

COMMUNITY CASE STUDY

Effects of Deferred Puppy Intake on Incidence of Canine Parvovirus Infection and Survival: A Community Case Study

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Abstract

Canine parvovirus (CPV) threatens many canine populations, particularly those in underfunded, rural shelters, as well as the supporting organizations that transfer/transport puppies from these shelters. This study investigates the impact of a deferred puppy intake protocol on CPV incidence and outcomes among puppies transferred from a rural shelter to a supporting organization in central Ohio (Gigi's). Rather than housing surrendered puppies within their building, the rural shelter requested that community members defer the surrender of unwanted or stray puppies. Community members then maintained possession until the next scheduled Gigi's transport, allowing puppies to be directly placed into a clean crate and loaded onto the transport vehicle. After implementation of this protocol, CPV incidence decreased from 47% (18/38) to 9% (9/103) ($P < .001$). Survival rates increased but this change was not statistically significant (13/18; 72% vs. 8/9; 89%, $P = .17$). In general, puppies developing CPV after transport were more likely to survive than those diagnosed prior to transport (3/9; 33% vs. 18/18; 100%, $P < .001$). More stray puppies (20/64; 31%) than owner surrendered puppies (7/77; 9%) were diagnosed with clinical CPV ($P < .001$). These findings support the effectiveness of deferred intake strategies on mitigating CPV transmission and early illness identification on CPV survival.

Keywords: *canine parvovirus; puppies; deferred intake; open admissions shelter; limited admissions shelter; transport; transfer; biosecurity; incidence; infectious disease*

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Canine parvovirus (CPV) is a common, highly contagious pathogen with high morbidity and mortality when able to thrive in dogs lacking adequate immunity. In susceptible dogs, the virus invades and destroys rapidly dividing cells, specifically targeting intestinal epithelium and bone marrow cell lines, compromising both the gastrointestinal (GI) and immune systems. Without supportive care, infected dogs often succumb to sepsis, septic shock, and death.^{1,2} Puppies under 5 months of age are especially vulnerable to CPV due either to a lack of passive transfer of maternal antibodies or the suppression of adequate vaccine response as a result of maternal antibody interference.^{3,4}

Housing puppies in high-density shelter environments elevates the risk of CPV spread,⁵ as the virus may survive for several months on soiled surfaces and is resistant to disinfection by many commonly used agents.⁶ A CPV outbreak can be operationally and financially challenging for shelters with limited means,⁵ such as those in impoverished, rural communities. Consequently, some may

choose to euthanize infected dogs to protect the remaining population from infection.⁷

Many rural community shelters rely on the transfer of clinically healthy puppies to other organizations as a strategy to reduce outbreak risk.⁸ While the intent may be to limit opportunities for a vulnerable population to contract or transmit disease, asymptomatic puppies infected with CPV can shed the virus through saliva and feces as early as 72 h prior to the onset of clinical illness.^{5,6} The receiving organizations may then risk CPV spread to other puppies during transport and to their own population on arrival. Moreover, an already vulnerable population endures the stress of transport and multiple shelter intake processes, further increasing their susceptibility to infectious disease.^{9,10} Receiving shelters must take precautions to ensure they are not perpetuating disease spread.

This study examined a shift in protocol regarding the transfer of puppies from a rural, open intake shelter to a well-resourced, managed intake shelter in Ohio. The primary objective was to assess the effectiveness of a deferred

intake protocol for puppies at a) reducing the incidence of CPV infections and b) increasing survival rates for dogs that did succumb to infection, compared to the standard transport protocol where puppies were housed in their originating shelter before transport. Secondary objectives were to assess for factors associated with CPV incidence and survival rates in both protocols, including stray versus owner surrendered puppies, time spent in puppy-specific housing at the originating shelter, and the timing of CPV detection.

Background

Lawrence County Animal Shelter (LCAS) is an open-admission, municipal dog shelter in Lawrence County, Ohio – a rural community with a population of approximately 58,000 people and a poverty rate of 19%.¹¹ In 2023, LCAS took in 1,142 dogs, adopting 224 (20%) of them to local community members and electing humane euthanasia for 16 (1%) dogs. This shelter relied on the transfer of the remaining 902 dogs to other supporting organizations, including Gigi's, to meet intake demands that far exceeded their limited local placement opportunities.

