Are Dogs Really “Scrotally Aware?”
New Research Results on Scrotal vs. Prescrotal Castration

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The preferred method to castrate canines has been an area of debate in the veterinary field in recent years. Many general surgery references describe only the prescrotal technique for adult dogs, while nearly every high volume surgery reference describes both techniques. Although the scrotal technique was first described for dogs in 1974, there has been a reluctance in the veterinary community to shift from a prescrotal to a scrotal technique. Many cite a “scrotal awareness” in dogs as the reason for using the prescrotal rather than scrotal technique. This means that the dog is thought to be more sensitive to and more aware of irritation to the scrotum. In fact, during a prescrotal technique, veterinarians are taught to not shave or prep the scrotum, but rather to place the surgical drapes in a manner that excludes the scrotum from the sterile field. The prevailing belief is that even the irritation of shaving the scrotum could cause the dog to self-mutilate post-operatively.

As the fields of shelter medicine and high volume surgery have been evolving over the last two decades, one of the issues that has been brought forth is the need for more efficient surgical techniques. This is for the benefit of both the patient and the surgeon. Efficient techniques with smaller incisions require the patient to be under anesthesia for less time, decrease healing time, decrease wound dehiscence, and decrease post-operative pain. Efficiency is also important to the surgeon. High volume surgeons often perform 40 or more surgeries a day. Decreasing the amount of time it takes to perform standard procedures can make a dramatic difference in shelter or clinic operations.

In 2015, Dr. Woodruff et al. published results from a study performed at Humane Alliance (HA) and Mississippi State University (MSU) that tracked post-operative complications immediately following the two techniques as well as surgical times. Experienced surgeons performed the procedures. They found that the scrotal procedure was 30% faster and had a lower risk of self-trauma when compared to the prescrotal technique. Other postoperative complication rates were not statistically different between the two techniques.

Further studies on this matter are important to provide dogs with the best surgical care possible. If scrotal castrations require less anesthetic time and lead to less self-trauma following surgery, dogs should have the benefit of this technique.

The data collection for the study described in this presentation was conducted over the course of one year at the University of Tennessee and is ongoing. Preliminary findings are presented. The shelter medicine spay/neuter program sourced dogs over 6 months old with two descended testicles from 6 local animal shelters. In order to properly represent dogs from shelters, minor health issues were allowed unless the veterinarian in charge felt that they were not healthy enough for elective surgery. The procedure technique and student surgeon were selected by random draw. During physical examination, the dog’s weight and estimated age were recorded. The animals were prepped according to the procedure (cranial to the scrotum for prescrotal, scrotum for scrotal). Surgical time was started at first cut and ended upon closure. The same pain management and anesthetic protocol was utilized for all patients. The animals were then returned to the shelter with a list of potential complications they needed to monitor. These included redness, swelling, draining, bleeding, licking, and bruising. Complications were noted every other day for 7 days, upon which time the record was returned to the faculty veterinarian.

To determine whether a statistically significant relationship existed between the rate of complications and multiple factors associated with surgery, a Chi square test was used. The data was categorized to simplify analysis and because some categories led to a natural separation of data (example: large vs small dogs). The study outcome was the presence or absence of complications. The exposures were the size, age, surgical time, and procedure type.

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Large Dog</td>
<td>Over 25#</td>
</tr>
<tr>
<td>Small Dog</td>
<td>Under 25#</td>
</tr>
<tr>
<td>Short Surgery Time</td>
<td>30 minutes or less</td>
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<tr>
<td>Long Surgery Time</td>
<td>31 minutes or more</td>
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<tr>
<td>Young Dog</td>
<td>6 months to 2 years old</td>
</tr>
<tr>
<td>Older Dog</td>
<td>3 years and over</td>
</tr>
<tr>
<td>Complications (yes)</td>
<td>Presence of 1 or more complications</td>
</tr>
<tr>
<td>Complications (no)</td>
<td>No complications noted</td>
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</tbody>
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The total number of dogs in the study was 155, but only 69 of those had postoperative data and were included in the data interpretation for complication rates. Most dogs were mixed breed dogs, although various pure breeds were also represented.

Ages were estimated using full adult dentition as the marker for a dog being over 6 months old. A dog was deemed to be 3 years or over if his external genitalia and dentition was suggestive of the age. Young dogs were those that were listed as 6 months to 2 years, and older dogs were those listed as over 3 years old. Of the total 155 dogs, 56.1% were 2 or younger, with the rest being 3 or
over. Of the dogs with complication data 57.4% were 2 or younger, with the rest being 3 or over. The weight range was 6.1-85 pounds, with a mean of 35.37.

Dogs were grouped according to weight class, with small dogs being up to 25 lbs, and large being those over 25.1 lbs. When looking at the entire sample, 32.9% were small dogs and 67.1% large. Of the dogs with complication data, 32.4% were small and 67.6% large.

Surgery times varied from 4-75 minutes, with a mean of 24.66. There was a need to block surgical times for statistical analysis, and the times did not lend themselves to a natural division of “long” vs “short”. Surgical times were therefore blocked according to what is generally considered to be a normal time for an elective procedure performed by a student. Although unpublished, the author (AD) has maintained records of surgical times for nearly 300 students that indicate that the average student can perform an elective procedure in 30 minutes after completing training on efficient surgical technique. Thus, the 30 minute designation was somewhat arbitrary but was based on the level of surgical efficiency that many inexperienced surgeons can attain with proper training. Of all dogs, 74.8% had surgery times of 30 minutes or less. Of those with complication data, 76.5% were 30 minutes or less.

When looking at the entire sample, 49.7% of dogs had a prescrotal technique. Of those with post-operative data, 51.5% had a prescrotal surgery.

Post-operative data was missing from 55.5% of the sample, with most of those being due to adoptions immediately following surgery.

To determine whether an association was present, SPSS was used to run crosstabs using different variable pairings. First, the presence of complications (yes or no) was compared with technique (scrotal or prescrotal), dog size, dog age, and surgery time. The results can be found in the table below, and the only variable that was significantly associated with complications was surgery time. Surgery time was positively and significantly associated with complications (Chi-square value = 4.193, P value = 0.041), meaning that a surgical time of 31 minutes or more was associated with a greater occurrence of complications.

