

ORIGINAL RESEARCH ARTICLE

Management of a *Feline Bordetellosis* Outbreak in a Limited-Admission Animal Shelter in the Southeast USElizabeth Fuller^{1*}, Kathleen V. Makolinski², Miranda Tipton³ and Elizabeth A. Berliner²¹Charleston Animal Society, Charleston, SC, USA; ²American Society for the Prevention of Cruelty to Animals (ASPCA), NYC, NY, USA; ³East Asheville Family Vet, Asheville, NC, USA*Abstract*

Feline bordetellosis is a respiratory disease caused by *Bordetella bronchiseptica*, a primary pathogen in domestic cats, dogs, and other species, particularly in densely housed populations. This case report outlines the management of an outbreak of *B. bronchiseptica* in cats in a suburban, limited-admission animal shelter in the Southeastern United States in October 2023. A group of 43 cats were managed, with 93% (40/43) morbidity and 100% (43/43) live outcomes (adoption) for treated cats. Outbreak management included recognition, case identification, risk assessment, diagnosis and treatment, decontamination, population management, documentation, and communication. The establishment of an offsite isolation facility and targeted treatment based on diagnostic testing were key to timely resolution. With proactive management and in collaboration with shelter medicine specialists, resolution of this outbreak occurred in 45 days.

Keywords: *Bordetella bronchiseptica*; feline respiratory disease; animal shelter; shelter medicine; outbreak; risk assessment

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Supplementary material

Supplementary material for
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Feline bordetellosis is a respiratory disease caused by *Bordetella bronchiseptica*, a primary pathogen in domestic cats, dogs, wild carnivores, pigs, rabbits, horses, rodents, turkeys and humans.^{1,2} *B. bronchiseptica* is a gram-negative bacillus that colonizes the ciliated epithelium of respiratory tissues. Common clinical signs include fever, serous ocular and nasal discharge, sneezing, and lymphadenopathy; signs may progress to coughing, dyspnea, pneumonia, cyanosis, and death.^{1,3} Bacteria are shed in oral and nasal secretions. Routes of transmission include airborne, droplet, direct contact, and fomite transfer.^{2,3} Transmission can occur between dogs and cats.^{1,4} Spread of infection from animals to humans is rare.^{5,6,7}

Shelters can be high stress, densely housed environments, which predispose cats to developing infectious respiratory disease.⁸ A positive correlation exists between crowding and the presence of *B. bronchiseptica*.⁹ Additionally, cats already infected with other respiratory pathogens may be more easily colonized by *B. bronchiseptica*.¹⁰

Crowded or unsanitary conditions create a higher risk for transmission of respiratory disease due to increased opportunities for shedding and droplet transfer: closely placed enclosures, increased physiological stress, compromised biosecurity, high pathogen load, and increased length of stay all contribute to respiratory disease development.^{2,9,11,12,13} When sneezing, cats expel respiratory pathogens no more than 4 to 5 feet.¹³ In shelters, fomites are an important mechanism for the transmission of respiratory pathogens.² The infectious dose needed for natural transmission has not been established.

Duration of shedding may be prolonged. In a challenge study, specific pathogen-free cats inoculated with *B. bronchiseptica* cultured positive for the organism on nasal swabs for up to 19 weeks; however, the clinical significance of recovering the organism from these cats is unclear as cats did not remain symptomatic or transmit the disease to other cats, even with intimate contact.¹⁰ Cats in this study were not treated with antibiotics.

B. bronchiseptica has also been recovered from clinically healthy cats.^{10,14,15,16}

There are limited reports on the clinical diagnosis and management of outbreaks of *B. bronchiseptica* in cats.^{4,17} This case report outlines the management of an outbreak of *B. bronchiseptica* in cats in a suburban, limited-admission animal shelter in the Southeastern United States in October 2023.

Case

Shelter description

In 2023, the shelter admitted 958 cats and 756 dogs. Adoption and live outcome percentages, along with feline demographic information, is in Table 1. Intake types for dogs and cats included stray, owner surrender, and transfer from shelter partners. In 2023, they reported a live release rate of 95%, the majority of live outcomes being adoptions. Intake exams were performed by trained staff, including one on-staff licensed veterinary technician.