Since opening in 2018, Gigi's, a 501(c)(3) non-profit managed-intake dog shelter in the greater Columbus, Ohio area, has had a central mission to provide access to quality shelter, veterinary, behavior, and adoption services to the homeless dogs in impoverished, rural areas of Lawrence County, Ohio. Intake from this area is limited to six partner shelters. Columbus encompasses both urban and dense suburban areas with a population of just under 1 million people.¹² In 2023, LCAS transferred 251 dogs to Gigi's.

LCAS has the capacity to house 20 adult dogs and 4 puppies/litters of puppies. Puppies are housed in a separate Puppy room, consisting of four single-sided kennels. Dogs are classified as 'puppies' at the discretion of staff and are vaccinated for distemper, adenovirus, CPV, and parainfluenza using a modified live, combination vaccine upon intake.

Transportation of dogs from LCAS to Gigi's occurred biweekly via one of two utility vans (Ford Transit, 2018). Puppies labeled to be <5 months of age were carried from the Puppy room to the van and placed into secured crates, following Association of Shelter Veterinarians 'Guidelines for Standards of Care in Animal Shelters' (ASV Guidelines) for biosecurity and transportation practices.¹³ Upon arrival, puppies were handled with the same biosecurity measures and placed into kennel housing at Gigi's and examined by a licensed veterinarian within 1–2 h.

Once housed at Gigi's, dogs <5 months of age were handled with biosecurity measures based on their age, vaccination status, and overall health and were placed into Healthy Puppy Management stages: 1, 2, or 3. All

puppies <5 months of age remained in stage 1 for the first 7 days. Stage 1 puppies were available for adoption and were only permitted to have contact with the ground in their home kennels and designated rooms that could be cleaned and disinfected before and after contact. Staff and volunteers used body suits (Tyvek®, DuPont, Wilmington, DE), double gloves, and double booties as personal protective equipment (PPE) for all handling, apart from interacting with potential adopters. Puppies >8 weeks of age progressed to stage 2 after 7 days. PPE for handling stage 2 puppies included cloth coveralls and gloves (and booties if walking inside the puppy's kennel). Stage 2 puppies were permitted to walk on paved areas outdoors and were carried or strolled when moving within the building. Three days after a second DA2PP vaccine, stage 2 puppies progressed to stage 3 and were then permitted to walk on both indoor and outdoor walkways and designated grassy areas with no PPE requirement for handling.

Any dogs showing clinical signs of CPV at Gigi's had stool samples tested via point-of-care ELISA testing (IDEXX SNAP® Parvo test [SNAP]). Dogs testing positive were immediately moved to isolation in the Parvo Treatment Center. If LCAS reported dogs showing clinical signs of CPV, either in the Puppy room or the general housing area, staff members were instructed to test stool samples via SNAP immediately. Gigi's then made separate transportation arrangements for any puppies testing positive to get them to the Parvo Treatment Center – an isolated, critical care unit adjacent to their primary housing facility, as soon as possible that same day. Gigi's also offers low-cost CPV treatment for dogs belonging to shelter and rescue organizations outside of their six partner shelters.

CPV positive dogs were handled according to ASV Guidelines for biosecurity.¹⁴ Dogs entering the Parvo Treatment Center were immediately administered a commercially available monoclonal antibody product specifically targeting CPV (Canine Parvovirus Monoclonal Antibody, Elanco, Greenfield, IN).^{15,16} Additional supportive care varied from observation to intensive care, based on severity of clinical signs. Dogs remained in isolation until clinical signs resolved and stool samples tested negative on SNAP for 2 consecutive days. At that point CPV survivors were bathed and moved back into the general population for rehoming purposes. The survival rate for the 15 dogs treated in Gigi's Parvo Treatment Center between January 1 and November 5, 2023, was 93% (14/15).

Between January 1 and November 5, 2023, the development of CPV infections post-transport was uncommon. Including dogs from all partners, Gigi's had a CPV incidence of 2% – calculated by dividing the number of dogs who developed CPV infections while housed at Gigi's ($n = 15$) by the total number of dogs transferred in ($n = 874$).

In November and December of 2023, a spike in incidence of CPV infections in dogs from LCAS was observed. This prompted a change to the LCAS intake protocol, with immediate effect from December 18, 2023.

