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RETROSPECTIVE STUDY

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Retrospective evaluation of outpatient canine parvovirus treatment in a shelter-based low-cost urban clinic

Kimberly Perley ScB* | **Charlotte C. Burns BS*** | **Caroline Maguire VMD** | **Virginia Shen VMD, MHS** | **EmmaRose Joffe VMD** | **Darko Stefanovski PhD, MS** | **Laurel Redding VMD, PhD** | **Lisa Germanis VMD** | **Kenneth J. Drobatz DVM, MSCE, DACVIM, DACVEC** | **Brittany Watson MS, VMD, PhD, DACVPM**

Pennsylvania SPCA, Philadelphia, PA, University of Pennsylvania School of Veterinary Medicine, Philadelphia, PA

Correspondence
Dr. Brittany Watson, University of Pennsylvania School of Veterinary Medicine, 3900 Delancey St, Philadelphia, PA 19104
Email: brittawa@upenn.edu

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*These authors contributed equally.

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Abstract

Objective: To evaluate survival and associated risk factors when utilizing an outpatient treatment protocol for treatment of canine parvovirus (CPV) performed in a shelter-based low-cost urban clinic.

Design: Retrospective study.

Setting: Pennsylvania Society for the Prevention of Cruelty to Animals.

Animals: Ninety-five CPV positive dogs presented between June 1 and July 31, 2016. Owners elected for outpatient care when inpatient care was not financially feasible and the dog was considered medically stable for outpatient care.

Interventions: None.

Measurements and Main Results: Of the 95 CPV positive dogs, 79 (83%) survived treatment. Logistic regression indicated that an increasing number of days with clinical signs prior to treatment and an increase in percent body weight during treatment were significantly associated with survival (odds ratio [OR], 3.15, $P = 0.020$; and OR, 1.29, $P = 0.027$, respectively). Hypothermia upon presentation (T < 37°C) was negatively associated with survival (OR, 0.002; $P = 0.002$).

Conclusions and Clinical Relevance: The survival rate of this clinic suggests that an outpatient program may be a potential alternative treatment to inpatient care. Longer duration of clinical signs prior to treatment and an increase in percent body weight during treatment appear to be associated with increased survival outcomes, while hypothermia on presentation appears to be associated with decreased survival outcomes.

1 | INTRODUCTION

Canine parvovirus (CPV), a highly contagious virus that attacks rapidly dividing cells, is a significant cause of morbidity and mortality in young domestic dogs.[1-3] Reported mortality rates range from 4% to 48% with supportive care and as high as 91% in untreated experimentally infected dogs.[2,4-7] While there is an effective vaccine available, the disease still persists. This may be due to a lack of access to the vaccine, improper administration, or incompletion of the vaccination series.

Treatment of CPV entails often costly hospitalization with aggressive IV fluid therapy,* antimicrobials,† electrolyte and glucose supplementation,‡ antiemetics,§ analgesia,¶ and nutritional support.[1]

Abbreviations: BG, blood glucose; CPV, canine parvovirus; CRT, capillary refill time; DHPP, distemper, hepatitis, parvovirus, parainfluenza; LRS, lactated Ringer's solution; TS, total solids.

Unfortunately, this current gold standard treatment can be financially constraining, costing between $3000 and $5000 USD.[#]

While outpatient treatment protocols have been mentioned in the literature,[8] limited information on their success is available. This may be due to: the perceived difficulty in maintaining hydration in dogs without IV fluid support, the contagious nature of the virus, or the severity of the potential complications of the disease. In 2013, the Colorado State University College of Veterinary Medicine described an outpatient protocol with an overall survival rate of 80%.[9] This study was instituted in a controlled hospital setting without the difficulties of owner compliance and other challenges of true outpatient care. Furthermore, animals in the Venn et al[9] study that were declining with outpatient treatment were able to be transferred to inpatient care with standard diagnostics and monitoring. In a more realistic outpatient setting, such as the one analyzed in this study, these types of inpatient treatments are not available. Additionally, in a recent retrospective study, Sarpong et al[10] demonstrated that outpatient treatment in a private practice resulted in a survival rate of 75%.[10] However, this study lacked a standardized protocol for treatment, making it difficult to replicate in other private practices and shelters.

