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# Feline Infectious Disease Control in Shelters

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Managing feline infectious disease in animal shelters is an immensely challenging task. Financial resources are limited, facilities are often less than ideal, and cats are highly susceptible to the effects of a stressful and crowded environment. Carrier states are common for feline infectious conditions, which means a constant influx of potentially contagious animals. High turnover of caretakers necessitates clearly written systems of communication and constant training to maintain consistency. Adding to the challenge, the medical program must contribute to the overall goals of the shelter, including adoption of cats into permanent homes. Moving cats promptly through the shelter for placement sometimes conflicts with ideal infectious disease control. A clearly thought out and systematic approach is required to develop an effective program in the face of all these challenges.

## **Disease in feline shelter populations**

Infectious diseases of greatest concern in shelters include respiratory disease (feline viral rhinotracheitis, feline calicivirus [FCV], and others), skin disease (particularly dermatophytosis), gastrointestinal disease (eg, panleukopenia, protozoal and parasitic infestation), and systemic disease, such as feline infectious peritonitis [1,2]. In addition, shelter cats may present with infections that are virtually unheard of in private veterinary practice or may develop relatively severe signs of common infectious conditions [3,4]. Specific strategies for management of shelter infections are beyond the scope of this article and are detailed elsewhere [1,2,5]. Visible disease is often only the tip of the iceberg, however. High levels of upper respiratory infection (URI), for example, often reflect an overall breakdown in husbandry and

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infectious disease control. All too commonly, veterinary services in shelters are used only in reaction to occurrences of a particular disease. Although admittedly difficult to implement in the hectic environment typical of many shelters, a proactive preventive approach to disease control is more effective, more humane, and less costly in the long run.

### **Principles of prevention**

Contact with a pathogen does not guarantee that infection and disease are going to result. It is common to find evidence of exposure to various pathogens in healthy cats raised in a low-density and low-stress environment [6–8]. These same pathogens can cause significant morbidity and mortality in a shelter or cattery. The outcome of disease is determined by an interaction of environmental, host, and agent factors. This provides three general targets for a preventive medicine program:

1. Environment: prevent disease from building up or spreading in the environment.
2. Host: support the host's immune response.
3. Agent: develop written procedures for control of specific pathogens of importance, based on an understanding of pathogen life cycle.

**Box 1** lists some of the factors that should be considered when developing a comprehensive prevention program.

#### *Environmental management*

Reducing environmental contamination provides a powerful tool for prevention. Environmental control offers broad protection for the entire population. The list in **Box 1** should be systematically reviewed with shelter management, and each factor should be optimized to the extent possible. Management of population density, effective cleaning and disinfection, and accurate disease recognition and segregation are particularly critical.

#### *Population density*

Population density is a key determinant of health, well-being, and productivity in many species, ranging from livestock to human hospital settings [9–13]. Crowding increases the overall environmental pathogen load and contact rate and intensifies the effects of many other negative factors, such as poor air quality, excessive noise, and stress. Controlling density is particularly critical in cats. Although cats may choose to live in loose-knit groups in the wild, they are poorly adapted to close confinement [14]. Managing population density in a shelter can be an emotional as well as logistic challenge, however. The constant excess of homeless cats often leads well-meaning shelter managers to house more cats than the facility can

**Box 1. Environmental, host, and agent determinants of disease**

## Environment factors

- Population density
- Sanitation/disinfection
- Disease recognition
- Segregation/animal flow
- Air quality/ventilation
- Temperature/humidity
- Noise control
- Light cycles
- Pest control

## Host factors

- Stress
- Age
- Immunity
  - Natural exposure
  - Vaccination
  - Maternal antibodies
- Genetics
- Nutritional status
- Physiologic state (eg, pregnancy)
- Concurrent disease
- Internal or external parasites
- Drug treatment

## Agent factors

- Virulence
- Strain differences
- Dose
- Method of spread
- Route of infection
- Incubation and shedding
- Carrier state

readily accommodate. It is important to recognize that crowding is likely to cost rather than save lives in the long run, through increased infectious disease, a damaged shelter reputation, and reduced adoptions.