The shelter facility was an approximately 8,000-square-foot converted warehouse. Dogs were housed in 29 double-sided, indoor/outdoor enclosures. Cats were housed in the lobby and a small additional room. Cat enclosures were three-level vertical cages with glass fronts. The building had a central HVAC system, and no dedicated isolation areas for either species. Standard sanitation protocols employed accelerated hydrogen peroxide at 1:64 in a 2-step detergent-disinfection process, increasing the concentration to 1:16 during outbreaks. Four staff members provided daily animal care. Medical staff included one licensed veterinary technician acting as medical manager and one medical assistant; veterinary services were provided twice weekly by a contracted veterinarian.

Shelter intake protocol

Within 24 h of intake, cats 4 weeks of age and older were examined, weighed, and received a subcutaneous modified live virus (MLV) vaccine for rhinotracheitis, calicivirus, and panleukopenia (FVRCP). This vaccine was repeated every 2 weeks until kittens were 20 weeks old. For cats older than 20 weeks at the time of intake, an MLV FVRCP vaccine was administered within 24 h of intake and 2 weeks later. A killed virus rabies vaccine was

administered subcutaneously to cats 12 weeks of age and older. All cats and kittens > 0.6 kg were tested for Feline Leukemia with a point of care ELISA (enzyme-linked immunosorbent assay) test (FeLV [Feline Leukemia Virus] SNAP [proprietary point of care diagnostic ELISA manufactured by IDEXX], IDEXX [an international company providing diagnostic tests and software for the veterinary field]). Kittens < 16 weeks of age were dewormed with oral fenbendazole (50 mg/kg) and ponazuril (90 mg/kg). Cats > 16 weeks received a dose of Revolution (Selamectin, Zoetis) topically.

Outbreak recognition

In September 2023, staff noted several cats were exhibiting atypical respiratory signs: in addition to oculonasal discharge and sneezing, some had developed bloody nasal discharge and coughing. After consultation with the shelter's contracted veterinarian, shelter staff administered doxycycline hyclate at 10 mg/kg orally every 24 h to symptomatic cats.

Performing respiratory PCR (polymerase chain reaction, a laboratory test used to make many copies of a section of DNA) testing on cats showing symptoms of Feline Infectious Respiratory Disease (FIRD) was not routine for this shelter. However, due to unusual clinical signs (eg. coughing) and their severity in some cats, samples obtained by conjunctival and laryngeal swabs from three cats were submitted for Feline Upper Respiratory Disease RealPCR Panels (IDEXX) on 9/13/23. Cats tested during this initial phase were selected due to lack of response to the typical interventions. These samples recovered multiple agents common in cases of FIRD: feline herpesvirus (FHV) was recovered from all three cats, *Mycoplasma felis* from 2, and feline calicivirus (FCV) from 1; only one cat had FHV at a level suggesting clinical infection. Given its efficacy against *M. felis*, doxycycline treatment was continued. Clinically affected cats were housed separately from asymptomatic cats in a separate small room in the shelter temporarily labeled 'Isolation'.

Typically, the occurrence of FIRD at this shelter involved few cats and required minimal intervention. Since initial RealPCR test results did not identify *B. bronchiseptica*, shelter staff continued to treat cats showing signs of FIRD and monitor for new cases. When the number of cats involved continued to be above what staff

Table 1. Summary of 2023 intake and outcome data in this limited-admission animal shelter in the Southeast US

Species	Intake <i>n</i> (stray, owner surrendered, transferred in)	Live Outcomes <i>n</i> (%)	Adoptions <i>n</i> (%)
Felines	958	925 (97)	849 (89)
Kittens (0–20 weeks)	525		
Adults (> 20 weeks)	433		
Canines	756	718 (95)	686 (91)

considered baseline, additional testing was pursued following approval for this expenditure. One month after the first testing (10/13/24), samples from three more cats were sent for Feline Upper Respiratory Disease RealPCR Panels (IDEXX), and *B. bronchiseptica* was isolated in all samples (Table 2). Cats selected for this second testing group were either clinically ill and/or exposed to the sickest cats. Given this finding was different from previous tests, and case numbers were increasing, cat intake and adoptions were temporarily halted so more information could be collected. In consultation with the contracted veterinarian, the treatment protocol evolved to treat symptomatic cats with doxycycline hyclate (10 mg/kg) orally every 24 h and exposed cats with enrofloxacin (10 mg/kg) orally every 24 h.