The outpatient clinic mentioned in this retrospective study offered exclusively outpatient care for owners that could not afford inpatient care. Additionally, this clinic utilized a set outpatient protocol to help standardize treatment among dogs. To the authors' knowledge, a standard outpatient protocol has not been studied in a shelter-based low-cost clinic setting. Therefore, the purpose of this study was to retrospectively determine the survival and associated risk factors in dogs with CPV receiving outpatient treatment for their disease in a shelter-based low-cost clinic setting. The authors hypothesized that survival rates similar to those reported in the Colorado State study[9] could be achieved when using a standardized protocol in which owners care for their dogs at home while receiving outpatient treatment.

2 | MATERIALS AND METHODS

2.1 | Case selection

Medical records were obtained for dogs presenting to the Pennsylvania Society for the Prevention of Cruelty to Animals (PSPCA) Parvovirus Outpatient Clinic during an 8-week period from June 1, 2016 to July 31, 2016. Records were included in the analysis if dogs had clinical signs consistent with canine parvovirus (eg, lethargy, inappetence, diarrhea, or vomiting) and tested positive on IDEXX SNAP Parvo Test.[‖] Via communication with the veterinarian on staff, all dogs were diagnosed with parvovirus using a valid, in-date SNAP test performed according to the manufacturer's recommendation unless otherwise stated in the record for that dog.

2.2 | Treatment procedures

The treatment protocol used at this clinic was based on the Colorado State University Outpatient Treatment Protocol for Parvoviral Enteritis.[9] It was adapted to a twice-daily outpatient treatment regimen through a shelter-based low-cost clinic (Figure 1). The full protocol is included in Appendix 1. Owners of all infected animals were first advised to seek treatment at a local specialty or general practice. If the owners declined, they were given the option of receiving treatment in the outpatient treatment program. Prior to beginning care at this clinic, all owners were educated on the risks of outpatient treatment and then signed a waiver acknowledging that they had been informed of these risks and wished to pursue treatment at the PSPCA.

2.3 | Medical records review

Electronic medical records of CPV-positive dogs treated at the clinic were reviewed. Data collected at presentation related to signalment and history included: sex, breed (determined by visual assessment), age, vaccination history, history of hospitalization prior to coming to the clinic, and duration of clinical signs (eg, how long they have had clinical signs prior to presenting to the clinic). Physical examination data at presentation included: weight, heart rate, respiratory rate, rectal temperature (°C), PCV, total solids (TS), blood glucose (BG), percent dehydration, mucous membrane moisture, mucous membrane color, capillary refill time (CRT), body condition score (BCS), mentation, and whether the dog was eating and drinking or having vomiting and diarrhea.

Information pertaining to treatments throughout outpatient therapy included: percent treatments attended, percent treatments received at home, and time between each treatment when receiving treatments twice a day. Additional data recorded from the outpatient treatment period consisted of information on fluid therapy such as number of days requiring SC fluid therapy both at home and at the clinic, how many dogs required more than 1 day of fluid therapy, and the use of the rescue fluid protocol (Appendix 1).

Further information recorded included: use of the rescue pain protocol, use of the rescue emesis protocol (Appendix 1), final weight on record used for calculating percent change in weight, need for glycemic support, and need for heat support (for animals who presented with hypothermia T < 37°C). Case outcomes were categorized as survived, died, euthanized, left for more advanced care, or lost to follow-up.

2.4 | Statistical analysis

Exploratory data analysis was performed to compare the dogs that survived and the dogs that either died or were euthanized. Fisher's exact test or chi-squared tests, as appropriate, were used for categorical variables to compare between the 2 groups. Categorical variables are described with proportions (%). Wilcoxon rank-sum tests were used for non-normally distributed continuous variables, and *t*-tests were used for normally distributed variables. Normally distributed continuous variables are described with mean (±SD), and non-normally distributed variables are described with median (range). A logistic regression analysis was conducted to identify factors associated with survival. A *P*-value entry threshold of 0.2 was used for initial variable selection along with a backward elimination strategy to develop multivariable

