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Canine Respiratory Infections in Animal Shelters

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Overview

Contagious respiratory infections are likely the most common cause of illness in dogs in shelters. These infections represent a significant and frequent drain on shelter resources, including treatment costs, staff time, and staff morale. Holding dogs for treatment and recovery adds to the number of animal care days until adoption, which in turn impacts the holding capacity for the shelter and contributes to potential for crowding. Many shelters do not have adequate isolation areas to house dogs with contagious respiratory infections, so they are frequently kept in the general population, assuring the transmission and perpetuation of the pathogen so that it becomes an accepted “endemic” problem. In other words, respiratory infections are mostly accepted as a “fact of life” in shelters. However, some respiratory pathogens such as canine distemper virus and canine influenza virus, have resulted in temporary closure of numerous shelters and depopulation due to severity of disease or numbers of affected dogs. These situations not only impact animal health and welfare, but also attract unfavorable scrutiny by the media and community.

This document provides a basic overview of: 1) common canine respiratory pathogens in shelters, including the new canine respiratory coronavirus; 2) incubation times, clinical disease, duration of virus shedding, modes of transmission; 3) diagnosis; and 4) strategies for management and prevention in shelters.

CIRD

Canine infectious respiratory disease (CIRD) is complex because the same clinical syndrome, commonly referred to as “kennel cough”, can be caused by many different pathogens, including the following:

- *Bordetella bronchiseptica* bacteria
- Parainfluenza virus (CPiV)
- Adenovirus type 2 (CAV)
- Distemper virus (CDV)
- Influenza virus (CIV)
- Respiratory coronavirus (CRCoV)

Any one of these pathogens can cause a primary infection, but dogs are often co-infected with more than one. Recent studies in the U.S. and Europe have provided evidence that **viral pathogens are the more common primary cause of respiratory infections in dogs in shelters**. Viral replication damages the respiratory epithelium and mucociliary apparatus, providing opportunity for secondary infections by commensal bacteria, such as *Mycoplasma* spp, *Pasteurella multocida*, *Klebsiella pneumoniae*, *E. coli*, *Staphylococcus* spp, and *Streptococcus* spp., that exacerbate the severity and duration of disease. Conversely, primary infection by bacteria such as *Bordetella* or *Mycoplasma*, both of which destroy ciliated epithelial cells, can predispose to viral infections.



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This is not a comprehensive list of respiratory pathogens. There are still plenty of respiratory disease outbreaks in shelters where the causative pathogen is never identified despite extensive efforts. The recent emergence of CIV and CRCoV as significant causes of CIRDC illustrates the potential for discovery of new respiratory pathogens in the future.

Risk factors for CIRDC

CIRDC is also complex because the intricate interplay between host, pathogen, and husbandry factors determines risk for infection.

Host factors	Pathogen factors	Husbandry factors
Age (puppy vs. adult)	Virulence	Crowding
Immune status	Incubation period	Random co-mingling
Debilitation	Shedding period	Sanitation
Stress	Subclinical infection	Ventilation
	Carrier state (persistent infection)	Chronic moisture
	Transmission routes	Stress
	Incomplete protection by vaccines	Untrained staff
	No vaccines for new pathogens	

In general, puppies are most susceptible to infections than adult dogs because of their lack of protective immunity from maternally derived antibodies or from ineffective responses to vaccination. They typically enter shelters at an age when maternal immunity has waned to a level that does not protect against infection, but still interferes with responses to vaccination. Unvaccinated adult dogs are also at great risk for infection. Housing of puppies with adult dogs increases the risk for respiratory infections in the puppies. Puppies and adults that are debilitated by poor nutritional status, parasitism, infections with other pathogens, and stress from entering the shelter environment are more at risk for acquiring respiratory infections.

Inherent properties of pathogens also affect the risk for infection. Virulence, length of incubation period, preclinical shedding, duration of shedding, routes of transmission, and persistence in the environment significantly influence infection risk. The ability to establish subclinical infection or persistent infection increases the infectious dose of the pathogen. Respiratory pathogens are notorious for spread by aerosol which increases the difficulty in stopping rapid transmission throughout the kennel. Available vaccines for some of the respiratory pathogens provide only partial protection in that the vaccine-induced antibodies do not prevent infection, but do ameliorate the severity of clinical disease. In addition, there are no vaccines for some of the newly emerging pathogens such as CIV and CRCoV.