The Medical Manager reached out for consultation with shelter medicine specialists who advised, among other interventions, performing culture and sensitivity; this testing indicated *B. bronchiseptica* sensitive to doxycycline. The enrofloxacin protocol was discontinued (10/26/24) at the recommendation of consulting veterinarians, and five more cats had samples submitted for Feline Upper Respiratory Disease RealPCR testing

and culture; *B. bronchiseptica* was found in four cats. A culture of the sample for the 5th cat was positive for *B. bronchiseptica* despite no recovery of the agent on the RealPCR test (Table 2). Given the extent of signs and the susceptibility of cats to infection, these results were interpreted as representing an outbreak in this population, and outbreak measures were enacted.

Case definition and risk assessment

The case definition included cats exhibiting clinical signs of respiratory disease and/or exposed to affected cats. A risk assessment was performed on the shelter population. Risk was determined as follows:

- High risk: Cats with clinical signs housed in the shelter and cats exposed to affected cats. All cats in the main facility were considered high risk.
- Moderate or undetermined risk: Cats without clinical signs housed in foster care who were briefly exposed when they visited the shelter for outpatient services (e.g. vaccination and spay/neuter).
- Low risk: Cats without clinical signs who were held in foster care and not exposed to cats in the shelter.

Table 2. Summary of diagnostic testing results in a *B. bronchiseptica* outbreak in an animal shelter

Patient ID	Patient age (months)	Sample Date	RealPCR positive*results	Culture and sensitivity results	Notes on interpretation
A1	6	10/13/23	<i>B. bronchiseptica</i> FHV <i>M. felis</i>		FHV active infection
		11/2/23	<i>B. bronchiseptica</i>	<i>B. bronchiseptica</i> 2+	
F2	12	10/13/23	<i>B. bronchiseptica</i> FCV <i>M. felis</i>		
		11/2/23	<i>B. bronchiseptica</i>	<i>B. bronchiseptica</i> 2+	
C3	10	PCR 10/13/23	<i>B. bronchiseptica</i> FHV		FHV viral load low
		C/S 11/2/23	<i>M. felis</i>	<i>B. bronchiseptica</i> 2+	
R4	5	10/30/23	<i>B. bronchiseptica</i> FCV FHV	<i>E. coli</i>	<i>B. bronchiseptica</i> not cultured despite positive RealPCR for <i>B. bronchiseptica</i>
S5	3	10/30/23	FCV FHV	<i>B. bronchiseptica</i> 2+	<i>B. bronchiseptica</i> cultured despite neg PCR for <i>B. bronchiseptica</i>
T6	2	10/30/23	<i>B. bronchiseptica</i> FCV FHV <i>M. felis</i>	<i>B. bronchiseptica</i> 3+	FHV viral load low
O7	7	10/30/23	<i>B. bronchiseptica</i> FHV	<i>B. bronchiseptica</i> 2+, normal flora 1+	
K8	4	10/30/23	<i>B. bronchiseptica</i> FHV <i>M. felis</i>	Normal flora 2+	<i>B. bronchiseptica</i> not cultured despite positive PCR for <i>B. bronchiseptica</i>

*PCR panel included *Chla mydophilia felis*, Feline Calcivirus, Feline Herpesvirus, H7N2 Influenza, Influenza A, *Mycoplasma felis*, *B. bronchiseptica*

Of the cats in the custody of the shelter, 43 were considered high risk and therefore subject to outbreak management procedures in the offsite facility. Forty of these exhibited clinical signs during the course of the outbreak; three cats were directly exposed to affected cats but never exhibited clinical signs of respiratory disease. Three clinical cats were euthanized on 10/19/24 prior to their offsite relocation due to intractable behavior, which deemed long-term housing and handling for treatment inhumane. In total, 37 cats exhibited at least one clinical sign of respiratory disease. The majority of cats that displayed symptoms exhibited mild to moderate disease, with sneezing, ocular discharge, and nasal discharge. Fewer cats, 13% (5/40), were noted to be coughing. Ten additional cats that had demonstrated clinical signs and recovered or were already successfully completing treatment in their pre-existing foster homes were excluded from offsite housing and interventions described in this report.