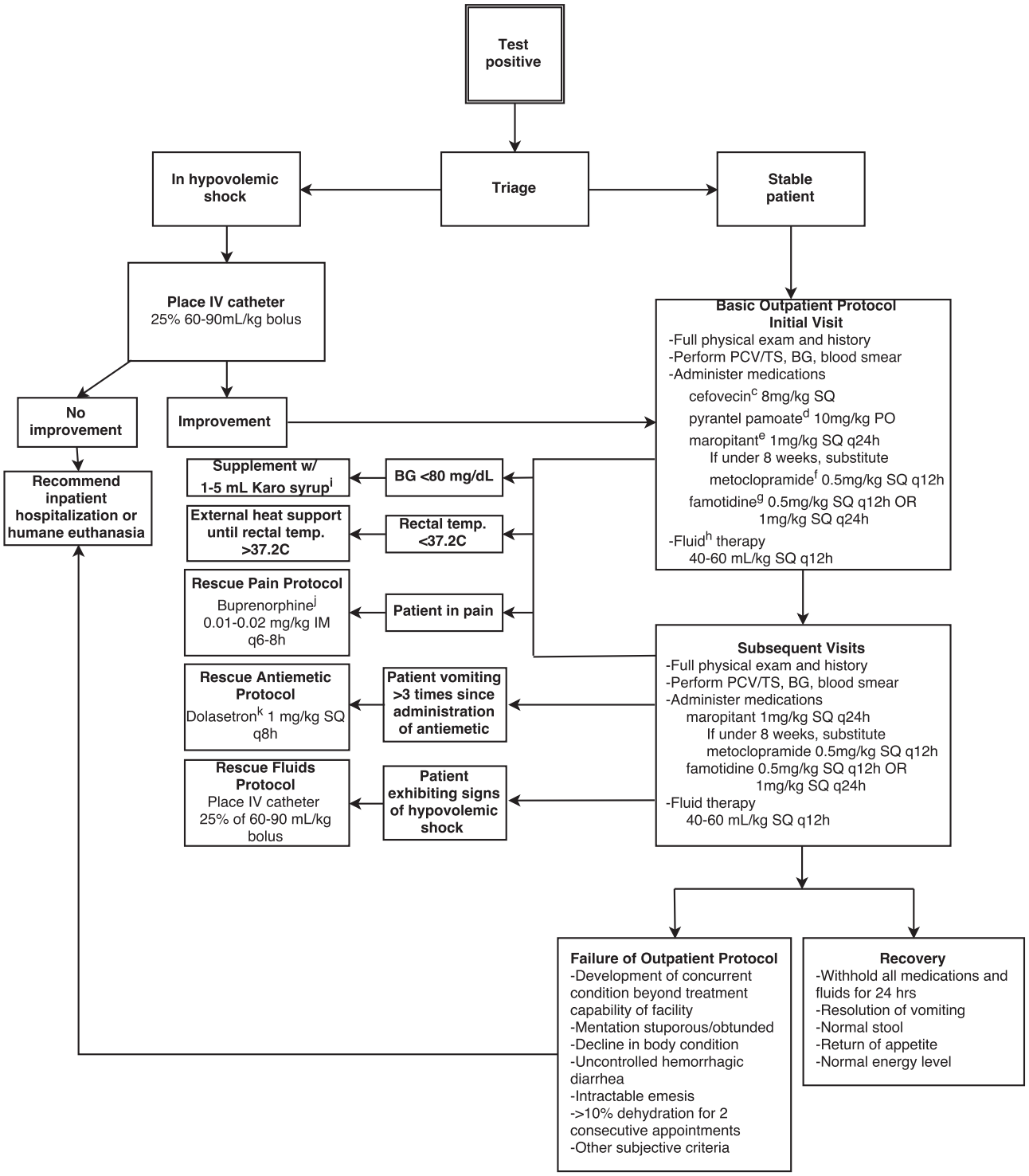

FIGURE 1 Pennsylvania society for the prevention of cruelty to animals outpatient parvovirus protocol. Flow chart demonstrating the protocol used in the clinic analyzed in the retrospective study

models to assess confounding. Risk factors with $P < 0.05$ and any confounders that altered associations by 15% or more were retained in the final model. Dogs that were lost to follow-up or left for more advanced care were excluded in the statistical models and descriptive statistics, with the exception of calculations of overall survival and general proportions. Stata statistical software[**] was used for all analyses.