Some guidelines are available regarding recommended cat-housing density. For individually housed cats, a minimum cage space of 2.55 m<sup>2</sup> (8.4 ft<sup>2</sup>) has been recommended [15]. For group-housed cats, the recommended minimum is 1.67 m<sup>2</sup> per cat (5.5 ft<sup>2</sup>), with a maximum group size of 10 cats [15–17]. The number of cats available for adoption should be driven by the expected number of adoptions rather than by the maximum

physical capacity of the shelter [18]. Overflow space for busy seasons or large-scale emergencies should be planned in advance (eg, development of a foster home network or temporary caging). Although minimum space guidelines are helpful, the number of cats that can be kept without overcrowding is not simply a matter of cage space; rather, maximum capacity depends on many factors, including facility design, ventilation, and staff availability. If the population outstrips the staff's ability to provide adequate care, overcrowding is present, regardless of the number of cats. Indications of serious overcrowding are provided in **Box 2**.

For a given facility size and staffing level, crowding can be controlled through limiting admissions, euthanasia, or decreasing the amount of time each cat is in the shelter (turnover time). Clearly, the latter would be the preferred choice whenever possible. Turnover time is reduced by daily assessment of every cat in the shelter to make decisions and take any needed action at the earliest possible point. This includes medical and behavioral assessment, surgical sterilization or other preadoption procedures, resolution of legal issues, and placement for public viewing. The less time a cat spends in the shelter, the less likely it is to become ill, further reducing the population burden on the facility [19]. The impact on turnover should be kept in mind when developing policies that delay placement for adoption.

### **Box 2. Indications of overcrowding in a shelter**

Animals are routinely housed in inappropriate areas of the facility or in inappropriate cages (eg, cats remain in short-term intake areas rather than being moved to stray-holding or adoption areas; cats are housed in carriers, wire cages, or other housing not intended for long-term use).

Animals with infectious disease remain in the general population rather than being moved to isolation.

More animals are placed in a kennel or cage than it was designed for, or frequent aggressive incidents are observed in group housing.

There is a noticeable smell of animal waste in the facility.

Cleaning and disinfection are compromised because of crowding (eg, cats are placed in a transport carrier or cage without thorough cleaning between occupants).

Vaccines are not given promptly at intake because of overwhelming animal numbers or lack of staff time.

Sick animals often do not receive needed treatment.

Serious disease spreads repeatedly within the shelter or common infections, such as URI, are noticeably more severe or persistent than expected.

Such policies are not necessarily wrong, but the effect on population density must be considered. Even a few days make a big difference when multiplied by many cats. The average turnover time per cat to avoid overcrowding can be estimated as follows:

$$\text{Average Turnover Time in Days} = (\text{Total Cage/Cat Holding Spaces} \div \text{Total Yearly Cat Intake}) \times 365 \text{ Days}$$

### *Sanitation and disinfection*

Substantial time and energy are spent cleaning and disinfecting shelters, and this is relied on as a major barrier against disease. A clean shelter encourages adoptions and public support as well as protecting animal health. Because of its importance, cleaning should be approached systematically. A well-conceived plan needs to be developed, implemented, and periodically revisited to make sure it is still functional. Incorrectly performed disinfection can be ineffective or actually serve to spread disease [20].

Choice of cleaning and disinfectant products should reflect the pathogens most likely to be present and the type of surface to be cleaned. Other considerations include cost, ease of application, and staff tolerance. No single product is ideal under all circumstances; advantages and disadvantages of various products are presented in Table 1. Unenveloped viruses, such as panleukopenia and FCV, are resistant to many commonly used disinfectants but are susceptible to sodium hypochlorite and potassium peroxymonosulfate [21–24]. Dermatophytes are inactivated by sodium hypochlorite at higher concentrations with repeated applications (5% bleach diluted at a ratio of 1:10) [25]. Disinfectants must be applied to a clean surface free of organic matter, with the correct concentration and adequate contact time to be effective. This requires careful ongoing staff training.

No disinfectant can be relied on to inactivate all pathogens. Careful handwashing can reduce the effects of residual environmental contamination [26]. Mechanical cleaning, desiccation, and exposure to ultraviolet light are important adjuncts to chemical disinfection, and cat-housing areas should be designed to take advantage of these factors. Scratching posts, soft furniture, and home-like environments can become heavily contaminated over time. Ideally, bedding and toys should be washable, and larger items, such as scratching posts, if used, should be periodically replaced (particularly after a known contamination with a durable agent, such as ringworm or parvovirus). Some pathogens, such as ascarid eggs and coccidial cysts, are virtually impossible to inactivate or remove from porous surfaces [27]. Kittens and cats should be tested or treated for these infections before being placed in environments that are hard to clean. It is particularly important that kitten-housing areas be readily cleanable because of the frequency of infectious disease in this population.