Chi-square comparing complications with other variables

<table>
<thead>
<tr>
<th>Factor</th>
<th>Technique</th>
<th>Dog Size</th>
<th>Dog Age</th>
<th>Surgery Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>0.22</td>
<td>1.428</td>
<td>1.556</td>
<td>4.193</td>
</tr>
<tr>
<td>P value</td>
<td>0.883</td>
<td>0.232</td>
<td>0.212</td>
<td>0.041</td>
</tr>
</tbody>
</table>

Next, crosstabs were ran to compare surgery time with technique, dog age, and dog size. The results can be found in the table below, and again, only one variable was significantly associated with surgery time. Technique was positively and significantly associated with surgery time (Chi-square = 10.197, P value = 0.001), meaning that prescrotal technique was associated with a longer surgery time.

Chi-square comparing surgery time with other variables

<table>
<thead>
<tr>
<th>Factor</th>
<th>Technique</th>
<th>Dog Age</th>
<th>Dog Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi Square</td>
<td>10.197</td>
<td>1.162</td>
<td>2.279</td>
</tr>
<tr>
<td>P value</td>
<td>0.001</td>
<td>0.281</td>
<td>0.131</td>
</tr>
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</table>

In order to further demonstrate that the postoperative complications were related to time rather than procedure, a linear regression model was ran. The result demonstrated that as time increased, there was a statistically significant increase in complications, holding procedure constant.

The most important and interesting finding is that the procedure did not influence the outcome as much as the surgical time. It was initially thought that the outcome would be associated primarily with procedure and the time would be a confounding factor. It appears, however, that the outcome is primarily related to time.

This data does have some limitations. First, the shelter staff were trained to recognize complications, but using non-medical staff and having more than one person evaluating complications can lead to differences among the shelter cohorts. In the future, it would be best to have medical personnel follow up with all patients in order to properly assess animal health postoperatively and eliminate this potential source of bias. Also, one important factor to consider is the effect of the surgeon on the outcome. While all students suffer from inexperience, some have more advanced skills than others. Because students only perform 4-5 castrations each, it is not possible to evaluate the effect of the student on the outcome. It would be interesting to match dogs of similar weight and age, with the same student performing the procedure, to determine if the outcomes vary by student or by procedure. Given the random sourcing of the dogs, this was not possible. In order to minimize this effect, surgeries were randomly assigned to students. Another shortfall was missing data. Many dogs were adopted over the course of the data collection so a full 7 days of follow up was not available for many dogs. There was not a humane way to ensure a week of follow up without trusting untrained adopters to provide complication information so this was not attempted. One could assume that the more adoptable dogs are more likely to leave the shelter quickly and are thus underrepresented in the sample with complication data. Because so many factors are related to “adoptability”; including color, behavior, breed, size, kennel presence, prior housetraining, and hair coat; it is simply not possible to determine the effect of this on this data. After 6 months of age, age is not known to be a significant factor in “adoptability” so simply looking at the age of those
with post-operative data versus those without data will not provide much information about the effect of “adoptability” on the results. The ages of those with and without data was compared, however, to demonstrate this point. As expected, significant difference was not noted. Small dogs are often considered more “adoptable” than large dogs, so a chi square was also ran to compare the size of the dogs with and without postoperative data. There was not a significant difference.

Further studies should be performed with owned animals, animals in different shelters, and surgeons of various experience levels.

References
Feline Herpesvirus-1: A Review and Exploration of the Role Stress Plays in Upper Respiratory Infections
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Feline Upper Respiratory Tract Disease (URTD) is a multifactorial disease that is common in shelters, foster homes, sanctuaries, multi-cat households, catteries, and other places of high-density animal housing. Many pathogens have been implicated in the disease, and numerous risk factors have also been identified. Definitive diagnosis is difficult in field conditions, especially with limited financial resources. Treatment is often empirical and not always effective. Recurrence is common, and long-term complications are possible. Complete prevention of disease is likely not possible, but management strategies can lower incidence rates and improve welfare. The discussion of URTD and all the potential causes and implications is broad and evolving and thus not possible within the scope of a single report. This presentation focuses on Feline Herpesvirus-1 (FHV-1), highlighting aspects of its pathogenesis and ways in which this information can be used to prevent URTD in shelters.

Feline herpesvirus-1 is a highly infectious, ubiquitous alpha-herpesvirus containing double-stranded DNA with a glycoprotein-lipid envelope that allows the virus to be readily inactivated outside the host. It is presumed that most cats are exposed to FHV-1 at some point during their lifetime. Infection routes for FHV-1 are nasal, oral, and conjunctival mucus membranes under natural conditions. After initial infection, viral replication occurs primarily in the mucosa of the nasal septum, turbinates, nasopharynx, and tonsils. The virus rapidly replicates in these epithelial cells and can be detected in oropharyngeal and nasal swabs within 24 hours of initial infection. This viral excretion typically lasts 1-3 weeks. The conjunctiva, mandibular lymph nodes, cornea, and neurons are also common replication sites.

The diffuse lytic proliferation in epithelial tissues causes lesions with multifocal epithelial necrosis and leads to neutrophil infiltration and inflammation in these tissues. The epithelial damage also allows for secondary bacterial infection in some cases. Early in the course of disease, intranuclear inclusion bodies may be seen. Severe erosion of the nasal mucosa may expose underlying bone and cartilage. Osteolytic changes in the turbinate bones can occur due to viral damage. A lifelong latent infection is common following acute FHV-1 infection. During initial infection, the virus ascends the axons of sensory nerves to reach neurons, where a neuronal latency develops following the primary neuronal infection. The trigeminal ganglia have been found to harbor the virus and have historically been presumed to be the main sites of latency. Newer diagnostic methods have identified viral DNA in other neurological sites and in various ocular and respiratory tissues also, however, it is not clear if the finding indicates that FHV-1 is latent in these tissues or if the finding represents low level persistent infection.

