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Feline Respiratory Infections in Animal Shelters

Overview

Contagious respiratory infections are the most common cause of illness in cats in shelters and the most difficult to prevent or manage. These infections represent a significant and frequent drain on shelter resources, including treatment costs, staff time, and staff morale. Holding cats 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 have accepted cats with respiratory infections as an "endemic" problem that is a "fact of life" in shelters. In many cases, the number of affected cats and the severity of disease have caused temporary closure and depopulation to achieve a clean slate for starting over. 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 feline respiratory pathogens in shelters; 2) incubation times, clinical disease, duration of pathogen shedding, modes of transmission; 3) diagnosis; and 4) strategies for management and prevention in shelters.

Feline URI

Feline Upper Respiratory Infection (URI) is caused by a complex of viral and bacterial pathogens that are highly contagious among cats housed in high density/high turnover facilities. The most common feline respiratory pathogens include:

- Herpesvirus (FHV)
- Calicivirus (FCV)
- *Bordetella bronchiseptica* bacteria (Bordetella)
- *Chlamydophila felis* bacteria (Chlamydophila)
- *Mycoplasma felis* bacteria (Mycoplasma)
- *Streptococcus zooepidemicus* bacteria (Strep zoo)

While any of these pathogens can cause a primary infection, most cats frequently have mixed viral and bacterial co-infections. Recent studies in the U.S. and Europe have provided evidence that the ***viral pathogens are the more common primary cause of respiratory infections in cats 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, Staphyloccus spp, and Streptococcus spp.* that exacerbate the severity and duration of disease. Conversely, primary infection by bacteria such as *Bordetella, Chlamydophila,* or *Mycoplasma* that destroy epithelial cells can predispose to viral infections.

This is not an exhaustive list of respiratory pathogens. There are still plenty of respiratory disease outbreaks in shelters where the causative pathogen is never identified despite extensive diagnostic efforts. The emergence of H3N2 canine influenza virus in 2015 as a respiratory pathogen for shelter cats, and the 2016 feline URI outbreak in New York City shelters caused by H7N2 avian influenza virus highlight the potential for discovery of new respiratory pathogens in the future.

Risk factors for feline URI

Risk for feline URI arises from the intricate interplay between host, pathogen, and husbandry factors.

Host factors	Pathogen factors	Husbandry factors
Age (kitten 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	Improper vaccination strategies

In general, kittens are more susceptible to infections than adult cats 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 cats are also at greater risk for infection. Housing of kittens with adults increases the risk for respiratory infections in the kittens since some pathogens result in unapparent disease in infected adults, but the infected adults are contagious. Kittens 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 in the environment. **Available vaccines for most 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.**

Feline URI is strongly associated with poor housing conditions and poor population management strategies leading to crowding, long stays in the shelter, stress, and sanitation breaks.
Inappropriately-sized cages, high stocking densities in rooms, and long lengths of stay are the greatest risk factors for URI because of stress due to inability to perform natural behaviors, higher contact rates between cats, and ineffective cleaning and disinfection procedures increasing the infectious dose of pathogens in the environment. Inappropriate housing and crowding also decreases ventilation and air quality which contributes to irritated airways, predisposing to colonization by respiratory pathogens. The risk for acquiring respiratory infections also increases with every day of residence in the shelter. One

study showed that the probability of URI in cats was 80% by the second week in the shelter. URI significantly increases length of stay in shelters where cats are held for treatment and recovery, greatly compounding stress and perpetuating the vicious cycle.

Clinical and epidemiological features

Most of the known feline viral and bacterial respiratory pathogens cause similar clinical signs: acute onset of sneezing and nasal and ocular discharge ("feline URI"). The exception is virulent systemic FCV (VS-FCV).

Approximately 80-90% of feline URI is caused by FHV and FCV. FHV causes rhinitis, conjunctivitis, keratitis, stomatitis, and facial dermatitis resulting in sneezing, oculo/nasal discharge, ocular ulcers, oral ulcers, and hypersalivation from oral ulcers. Kittens typically have more severe disease than adults, including pneumonia. The incubation period is <1 week. Clinical signs and virus shedding in ocular, nasal, and oral secretions can persist for 1-3 weeks. Infection is life-long due to viral latency in the facial trigeminal ganglia (life-long carrier). Stress reactivates virus replication in at least 50% of cats but not all cats recrudesce with clinical disease. Virus shedding in oronasal and ocular secretions starts within one week of the stressful event and can continue for 1 to 3 weeks. Kittens are very susceptible to acquiring primary FHV infection from direct or indirect contact with previously infected adults that start shedding reactivated virus within 1 week of entering the shelter.