Most husbandry issues stem from ineffective population management and random co-mingling, resulting in exceeding the housing capacity of the facility, crowding of numerous and sometimes incompatible dogs into each kennel, longer resident time in the shelter, and increased stress for the animals and staff. Crowding hampers effective cleaning and disinfection procedures, which increases the infectious dose of pathogens in the environment. Because of multiple dogs per run and no empty runs to facilitate cleaning/disinfection, cleaning may consist only of spraying kennel floors (and dogs) with water to remove feces and urine. This results in chronic environmental moisture which favors pathogen survival and is stressful to the dogs. Crowding also decreases ventilation and air quality which causes irritated airway epithelium that is predisposed to colonization by pathogens. The risk for acquiring respiratory infections also increases with every day of residence in the shelter. Lastly, staff that are not trained to recognize respiratory infections and follow a plan for prompt removal of dogs from the general population contribute to increased pathogen transmission and infectious dose in the environment.



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Clinical features

All of the known canine respiratory pathogens cause similar clinical signs of acute onset of cough and nasal discharge ('kennel cough'). Factors that promote their transmission and severity of disease include the vaccination status of the dogs, length of incubation period, preclinical shedding, duration of shedding, routes of transmission, and persistence in the environment. These same factors also affect diagnosis and management and prevention strategies.

The incubation period for all of the pathogens associated with CIRP is a few days except for CDV. Preclinical shedding occurs for all of the pathogens, meaning infected dogs are contagious **before** they are identified as infected by appearance of clinical signs. The longer incubation period for CDV results in exposure of many more dogs before a problem is recognized, and the adoption of apparently healthy dogs that subsequently become ill after transfer to adoption groups and new owners. The prolonged incubation period of CDV contributes to the typical scenario of gradually increasing numbers of affected dogs that do not respond to treatments and progressively worsen. In contrast, the other pathogens typically cause a rapid increase in numbers of affected dogs, particularly CIV and CRCoV. Most dogs have not been exposed to these new pathogens and thus do not have any immunity. These 2 viruses spread quickly, resulting in illness in 50-80% of the population within 5 to 14 days.

Most of the pathogens are shed in respiratory secretions for 7 to 10 days. After shedding ceases, the dog is no longer contagious to other dogs. The short shedding period contributes to feasibility of quarantining exposed/affected dogs for 2 weeks before sending to adoption groups or new owners. The important exceptions are Bordetella and CDV – these 2 pathogens are shed for weeks to months, making quarantines unfeasible and too costly, and transfer to other groups too risky. Most of the pathogens cause subclinical infections which increases the number of exposed dogs that have to be quarantined.

	Bordetella	CPiV/CAV	CDV	CIV	CRCoV
Clinical disease	cough/ND pneumonia	sneezing OD/ND	cough/OD/ND pneumonia	cough/ND pneumonia	cough/ND pneumonia
Subclinical infection	yes	no	yes	yes	yes
Incubation period	< 1 week	< 1 week	2-4 weeks	2-4 days	< 1 week
Peak shedding	first week	first week	first 2-4 weeks	first 4 days	first week
Duration of shedding	weeks to months	7 days	weeks to months	7 to 10 days	10 to 14 days
Morbidity	low to high	low	low to high	high	high
Mortality	low	low	high	low	low
Transmission	aerosol, fomites	aerosol, fomites	aerosol, urine, feces, fomites	aerosol, fomites	aerosol, fomites
Vaccine	yes	yes	yes	no	no



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The numbers of dogs infected by Bordetella, CAV/CPiV, and CDV is dependent upon pre-existing immunity conferred by recovery from natural infection or vaccination *before* exposure. The numbers of dogs infected by CIV and CRCoV will be high because they probably do not have natural infection-induced immunity and there are no vaccines. Most of the pathogens have low mortality rates, and most dogs recover without complications. CDV is the exception since many dogs die or are euthanized because of progressive disease associated with viral infection of many tissues other than respiratory. For all of the pathogens, puppies are more prone to develop secondary bacterial pneumonias which could be life-threatening if not treated aggressively.

All CIRP pathogens are transmitted by direct contact with respiratory secretions of infected dogs or contact with contaminated fomites. Staff is the most important fomite promoting spread of the pathogens. In addition, all of the pathogens are effectively spread over distances of many feet by aerosols generated by sneezing and coughing. This is one reason why clinically ill dogs should be removed promptly from the population in order to decrease aerosol spread and infectious doses. However, remaining dogs in the same room are considered exposed and should be quarantined

CDV is the only CIRP pathogen that causes systemic infection – virus replication occurs in epithelial cells lining airways, intestines, kidney tubules, urinary bladder, eyes, CNS, skin, and tooth enamel. The initial clinical signs are copious nasal discharge and cough, mimicking infection by the other CIRP pathogens. Some dogs also have vomiting and diarrhea, KCS, or develop seizures and myoclonus within 1-3 months. Most dogs develop hyperkeratosis of the nasal planum and footpads (“hardpad”). The enamel of immature permanent teeth in puppies will become pitted, eroded, and stained (crumbly teeth). Since CDV is multi-organ infection, virus is present in respiratory secretions, feces, urine, saliva, tears, and even skin.