Characteristics of high-risk cats considered part of this outbreak are described in Table 3. Moderate/undetermined and low risk cats remained in foster care until after the outbreak resolved, and none required additional interventions.

Housing and enrichment

In order to establish a clean break while reopening limited shelter activities for cats, the shelter staff secured an offsite

isolation facility. Affected and exposed cats were isolated offsite for 38 days. Cats were first housed at the offsite location beginning October 20th. Others returned from foster care and joined the offsite population in the days after, and all cats remained at the offsite location until they returned to the main shelter for adoption on November 27th. Each day, 1 of 5 rotating staff members worked a full day at the offsite facility and did not work at the main shelter on such days. Cats were housed individually in multi-level wire cat condos; bedsheets were used to provide temporary barriers between cages in an attempt to prevent spread of Bordetellosis by droplets. Behavioral enrichment was provided in the form of toys, scratchpads, and soft bedding. On most days, one volunteer wearing PPE (gown and gloves) encouraged cats to play with toys and provided petting, while cats remained in their enclosure. Cats were monitored daily for signs of Fear, Anxiety, and Stress (FAS).^{18,19} Four cats that were exhibiting signs of FAS were provided with gabapentin orally (10–20 mg/kg every 12 h). In total, 40 cats were managed at the offsite building.

Treatment

Prior to the identification of *B. bronchiseptica* by PCR testing, symptomatic cats had been treated with doxycycline as per the standard shelter protocol. Following the identification of *B. bronchiseptica*, 25 cats, including asymptomatic cats, were started on oral enrofloxacin based on a consulting veterinarian's recommendation. However, shelter medicine consultants discontinued enrofloxacin based on best practice guidelines²⁰ for the treatment of FIRD. In all, 32 cats were treated with doxycycline, and for the majority of cats, signs resolved with one treatment course (10–14 days). Hospitalization was not required for any affected cats, and no natural deaths occurred.

Vaccination

Vaccination against *B. bronchiseptica* is not considered core in shelter vaccination protocols^{18,21} and was not standard protocol in this shelter. This bacterin vaccine does not induce sterilizing immunity but lessens clinical signs and decreases likelihood of transmission.² *B. bronchiseptica* is a novel pathogen for many cats, and widespread disease can occur in populations so vaccination is advised in an outbreak.^{2,12} Therefore, all dogs in shelter were revaccinated with an intranasal product that contained adenovirus type 2 and parainfluenza (modified live viruses) and Bordetella Bronchiseptica (avirulent live culture) (Intra-Trac3 Nobivac). All cats in the care of the shelter received a *B. bronchiseptica* intranasal, avirulent live culture vaccine (Novibac). Employees were offered the option to vaccinate their personal pets for *B. bronchiseptica*, although there is no available information about how many staff members took advantage of this benefit. The shelter continued to administer this non-core vaccine

Table 3. Descriptive Characteristics of 43 cats managed in a shelter outbreak of *B. bronchiseptica*

Characteristics	N (%)
Age	
Kittens (≤20 weeks)	16 (37)
Adults (>20 weeks)	27 (63)
Sex	
Male	15 (35)
Female	27 (63)
Unknown	1 (2)
Intake type	
Stray	0
Owner/guardian surrender	14 (33)
Transfer	19 (44)
Unknown	10 (23)
Clinical signs	
Clinically affected	40 (93)
Exposed but asymptomatic	3 (7)
Outcome	
Live outcome/placement	40 (93)
Euthanized	3 (7)
Total cats	43 (100)

to all cats of age in the shelter's system during the outbreak. The consultation team recommended the shelter continue to vaccinate incoming cats for *B. bronchiseptica* for 6 months following the outbreak.