Table 1  
 Characteristics of commonly used disinfectants

Disinfectant	Advantages	Disadvantages
Quaternary ammonium compounds	Some detergent activity Moderate inactivation by organic matter (less so than with bleach) Low tissue toxicity Inexpensive	Unreliable efficacy against unenveloped viruses (eg, feline panleukopenia, calicivirus) or dermatophytes Inactivated by soaps and detergents
Sodium hypochlorite (bleach)	Completely inactivates unenveloped viruses when used correctly Inactivates dermatophytes at higher concentration Low tissue toxicity Inexpensive Can be combined with quaternary ammonium compounds	Significantly inactivated by organic matter, exposure to light, or extended storage No detergent activity Fumes can be irritating at high concentration Corrosive to metal Hard water reduces effectiveness
Potassium peroxymonosulfate (Virkon or Trifectant)	Completely inactivates unenveloped viruses when used correctly. Some detergent activity Low tissue toxicity Less corrosive to metal than bleach Relatively good activity in the face of organic matter	Comes in powdered form, cannot be applied through hose-end applicator systems Leaves visible residue on some surfaces More costly than bleach
Chlorhexidine (Nolvasan)	Extremely low tissue toxicity	Relatively expensive Ineffective against unenveloped viruses, ringworm
Alcohol (usually in hand sanitizer)	Less irritating to tissue than quaternary ammonium or bleach Ethanol (70% concentration) moderately effective against calicivirus	Ineffective against unenveloped viruses, dermatophytes Adequate contact time required (15–30 seconds recommended by manufacturer) May encourage false sense of security

The logistics of cat cage cleaning can be problematic. Many shelters house cats in single cages, necessitating removal and extensive handling to clean. Moving cats from cage to cage can cause sufficient stress to activate latent feline herpesvirus (FHV) infection [28]. Extensive fomite spread is almost inevitable in this circumstance. Ideally, individually housed cats should be provided with double-sided cages or switched between the same two cages throughout their shelter stay. An alternative is to assign each cat its own carrier or “feral cat” box for use during cleaning. If the cage size is sufficient, the carrier can remain in the cage to provide a hiding place,

providing the added benefit of stress reduction [29]. Less frequent cage cleaning (within reason) has been correlated with improved health in laboratory rodents [30]. In shelters that house healthy cats for extended periods, intensive daily cleaning may not be required, although frequent litter box cleaning and removal of any visible debris are necessary under all circumstances. It may be beneficial to leave bedding with the animal if it is not heavily soiled [31].

Fomite transmission on human hands and clothing is, of course, a significant means of disease spread. This poses a particularly vexing problem in the shelter population, where human interaction must be encouraged to some extent to promote socialization and adoption of the shelter's charges. Friendly signs can be posted to remind the public not to touch cats, but unless given a reasonable alternative, the desire to interact with the animals often outweighs caution. Alcohol hand sanitizers are commonly used and better than nothing in most cases, although they do not reliably inactivate some important feline pathogens, such as panleukopenia virus, FCV, and dermatophytes [24,25,32,33]. When possible, thorough handwashing or a change of gloves is greatly preferred. This is important for prevention of zoonotic disease transmission as well as for shelter cat health. Handwashing stations for the public and staff should be planned in new facilities. Lightweight plastic gloves used in food service can be obtained inexpensively; some shelters require that the public as well as staff wear gloves and change gloves between cats. Other shelters house cats in solid-fronted cages with an attached toy that can be used for interaction. If solid-fronted cages are used, careful attention must be paid to ensure adequate ventilation.

### *Segregation and animal flow*

Segregation of subpopulations is an essential principle of population health management. In addition to health, categories for segregation include age, intake date, and intake type (stray/recent intakes from adoptable/longer term cats). Increasing the number of separate subpopulations facilitates infectious disease control. At a minimum, separate housing areas must be provided for cats with active signs of infectious disease. Ideally, isolation areas should be further subdivided to separate cats with respiratory infections from those with skin or gastrointestinal infections. If space permits, it is preferable to separate mildly ill cats or cats recently recovering from URIs from more severely ill cats. Even separating healthy cats into smaller populations is useful. This should be kept in mind when designing new facilities.