Diagnosis

All of the CIRP bacterial and viral pathogens cause similar clinical syndromes, at least during the first week of illness. Therefore, ***the pathogen causing the infection cannot be diagnosed based on clinical signs!*** Most shelters assume that “kennel cough” is due to Bordetella bacterial infection and treat for several days with doxycycline antibiotic. Accumulating evidence from diagnostic testing indicates that ***most respiratory infections in shelter dogs are viral!*** Dogs infected with CPiV/CAV, CIV, and CRCoV may appear to respond to antibiotic treatment, but in reality, these viruses have “run their course” in a time frame that coincides with duration of antibiotic therapy. The exception once again is CDV infection – antibiotic treatment with doxycycline and other antibiotics do not alter the disease pattern of progression to pneumonia and other complications, particularly in pups <1 year old.

Shelters should invest in diagnostic testing when the numbers of affected dogs persist or increase despite antibiotic treatment, there is explosive spread through the population over a period of a few days, dogs progress to more severe disease or die, and there is an increased frequency of new owner and community veterinarian complaints of sick dogs from the shelter. ***Timely diagnosis substantially impacts how many dogs remain healthy and adoptable. No diagnosis or late diagnosis increases the number of sick and exposed dogs due to improper management and the number of dogs euthanized.***

The best diagnostic method for acute infections is performance of PCR for pathogen DNA on conjunctival, nasal, and pharyngeal swabs. IDEXX offers a canine respiratory pathogen PCR panel that detects Bordetella, CPiV, CAV-2, CDV, CIV, and CRCoV (<http://www.idexx.com/animalhealth/laboratory/realpcr/tests/crd.jsp>). IDEXX offers a substantial discount on this diagnostic test to shelter programs (http://www.sheltermedicine.com/services/idexx_shelter_surveillance.shtml).



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Timing of swab collection is critical for diagnostic accuracy – swabs should be collected from 5 to 10 dogs with clinical signs for <4 days in order to catch the pathogens in their peak shedding period. Swabs collected during the downswing of shedding may not contain enough pathogen for PCR detection. A conjunctival, nasal, and deep pharyngeal swab should be collected on each dog and pooled together to maximize the probability of pathogen detection. The IDEXX canine respiratory pathogen PCR test is very sensitive and specific. However, it cannot differentiate vaccine strains from pathogenic strains of Bordetella, CPiV, and CAV-2 in dogs that received modified-live intranasal vaccines prior to onset of clinical disease. The more dogs that are tested, the more confident you can be in the diagnostic test results, especially if there is a consistent pattern of results for all tested dogs.

Necropsy of dogs that die or are euthanized during respiratory disease outbreaks is a valuable diagnostic tool. Tissues submitted for histopathology as well as diagnostic testing can detect the pathogens and determine pathogenesis. Tissues should be fixed in large amounts of buffered formalin (9:1 ratio of formalin to tissue) for histology. Fresh unfixed tissues can be submitted for the IDEXX PCR panel and for bacterial culture.

Management

Prompt removal of clinically affected dogs is the single most effective strategy for controlling spread of respiratory infections. This reduces the infectious dose in the environment. These animals should be housed in a physically enclosed isolation room pending diagnostic testing. Diagnosis will direct treatment and isolation time. Most dogs recover from bacterial and viral pathogens that cause CIRP, with the exception of CDV. Therefore, if shelters have the enough space and staff, dogs that do not have distemper can be held in isolation for 2 weeks for recovery and cessation of pathogen shedding. These dogs should be cared for by staff wearing full PPE (hair cover, gown, gloves, boots) dedicated to that area. If the staff is responsible for care of other dogs, they should care for healthy dogs before working in the isolation area.

Control of CDV transmission within a shelter is difficult due to the long incubation and shedding times. CDV is not considered a treatable disease in a shelter environment. CDV-infected dogs are usually euthanized, but those with good prognosis for recovery may be transferred to foster programs able to isolate the dog and provide supportive care.