Latency is thought to occur in approximately 80% of cats, although an exact incidence is unknown. Some reports suggest that nearly all cats infected with FHV-1 become lifelong carriers. During periods of latency, the viral genome persists in the nucleus of infected neurons and does not replicate. This poses a diagnostic challenge for the individual cat as well as for those investigating prevalence because the latent virus is not detected on routine tests. Reactivation of viral shedding has been found to occur in about 45% of cats latently infected with FHV-1. The reactivation can occur spontaneously or due to stimuli, and the cat can shed virus with or without recrudescence clinical disease. Stimuli known to lead to reactivation include corticosteroid administration, parturition, lactation, shelter admission, and a change of housing. It is believed that the natural or artificial stress interferes with the ongoing immunity that keeps the FHV-1 genome in a latent state, although the exact mechanism is not known.

During these episodes, infectious virus in the oronasal and conjunctival secretions can be a source of infection for other cats. This carrier state with periods of viral shedding following stress is important to the epidemiology of FHV-1 in animal shelters because these latent carriers act as a reservoir of infection for susceptible cats. Viral shedding typically occurs 4-11 days after the stressful event and lasts approximately 2 weeks, meaning that cats are most likely to be infectious for about 3 weeks after entering a shelter. It has been demonstrated that a refractory phase occurs after a period of reactivation, meaning that cats have a lapse where they are less likely to have another reactivation. After a period of time, the latent FHV-1 infections become easier to reactivate. It is not known if the FHV-1 becomes easier to reactivate over time due to a decline in the host immunity or do to another mechanism.

While the exact molecular mechanism that leads to recrudescence is also not completely understood, it is known that it results from viral migration down the sensory axons to the epithelial tissues where the virus may replicate. Ocular infections are the result of reactivated virus traveling via the axons of the ophthalmic branch of the trigeminal nerve to the eye. It is also known that three potential pathways may follow reactivation. First, cytolysis with clinical signs similar to those in primary infection, is possible. The second potential outcome is development of an immune-mediated response that may result in immunopathological disease. Finally, re-excretion of virus without clinical signs, also known as subclinical shedding, is possible.

Transmission is primarily due to direct contact with an infected cat that is shedding infectious virus through its nasal, oral, and ocular secretions. During acute disease, infected cats shed large amounts of infectious virus, with viral shedding peaking at about 7
days post-infection and lasting as long as 42 days in some cases.26 Because the virus is relatively unstable in the environment, indirect transmission is not thought to be a primary means of transmission in pet cats,7,8 but in crowded environments with frequent contamination, fomite transmission plays an important role.3,7 Aerosol transmission is thought to be of minor importance because cats do not produce an infectious aerosol during normal respiration.3,21 Macrodroplets may be a source of transmission, however, especially in densely housed cats.3,9 Sneezed macrodroplets can transmit infection a distance of approximately 1 to 2 meters.6 Transmission from queen to kitten is common following reactivating of shedding due to the stress of parturition and lactation.8,14,21 The outcome of infection in the individual kitten is partially dependent on the level of maternally derived antibody (MDA) they possess.21 If MDA levels are sufficient, the kitten may be protected against clinical disease but may still be subclinically infected.21 In such cases, the kitten could become a latent carrier without ever displaying signs of clinical illness.

The average incubation period of FHV-1 is 2-6 days.5,25-27 Infection is known to cause severe acute rhinotracheitis and ocular disease,8 although virulence and clinical signs vary by isolate.14,25 Early serous ocular and nasal discharges often become mucopurulent. This can lead some to believe the infection is bacterial,28 but the neutrophilic inflammatory response is likely elicited by the byproducts of the epithelial necrosis.11

In uncomplicated acute FHV-1 infection, cats generally recover without specific treatment within 2-3 weeks,1,9,27 although some may still display clinical signs beyond 30 days.14 (Note: FHV-1 infection in sheltered cats is rarely uncomplicated due to the presence of co-pathogens, stress, and other factors.) The resolution of clinical signs with repair of the lesions in the upper respiratory mucosa can occur while the cat is still shedding infectious virus from nasal fluids and before antibody is detectable in the serum.11 Half of infected cats may remain asymptomatic, though they may still develop latent infection and display clinical signs of disease when under stress later in life.14 Turbine damage and ocular manifestations may be permanent.3,25,27,29

Multi-cat environments are prone to high numbers of FHV-1 infections due to the mixture of older carriers and younger susceptible animals, the close proximity in which they are housed, and the stressors that cause reactivation and shedding.14 While FHV-1 is common in all shelter management models, it has been demonstrated to be more prevalent in short term shelters than other types of facilities.30,31 Despite its relative fragility in the environment, FHV-1 is nearly impossible to eradicate from colonies14 and likely is impossible to eradicate from shelters.32 Poor hygiene in multi-cat environments has been linked to an increased prevalence of FHV-1.33 Age has been found to be related to the risk of FHV-1 shedding.34 with young cats more likely to be shedding infectious virus.20,35 Prevalence has also been found to be seasonal.34 Shedding rates have also been linked to breed, with purebred cats more likely to be infected.36 Gender has also been linked to FHV-1 status, although reports are confounding.35 In some studies, previous vaccination has been found to be negatively associated with shedding rates.35

Understanding the pathogenesis and prevalence of FHV-1 in shelters is vitally important to understanding the management and prevention of URTD. Absolute prevention of infection is likely not possible, and removing shedding cats from the population is impossible given the ubiquitous nature of the virus. Quarantine of incoming cats is not humane, and the resulting increase in length of stay would be detrimental to the population rather than helpful. Vaccinations help prevent severe disease, but do not prevent infection or viral shedding. Supplements such as lysine have proven to not be helpful in the shelter,22,37 and the use of antivirals upon intake is also not likely prevent clinical disease.22,38 Treatment of FHV-1 is supportive, and other than some systemic antiviral medications, non-specific. In general, prevention of transmission and recrudescence is the best way to manage the virus in sheltered cats.