Handling, cleaning, and foot traffic should proceed from the most vulnerable or healthiest populations to those that are relatively less vulnerable to disease or more likely to be shedding infectious pathogens. For example, handling could proceed from kittens to adult adoptable cats, to stray/recent intakes, and, finally, to sick cats housed in isolation. If the design



of the shelter prohibits an ideal handling/traffic pattern, careful handwashing and use of protective clothing should be particularly encouraged to prevent cross-contamination of areas.

### *Disease recognition*

To segregate animals appropriately, a system for disease recognition and reporting must be in place. All staff and volunteers should be trained to look for general signs of disease, and a clear reporting system should be developed. In addition to noting signs on the animal's cage card or other record, concerns should be recorded in a central location so that medical staff can follow up efficiently. Medical problem reports should include the signs; signalment, including animal identification number and name if available; the animal's location in the shelter; the date and time the problem was observed; and the initials of the person making the report. This is especially important in a high-turnover shelter, where the animal may have been moved from its original cage by the time the veterinarian is able to check up on medical concerns.

The next level of disease recognition is an individual examination of each animal. Ideally, this is performed by a veterinarian. An initial examination by a trained technician can be a valuable screening tool to identify animals requiring additional veterinary attention, however. This examination is ideally performed at intake, particularly at shelters that place virtually every animal they admit. At shelters where a higher percentage of cats are euthanized, it may be more practical to perform the screening examination after completion of a stray-holding period but before placement for adoption. An additional brief examination at the time of adoption can catch problems, such as URI, that develop during the shelter stay and allow adopters to be counseled accordingly.

Identification of specific diseases also has an important place in a preventive medicine program. Diagnostic testing allows segregation or removal of potentially infectious individuals, protects adopters from taking home an unexpected veterinary bill or heartache, and allows the shelter to invest resources in animals most likely to benefit. For treatable conditions (which vary greatly according to a shelter's resources), diagnostic testing also allows the animal to receive appropriate care promptly. Diagnostic testing is not without cost, however, in terms of scarce resources of money and time as well as in the consequences of inaccurate results. It is critical that diagnostic tests be used, interpreted, and documented carefully.

Accuracy of diagnostic testing is always a concern, and in a shelter, the stakes are particularly high. A false-negative result can lead to exposure of the entire population to a devastating disease, whereas a false-positive result may cause an individual animal to be needlessly isolated or euthanized. Choice and interpretation of test results should reflect the relative risk of each of these scenarios. For diseases like ringworm or panleukopenia, which

pose a high population risk, testing strategies should be chosen to minimize the risk of false-negative results. For diseases like feline immunodeficiency virus (FIV), which are not readily spread but may prove devastating to the individual, a testing strategy should be selected to decrease the risk of false-positive results. Staff performing these tests should be carefully trained and should understand the reliability and possible causes of inaccurate results for all tests commonly used in the shelter [34].

### *Air quality*

Poor ventilation and high humidity contribute to disease by promoting buildup of pathogens in the environment and by direct irritation of the respiratory tract from airborne debris and fumes from urine and cleaning products. Air quality is of particular importance in shelters, given the frequency of respiratory syndromes. Although true aerosol transmission is not thought to be a significant method of spread for feline URI, droplet spread can transmit respiratory infections for distances up to 4 ft (1.2 m) [35,36].

Three general strategies exist for maintaining indoor air quality [37]. In order of decreasing effectiveness, these strategies are:

1. Source control: reducing the amount of contaminants in the air
2. Ventilation: bringing outside air indoors
3. Air cleaning: processing indoor air through a filter (ie, HEPA filter)

Indoor air contamination is reduced by decreasing population density, cleaning litter boxes frequently, using low-dust litter, and applying cleaning products at the correct dilution. Cleaning products themselves can be respiratory irritants and should not be sprayed around cats. A fresh air exchange rate of 10 to 12 air exchanges per hour is commonly recommended [38]. The relevant air exchange rate is at the level of the cat's nose, however, which may be quite a bit lower than the overall air exchange rate in the room, especially if cats are housed in cages that are enclosed on three sides [39]. High air exchange rates are costly in terms of heating and cooling; thus, design of caging to take full advantage of ventilation systems is crucial. In shelters with poor air exchange systems, air filters are sometimes used as an adjunct to improve air quality. The efficacy of this approach in reducing feline disease has not been documented. Frequent filter changes are required, which may lead to substantial costs. Investment in fresh air sources, such as adding a window or skylight with a fan, may provide a better return in the long run, especially in mild climates. The importance of source control should never be overlooked.