Many strains of FCV exist and frequent mutations lead to new strains that vary in virulence and vaccine resistance. Like FHV, FCV-infected cats have sneezing, oculo/nasal discharge, oral ulcers, and hypersalivation from oral ulcers. Kittens typically have more severe disease than adults, including pneumonia and the limping syndrome. About 25% of adult cats have a subclinical infection but are still contagious. The incubation period is <1 week. Clinical signs can persist for 1-3 weeks or longer. Virus shedding in ocular and oronasal secretions stops within 4 weeks in about 50% of cats, but the other 50% shed virus up to 11 weeks. A few cats may shed for life (carrier state). In contrast to FHV, recovering or chronically infected cats may shed constantly or intermittently in a pattern that is unaffected by stress. Carrier cats can re-contaminate the environment or directly spread disease to naïve cats. FCV vaccines do not protect against infection or establishment of a carrier state - vaccinated cats are susceptible to infection and severe disease from some strains of FCV.

Virulent systemic FCV (VS-FCV) strains arise from FCV mutations. Unlike other feline respiratory pathogens, this highly virulent and lethal virus causes systemic infection and clinical disease due to vasculitis - edema of face and limbs; ulcerative lesions on skin and paws; ulcers on nose, lips, ears, eyes, footpads; icterus. In contrast to regular FCV, the virulent systemic virus causes more severe disease in adults than kittens, including well-vaccinated adults. Fortunately, infections by VS-FCV occur infrequently. ***A severe infection with regular FCV is often mistaken for VS-FCV, but the difference is the extensive and widespread vasculitis disease with VS-FCV.***

Bordetella and *Chlamydophila* bacterial infections are not as common in cats as the viruses. ***Occurrence of these infections is most often an indicator of poor husbandry practices and ventilation***. Similar to FHV and FCV, these bacterial pathogens have an incubation period of <1 week. *Bordetella* causes sneezing and oculonasal discharge like FHV and FCV, but ***coughing is a unique indicator of Bordetella infection.*** *Bordetella* infection causes severe life-threatening pneumonia in kittens. If not treated with appropriate antibiotics, chronic *Bordetella* infection with intermittent bacterial shedding can

occur for up to 3 months. *Chlamydophila* causes mostly ocular signs, including conjunctivitis, chemosis, and blepharospasm. This bacterial pathogen can be shed in ocular discharges for up to 2 months. *Bordetella* and *Chlamydophila* are best treated with doxycycline or minocycline for 4 weeks to eliminate infection.

The ability of *Mycoplasma felis* to initiate primary respiratory infection is unclear but this bacterium is very commonly found in cats with respiratory infections initiated by other pathogens. It also occurs in normal cats. *Mycoplasma* are best treated with dpxycycline, minocycline, or azithromycin.

Strep zoo is an emerging pathogen in cats, particularly those housed in shelters and sanctuaries where large numbers of cats are hoarded in inhumane conditions without adequate care and respiratory disease is rampant. One recent study [Polak. Infectious diseases in large-scale hoarding investigations. *The Veterinary Journal* 2014; 201:189-195] found that *Strep zoo* was one of the most common respiratory pathogens found in cats rescued from large-scale hoarding cases. *Strep zoo* was identified in cats with severe life-threatening URI and pneumonia - the bacteria were in the nose, lungs, and brain. Unlike *Strep zoo* infection of dogs, hemorrhage in the lungs is not a characteristic of the infection in cats. The best antibiotics for *Strep zoo* infections are Clavamox and Convenia

All of the respiratory pathogens are highly contagious in a high density/high turnover room, especially if there are lots of susceptible kittens mixed in with adults that have subclinical infection and shedding. ***The incubation period for all of the bacterial and viral respiratory pathogens is a few days (2-6 days). The short incubation period contributes to a rapid increase in number of cats within a short period of time.***

Preclinical shedding occurs for all of the respiratory pathogens, meaning infected cats are contagious before appearance of clinical signs. The viral and bacterial pathogens may be shed for 1 to 3 months. Some cats can have subclinical infections yet are contagious. Cats with sneezing and oculonasal discharges likely shed greater amounts of virus and bacteria than the asymptomatic cats. Many cats are still shedding increased amounts for a few weeks following recovery. However the risk of transmission is greatly reduced once clinical signs have fully resolved. ***FHV and FCV establish chronic infections (carriers) – FHV shedding is activated by stress while FCV shedding is continuous or intermittent regardless of stress.*** Carrier states are important to maintaining infection in a population and development of control strategies.

Feline respiratory pathogens are spread by three mechanisms: direct contact of sick cats with susceptible ones, environmental and staff contamination (fomites), and contact with carrier cats. ***In contrast to canine respiratory pathogens, feline pathogens are not transmitted by aerosols. Sneezing cats generate large droplets that only travel 4 feet or less.*** This small shed and spread zone makes in-cage isolation a feasible alternative to relocation of the cat to an isolation room. For in-cage isolation, the door can be covered with a towel to reduce spread of the pathogens outside of the cage.

