz RD, Welborn LV. Canine vaccination guidelines. Journal of American Animal Hospital Association. 2017;53(5):243-251.
14. Gaykwad C, Garkhal J, Chethan GE, Nandi S, De UK. Amelio-rationofoxidative stress using n-acetylcysteine in canine parvoviral enteritis. Journal of Veterinary Pharmacologyand Therapeutics. 2018;41(1):68-75.
15. Goddard A, Leisewitz AL, Christopher MM, Duncan NM, Becker PJ. Prognostic usefulness of blood leukocyte changes in canine parvoviral enteritis. Journal of Veterinary Internal Medicine. 2008;22:309-316.
16. Harizan M, Khinchi RK, Sharma SK, Meena VK. Alterations in haemato-biochemical and oxidative stress indices in dogs affected with parvoviral enteritis. The Pharma Innovation Journal. 2021;10(8S):428-431.
17. Hasan K, Rathnamma D, Narayanaswamy HD, Isloor S, Chandranaik BM, Kshama MA, *et al*. Comparative evaluation of lateral flow assay & PCR for detection of Canine parvovirus. Advancement of Animal & Veterinary Science. 2017;4(11): 580-583.
18. Jacob RM, Weiser MG, Kowalski JJ. Clinic pathogenic features of canine parvoviral enteritis. Journal of American Veterinary Medicine Association. 1980;16:809-813.
19. Kataria D, Agnihotri A, Bangar YC, Kumar T. Comparative evaluation of haemato- biochemical alterations in dogs regarding CPV infection. The Pharma Innovation Journal. 2020;9(2):88-91.
20. Khare DS, Gupta DK, Shukla PC, Das G, Tiwari A, Meena NS, Khare R. Prevalence of canine parvovirus infection in dogs in Jabalpur (M.P.). Journal of Entomology and Zoology Studies. 2019;7(3):1495-1498.
21. Macintire DK, Smith-Carr S. Canine parvovirus. Part II. Clinical signs, diagnosis and treatment. Compendium on Continuing Education for the Practising Veterinarian. 1997;19(3):291-302.
22. Mallikarjun G. Studies on certain aspects of gastroenteritis with special reference to canine parvoviral infection in dogs (M.V.Sc. Thesis). Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, India; c2015.
23. Mohanta L, Mohanty AK, Sahoo N. Impact of haemorrhagic gastroenteritis on Hb, TEC, PCV and erythrocytic indices. International Journal of Current Research. 2018;10(6):69986-69988.
24. Mylonakis EM, Kalli I, Rallis ST. Canine parvoviral enteritis: an update on the clinical diagnosis, treatment, and prevention. Veterinary Medical Research Reports. 2016;7:91-100.
25. Navarro C. Detection of canine parvovirus in dogs by means polymerase chain reaction. American Journal of Biomedical Science Research. 2020;7(6):540-547.
26. Reddy BK. Clinico-epidemiological studies on canine parvoviral infection in and around Tirupati. Sri Venkateswara Veterinary University, Tirupati (AP) India; c2013.
27. Roble ES, Ybañez RH, Yandug RS, Ybañez A. Canine parvovirus infection and pet owner's perception: a case study in Cebu, Philippines. International Journal of Scientific and Research Publications. 2016;6(2):77-84.
28. Sakulwira K, Vanapongtipagorn P, Theamboonlers A, Oraveerakul K, Poovorawan Y. Prevalence of canine coronavirus & parvovirus infections in dogs with gastroenteritis in Thail. Veterinary Medicine. 2001;48:163-167.
29. Salem N. Canine viral diarrhea: clinical, haematologic &

biochemical alterations with particular reference to in clinic rapid diagnosis. Global Veterinarian. 2014;13:302-307.
30. Saravanan S, Ramprabhu R, Mohanapriya T, Chitra R, Ponnu Swamy KK. Retrospective study on risk factors and haemato-biochemical alterations associated with canine parvo viral enteritis. Journal of Entomology and Zoology Study. 2020;8(6):342-346.
31. Saxena R, Dua K, Uppal SK, Saini N, Kumar A. Effect of fluid therapy and lignocaine in management of gasro-enteritis in dogs. Indian Journal Veterinary Medecine. 2006;26(2):81-85.
32. Shima FK, Gberindyer FA, Tion MT, Fagbohun OA, Omobowale TO, Nottidge HO. Diagnostic performance of a rapid immunochromatographic test kit for detecting canine parvovirus infection. Topics in Companion Animal Medicine. 2015;45:100551.
33. Sulthana CMJ. Clinico-pathological findings in dogs affected with canine parvo virus (CPV) infections. Intas Polivet. 2015;16(2):443-444.
34. Suresh RV, Rajan TSS, Gnanaprakasan V. Haematological and serum biochemical changes in canine gastroenteritis. Indian Veterinary Journal. 1994;71(5):518- 519.
35. Tanwar J, Choudhary S, Jain G, Bihani DK. Comparative study for efficacy of Immunochromatography Antigen Assay (ICA) test kit with Polymerase Chain Reaction (PCR) to detect canine parvo virus. Journal of Entamology and Zoology. 2020;8(4):416-419.
36. Tatiana Castro X, Rita de Cássia N, Cubel Garcia, Luciana PS, Gonçalves, Erika Costa M, *et al*. Clinical, haematological and biochemical findings in puppies with coronavirus and parvovirus enteritis. The Canadian Veterinary Journal. 2013;54:885-888.
37. Wang B & Wang X. Species diversity of fecal microbial flora in Canis lupus familiaris infected with canine parvovirus. Veterinary Microbiology. 2019;237:108-390.
38. Zafar MS, Khan SA & Rabbani A. Haematological studies and estimation of electrolytes in dogs exhibiting diarrhoeal signs. Pakistan Veterinary Journal. 1999;19(1):35-39.