### *Other environmental factors*

Noise, temperature, humidity, and light cycles affect feline health and well-being [14,40]. Exposure to noise from dogs should be minimized, and

temperature should be maintained between 10°C and 29°C (50°F–85°F), with humidity between 10% and 50%. Lights should be turned off at night. Overall environmental comfort for cats and visiting adopters is an important contributor to population health and the ultimate outcome of successful adoptions. Environmental enrichment is discussed in greater detail elsewhere in this article.

### *Selected host factors*

Given that some level of exposure to pathogens is inevitable, support of the host's immune response is a crucial part of disease prevention. As with environmental control, no single factor is adequate in itself. Stress reduction, vaccination, nutrition, and other factors listed in [Box 1](#) all contribute to the cat's ability to resist disease.

### *Stress reduction/environmental enrichment*

Mental wellness is key to maintaining feline health, particularly given the frequency of stress-activated herpesvirus infection in cats [28]. Stress in cats also results in decreased play and exploration, increased hiding, and stereotypic behaviors, all of which may lead to a lower likelihood of adoption [15,41]. Stress results from aversive stimuli, such as noise; odors; uncomfortable temperatures; unfamiliar people, animals, and environments; and unpredictable handling. Even minor changes, such as moving from one cage to another or being placed in a carrier, can be significantly stressful for cats [29,35]. Stressful effects of aversive stimuli are amplified when events are unpredictable or the animal lacks the opportunity to modulate their effects through behavioral responses [29,40]. A feline stress-scoring system has been proposed, which may help to monitor the success of interventions [42]. Efforts at enrichment must take each cat's individuality into account. What is relaxing to one cat may be highly stressful to another, depending on past experience, genetics, and individual temperament [43,44].

Recommendations for environmental enrichment include provision of adequate quantity of space as described in the section on population density. Quality of space is also important, and an optimal cage should include a place to hide, an elevated resting area, feeding and litter areas separated as widely as possible, comfortable bedding, and a scratching surface [40,45–48]. Solitary cats in double-sided housing have more control over their environment and are more interactive with strange people than solitary cats in traditional single cages [41]. Space limitations make some of these provisions impractical in some shelters, but even simple interventions, such as toys and a paper bag or box to hide in, can reduce stress and improve adoptability [49]. Additional recommendations for group-housed cats include provision of multiple litter boxes of various types (including at least one or two uncovered litter boxes) and multiple feeding stations to avoid competition around resources. Regardless of housing type, cats

benefit from reduction of noise, exposure to natural light and fresh air, a variety of toys, and consistent friendly interaction with known caretakers. Feeding, cleaning, and socialization should follow set schedules as much as possible.

Group cat housing is increasingly popular in shelters and affords an opportunity to provide more of the features of an enriched environment while conserving the amount of space required to house each cat [17]. The effect of group versus single housing on feline stress levels is variable, however, and depends on the density and quality of housing, the temperament and prior experience of the cats, and the rate of turnover. Boarding cats observed for their first 14 days in a cattery did not show significant differences in stress levels between cats housed singly, in pairs, or in small low-density groups (<10 cats per group with 2–3 m<sup>2</sup> of space per cat) in a boarding cattery [42]. In animal shelters, cats housed at high density or in large groups displayed more signs of stress than cats housed singly [16,50]. Cats that had not been socialized to other cats also experienced more stress in group housing [51]. Stable groups are preferred to the extent possible, because the introduction and departure of new animals inevitably create some stress as well as disease control challenges [41,50]. Group housing should not be viewed as a way to inexpensively house large numbers of cats, regardless of individual needs, but may be valuable as an alternative to single caging as long as it is used appropriately, particularly in shelters that often house cats for more than a few weeks [52].