On December 18, 2023, Gigi's medical care team members visited LCAS to review sanitation and biosecurity protocols with LCAS staff so that appropriate infectious disease control measures could be taken and maintained before additional puppies entered their facility. This review included but was not limited to appropriate deep cleaning of kennels with accelerated hydrogen peroxide (Rescue®, Virox Technologies Inc. Ontario, Canada) and PPE training, following ASV Guidelines.¹⁴

Materials and methods

Study population

The study population consisted of dogs transferred from LCAS between November 6, 2023 and February 20, 2024 to provide data before and after the intervention on December 18th. Records from Gigi's PetPoint® Data Management System (PTZ Insurance Services Ltd. Ontario, Canada) were reviewed. Puppies were defined as dogs <5 months of age. Estimated ages were assessed by medical staff at Gigi's and revised as deemed necessary. CPV infection was defined as typical clinical signs (lethargy and/or vomiting and/or diarrhea) and a positive SNAP test result.

Deferred puppy intake protocol

LCAS staff requested that community members maintain possession of any unwanted or stray puppies until the next Gigi's transport day. This deferment of intake eliminated or reduced the time puppies spent in LCAS housing. Whenever possible, deferred puppies waited with their surrendering community members in their personal vehicle until the puppies could be moved directly to a clean Gigi's crate on the transport van. If puppies were surrendered to LCAS the morning of a scheduled Gigi's transport day and the community member could not wait the 1–2 h until the transport van's arrival, the puppies were housed in a clean crate provided by Gigi's and kept in the front lobby, separated from the remaining LCAS population. If a puppy was found stray by the county dog warden or if a community member was not able to defer surrender until transport day, the puppy would be housed in the Puppy room at LCAS until the Gigi's scheduled transport day. Gigi's increased transport frequency from biweekly to weekly (every Monday) to minimize the deferment timeframe for community members and to ensure room for every puppy in the LCAS system. Priority for transport was given to puppies, then to dogs <12 months of age. Upon arrival at Gigi's, all dogs were bathed using standard dog shampoo. Due to the concern regarding

potential CPV exposure, puppies underwent a 7-day quarantine period where they remained confined to their home kennels if they had been housed in a LCAS kennel at any point. If any puppy was reported to be showing clinical signs of CPV while in possession of a community member, LCAS requested that they be brought in for stool or rectal swab CPV SNAP testing. Puppies testing positive for CPV infection were transported to Gigi's immediately for admission to the Parvo Treatment Center and not held until the next regularly scheduled transport day.

Data analysis

Descriptive data were recorded and summarized for the following: intake type (stray/owner surrendered); length of stay (LOS) at LCAS; housing at LCAS; vaccination; breed; age; sex; CPV infection; and CPV-associated mortality. Non-deferred (November 6 to December 16, 2023) and Deferred (December 18, 2023 to February 20, 2024) groups were compared for CPV incidence and mortality. Intake types were also compared for these variables. Pearson chi-squared tests were used for comparisons of categorical variables; Fisher's exact tests were used if any expected cell value was ≤ 5 . Statistical significance was based on a P -value $< .05$. A 95% confidence interval was used, with a Haldane-Anscombe correction when any given cell value was zero.

Results

A total of 160 dogs were transferred from LCAS to Gigi's during the study time frame. A total of 66 were males (3 were castrated) and 94 were females (none were ovari-hysterectomized). All dogs were mixed breeds. In all, 19 dogs classified by LCAS as puppies were determined by veterinary staff at Gigi's to be >5 months old and were excluded from further analysis. These exclusions left 38 puppies in the Non-deferred category and 103 puppies in the Deferred category for comparative analysis ($n = 141$ total). Of the puppies in the Non-deferred category, 33/38 (87%) were strays and 5/38 (13%) were owner surrendered to LCAS. In the Deferred category 31/103 (30%) were strays and 72/103 (70%) were owner surrendered to LCAS.

CPV infections

While not included in further analysis, two of the four dogs ≥ 5 months of age in the Non-deferred category developed (and survived) clinical CPV infections and no dogs ≥ 5 months of age in the Deferred category developed CPV infections. The Non-deferred category had significantly more puppies (18/38; incidence = 47%) diagnosed with CPV infection than the Deferred category (9/103; incidence = 9%); ($P < .0001$; odds ratio [OR] = 9.4, confidence interval [CI] = 3.69, 23.93). Overall, significantly more stray puppies were diagnosed with CPV infections than were owner surrendered puppies (20/64;

31% vs. 7/77; 9% [$P < .001$; OR = 4.5, CI = 1.78, 11.63]), but the proportion of stray and owner surrendered puppies with infections varied between the two groups. A significantly greater proportion of stray puppies in the Non-deferred category (17/33; 52%) were diagnosed with CPV infections than stray dogs in the Deferred category (3/31; 10%) ($P < .001$; OR = 9.9, CI = 2.51, 39.12). There was no significant difference in CPV infection rates between the two categories for owner surrendered puppies (1/5; 20% vs. 6/72; 8% [$P = .2$; OR = 2.8, CI = 0.26, 28.70]) (Table 1a).