3 | RESULTS

During the 2-month period, 102 dogs presented to the PSPCA Parvo Outpatient Clinic because of signs of gastrointestinal disease or a history of exposure to CPV. Of the 102 dogs, 95 dogs had positive results on the IDEXX SNAP Parvo test. Overall, 83% (79/95) of the dogs sur-

TABLE 1 Univariate analysis of baseline parameters (average with standard deviation) and percentage (proportion of group) expressing measured values at initial presentation for survived group and died group

Measured variable	Survived	Died	*P*-value
Heart rate	148.9 (±34.0)	163.8 (±27.9)	0.188
Respiratory rate	41.1 (±16.3)	45.6 (±22.7)	0.636
Temperature (°C)	38.7 (±0.8)	38.0 (±1.52)	0.013*
Initial weight (kg)	10.0 (±8.2)	4.0 (±3.8)	0.009*
Blood gas	119.8 (±27.3)	133.1 (±30.6)	0.201
Packed cell volume	45.0 (±9.0)	41.6 (±7.9)	0.339
Total plasma protein	6.3 (±1.2)	5.6 (±0.8)	0.114
Vomiting	55/67 (82.0%)	8/10 (80.0%)	0.896
Diarrhea	59/74 (80.0.%)	6/8 (75.0%)	0.754
Eating	19/72 (26.4%)	5/9 (55.5%)	0.028*
Drinking	37/59 (62.7%)	5/8 (62.5%)	0.652
% Dehydration			0.015*
Adequate	12.8 (10/78)	0	
5%	5.1 (4/78)	10.0 (1/10)	
6%	39.7 (31/78)	40.0 (4/10)	
6-8%	28.2 (22/78)	0	
8%	10.3 (8/78)	20.0 (2/10)	
8-10%	3.8 (3/78)	30.0 (3/10)	
Capillary refill time			0.100
< 2 seconds	47.4 (37/78)	20.0 (2/10)	
≥2 seconds	52.6 (41/78)	80.0 (8/10)	
Mucous membrane color			0.128
Pink	76.9 (60/78)	44.4 (4/9)	
Pale pink	8.9 (7/78)	33.3 (3/9)	
White/pale	10.2 (8/78)	11.1 (1/9)	
Red	1.2 (1/78)	0	
Pigmented	2.5 (2/78)	11.1 (1/9)	
Mucous membrane moisture			0.105
Moist	39.0 (30/77)	2.0 (2/10)	
Slightly tacky	5.2 (4/77)	0	
Tacky	32.5 (25/77)	2.0 (2/10)	
Hypersalivating	23.4 (18/77)	60.0 (6/10)	
Mentation			0.099
BAR	41.6 (32/77)	10.0 (1/9)	
QAR	54.5 (42/77)	70.7 (7/9)	
Depressed	1.3 (1/77)	10.0 (1/9)	
Stuporous	2.6 (2/77)	0	
2	2.6 (2/78)	0	
3	5.1 (4/78)	10.0 (1/10)	
4	55.1 (43/78)	60.0 (6/10)	
4.5	2.6 (2/78)	0	
5	34.6 (27/78)	30.0 (3/10)	
Prior DHPP vaccinations			0.430
Yes	33.3 (26/78)	50.0 (5/10)	
No	57.7 (45/78)	50.0 (5/10)	
Did not know	9.0 (7/78)	0	
Treatment prior to PSPCA protocol			0.790
Yes	7.3 (6/82)	10.0 (1/10)	
No	89.0 (73/82)	90.0 (9/10)	
Use of rescue fluids protocol			0.027*
Yes	7.6 (6/79)	30.0 (3/10)	
No	92.4 (73/79)	70.0 (7/10)	
Use of rescue pain protocol			0.076
Yes	5.0 (4/79)	20.0 (2/10)	
No	95.0 (75/79)	80.0 (8/10)	

Abbreviations: QAR, quiet/alert/responsive; BAR, bright/alert/responsive; DHPP, distemper, hepatitis, parvovirus, parainfluenza; PSPCA, Pennsylvania Society for the Prevention of Cruelty to Animals.
*Signifies statistical significance.

vived. Six dogs died at home. Four dogs were humanely euthanized at the clinic as they were deemed failing outpatient treatment by the shelter staff (outlined in Appendix 1). Five dogs were lost to follow-up, and 1 dog left for more advanced care. The remaining 7 dogs that presented at the clinic included 1 dog who died before treatment could be initiated and 6 dogs who had negative results on the SNAP test but were treated on the basis of a history of exposure or clinical signs suggestive of CPV. These last 7 dogs were not included in the study.