Documentation

The shelter maintained individual and population records in a commercially available shelter software system (ShelterLuv). Additionally, medical staff kept a demographic spreadsheet of cats in the offsite isolation facility to provide more detailed population oversight. This spreadsheet was shared with shelter medicine consultants to inform recommendations and decision-making.

Sanitation protocols

Cat kennels in the main shelter were sanitized using a 2-step cleaning-disinfection procedure. Accelerated hydrogen peroxide (Rescue) in 1:16 dilution was first used as a detergent to clean kennels. Rescue was then re-applied with a 10-min contact time as a disinfectant. Spot cleaning, in which the cat was allowed to stay within the cage and retain reasonably clean bedding and other furnishings while freshening food and litterbox areas, was employed as often as possible. When necessary, cats would be removed from the enclosure to facilitate spot cleaning but were immediately returned following cleaning. Spot cleaning is recommended when possible, for cats remaining in their enclosures, as it retains familiar smells and reduces the stress associated with handling.^{12,22}

Population management

Two weeks after the start of the outbreak (10/31/24), new cats were admitted to the main shelter after deep cleaning. Transfer out of unaffected and unexposed cats to partnering organizations was utilized to preserve capacity for care and continue healthy cat placement. Transport also allowed staff to dedicate time and resources to sick and recovering cats and create space for clinically resolved cats to return from the offsite facility.

Adopter education and communication

In preparation for cats returning to the main facility, the consultation team met with shelter leadership and staff. Leadership was concerned cats would be contagious for as long as 19 weeks even after resolution of clinical signs based on a single published challenge study of experimentally infected cats.¹⁰ The shelter was also concerned about the community's perception of adopting treated and exposed cats and the risk of transmission from affected cats to cats in the community. The consultation team emphasized the role of clinical signs in shedding and transmission and developed educational materials for potential adopters. An example of an adopter handout is included in the Supplemental Materials.

Outbreak resolution

Forty days after the initiation of treatment, all cats held at the offsite facility were returned en-masse to the main shelter after a course of doxycycline and resolution of signs. This return was delayed several days by a holiday. Attempts were made to segregate returning cats from unexposed animals (i.e. those returning from foster homes and those whose intakes had occurred during the outbreak). Given facility limitations, complete separation was not feasible. Cats with resolved FIRD were made available for adoption, and no new cases occurred. All of the recovered cats were adopted.

Debriefing included a comprehensive review of care and sanitation protocols as well as a cost analysis for the event (see Table 4).

Discussion

This case is an example of a feline *B. bronchiseptica* outbreak successfully managed using population management, preventive medicine, and facility adaptations, including use of an offsite facility to establish an effective clean break. The shelter engaged shelter medicine specialists through virtual meetings and sharing of materials, including diagnostic testing results. Medical staff and leadership at the shelter reached out for consultation quickly upon identifying *B. bronchiseptica* in their cat population, and after noting disease was spreading in spite of antimicrobial treatment. Serious sequela such as widespread or community transmission, progression to pneumonia, or disease-related deaths did not occur.

Shelters are always challenged to manage intake based on capacity for care; however, timely suspension of intake can be critical in outbreak management. Upon recognizing the risks to cats, intake was suspended until the affected population was isolated, and sanitation was performed. Suspending intake allows appropriate capacity for care of affected animals, deliberate attention to outbreak management, and effective disease isolation. Strategies to curtail intake – including diversion of owner surrenders to other organizations, use of finder to foster strategies, providing owner support to keep their pet, supporting owner re-homing of pet, or enrolling other community partners – are critical to facilitating the management of disease outbreaks such as this.

Creation of an offsite treatment facility to enable a clean break was key for this organization. With only one main room for housing cats in main shelter, the shelter could not isolate affected cats. While environmental and operational measures help reduce transmission, given that *B. bronchiseptica* was a novel pathogen in this population and vaccination was not core, widespread transmission to new intakes would have been likely without physical isolation. Facilities with pre-designated isolation housing or capable of creating isolation space can be successful

Table 4. Estimated costs of managing an outbreak of feline bordetellosis in 43 cats housed in a shelter