While one would think that the cats not previously exposed to virus are the lowest risk in the shelter, the opposite is often true. A lack of biosecurity in many shelters exposes these cats to FHV-1 at a time of great stress, shelter admittance combined with vaccination, and stress is known to lower the immune response and make them vulnerable to disease.39,40 They are thus at great risk of developing clinical disease and, as previously mentioned, shedding large amounts of viral particles. As was also previously mentioned, latent carriers and asymptomatic shedders are also important to the spread of FHV-1 in shelters. These cats are not isolated due to a lack of clinical signs and, without proper biosecurity, will spread disease despite the relatively low numbers of viral particles they secrete. While prevalence studies vary greatly, most have found that a large percentage of cats admitted to shelters are carrying FHV-1 upon intake or will be shedding the virus within 10-14 days of intake.20,22,41,42 Thus, every cat in the shelter should be treated as though it is shedding infectious virus.

The question becomes: How do we prevent URTD in shelters if every cat is potentially infected or will be infected with FHV-1 soon after admission? The answers are to provide exceptional biosecurity to prevent the spread of disease and to decrease stress. Decreasing stress in sheltered cats was once overlooked in days when cats were fit into small stainless steel boxes and relatively ignored while people focused on the mental well-being of dogs. Important research has demonstrated repeatedly that respecting the cat’s environment and decreasing the stress cats experience in the shelter will save time and money while improving the welfare of feline shelter residents.

Overcrowding is widely accepted as the most pronounced cause of URTD in the shelter.1,7,28,30,32,43 Intensive housing is very stressful for the cat and increases the exposure, dose, and evolution of pathogens in the shelter.41 The stress on the staff required to care for excess animals can worsen the problem as overworked staff may handle cats roughly and may not practice excellent hygiene.32 Active population management is necessary to preserve the health of sheltered animals,34 and high rates of URTD are often
seen as an indicator that a shelter has more cats than they can care for humanely. Maintaining the capacity for care will help shelters efficiently utilize resources, decrease infectious disease rates, and increase live release rates. Many of the other means by which shelters can reduce URTD; including decreasing length of stay, utilizing humane housing, and proper disinfection; cannot be achieved unless the capacity for care is maintained. Determining the capacity of care, or the number of animals a shelter can humanely care for with available resources, is very shelter-specific and fluid. An online calculator is available to help shelters determine their capacity for care.

Length of stay is vitally important to managing URTD occurrence in the shelter due to the risk of URTD rising significantly with increasing time spent in the shelter. Use of effective population management strategies can help decrease the average LOS. These include adoption driven capacity, fast and slow track planning, daily population rounds, and open selection. Performing intake examinations that closely check for signs of infectious disease can also help decrease LOS as medical concerns can be addressed immediately. Making appropriate housing decisions and designating cats as fast track or slow track upon intake has benefits other than decreasing LOS. Protocols that call for immediate housing decisions allow shelters to decrease the amount of times a cat has to be moved. Re-housing cats has been demonstrated to cause enough stress to lead to the development of URTD and/or to lead to reactivation and shedding of FHV-1. Minimizing movement also decreases handling of cats, which can also help lower URTD rates.

Poor hygiene is known to promote spread of disease, and effective sanitation protocols are essential to reducing URTD rates. Cleaning protocols are tailored to inactivate FCV, as it is the most difficult of the respiratory pathogens to remove from the environment. Like parvoviruses, FCV is resistant to chlorhexidine, quaternary ammonium, and several other disinfectants. Potassium peroxymonosulfate, accelerated hydrogen peroxide, or sodium hypochlorite diluted 1:32 are good options for disinfection. Cleaning practices should also be minimally invasive and respect the cat’s sense of smell.

Exposure of naïve cats to those that are shedding infectious agents facilitates disease transmission. Intake examinations and daily medical rounds will allow for cats with clinical signs to quickly be identified and isolated from the rest of the population. Although not effective as the only means of disease control, isolation is generally recommended for clinical cats because of the higher levels of infectious organisms they shed. Isolation practices should therefore focus on those with clinical signs with biosecurity measures based on the assumption that carriers will always be present in the population. Biosecurity measures that can be taken include impermeable barriers between cats, handwashing before and after handling, separation of cats by age group, and maintaining a distance of at least 1.25 meters between kennels that face each other. Because kittens are more susceptible to disease and often experience more profound clinical signs, a foster program can be helpful to protect them from exposure. Along with foster programs, proper vaccination protocols can decrease the amount of naïve animals in the population. The use of MLV vaccinations upon or before intake into the shelter is an important component of disease prevention in the shelter.

Appropriate, humane housing is another component of shelter management that can help decrease stress and lower URTD incidence. Small cages are known to cause stress and potentially lead to clinical disease. One publication noted that cats that were allotted 1 square meter of floor space were less stressed than those only given 0.7 square meters. Recent work at UC Davis has shown that cage size is related to infection rates as well as to euthanasia rates. Their work suggests that large cages can help make cats less stressed, less likely to get sick, and less likely to be euthanized. Further research looked at multiple risk factors for development of respiratory infections in cats and found that inadequate floor space was one of the primary risk factors. It is recommended that individual cat kennels have 0.84 square meters of floor space with 0.6 triangulated meters separation between food, resting, and elimination areas. For group housing, it is recommended to have multiple and separated resources including adequate litter boxes and resting perches for the number of cats housed.

Providing enrichment that encourages normal behavior will also allow cats to adapt better to the shelter environment and decrease stress. Providing the opportunity for play and predatory behavior is a fundamental of feline care. Hiding is a coping mechanism, and providing a hiding space is an important component of feline housing. Providing a routine schedule with consistent, positive humane interaction has also been shown to decrease risk of clinical disease.

High traffic areas can increase the risk of fomite spread and also increase the level of stress cats experience, and they should be avoided for feline housing. Air quality is important both to respect the cat’s delicate sense of smell but also to avoid irritating the upper airways so air quality should be a consideration. Proximity to dogs is a known risk factor for URTD in cats, and cats should be housed where they can neither see nor hear dogs. Inadequate nutrition or frequent diet changes can also increase risk so proper, consistent nutrition should be provided. Concurrent medical problems and a lack of proper medical care lead to an increased risk of disease and an increased severity of disease when present; every effort should be made to provide proper preventative care and treat existing medical concerns. Other considerations for URTD prevention in the shelter include minimizing noise, providing soft bedding, monitoring weight changes and food intake, appropriately using antibiotics, properly training staff, decreasing intake, and tracking disease frequency to allow for monitoring trends and properly allocating resources.