Thirty-eight percent (36/95) of dogs treated at the clinic were female, and 62% (59/95) were male. All dogs were intact except for 1 male dog. There was no significant difference in sex ($P = 0.391$) between dogs that died and dogs that survived. A total of 23 different dog breeds and mixes of breeds were represented, with a large percentage (41/95, 43%) being of Pit Bull Terrier descent. Being a Pit Bull Terrier was not found to be statistically significantly associated with survival ($P = 0.367$). The median age was 4 months (range, 1 to 48 months). Age was statistically different between the 2 groups upon univariable analysis (odds ratio [OR], 1.47; 95% CI, 1.02-2.12, $P = 0.035$), with a median age of 2.4 months (range, 1.5-6 months) for dogs that died and a median age of 4.5 months (range, 1 to 48 months) for dogs that survived. Vaccination history and hospitalization prior to coming to the PSPCA were not significantly different between the 2 groups ($P = 0.430$ and $P = 0.790$, respectively) (Table 1).

The mean duration of clinical signs was 2.37 days (SD, 1.85) among all animals. The median duration of clinical signs was significantly higher among survivors (3-day range, −2 to 7 days) than among dogs that died (1-day range, −4 to 3 days; $P = 0.039$).

None of the following vitals or physical parameters from admission were found to be significantly different between the 2 groups ($P > 0.05$): heart rate, respiratory rate, vomiting, PCV/TS, blood glucose, mucous membrane moisture, mucous membrane color, CRT, BCS, mentation, diarrhea, vomiting, and drinking (Table 1). Initial body weight ($P = 0.009$), percent dehydration ($P = 0.015$), temperature ($P = 0.013$), and whether the dog was eating ($P = 0.028$) were found to be significantly different between the 2 groups (Table 1).

With regards to compliance in attending scheduled visits, 66% of owners showed up for all of their scheduled appointments, and only 12.4% of owners showed up for less than 80% of their appointments. The proportion of missed appointments had no effect on survival ($P = 0.257$). Owners were instructed to bring animals twice a day, spacing treatments out as far apart as possible. The average time between morning and evening treatments was 6.67 h (±1.53) for all dogs, 6.60 (±1.54) for dogs that survived, and 7.39 (±1.33) for dogs that died, which was significantly different ($P = 0.033$). The average time between evening and morning treatments was 18.0 h (±2.31) for all dogs, 18.0 (±2.34) h for dogs that survived, and 17.0 (±2.31) h for dogs that died, and this difference was not significant ($P = 0.074$). Forty-eight percent of dogs received all of their treatments at the clinic. When the clinic was closed on Sundays or owners could not bring their dog in twice a day, owners were given SC crystalloid fluids and medications (maropitant[††] and famotidine[‡‡]) to administer at home to replace the clinic appointment. Among dogs that received any treatments at home the mean percentage was 18.6% (±7.63). There was no association between survival and proportion of treatments received at home ($P = 0.258$).

Dogs spent an average of 3.8 (±2) days on SC crystalloid fluid therapy, including at the clinic and at-home treatments. Eighty-nine percent of dogs required more than 1 day of SC crystalloid fluid therapy, and the number of days of SC crystalloid fluid therapy received did not appear to be associated with survival ($P = 0.450$). In contrast, use of the rescue fluid protocol was significant ($P = 0.027$). Nine (10.1%) dogs received IV fluid resuscitation (rescue fluids protocol) upon presentation to the clinic, and dogs receiving IV fluid resuscitation on presentation were 5 times less likely to survive (OR, 0.19, $P = 0.042$).

Finally, use of the rescue pain protocol ($P = 0.076$) was not significantly associated with survival. Five percent (4/79) of the dogs that survived and 20% (2/10) of the dogs that died required rescue analgesia upon presentation. Additionally, because of a nationwide shortage of dolasetron,[§§] only 9 dogs received the rescue emesis protocol, and that parameter was not analyzed. The need for glycemic support was not significantly associated with survival ($P = 0.262$). Eight (9.8%) of the dogs that survived and 3 (30%) of the dogs that died required glycemic support upon presentation. A positive percent change in weight (OR, 1.16; 95% CI, 1.05-1.29, $P = 0.003$) was significantly associated with survival. In contrast, dogs with hypothermia on initial presentation were significantly less likely to survive (T < 37°C)[11] (OR, 0.04; 95% CI, 0.005-0.25, $P = 0.001$).