All puppies ($n = 38$) in the Non-deferred category and 2 puppies in the Deferred category had been housed in the Puppy room at LCAS at some point prior to transfer to Gigi's. Mean Puppy room length of stay (LOS) prior to transport for CPV positive puppies in the Non-deferred category was 9 days (range 1–25 days) and was 4 days for the CPV positive puppies in the Deferred category. Across both categories, puppies with a history of being housed in the Puppy room at LCAS were more likely to be diagnosed with CPV than puppies who had no history of being housed in the puppy room (20/40; 50% vs. 7/10; 7% [$P < .0001$; OR = 13.4, CI = 5.01–36.02]).

CPV infection outcome

Most puppies diagnosed with CPV infections had favorable outcomes, with 13/18 (72%) in the Non-deferred

category and 8/9 (89%) in the Deferred category surviving. The increase in survival rates was not significantly different ($P = .17$). Of the 18, 8 (44%) CPV infected puppies in the Non-deferred category and 1 of the 9 (11%) CPV infected puppies in the Deferred category had reports of CPV infection prior to transfer to Gigi's. Of the 9, 3 (33%) puppies who developed CPV infections *prior to* transfer survived, and all the 18 (100%) puppies who were diagnosed with CPV infections *after* transfer survived. This difference in survival rates was significant ($P < .001$; OR = 42, CI = 3.71, 475.04) (Table 1b).

Discussion

Deferring intake of puppies prior to inter-organizational transfer correlated with a rapid and substantial reduction in CPV infections. Lower infection rates among Deferred puppies seem to be due in part to their reduced time spent in contaminated housing. Prior to the shift in protocol, puppies spent an average of 9 days inside the Puppy room. This duration provided ample opportunity for asymptomatic, CPV-infected puppies to contaminate the area and for vulnerable puppies to become infected. Most of the LCAS puppies diagnosed with CPV infections were housed in the LCAS Puppy room at some point, including those housed there after LCAS staff underwent biosecurity training. This suggests that a single day of training

Table 1. CPV incidence (a) and survival rates (b) for CPV in 141 puppies transferred from LCAS to Gigi's between November 6, 2023 and February 20, 2024

	Non-deferred	Deferred	P	OR	CI
	<i>n</i> = 38*	<i>n</i> = 103*			
	<i>n</i> (%)	<i>n</i> (%)			
Incidence	18 (47)	9 (9)	<0.0001	9.4	3.69, 23.93
Stray	17 (52)	3 (10)	<0.001	9.9	2.51, 39.12
Owner surrendered	1 (20)	6 (8)	0.2		
*Reflects total number of puppies in each category					
	Non-deferred	Deferred	P		
	<i>n</i> = 18*	<i>n</i> = 9*			
	<i>n</i> (%)	<i>n</i> (%)			
Survivors	13 (72)	8 (89)	0.17		
Stray	12 (70 [^])	3 (100 [^])	0.61		
Owner surrendered	1 (100 ⁺)	5 (83 ⁺)	0.78		

Incidence (a) calculated based on 33 stray and five owner surrendered puppies in the Non-deferred category and 31 stray and 72 owner surrendered puppies in the Deferred category.

*Reflects number of dogs diagnosed with CPV in each category

[^]Calculated based on CPV infections for stray puppies in each category

⁺Calculated based on CPV infections for owner surrendered puppies in each category

had little effect and/or repeatedly housing high risk dogs may contribute to ongoing spread. Environmental sampling and staff observations would be valuable next steps in assessing residual contamination and evaluating the impact of the training.

Several puppies from LCAS contracted CPV without ever having physical contact with the inside of LCAS, indicating that the outbreak was likely multifactorial. While a reduction in CPV incidence rates from 47 to 9% in a 2-month period is substantial, the latter rate remains more than three times higher than the incidence reported by DiGangi et al. (2%)⁸ for puppies relocated between shelters. This discrepancy may suggest evidence of an ongoing outbreak and/or poor immunity to CPV among dogs within the LCAS local community. Previous research¹⁷ has shown that low-income areas with limited supermarket access often overlap geographically with regions where dogs lack protective antibody titers (PAT) against CPV. According to the United States Department of Agriculture's Food Desert Atlas,¹⁸ over three-quarters of LCAS county is classified as low-income and/or having limited supermarket access. These socioeconomic factors likely contributed to the under-protection of dogs in this community. Targeted community outreach, such as low-cost spay/neuter services and vaccine clinics, could play a critical role in reducing the number of unwanted litters and increasing inoculation for the existing dog population in LCAS County. Local efforts to raise awareness and to provide education on the importance of these services may be necessary.