60. UC Davis Koret Shelter Medicine Program. Effect of cage size on the behaviors of cats housed in an animal shelter. Unpublished.


There are few topics in animal control as widely debated and controversial as feral cat population management strategies. There are many stakeholders involved, including veterinarians, public health officials, local politicians, cat caretakers, pet owners, shelter workers, environmentalists, biologists, and quite possibly nearly everyone else in the community. The cats themselves are also stakeholders in the argument. Many debates center around whether the best control measure is trap-kill, trap-vasectomy-hysterectomy-release (TVHR), or shelter-neuter-return (SNR). While most can agree that the long-term goal is to decrease the population of free-roaming cats while maintaining their welfare, how to best focus efforts to achieve that goal has not been decided. Recent research has been performed looking at population control measures and how they can affect the welfare of cats in a community, and this presentation will focus on that work and what it means for shelter veterinarians.

One of the first questions asked is: What is the best way to manage feral populations? Communities have been considering this and debating it for years, and limited field research that is sometimes confounding makes this a difficult question to answer.

A simulation model was used by McCarthy et al. to evaluate the effectiveness of trap-neuter-return (TNR), trap-kill, and TVHR in decreasing the size of feral cat populations. In their models, TVHR was the most effective means for decreasing population size and decreasing the effects on wildlife. In theory, male cats that have a vasectomy rather than castration maintain their position in the colony and continue to compete with other males for females. Also, females that have their ovaries intact after surgery continue to attract males and compete with intact females, with a pseudopregnancy period following coitus. Unlike TNR, TVHR does not lead to increased adult survival times nor does it increase kitten survival rates. The decreased survival days and the unproductive matings decrease population size more efficiently than other methods in this model.

While this paper may lead communities to consider TVHR, there are some important points that veterinarians need to consider before recommending it. First, the decrease in survival times is something that needs to be addressed. Although population control is a primary goal of many feral management programs, improving the welfare of the cats should be just as high on the list of priorities when considering different options. The authors point out that the decreased survival times are partially due to the cats being more likely to succumb to trauma, infections, agonistic behaviors, and other conditions caused by chronic stress. This should raise concerns for those trying to improve welfare. Also, if a goal of the program is to decrease nuisance calls and shelter intakes, TVHR will not prevent many of the undesirable behaviors that TNR prevents. Finally, if a goal of the program is to prevent infectious disease transmission, TVHR is unlikely to decrease the spread of disease.

Trap-kill programs would have the most immediate effect due to the lack of lag time, the financial burden associated with these programs may be smaller than with TVHR or SNR, and nearly half of the citizens in some areas may find them acceptable. But many people would find the trapping and euthanasia of large numbers of cats to be quite unsettling, if not appalling.

Relocation is another idea that has been attempted in some communities, but relocation of cats to new areas is not widely supported. In some cases, captured cats cannot safely be returned to the area of capture due to dangerous conditions or the potential impact on wildlife. In those cases, some shelters will attempt to relocate them to barns or other suitable outdoor environments, while others advocate that euthanasia is more humane than relocation.

Another alternative not previously mentioned is the use of non-surgical contraceptives. The use of contraceptives is being studied, as are ways to identify those cats that have been treated. Currently, non-surgical options have not been found to be as effective as surgical sterilization. The benefits of surgical sterilization; including permanence, decrease in nuisance behaviors, and improved health of the individual cat; outweigh the benefits of non-surgical intervention at this point. As non-surgical options are improved and further studied, this will likely change.

The long-term solution to managing colonies varies based on many community and regional factors as well as the financial resources and the goals of the program. Currently, many communities are finding that the most acceptable option for management of feral cat populations is SNR. In order for SNR to have dramatic benefits, however, the focus has to be broader than simply trapping and sterilizing large numbers of cats. A multifaceted approach is necessary to make an impact, and that will likely require many groups with varied interests working together to improve feline welfare in communities while also improving public health and preserving the natural environment.

One important point mentioned by many authors is that in order for any feral management program to be effective, immigration into the colony needs to be decreased. Efforts to change public perception and mitigate contributing human behaviors are an important component of successful SNR programs. Educating the public about the importance of not allowing pet cats to roam freely, not abandoning unwanted cats, microchipping pets, and otherwise responsible pet ownership practices has been widely recommended as a component of successful feral cat management. Increasing sterilization rates in owned cats may also
reduce the effects of irresponsible pet ownership on community cat colonies. Generally speaking, the effectiveness of any population control program can be increased dramatically by reducing the level at which dispersal and abandonment supplement the target population.

Educating caretakers about the need to manage the carrying capacity of a region should also be done when possible. Removing sources of food or shelter can effectively help prevent new cats from joining a colony that has been purposefully downsized. The removal of these cats into foster and adoption programs has an immediate impact on the colony size. Part of this plan is to engage community support for adoption and fostering of shelter cats.

Targeting SNR programs to well-defined geographic areas or populations is also important in order to see the most dramatic effects. Spreading resources over large areas may dilute the efforts and result in a community not seeing any measurable impacts on population control or shelter intake. Ideally, the target population should be carefully defined prior to starting a program and should correspond to a natural grouping of cats. Once this target is defined, a baseline survey can be used to estimate the population size and set goals for the program. There are also tools available online to help estimate the number of cats in a targeted geographic area. In order to reduce population size, it may be necessary to sterilize approximately 70% of the target population. Maintaining a 70% sterilization rate requires ongoing work in the target area. For example, if trapping is performed every 6 months, approximately 30% of the unaltered cats present would need to be sterilized in order to maintain a 70% sterilization rate. Substantial decreases in shelter intakes may occur at lower sterilization rates.