	FHV	FCV	Bordetella	Chlamydophila	Mycoplasma	Strep zoo
Incubation period	<1 week	<1 week	<1 week	<1 week	<1 week	<1 week
Shedding period	1-3 wks	1-3 mo	up to 3 mo without antibiotic tx	up to 2 mo without antibiotic tx	weeks without antibiotic tx	weeks without antibiotic tx
Carrier state	yes	yes	no	no	?	?

Diagnosis

Since all the respiratory bacterial and viral pathogens cause overlapping URI signs, ***the pathogen causing the infection cannot be diagnosed based on clinical signs!*** Accumulating evidence from diagnostic testing indicates that ***most respiratory infections in shelter cats typically involve both viruses and bacteria.*** Shelters should invest in diagnostic testing when the number of cats with URI increases above a typical baseline for the shelter, there is explosive spread throughout the population in a short period of time, cats progress to more severe disease or die, the duration of illness is more prolonged, and there is an increased frequency of new owner and community veterinarian complaints of sick cats from the shelter. ***Timely diagnosis substantially impacts how many cats remain healthy and adoptable. No diagnosis or late diagnosis increases the number of sick and exposed cats and the number of cats euthanized.***

Diagnostic testing to identify the respiratory pathogen(s) provides for:

1. Proper patient management, including treatment options and costs, prognosis for recovery, and average time to recovery;
2. Proper management of the at-risk population
3. Isolation time (shedding period)
4. When cats can be re-introduced back into the general population

The best diagnostic test for feline URI is performance of PCR for pathogen nucleic acid on conjunctival and pharyngeal swabs. PCR is very sensitive and specific, and the turnaround time for results is usually 3 days which allows for timely patient and population management. Several diagnostic laboratories offer Feline URI PCR panels that test for multiple viral and bacterial respiratory pathogens in a single sample. Test costs range from $80 to >$100 per sample. IDEXX offers a substantial discount on their Feline URI PCR panel for shelters. IDEXX also offers the most comprehensive feline URI pathogen PCR Panel that includes identification of any influenza A virus and *Strep zoo.* In addition, the IDEXX panel contains a quantitative FHV PCR assay that determines the viral load in the sample. Low viral loads typically occur in latent or low-level chronic infection signifying that the virus is likely not contributing to an active respiratory infection with clinical signs. High viral loads indicate a high level of viral replication that is most likely causing the active clinical disease.

	Feline Upper Respiratory Disease RealPCR Panel (IDEXX)	FastPanel PCR Feline Upper Respiratory Panel (Antech)	Feline Respiratory PCR Panel (Cornell Animal Health Diag Cntr)	Feline Respiratory PCR Panel (Zoologix)	Feline Respiratory PCR Panel (Abaxis)
FHV	✓ quantitative	✓		✓	✓
FCV	✓	✓		✓	✓
Bordetella	✓	✓	✓	✓	✓
Chlamydophila	✓	✓	✓	✓	✓
Mycoplasma	✓	✓	✓	✓	
Influenza A virus	✓ any flu A strain	✓ H1N1 only	✓ any flu A strain	✓	
Strep zoo	✓ by request				

To increase diagnostic accuracy and identify a pattern, swabs should be collected from at least 5 cats with clinical signs. The more cats that are tested, the more confident you can be in the diagnostic test results, especially if there is a consistent pattern of results. The best sites to swab are the conjunctiva and deep pharyngeal area beyond the tongue. These sites should be rubbed with the swab tip to collect infected epithelial cells. At least 2 swabs should be collected from each cat and pooled together to maximize the probability of pathogen detection.

Necropsy of cats that die or are euthanized during respiratory disease problems is a valuable diagnostic tool. Tissues submitted for histopathology as well as diagnostic testing can help identify 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 Feline URD PCR Panel and for bacterial culture. Necropsy is especially valuable since the pathogen may not be recognized or included in PCR panels, including VS-FCV.

Disease Management

Isolation of sick and asymptomatic exposed cats is required for minimal control of disease spread. This reduces the infectious dose in the environment and threat of infection spillover to more susceptible cats. Sick cats in group housing need to be moved to individual housing for treatment, monitoring, and stress reduction. Cats exposed to sick animals either by direct contact or fomite contact should be considered at risk for infection and also isolated. A physically enclosed isolation room is ideal, but in-cage isolation is acceptable if the cat can be cared for without fomite contamination of other cats. A cover over the front of the cage contains droplet fomites and reduces stress. Minimal handling, use of the

spot-cleaning method with a disinfectant that kills FCV, and changing gloves between cats is paramount. Staff should care for exposed cats before sick cats and wear a long-sleeve gown that can be removed when leaving the room. Kittens should not be housed in the same room as sick or exposed adults.