Survival rates within both categories were similar to previous reports from other organizations treating CPV in puppies.^{19,20} Only a single puppy died as a result of CPV infection in the Deferred category. However, the difference in survival rates between Non-deferred (75%) and Deferred (89%) categories was not statistically significant. This is likely due to there being too few CPV infected puppies in the Deferred category to detect a statistical difference, as well as survival rates being high in both categories.

Immediate access to infectious disease monitoring and veterinary care appeared to have had substantial impact on CPV infection outcome. All puppies developing CPV infection after transfer to Gigi's survived, while two-thirds of those who developed illness prior to transfer died despite aggressive treatment. These findings highlight the importance of early diagnosis and prompt treatment at the onset of clinical signs and align with previous research¹⁵ demonstrating the benefits of CPV monoclonal antibody administration early in the disease course. While the cost-benefit ratio of monoclonal antibody treatment remains a subject of debate, this study provides a partial explanation for the improved survival rates observed in early-treated patients, supporting the value of timely intervention.

Overall, stray puppies had significantly higher odds of developing clinical CPV infections than owner surrendered dogs. These results suggest that stray puppies in Lawrence County, Ohio gained the most benefit from deferred intake. It is possible that stray dogs had less access to veterinary care prior to intake than owned dogs and, therefore, were less likely to have PAT against infectious diseases. One study¹⁷ reported that stray puppies were just as likely to lack PAT against CPV as owner surrendered puppies, but did show that stray puppies had a lower likelihood of PAT against Canine Distemper Virus. The disparity in group composition for stray puppies in the two categories limits the validity of the stray intake status data to some extent. There was a substantially smaller percentage of stray dogs in the Deferred category (31%) compared to the Non-deferred category (87%). One issue with this disparity is that it weakens the assertion that being surrendered by an owner offers greater protection from CPV infection than being found as a stray. Another consideration is that the lower number of Deferred stray puppies contributed to the lower CPV incidence rate in that category. It is important to notice that prior to the change in protocol, community members typically brought puppies to LCAS within a day of finding them. However, after the protocol change, community members retained puppies in their home for 1–3 weeks before placing them directly into the hands of a Gigi's transporter from their personal vehicle. It is reasonable to speculate that many of these puppies may have been documented as 'owned' at the time of surrender, despite initially being found as strays.

Seasonality of CPV infections is another factor that could have affected the change in incidence rates between sequentially measured categories. While there is no published data to support a seasonal peak of CPV infections during the 6-week period when Non-deferred puppy data were measured, some studies¹⁹ have suggested a seasonality that extends beyond the summer months. A study of over 5,000 dogs treated for CPV in Austin, TX over 11 years showed strong evidence for a May-June peak seasonality with some evidence to suggest a potential second, smaller season in October.¹⁹ Authors of this study also acknowledge that the factors contributing to a second season are likely complex and have yet to be studied. A review of CPV infection numbers at Gigi's occurring in dogs transferred from LCAS between the same 6-week period revealed only 2 cases of CPV in 2020 and 0 cases in 2021 and 2022. While it is possible that LCAS had CPV infections during that time and did not report them or had them treated elsewhere, evidence is lacking for a second seasonal trend in CPV infections in southern Ohio and may simply point to an outbreak in this geographic area at a single timepoint.

Conclusion

Minimizing the time young puppies are shelter housed is a crucial consideration for organizations taking in dogs from shelter partners with low access to veterinary care and high risk of infectious disease. Providing more frequent transport opportunities for puppies further increases their chances of a successful outcome. Local community members seeking to surrender puppies appear willing to care for them for a short period and deliver them directly into the hands of the supporting partner organizations later. While frequent, deferred intake programs can significantly reduce CPV incidence during existing outbreaks, proactive deferment programs during known peak CPV seasons could also help preemptively mitigate future outbreaks. Such efforts not only prevent animal suffering and potential loss of life on both ends of transport but also keep operations running efficiently and effectively without the hindrance of lengthy quarantines and movement restrictions for CPV exposed dogs.

Authors' contributions

Hayley Hadden: conceptualization, data curation, formal analysis, resources, investigation, methodology, writing-original draft, visualization.

Meghan Herron: conceptualization, formal analysis, project administration, resources, validation, methodology, writing-review and editing, visualization.

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