There has been some recent research that is extremely valuable to shelter veterinarians. Shelter veterinarians are widely aware of the importance of decreasing intake in order to better manage feline populations in their shelters. Better population management can lead to such outcomes as lower length of stay, increased adoptions, decreased infectious disease rates, decreased financial costs, decreased burden to workers, decreased euthanasia, improved housing, improved welfare, and many other tangible and intangible benefits. In an effort to decrease the euthanasia and improve the welfare of cats, many programs aimed at decreasing intake have been implemented with varying success. These include attempts to improve community sterilization rates, public education campaigns intended to keep pets in homes and decrease the amount of stray animals, targeted interventions (such as food pantries and low cost medical care) in high risk areas, diversion programs, and other programs aimed at managing intake. Given that the proportion of owned cats that are sterilized is much higher than the proportion of unowned cats that are sterilized, the next big step in decreasing intake in many communities may be to target spay/neuter efforts towards unowned cats. In many communities, it is likely that a large proportion of their impounded cats and kittens are the result of community cat breeding.

In 2014, Levy et al. studied the effect of TNR concentrated in a Florida community that had experienced high cat impoundments. Their 2-year program focused on the surgical sterilization followed by return to origin or adoption of over half of the estimated community cats in one zip code along with nuisance resolution counseling for residents. They also utilized extensive community education, including post cards, flyers, and door-to-door communication. They compared the shelter intakes in the target area to those of the rest of the county and found that shelter impoundment from the targeted zip code decreased 66% over 2 years. In the non-target area, cat impoundment only decreased by 12% in the same time period. At the end of the study period, per capita shelter euthanasia was 17.5-fold higher in the non-target area when compared to the target area. The conclusion was that targeted TNR combined with adoption of socialized cats and nuisance resolution counseling is an effective tool for decreasing shelter cat intake whereas lower impact TNR spread over large areas is not likely to have the same effect. An interesting side effect of this program was that the shelter also saw dog intake decrease in the target area. The authors felt that this could be due to the community education involved with the project as well as the paradigm shift experienced by animal control officers that offered alternatives to immediate impoundment of animals.

Another publication from 2014 analyzed the effect of high impact SNR on the intake of cats into a California shelter. A community survey in that area found that nearly all owned cats were altered but few unowned cats had been sterilized. They also noted that nearly all impounded cats were unaltered and only 2% were reclaimed. They used this information to determine that a majority of shelter impoundments were likely due to the reproductive abilities of community cats. They focused efforts on the SNR of over 10,000 cats and education of local citizens in the area of return. The program was implemented in 2010, and the shelter saw 29.1% fewer cat impounds per 1000 humans in 2014 than they had in 2009. Adult cat and kitten euthanasia per capita also declined dramatically during the study period. The “save rate” increased from 29.1% in 2009 to 76.7% in 2014. The number of dead cats picked up on the street declined 20%, and the number of cats euthanized due to respiratory infection declined 99%. The significant decrease in euthanasia due to respiratory disease could not be fully explained by any other management changes, and the authors felt that this was likely a result of the shelter having the capacity to care for those cats. The authors also pointed out that the costs associated with SNR should be weighed against the costs associated with caring for future intakes that could be prevented with effective SNR efforts.

While the debate continues about the best way to manage feral cat colonies, research is supporting the idea that improving and expanding SNR efforts may be the best way to decrease colony size, support the welfare of cats, protect wildlife, and improve public
health. It is showing, however, that simply trapping and sterilizing cats is ineffective and unlikely to produce noticeable results. Efforts that are targeted, support community engagement and education, and rehome social cats and kittens are proving to be successful.

References
A review of terminology related to epidemiology is pertinent to the discussion of outbreak response. First, outbreak (or epidemic) refers to an increase in the number of cases above what would normally be expected in a population. An epidemic curve can be used to plot the number of affected animals in a population over time. In shelters with good prevention protocols and high community vaccination rates, many infectious diseases could be labeled as sporadic, meaning that you see them infrequently and irregularly. In shelters with good prevention protocols but low community vaccination rates infectious diseases could be endemic, meaning that they are a constant presence in your shelter in low numbers. In shelters with poor prevention protocols and low community vaccination rates infectious diseases could be hyperendemic, meaning that you see persistent, high levels of disease occurrence.

Another valuable tool is the attack rate. Measuring the attack rate is relatively simple and done by dividing the number of cases by the population. This is very useful in shelter disease outbreaks because the attack rate can be determined for various risk factors to help determine potential causes. For example, the attack rate could be determined for cohorts of animals transported from different shelters or for all animals in one specific holding area. If vaccine failure is suspected, attack rates for animals vaccinated by different people or on different days could be determined.

In each instance, the number of cases is defined as the clinical animals in the population one is evaluating, and the population is the total number of animals in that group. For example, if Fred vaccinated 87 cats for feline panleukopenia virus (FPV) last month and 14 of those developed panleukopenia, the attack rate would be 14 divided by 87 or 16%. The entire shelter population is only used if one is attempting to determine the attack rate for the entire facility. This is a simplified explanation, and the reader is encouraged to review the courses available at [www.cdc.gov](http://www.cdc.gov) for further information.

Investigating outbreaks can be very difficult when neither the specific clinical signs observed in the population nor the infectious agent(s) present in the facility are known. In these cases, a stepwise approach to investigation can help determine the cause and lead to potential solutions. The initial outbreak response plan requires flexibility as new information is presented that changes the course of the response. While shelters should have specific outbreak management plans for each infectious disease, a broad-based plan is also necessary that can be used in the event of an unknown pathogen. Given the likelihood of emerging infectious disease in shelters and the lack of diagnostic equipment available in many facilities, protocols should be in place for those times when the infectious agent cannot be immediately identified.

No matter what species or disease one is discussing, the importance of an efficient response cannot be understated. Rapid outbreak response can mitigate the damage done by that outbreak. This damage can be measured in lives lost, suffering caused, financial resources utilized, loss of shelter reputation, emotional impact on staff, and many other tangible and intangible losses.