Many shelters have programs that allow volunteers to pet, groom, and play with cats. Such programs can foster goodwill in the community and provide cats with extra attention. Poorly controlled volunteer interactions may actually increase stress for some cats, however. Interaction with strangers and being moved from a familiar cage are potentially stressful events, especially if the cat is taken to a room filled with the smells of many unfamiliar animals [44,47]. Cats' willingness to approach unfamiliar people is highly variable and often follows a slower schedule than if the interaction is initiated by the person [53]. Cat socialization programs should be responsive to the individual cat's needs. Some cats may do better if allowed to initiate interaction at their own pace, and it may be preferable to groom or play with cats in their own cage rather than moving them to another room, especially in shelters where cats stay short term. Limiting indirect exposure to other cats is also preferable from a disease control perspective. An advantage of group housing (or spacious single cat housing) is that it allows interaction with cats on their own turf and offers cats the opportunity to withdraw at will.

Incorporating infectious disease control with enrichment is critical, especially in areas where new intake cats are housed and in shelters with high population turnover. Illness and the attendant isolation and medication are highly stressful—there is no benefit to an enrichment program that fosters spread of infectious disease. Toys and bedding should be washable,

disposable, or go home with the cat at the time of adoption. Volunteers should be trained to scan carefully for signs of illness, and careful precautions should be taken before and after handling cats. A well-designed enrichment program fosters overall mental and physical health of sheltered cats.

### *Vaccination*

The best vaccination strategy depends somewhat on characteristics of the shelter population, facility, staff resources, and prevalent diseases in the region. Factors to consider include which pathogens to vaccinate against, whether to use modified live versus killed vaccines, route of administration, timing, and revaccination schedule. Some general recommendations can be made, but, ultimately, the vaccine program must be tailored to the particular population.

Core vaccines generally recommended for all shelter cats are: FHV type 1 (feline viral rhinotracheitis), FCV, and feline panleukopenia (FPV). FPV has been reported with increasing frequency in many areas of the United States. For communities in which FPV is an active threat, prevention of this deadly disease is a priority. The best protection is afforded by a modified live parenteral vaccine given immediately on shelter entry to all cats (including injured and mildly ill cats), with the exception of pregnant cats and kittens less than 5 weeks old. Modified live FPV vaccine is currently only available as part of three-way combination products also containing FHV and FCV vaccines.

If FPV is not a concern, parenteral or intranasal products may be chosen. Intranasal products have several theoretic advantages, including relatively rapid onset of protection, generation of local immunity, and efficacy in the face of maternal antibodies [54,55]. A disadvantage of intranasal vaccines (and, to a lesser extent, modified live vaccines in general) is the possibility of mild signs induced by the vaccine. For shelters that euthanize all symptomatic cats, this is a tremendous drawback. Anecdotally, shelters report varying results from use of an intranasal rather than parenteral vaccine to control URI; some have reported an increase, some have reported a decrease, and some have appreciated little change in overall URI levels. One study suggested that use of an intranasal respiratory virus vaccine in addition to a parenteral three-way feline viral rhinotracheitis-calicivirus-panleukopenia (FVRCP) vaccine resulted in decreased severity of URI in shelter cats [56].

Noncore vaccines include *Chlamydia* and *Bordetella bronchiseptica* vaccines. Use of these vaccines should be reserved for shelters in which infection has been confirmed by laboratory diagnostics as an ongoing problem. Other vaccines, such as feline leukemia virus (FeLV), FIV, and rabies, are best given after adoption, when the cat's individual circumstances can be better evaluated (although shelters that hold cats long term may consider vaccinating for rabies according to local regulations). Feline coronavirus and *Giardia* vaccines are not recommended because of a lack of demonstrated efficacy.

All staff members responsible for vaccination must be carefully trained in correct vaccine handling and administration. Staff should be aware of possible adverse consequences of vaccination, including recognition of anaphylactic shock. If parenteral modified live FVRCP is used, staff should be aware of the potential to cause severe URI if given inadvertently by the oronasal route [55]. Vaccines should be drawn up away from the cat's face. Vaccine spilled on cats' fur should be cleaned promptly with alcohol, and the environment should be wiped down with bleach solution.