Item	Unit cost (\$)	Dose per 2.5 kg cat	Total cost per cat (\$)	Number of cats	Total cost, population (\$)
Consumable items					
Feline Bordetella Vaccine	9.61 ea	1	9.61	40	384.40
Doxycycline, 50mg/ml compounded	0.31/ml	0.5 ml PO every 24 h x 10 days (10 mg/kg)	1.60	32	51.20
Consumables subtotal					435.60
Housing					
Offsite Isolation Facility	0				0*
Wire cat condos used at offsite facility	90		90	40	3600.00
Housing subtotal					3600.00
Diagnostic Testing					
Respiratory RealPCR	162.59		162.59	8	1300.72
Bordetella PCR + C/S	108.89		108.89	3	320.67
Culture and Sensitivity	141.85		141.85	3	425.55
Diagnostic testing subtotal					2046.94
Labor	Salary		Hours/week	Duration	
Staffing	22/h**		40	6 weeks	5,280.80
					11,362.54

* the offsite isolation facility was donated.

** salary estimate from national average for veterinary technician from Indeed (https://www.indeed.com/career/veterinary-technician/salaries?from=top_sb) Accessed 9/18/24

in outbreak management without an offsite facility. However, given this organization's limited cat housing in the main facility – 1 large room and 1 small room – it would have been difficult to prevent transmission.

Even with temporary use of an offsite facility, this organization struggled to provide separate isolation and quarantine spaces. Cats exhibiting clinical signs were not isolated from exposed, asymptomatic cats. Only three of the cats in the offsite location never exhibited any symptoms, but many cats cleared symptoms quickly and could have been separated from cats that took longer to resolve with more housing options. The limitations of the space and staff also did not allow for what would have otherwise been desirable modifications to housing.

Diagnostic testing was employed to determine appropriate treatment. Instead of testing every cat, a selection of cats was tested based on a risk assessment.²³ Cats were selected by identifying criteria most likely to yield helpful results, including new infections and more severe signs. Following testing, a presumptive diagnosis was made for the remaining cats based on risk and clinical signs. Ultimately, this approach effectively isolated affected cats and halted ongoing transmission.

The diagnostic testing yielded some conflicting results. Two cats yielded *B. bronchiseptica* on PCR testing, but culture failed to grow the organism. Conflicting results

may be explained by the relatively sensitive nature of PCR compared to bacterial culture. A third cat cultured *B. bronchiseptica* without showing the bacterin on the PCR test. This result may simply be an error, as it cannot be explained by relative sensitivity of the testing modality.

Early in the course of the outbreak, three clinically affected cats were euthanized due to severity of signs and behavioral challenges in handling. These cats exhibited clinical signs but were not PCR tested or submitted for necropsy. Necropsy is recommended as a component of outbreak investigation when animals die or are euthanized. Necropsy sampling provides an opportunity to obtain quality samples for diagnostic testing and can aid in case definition early in the course of an outbreak.^{24,25}

Early utilization of vaccination in both dogs and cats was a key component of management. *B. bronchiseptica* vaccinations for cats are not core in shelters since this pathogen is not as common as other pathogens in cats, the vaccine requires additional resources, and intranasal inoculation can be more difficult to administer.

Prior to engaging shelter medicine specialists, the shelter had initiated treatment with enrofloxacin in asymptomatic cats. This approach is not aligned with current guidelines, either as a first line antibiotic or at the dose of 10 mg/kg in cats due to risks of retinopathy.²⁰ Antibiotic treatment was corrected by diagnostic testing that

indicated doxycycline was the appropriate antibiotic for this outbreak based on antimicrobial stewardship guidelines for FIRD.²⁰

Staff made significant efforts to provide enriched housing, including soft bedding, elevated resting spaces, and tri-level caging to the cats at the offsite facility. However, floor space was smaller than the minimum recommended 8 square feet.¹⁸ The wire caging also allowed for respiratory droplets to pass between cages but was the best the shelter could do in an ‘emergency shelter’ situation. Behavioral enrichment was incorporated but limited to few in-cage items. Creating a more robust enrichment program including intermittent access to a large exercise kennel or individual enrichment plans would have been an improvement. Pharmaceuticals were successful in helping some cats experiencing FAS; for example, one anorectic cat who refused to interact with staff. With gabapentin, she became more active, used the litterbox, and was eating.