The first step is to stop movement. Until an initial risk assessment can be performed, animals should remain in place and strict biosecurity should be maintained. The initial risk assessment and triage can be performed very quickly, and initial movement can take place after this initial assessment. In general, it is advised to restrict movement into and out of the shelter until a full risk assessment has taken place to prevent secondary outbreaks and prevent further exposures, among other reasons. If intake cannot be stopped, such as when municipal contracts require the intake of animal control cases, a clean break is important to prevent further exposures. This will involve either a temporary facility or moving enough animals to clear and disinfect part of the shelter prior to taking more animals in. In order for it to truly be a clean break, there must not be movement of staff, supplies, or animals from one area of the shelter to the other.

Initial triage with individual and population risk assessment should be done immediately and swiftly. Initial population-level risk assessment involves the investigation of facility operations. One must look at the protocols utilized for intake, vaccination, antiparasitics, housing, animal movement, disinfection, nutrition, and other animal husbandry. Along with reviewing written protocols, if available, it is also important to observe shelter operations. For example, a shelter may have excellent disinfection protocols but may have never trained workers to follow them. Without proper training and follow up, written protocols do not prevent disease. One should also assess shelter data, such as average length of stay, intake and disposition, infectious disease rates, and other available data. If possible, determining the attack rate by cohort, life stage, or other applicable factors may help identify factors associated with disease. An epidemic curve will also be useful to determine if the outbreak was caused by a single exposure or if the disease is spreading in the shelter. An epidemic curve will also assist with determining if there truly is an outbreak and if the disease is endemic in the population.

During the process of animal triage, a differential diagnoses list that accounts for the clinical signs present in the population can be determined. All animals need at least a cursory examination for the purposes of triage and identification of those with clinical signs of disease. Physical exams must be performed to determine which signs are truly present, and observational history should not be trusted. Shelter workers are often not medically trained and should not be relied upon for determination of clinical signs. For example, staff
may state that an animal died suddenly and without clinical signs, but the trained veterinary professional may have noticed that the animal was actually dehydrated, anorexic, or lethargic. Untrained personnel may fail to notice subtle clinical signs, and overburdened personnel are more likely to fail to notice substantial clinical signs.

It is often recommended that 5-10% of the population with consistent clinical signs undergo diagnostic testing in order to determine the pathogen(s) present in the population. Which diagnostic tests are performed depends on the clinical signs present in the population and the differential diagnoses the clinician is considering. Necropsy and histopathology are often very helpful at arriving at a definitive diagnosis but are not always necessary.

Many factors need to be considered when determining an individual’s risk. The individual’s immune status, vaccination status, likelihood of exposure and proximity to the infected animals should all be taken into consideration as well as the cleanliness of their environment. The shelter population can be divided into four groups: 1. Those that are infected 2. Those that have been exposed and are at risk. 3. Those that have been exposed but are not at risk of developing infection. 4. Those not exposed. Infected animals need to be removed from the general population immediately and either isolated and treated (on-site or off-site) or euthanized. Euthanasia of otherwise healthy animals is difficult but if proper isolation facilities that can provide adequate care while safeguarding the rest of the population do not exist, euthanasia is the most humane option. Those known to truly not be exposed could be assumed to have the same risk as an animal that enters the facility in a non-outbreak period as long as they continue to be maintained in a manner that prevents exposure. For some pathogens, serology is a useful tool to determine which animals fall into the second and third groups.

In-house antibody titer testing is relatively inexpensive with high diagnostic accuracy for canine distemper virus (CDV) and canine parvovirus (CPV) and is thus a valuable tool for outbreak response. Two point-of-care tests currently available are the Synbiotics TiterCHEK™ and the Vacccheck ImmunoComb™ test by Biogal. TiterCHEK™ is a non-quantitative well test kit, and the ImmunoComb™ is a semi-quantitative dot ELISA titer test kit. Much of the available research has been performed using the TiterCHEK™, likely do to the more recent release of the Vacccheck ImmunoComb™.

One test commercially available for CPV testing (Synbiotics TiterCHEK™) was proven to be inappropriate for use in cats due to its low sensitivity for FPV antibodies. The same study found the point-of-care ELISA test available for cats only identified about half of cats with a protective titer for FPV. A later study did show better specificity, which could be due to modifications to the test, but the specificity for detecting antibody titers of 1:20 was still only 89%. Thus, when determining an antibody titer of 1:20 to be protective, the test was close to having a good performance and could be considered to have an acceptable level of specificity. The sensitivity of the test was much higher than in the previous study and was found to be 87% rather than 49%. This means the sensitivity of the test also almost reached a level of good performance and may make it acceptable for use. While acceptable, there will still be a fair number of false negatives and false positives with sensitivity and specificity only at 87% and 89%, respectively. Further modifications to the test could potentially make it of more use in risk management. In the meantime, clinicians may be advised to interpret results with caution and follow up with a laboratory assay when questions arise or when accurate results are imperative to management.

Serology should be reserved for exposed animals that are not displaying clinical signs of disease. Risk categories for exposed asymptomatic animals can be assigned in the following manner:

- High Risk: Any age animal not displaying clinical signs with a negative titer.
- Intermediate Risk: Puppies and kittens less than 5 months old with no clinical signs and a positive antibody titer.
- Low Risk: Adult animals with no clinical signs and positive titer results.

Animals that are not displaying clinical signs but have a negative titer are high risk and need to be placed in quarantine for 14 days (CPV, FPV) or 4-6 weeks (CDV). Juveniles should be bathed at the beginning and end of the quarantine period. The bath at the beginning of quarantine is particularly important to avoid exposure to pathogens in the feces on their fur as maternal antibody wanes. To help avoid unnecessarily long quarantine periods, antibody titer testing for CDV can be combined with PCR testing to further assess risk and potentially move more animals through the shelter, especially if the consulting veterinarian becomes involved later in the course of the outbreak. Because the incubation period for CDV varies so greatly, it is often recommended that these dogs be released with a medical waiver even if they have been quarantined for 6 weeks and have shown no clinical signs of disease. Intermediate risk puppies and kittens can be bathed and immediately placed in rescue, foster, or go out for adoption with a waiver. It is not possible to tell if the antibody titer is due to maternal antibody or vaccination so it is important to get these animals out of the shelter as soon as possible.