Since sick animals shed infectious respiratory pathogens before onset of clinical disease, all dogs exposed to sick animals either by direct contact or fomite contact should be quarantined from the general population for 14 days with twice daily monitoring for appearance of clinical signs. If clinical signs occur, the dog should be immediately removed to the isolation area. Staff caring for the quarantined population should also wear PPE since exposed dogs may be in the incubation period with preclinical shedding of pathogen.

Cleaning and disinfection

Bordetella bacteria and the canine respiratory viruses are easily inactivated by most quaternary ammonium disinfectants. The exception is CAV-2, which requires bleach or Trifectant for inactivation. For optimum killing activity, environmental surfaces contaminated with feces, urine, vomit, blood, and nasal discharge must first be cleaned with a detergent before applying the quat ammonium product, bleach or Trifectant solution. The minimum contact time for all of these disinfectants is 10 minutes. Air drying is preferred if possible, but if the animal needs to be returned to the same run or cage, the area should be rinsed and dried using a squeegee or towel. Moisture favors the survival of respiratory pathogens.

Although canine respiratory pathogens are inactivated by quaternary ammonium products, we still recommend that the routine daily cleaning and disinfection regimen include the use of bleach or Trifectant. This is because other



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potential pathogens in shelter environments are not inactivated by quats (e.g., parvoviruses). A 5% solution of household bleach (½ cup per gallon water) should be prepared fresh daily and stored in an opaque container since light exposure inactivates it. Trifectant solution should be prepared according to manufacturer instructions - it is not inactivated by light and is less corrosive to metal and skin than bleach. For both disinfectants, more is *not* better! The more concentrated the solutions, the more irritating and damaging to skin, eyes, and the respiratory tract of animals and staff. If a dog has a respiratory infection, the fumes generated by disinfectants that are too concentrated only worsen the disease due to tissue irritation.

Daily cleaning and disinfection should include food and water bowls, animal transport vehicle, and hallways to reduce the risk for environmental transmission of any infectious disease. Food/water bowls should be made of stainless steel instead of plastic because scratched plastic is difficult to fully disinfect.

Mop buckets should not be used for cleaning and disinfection of kennel runs. High pressure hoses and power washers should also not be used in kennels unless all dogs are removed, because the force sprays feces on all surfaces and can even aerosolize fecal matter. Cleaning and disinfection supplies should be dedicated to each room and not removed for use in other areas in order to minimize cross contamination.

Prevention

Vaccination of all dogs on intake is the cornerstone for prevention of transmission of most respiratory pathogens (Bordetella, CPiV, CAV-2, CDV) in shelters. All dogs 4 weeks of age and older should receive a vaccine containing modified-live Bordetella, CPiV, CAV-2, CDV on intake, regardless of intake status (stray, owner surrender, rabies quarantine, cruelty case, pregnant, lactating, injured, ill). Intranasal vaccines containing Bordetella, CPiV, and CAV-2 should be used in conjunction with the combination of CDV, CPiV, CAV-2, and parvovirus administered subcutaneously. A delay of even a day can significantly increase the risk for infection. All puppies should be re-vaccinated with the subcutaneous combination vaccine every 2 weeks while in the shelter until they are at least 4 months old. Restricting vaccinations to adoptable dogs only creates a large pool of susceptible animals that can make respiratory infections an endemic problem. The only possible exceptions to the vaccination on intake rule include dogs that will be euthanized shortly after intake. For animals that were not vaccinated *before* exposure, vaccination *after* exposure will have little no effect on the outcome.

Another strategy to reduce risk for respiratory disease outbreaks is to segregate puppies from adults. Puppies can be housed together using a planned co-mingling approach. In this approach, littermates can be housed together in very small groups (2-3 per group), and unrelated puppies that were already living together before admission can also be housed together. Dogs and cats should be housed in separate areas because Bordetella bronchiseptica bacteria can infect cats and cause fatal pneumonia in kittens.

In addition to vaccination, another strategy to reduce risk for respiratory infection is to move puppies from the shelter into foster care or adoption groups as soon as possible after intake, Vaccinations should be repeated every 2 weeks for puppies in foster care.

In combination with vaccination on entry and segregation of age groups, another key strategy is the daily cleaning of all areas followed by disinfection with bleach or Trifectant. Puppies should be cared for before adult dogs, and healthy animals should be cared for before sick or exposed animals.

Finally, all efforts to reduce stress should be pursued. The most effective way to reduce stress on animals and staff in the shelter is to prevent crowding by practicing population management and planned co-mingling principles. Limiting run and cage occupancy to 1-2 compatible animals each results in less stress, facilitates effective cleaning and disinfection, and substantially reduces risk for infectious disease.