Variables that were significant ($P < 0.05$) on univariable analysis, but not on multivariable analysis, were use of the rescue fluid protocol (OR, 0.13; 95% CI, 0.005-3.91, $P = 0.213$) and age (OR, 1.12; 95% CI, 0.708-1.77, $P = 0.625$). The final variables that were significant on multivariable analysis and included in the model were: duration of clinical signs prior to presentation to clinic (OR, 3.15; 95% CI, 1.19-8.33, $P = 0.020$), percent change in body weight during treatment (OR, 1.20; 95% CI, 1.02-1.43, $P = 0.027$), and hypothermia upon presentation to the clinic (OR, 0.002; 95% CI, 0.0006-0.119, $P = 0.002$). The model generated good discriminatory power (area under the curve [AUC] of 0.93, 95% CI, 0.864-1.000). The final logistic model indicates that for every additional day a dog presented with clinical signs, there was a 3.15 odds increase in survival, and for every 1% increase in body weight, there was a 1.20 odds increase in survival. For dogs who were hypothermic on presentation (T < 37°C), the odds of survival decreased significantly. Figure 2 illustrates the percent change in weight between dogs who survived vesus dogs who died.

4 | DISCUSSION

The protocol implemented in this outpatient clinic yielded a survival rate of 83%. The high survival rate of this program can be attributed to multiple factors. The daily treatments, monitoring, and clearing of dogs were performed by veterinary students under the supervision of a licensed veterinarian. Having trained staff that had consistent contact with the dogs may have helped identify subtle changes in the dogs' condition early on. This survival rate is consistent with 2 recent studies.[9,10] Unlike these 2 recent studies, this is the first time, to the authors' knowledge, medical records have been analyzed from a strictly outpatient treatment clinic in a shelter-based low-cost clinic setting. It is important to note that these survival rates are calculated based on dogs who were deemed suitable for outpatient treatment. Similar to Venn et al[9] and Sarpong et al,[10] a selection bias is created in that outpatient protocols select for dogs who are medically stable enough to receive treatment. Nevertheless, obtaining a survival rate comparable with that recorded in an academic and private practice setting, settings that normally have more resources, gives reason to believe this type of program may be implemented humanely in shelters and low-cost clinics. Additionally, this clinic treated animals with a modified standard protocol from Colorado State University that can be easily adapted for private practices and shelters. The estimated cost of treatment for 1 dog using this outpatient protocol is $479 USD.[¶]

Parameters that were included in the multivariable model and found to be associated with survival outcome included: hypothermia on presentation, percent change in weight during treatment, and onset of clinical signs prior to treatment.[***]

Hypothermia can be activated endogenously as a form of protection to decrease energy and oxygen use during severe metabolic disease.[12] Hypothermia could also be associated with poor perfusion to the gastrointestinal tract due to an increased sympathetic response.[13] This finding is interesting, as a previous study found that puppies who were febrile were more likely to survive.[14] Further research is needed to determine if temperature can be used as a prognostic indicator. The relationship between percent increase in weight and increased likelihood of survival could be attributed to dogs who are gaining weight

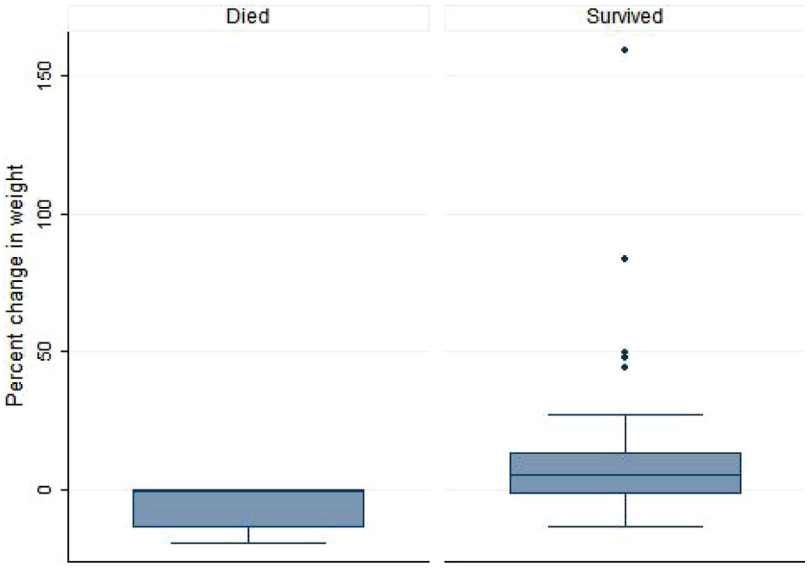

FIGURE 2 Comparison of percent change in weight between dogs who survived and dogs that died at home or were euthanized at the clinic