The best option for sick cats is to transfer them to foster homes without other cats or adopt them to homes without other cats. The home environment is much safer and far less stressful, promoting faster recoveries.

Technically speaking, infected cats should be isolated until no longer shedding the respiratory pathogen - this can be 1 to 3 months after recovery in many cases. However, the risk of transmission is greatly reduced once clinical signs have fully resolved. ***It is far better for the health and welfare of the cat to release them for adoption or foster once they have recovered from the illness*** than to hold them for weeks in the shelter waiting for shedding to stop. PCR testing of recovered cats can identify whether they are still shedding and minimize the risk that adopted or fostered cats will transmit infection to pet cats in the home. Exposed cats may have a subclinical infection or be a FHV/FCV carrier that is actively shedding virus without clinical disease. PCR testing can rule out these possibilities and hasten their release from isolation for adoption or foster.

The cornerstone for prevention of further spread of infection is creation of a clean break. This is defined as separation of unexposed cats and new arrivals from exposed or infected cats. A clean housing room must be secured for unexposed cats and new admissions that completely protects them from exposed or infected cats. Staff should care for cats in the clean area using dedicated supplies before moving to exposed and sick cats in isolation.

Cleaning and disinfection

FCV persists in the environment for more than 30 days. Since FCV is a common cause of feline URI, disinfectants that kill FCV should be used for cat housing. Trifectant and Accel/Rescue are the best choices since they have detergent properties and work in the face of mild contamination with organic matter. Environmental surfaces that are heavily contaminated with feces, urine, vomit, and nasal discharge must first be cleaned with a detergent before applying the disinfectant product. The spot cleaning method should be used for occupied cages to promote little to no handling of cats. PPE (long-sleeve gown, gloves) must be worn in rooms with sick and exposed cats and gloves changed between cages. Vacated cages, bowls and litterpans, and other disinfectable items should be thoroughly cleaned with a detergent followed by disinfection with bleach, Trifectant, or Accel/Rescue. Any items that cannot be disinfected or laundered in hot water with bleach should be discarded.

Prevention

Vaccination of all cats on intake is fundamental for reducing susceptibility to several respiratory pathogens. All cats 4 weeks of age and older should receive the modified-live FVRCP vaccine containing FHV and FCV on admission and 2 weeks later. Inclusion of *Chlamydophila felis* in the FVRCP vaccine is not warranted since it is not effective. Kittens should be re-vaccinated every 2 weeks while in the shelter until they are at least 5 months old. Vaccination does not prevent infection, but can reduce severity and duration of disease. Many FCV strains are resistant to vaccines, so even properly vaccinated cats can be susceptible to severe disease. The modified-live *Bordetella bronchiseptica* vaccine for cats is not considered a core vaccine for shelters, but including this vaccine for all cats at intake, at least for several

months, should be considered when *Bordetella* has been associated with URI cases, especially kittens.

In addition to vaccination, another strategy to reduce risk for respiratory infection is to move kittens from the shelter into foster care or adoption groups as soon as possible after intake since they are the most susceptible group for feline URI.

Finally, all efforts to reduce stress should be pursued. This is the cornerstone for preventing or minimizing feline URI in shelters. Ideally, all strategies for diverting intake of cats should be pursued. The most effective way to reduce stress in cats that must be admitted to the shelter is to practice sound population management strategies that decrease each animal's length of stay in the shelter.

Resources

1. Scarlett. Chapter 8. Feline upper respiratory disease. In: Infectious Disease Management in Animal Shelters, ed. by Miller and Hurley, 2009, Wiley-Blackwell.
2. ABCD guidelines on prevention and management of feline calicivirus infection. *J Feline Med and Surg* 2009;11:556-564
3. ABCD guidelines on prevention and management of Bordetella bronchiseptica infection in cats. *J Feline Med and Surg* 2009;11:610-614.
4. ABCD guidelines on prevention and management of feline herpesvirus infection. *J Feline Med and Surg* 2009;11:547-555.
5. ABCD guidelines on prevention and management of Chlamydophila felis infection. *J Feline Med and Surg* 2009;11:605-609.
6. AAFP.Chlamydophila felis disease information fact sheet. *J Feline Med and Surg* 2013;15 Supplemental File:785-808.
7. AAFP.Bordetella bronchiseptica disease information fact sheet. *J Feline Med and Surg* 2013;15 Supplemental File:785-808.
8. AAFP.Feline herpesvirus 1 disease information fact sheet. *J Feline Med and Surg* 2013;15 Supplemental File:785-808.
9. AAFP.Feline calicivirus disease information fact sheet. *J Feline Med and Surg* 2013;15 Supplemental File:785-808.