The shelter’s sanitation protocol prior to this outbreak was to clean between animals with detergent and water and to disinfect with Rescue at 1:64 with a 10-min contact time. This protocol would be effective at eliminating *B. bronchiseptica* but would have been ineffective at eliminating non-enveloped viruses. This outbreak was an opportunity to review and adapt sanitation protocols to increase their efficacy more broadly.

Outbreaks can result in extended lengths of stay in shelters. Partnering with another animal welfare organization enabled transfer out of healthy cats, increasing care capacity at the main facility. Returning recovered cats to the main facility from the offsite location enabled a faster return to normal operations, reduced the need for offsite staff, and streamlined pathways to adoption for affected cats. Additionally, the shelter was proactive in creating marketing and educational materials to help promote timely adoption of affected cats.

Respiratory RealPCR testing was not repeated to confirm resolution of disease. Although *B. bronchiseptica* can be recovered from infected cats for an extended period of time, cats that are clinically resolved seem to have less ability to transmit agents and cause disease.¹⁰ Therefore, the consultation team did not recommend retesting cats after resolution of clinical signs and felt comfortable releasing cats to placement earlier than the experimentally reported 19 weeks.¹⁰

Unfortunately, even with these measures, cats in the offsite location were housed offsite for just over 5 weeks, which encompassed a delay due to a holiday. Even 5 weeks was not ideal and raised behavioral and capacity concerns. Shelter stays longer than 2 weeks are considered long term.¹⁸ Ideally, cats would have been released from isolation on a rolling basis when treatment ended, and clinical signs resolved. A smaller number of resolved cats could have been returned and been made available

for adoption as their clinical signs resolved. Alternatively, the resolved cats could have transitioned to a foster home where they could have been made available for adoption.

The cost of responding to an outbreak can be significant. Concern about cost can influence decision-making in nearly every aspect of response, including housing, diagnostic testing, length of organization closures, and even euthanasia decisions. The costs of responding to this outbreak were estimated by the authors by including the equipment purchased specifically for the outbreak (primarily caging) and by estimating the labor cost associated with housing a group of cats in a temporary facility. The equipment cost and labor cost were calculated using market pricing (Table 4); however, costs are difficult to generalize across organizations. It is noteworthy that the shelter was able to secure the rental of the offsite location at no cost, representing significant cost savings. Shelters experiencing high rates of infectious disease are encouraged to engage shelter medicine experts at academic programs and national programs.²⁶

Conclusion

There are few published case reports of disease outbreaks involving feline Bordetellosis. This case demonstrates the successful management of a *B. bronchiseptica* outbreak with 93% morbidity and 100% live outcomes for treated cats. Outbreak response included recognition, case identification, risk assessment, diagnosis and treatment, establishment of an isolation facility, decontamination, population management, documentation, and communication with stakeholders. Vaccinations assisted in the control of the pathogen, and the establishment of the offsite isolation facility separated affected cats from unexposed cats, creating a clean break. Population management of unexposed cats was partially achieved by a transport of cats to partners, highlighting the importance of shelter partnerships. With proactive management in collaboration with shelter medicine experts, resolution of this outbreak occurred in 45 days, even with some logistical delays.

Author contributions

Elizabeth Fuller: Consultant, Conceptualization, Data Curation, Data Analysis, Investigation, Writing – original draft, Writing – review and editing; Kathleen Makolinski: Consultant, Conceptualization, Investigation, Writing-review and editing; Miranda Tipton: Data curation, writing – review and editing; Elizabeth A. Berliner: Consultant, Conceptualization, Investigation, Supervision, Writing – original draft, Writing – review and editing.

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Conflict of interest and funding

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Ethical review and informed consent

The work described in this manuscript involved the use of non-experimental, shelter-owned animals. Established internationally recognized high standards ('best practice') of veterinary clinical care for the individual patient were followed. Ethical approval from a committee was, therefore, not specifically required for publication. Although not required, ethical approval for this work was still obtained via an ASPCA internal research-oriented, ethical review committee, the Committee on Animals as Research Participants and Ethics (CARPE). Informed consent was obtained from the owner or legal custodian of all animals described in this work.

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