throughout treatment may be more likely to eat and drink due to treatment of clinical signs. Weight gain could also be associated with maintaining hydration through exogenous fluids provided during treatment or through reduced losses. Although percent change in weight has not been evaluated in previous studies, there have been studies that have suggested that dogs with lower body weight have a poorer prognosis.[15,16] Further research needs to be conducted to determine the significance of this finding. For example, future research could look at changes in weight to help determine the amount of exogenous fluids to give for treatment. Finally, the multivariable regression model shows that for everyday increase in clinical signs, there is a 3.15 increased odds in survival. While it is plausible that dogs who have had clinical signs for longer may have survived because they are better compensating for the disease, these results should be interpreted carefully due to survivorship bias. It is possible that there could be dogs who showed clinical signs longer, but were not accounted for because they died before being seen for treatment.

There are several limitations of this outpatient protocol design that need to be addressed. A potential hurdle for an outpatient protocol is the frequency at which owners are required to bring their dogs for treatment. For owners with a different work schedule or limited transportation options, this could pose a challenge in reproducing these results. Additionally, the success of this study depended on having full-time staff trained in the protocol along with the resources and space set aside to run the clinic. Realistically, this arrangement could pose a challenge in a shelter or general practice setting given staffing and biosecurity constraints. However, the potential to use this outpatient protocol in a shelter or foster setting exists.

A limitation of this study was the inconsistencies in the records, such as the lack of vaccination history. Clinic staff did not record the number of distemper, hepatitis, parvovirus, parainfluenza (DHPP) vaccines each of the previously vaccinated dogs received. There is no way to determine if having more than 1 dose shortened the course of disease or decreased the severity of clinical signs. Furthermore, since dogs that survived and died both received some level of vaccination, we are unable to determine whether having any of the DHPP series is protective against dying from CPV. These inconsistencies may be a result of interference from maternal antibodies, improper dosing interval, or an unreliable vaccine source. Further research on the effect of vaccination history and severity of CPV disease course is needed.

Further inconsistencies in the records included lack of documented cell counts on the blood smears, so this information could not be further analyzed. In the future, it may be helpful to analyze blood smears consistently throughout treatment as 1 study suggests that leukocyte changes may be more reliable for outcome prediction compared to leukocyte count at admission.[14] Additionally, it needs to be noted that a CRT of <2 seconds in the record could potentially be associated with vasodilatory shock.[17] With regards to treatment protocol, 1 limitation that should be noted is that metoclopramide was only given twice daily to due to the treatment schedule. Lastly, there were dogs that were negative on the IDEXX SNAP Parvo test and treated through the outpatient clinic. These dogs were not included in this study. In addition, dogs who were lost to follow-up or left for more advanced care were not included in the statistical analysis beyond discussing general proportions, and these criteria may have affected study results.

With an 83% survival rate, this program indicates outpatient treatment in a shelter setting may be a viable alternative when inpatient care is not financially feasible and the dog is deemed to be medically suitable for outpatient care. To the best of our knowledge, this is the first example of this type of outpatient treatment in a shelter-based low-cost clinic setting. The survival rate is consistent with other outpatient treatments reported in previous studies.[9,10] The multivariable regression model suggests that hypothermia on presentation may be an indicator for decreased survival outcomes, while percent increase in weight and longer duration of clinical signs prior to treatment is associated with increased survival outcomes. A randomized clinical trial comparing strictly outpatient treatment to strictly inpatient treatment is needed to draw further conclusions on the sustainability and efficacies of these types of programs.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ENDNOTES

[*] Lactated Ringer's solution, Hospira, Inc., Lake Forest, IL.

[†] Cefovecin sodium (Convenia), Zoetis Inc, Kalamazoo, MI.

[‡] Karo simple syrup, ACH Food Companies, Inc., Memphis, TN.

[§] Metoclopramide, Teva Parenteral Medications, Inc., Irvine, CA.

[¶] Buprenorphine, Stokes Healthcare, Mt. Laurel, NJ.

[#] Estimated from Penn Vet Ryan Hospital's inpatient hospitalization fees.

[‖] SNAP Parvo Test, IDEXX, Westbrook, ME.

[**] STATA 14, StataCorp, College Station, TX.