### *Nutrition*

Adequate nutrition is important to an animal's ability to mount an effective immune response [57]. Maintaining adequate nutritional intake for sheltered cats can be challenging for several reasons. Cats in a shelter may not eat enough because of stress, illness, competition for food in group housing, an unpalatable or novel diet, or simple underfeeding. Cats tend to be neophobic and may take some time to acclimate to an unfamiliar food [58]. Because of this, it is particularly important to feed cats a consistent diet rather than a variety of donated foods, as is sometimes practiced in shelters. Poor-quality or spoiled donated food also may lead to vomiting and diarrhea, which obscures recognition of infectious conditions and creates a poor public image. A high-quality readily absorbed diet can help to compensate for slightly decreased intake, although the benefits of a premium diet must balance the increased cost. The diet should be appropriate to the life stage of the cat. If donated food is used, a consistent brand or gift certificates to a local feed store are preferable to a random mix. If a consistent brand absolutely cannot be obtained, donations should be carefully inspected to make sure they are not damaged or spoiled and food should be thoroughly mixed to provide as consistent a blend as possible rather than switching from one brand to another [59].

Cats generally prefer taking multiple small meals and should have food freely available throughout the day [60]. Because cats have marked individual dietary preferences, wet and dry food should be offered, at least initially [61]. Food should be fed in consistent measured quantities to allow determination of how much is eaten daily. Cats in short-term shelter care should be offered the high end of the amount recommended by the manufacturer. This may need to be modified for cats in long-term care to prevent obesity. Monitoring and documentation of intake are important, especially when multiple caretakers are involved. Daily written notation should be made as to whether a cat seems to be eating (food should be measured if in doubt), and cats should be weighed at least every 2 weeks. Cats that do not eat for more than 1 or 2 days should be carefully evaluated for a medical condition and offered a variety of foods. Correction of B-vitamin deficiency through parenteral supplementation may be helpful in the treatment of anorexia, especially in sick cats. An appetite stimulant, such as cyproheptadine, may be helpful in the short term [62].

Cats, especially kittens, often enter shelters in a precarious nutritional state and may thus be more susceptible to dietary deficiencies. For this reason, homemade diets should be used with great care, under the supervision of a veterinarian, and only as indicated for treatment of diet-responsive disorders. In general, additional nutritional supplementation is not needed for healthy shelter cats fed a balanced commercial diet. The addition of L-lysine at a dose of 500 mg twice daily in adult cats has been recommended to reduce recrudescence and shedding of FHV, although the efficacy of this in a shelter population is unknown [63]. L-lysine is generally palatable to cats and may be added as a powder sprinkled on wet or dry food.

#### *Other host factors*

Concurrent infections and parasitic infestation reduce the animal's ability to respond to infectious challenge. External parasites, such as fleas, reduce adoptability as well as compromising health and causing discomfort and can facilitate transmission of zoonotic agents, such as *Bartonella spp* [64]. A variety of safe and effective flea and tick control products are available and should be used as needed. All kittens should be treated with a product effective against ascarids, and cats should be treated for other internal parasites based on results of diagnostic testing [7]. Antibiotic use should be reserved for cases in which a bacterial infection is confirmed or strongly suspected based on clinical signs. Overuse of antibiotics may select for antibiotic-resistant bacteria and compromise the cat's normal flora, increasing the cat's vulnerability to disease.

#### *Planning for agent factors*

Agent risk factors for disease are generally inherent to the specific pathogen and cannot be manipulated in the same way as environmental or host risk factors. Nevertheless, it is helpful to develop specific strategies for control of the most common diseases seen in a given population. Written infectious disease control protocols should include a description of the disease (including case definition, mode of transmission, and whether or not the disease is zoonotic) and considerations for protection of the population as well as care of the individual animal. Population considerations include requirements for environmental decontamination, length of quarantine for exposed animals, and level of infectious risk while symptomatic and after apparent recovery. Policies with respect to treatment and adoption of cats affected with various conditions should be developed in consultation with shelter management, based on the risk posed by the disease and the shelter's philosophy and resources.

### **Summary**

No single factor determines whether a population remains healthy or disease rages out of control. All host and environmental factors taken together

provide a number of tools to protect the vulnerable feline shelter population, however. A well-conceived infectious disease control program contributes to improved public perception, increased adoptions, and a healthier feline population within the shelter and in the community in general.

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