Serology is available but less useful for upper respiratory tract pathogens. It has been demonstrated that nearly 100% of cats may be serologically positive for feline herpesvirus-1 (FHV-1) and a positive titer does not always confer protection from disease. Nor does it offer any insight into active infection, latency, or the potential for recrudescence. Testing for antibody levels also does not provide any information about the likelihood that a cat may be inapparently shedding virus. The magnitude of the titer does not correlate with the presence or absence of clinical signs. Primary infection with FHV-1 can also lead to a meager serologic response, although further exposure may cause titers to rise more significantly and remain stable thereafter.
Titters for feline calicivirus (FCV) tend to be higher following infection than those for FHV-1, and their levels correlate better with protection from homologous challenge.\textsuperscript{15,16} It has also been found that prior infection with one strain may provide some level of cross-protection and either prevent or reduce signs of clinical disease and shedding when exposed to a heterologous strain.\textsuperscript{15} The level of cross-protection is strain-dependent.\textsuperscript{17} However, and there is no way to know what level of cross-protection will be provided based on interpretation of antibody titer results.\textsuperscript{18}

Cats may also be resistant to infection with either FHV-1 or FCV with little to no detectable serum antibody.\textsuperscript{14,16,17,19-21} A rapid anamnestic antibody response has been found in vaccinated cats with FHV-1 titers of less than 1:2, likely due to the establishment of memory B cells.\textsuperscript{16} It is likely that cell-mediated immunity and the ability to rapidly regenerate humoral immunity is a better reflection of immune status for these viruses.\textsuperscript{13,14,17,19,20} It is also likely that local immunity (both humoral and cellular) is important to disease resistance.\textsuperscript{14,19,22,23} In the case of FCV, false negative results may occur if the laboratory strains used to run the test are not neutralized by the cat’s antibody.\textsuperscript{17} Also, titers may appear higher or lower depending on the cross-protection of the particular strains used.\textsuperscript{17}

Researchers disagree on whether or not serologic testing is valuable in practice to predict whether or not cats are susceptible to clinical disease caused by FHV-1 and FCV. Some papers suggest that since the tests cannot predict whether or not disease will occur following challenge, they are not useful.\textsuperscript{15} Other authors state that there is currently no reliable way to predict protection in individual cats.\textsuperscript{19} However, many state that titers are useful to measure protection against clinical disease due to FHV-1 or FCV and are recommended as part of disease outbreak management.\textsuperscript{7,17,20} When serological titers are measured, the preferred diagnostic is ELISA because it is more sensitive than other methods.\textsuperscript{20,24}

In the case of URTD management, outbreaks are likely better managed by looking at population-level risk factors and making shelter management decisions that decrease the incidence of disease. Generally, the goal of URTD management in the shelter should be prevention from a population perspective rather than treatment and management of individual cases.\textsuperscript{25}

False positive results may occur with all antibody detection assays, likely due to nonspecific binding of substances in serum to test reagents so all results should be interpreted with caution.\textsuperscript{20} Another confounding factor is that universal laboratory reference standards and thresholds for protective antibody titers have not been established so interpretation can be difficult.\textsuperscript{26}

When shelters do not have access to either laboratory or point-of-care tests, decisions must be made on a case-by-case basis. Veterinarians can assess individual animals and make an educated guess as to their risk category. Studies have shown that the presence of protective antibody titers was correlated with being neutered, relinquished by an owner, and over 6 months of age.\textsuperscript{27} Also, any adult in the population that was known to have a MLV vaccination at least 1 week prior to exposure could be considered low risk for CPV, FPV, or CDV. Likely all juveniles would require quarantine to ensure the disease was contained. Risk assessment based solely on signalment is inaccurate and difficult, but is sometimes necessary in shelters without financial resources.

Decontamination is vital as animals are moved according to risk assessment. A common misconception is that kennels need to remain empty for a period of time before they can be used again. Decontamination should consist of multiple cycles of mechanical cleaning and disinfection followed by completely drying the area rather than letting it sit for a specified period of time.\textsuperscript{6} Three cleaning cycles with complete drying between cleanings is commonly recommended to completely remove all pathogens. If the causative agent is unknown at the time of initial decontamination, one should clean as though nonenveloped infectious viruses are present because they are often considered the most environmentally sturdy pathogens in shelters. Disinfectants should be chosen based on parvocidal activity, and dilutions and contact times should be followed at parvocidal levels.

Strict biosecurity measures should also be followed. Given the large number of pathogens that can spread via fomites in shelters, one should assume that an unknown pathogen can be transmitted in such a manner. Proper personal protective equipment; including gloves, masks, gowns, shoe covers, etc.; should be used to prevent cross contamination. Animals should not be allowed to mingle with unrelated animals, and interspecies spread should be prevented.

All measures possible should also be taken to improve individual and population resistance to disease during an outbreak response. If the shelter does not routinely provide preventative care upon intake, it may be prudent to administer antiparasitics and vaccinations to animals in the population. Providing proper nutrition and mitigating stress will help the individual immune response. Decreasing any existing overcrowding will decrease the pathogen load in the environment, limit new exposures, decrease stress, and allow for easier animal movement with decontamination as necessary.

Communication is another important part of outbreak management. Recent adopters, fosters, employees, volunteers, local veterinarians and potentially the local media all need to be informed of the outbreak and given accurate information. Outbreaks of disease can lead to rumors and a loss of reputation for the shelter. Not alerting local veterinarians or other animal care professionals may lead to secondary outbreaks and further loss of life. Providing accurate and timely information can help prevent further damage and save the shelter’s reputation.

Following an outbreak, it is necessary to review procedures and identify what factors lead to disease spread. Procedures and protocols should be reviewed to ensure all measures are being taken to prevent a future outbreak. If a widespread vaccine failure is suspected, vaccination protocols should be examined. If recovering from a CDV outbreak, any wildlife handling procedures should be
reviewed. Protocols need to be amended as necessary and staff training needs to be completed immediately to prevent another outbreak. As with nearly every aspect of shelter medicine, prevention is the goal of these measures.

References