[††] Maropitant citrate (Cerenia), Pfizer Animal Health, New York, NY.

[‡‡] Famotidine, West-Ward, Eatontown, NJ.

[§§] Dolasetron mesylate, Sanofi-Aventis U.S. LLC, Bridgewater, NJ.

[¶] Estimated from 2016 Final Expense Report Outpatient Parvovirus Clinic.

[***] Pyrantel pamoate suspension, Columbia Laboratories, Lexington, KY.

ORCID

Kimberly Perley ScB https://orcid.org/0000-0002-6014-5864
Brittany Watson MS, VMD, PhD, DACVPM
https://orcid.org/0000-0002-7999-6810

REFERENCES

1. Goddard A, Leisewitz AL. Canine parvovirus. *Vet Clin North Am Small Anim Pract*. 2010;*40*(6):1041-1053.
2. Otto CM, Jackson CB, Rogell EJ, et al. Recombinant bactericidal/permeability-increasing protein ($rBPI_{21}$) for treatment of parvovirus enteritis: a randomized, double-blinded, placebo-controlled trial. *J Vet Intern Med*. 2001;*15*:355-360.
3. Carr-Smith S, Macintire DK, Swango LJ. Canine parvovirus: part 1. Pathogenesis and vaccination. *Comp Cont Ed Pract Vet*. 1997;*19*(2):125-133.
4. Mann FA, Boon GD, Wagner-Mann CC, et al. Ionized and total magnesium concentrations in blood from dogs with naturally acquired parvoviral enteritis. *J Am Vet Med Assoc*. 1998;*212*:1398-1401.
5. Otto CM, Drobatz K, Soter C. Endotoxemia and tumor necrosis factor in clinical canine parvoviral enteritis. *J Vet Intern Med*. 1997;*11*:65-70.
6. Glickman LT, Domanski LM, Patronek GJ, et al. Breed-related risk factors for canine parvovirus enteritis. *J Am Vet Med Assoc*. 1985;*187*(6):589-594.
7. Kariuki NM, Nyaga PN, Buoro IBJ, et al. Effectiveness of fluids and antibiotics as supportive therapy of canine parvovirus-2 enteritis in puppies. *Bull Anim Hlth Prod Afr*. 1990;*38*:379-389.
8. Prittie J. Canine parvoviral enteritis: a review of diagnosis, management and prevention. *J Vet Emerg Crit Care*. 2004;*14*(3):167-176.
9. Venn EC, Preisner K, Boscan PL, et al. Evaluation of an outpatient protocol in the treatment of canine parvoviral enteritis. *J Vet Emerg Crit Care*. 2017;*27*(1):52-65.
10. Sarpong KJ, Lukowski JM, Knapp CG. Evaluation of mortality rate and predictors of outcome in dogs receiving outpatient treatment for parvoviral enteritis. *J Am Vet Med Assoc*. 2017;*251*(9):1035-1041.
11. Dhupa N. Hypothermia in dogs and cats. *Compend Contin Educ Pract Vet*. 1995;*17*(1):61-68.
12. Oncken AK, Kirby R, Rudlofff E. Hypothermia in critically ill dogs and cats. *Compend Contin Educ Pract Vet*. 2001;*23*(6):506-520.
13. Sheperd PA, Mailman D, Burks TF, et al. Effects of norepinephrine and sympathetic stimulation on extraction of oxygen and 86Rb in perfused canine small bowel. *Circ Res*. 1973;*33*(3):166-174.
14. Kalli I, Leontides LS, Mylonakis ME, et al. Factors affecting the occurrence, duration of hospitalization and final outcome in canine parvovirus infection. *Res Vet Sci*. 2010;*89*(1):174-178.
15. Dossin O, Rupassara SI, Weng HY, et al. Effect of parvoviral enteritis on plasma citrulline concentration in dogs. *J Vet Intern Med*. 2011;*25*(2):215-221.
16. Schoeman JP, Herrtage ME. Serum thyrotropin, thyroxine, and free thyroxine concentration as predictors of mortality in critically ill puppies with parvovirus infection: a model for human pediatric critical illness? *Microbes Infect*. 2008;*10*(2):203-207.
17. Brady CA, Otto CM. Systemic inflammatory response syndrome, sepsis, and multiple organ dysfunction. *Vet Clin North Am Small Anim Pract*. 2001;*31*(6):1147-1162.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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