



# Dermatophytosis: Decontaminating Multianimal Facilities

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**ABSTRACT:** Dermatophytosis is a frustrating and difficult disease to treat. In single-patient environments, the infection is usually cleared with traditional therapeutic strategies. In multiple-patient environments (e.g., multiple household pets, shelters, pet stores, breeders), the infection can be cleared only if aggressive and global surveillance and treatment protocols are instituted. In general, in a severely contaminated environment with multiple infected patients, the dermatophyte infection can be resolved over many months by incorporating systemic therapy to treat patients, topical treatments to prevent contagion, and thorough disinfectant procedures to decontaminate the facility.

**T**reating dermatophytosis can be frustrating, especially in multianimal facilities, including animal shelters and catteries. Because dermatophytosis is one of the most common zoonotic diseases in veterinary medicine, successful treatment of infections while limiting human exposure is of paramount importance.<sup>1-3</sup> Unfortunately, many multianimal facilities have persistent infections that are difficult to resolve.

*Microsporum canis* is a highly contagious fungal organism that can cause clinical disease in any haired animal. *M. canis* is not a normal part of the skin microflora and should always be consid-

ered a pathogen.<sup>4-7</sup> Animals that are group housed and in poor health (e.g., malnutrition, parasitism, viral infections) have an increased risk of developing active infections.<sup>1,2</sup> In some breeds (e.g., Persians, Parson Russell terriers), genetic factors may contribute to an increased risk for infection.<sup>1</sup> In addition, warm, humid environments, either within a facility or regionally, may encourage fungal growth.<sup>1,8,9</sup> *M. canis* organisms are shed from infected animals' hair and scales and can remain infectious for 12 to 24 months.<sup>6</sup> Because of the extreme pathogenicity of *M. canis*, almost any physical object (e.g., brushes, cages, beds, clippers, clothing, fans), hands, and even other animals can transfer organisms and spread the infection.

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Because of the zoonotic nature of *M. canis*, operators of multianimal facilities should be educated and encouraged to thoroughly evaluate their individual situation.<sup>10</sup> The ethical and legal issues associated with allowing a contagious zoonotic disease to persist are serious and must be considered.

## PROBLEMS RESULTING IN DERMATOPHYTE INFECTION

Multianimal facilities that have chronic dermatophyte infections generally have several fundamental problems. Patients in facilities that practice vigilant monitoring and have aggressive treatment and control practices typically do not develop chronic dermatophyte infections. Facilities with dermatophyte infections usually are financially challenged or have lax control practices. Facilities that have open-door policies for new animals and are unable to isolate infected animals are destined to develop dermatophytosis. Because these facilities are

adequately house animals, which are usually kept wherever there is space. Some cattery facilities are established in a spare bedroom or basement of the operator's home. The limited space makes isolating new or infected animals impossible. New animals are usually mixed in with uninfected animals, creating a risk for contagion.

Ventilation systems are an often overlooked but effective distribution system for infectious organisms. Ventilation systems in poor multianimal facilities are usually inadequate and detrimental to good infection control. In one study,<sup>12</sup> 85% of homes with infected cats had airborne *M. canis* organisms. If the ventilation system of each room is interconnected, organisms can be spread from room to room, even if animals are properly isolated. In older facilities, ventilation systems are absent and operators rely on fans and in-room units to control the climate. Fans are very efficient at dispersing infected hairs throughout an environment. In-room climate control units readily blow infectious material throughout a

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often charitable animal care facilities, the resources to monitor (through cultures) and treat infected animals and the facility are lacking. The "no kill" policies that are becoming more prevalent are making the situation more challenging. Many animals with cutaneous and systemic diseases are being introduced into no-kill facilities. Once dermatophytosis is introduced into a facility (which is just a matter of time), the operator is unable to eliminate the disease because of limited resources.

Insufficient planning and resources for building a facility can lead to poor design and operating practices, making fundamental infection control practices impossible. A facility should ideally have at least three separate rooms that can adequately house animals.<sup>11</sup> One room should be used for new animals and animals suspected of having a contagious disease. An isolation room should be used to house all animals with confirmed dermatophytosis. The main room should contain only animals confirmed to be free of dermatophytosis. Most facilities with chronic dermatophytosis have designs that do not adhere to this model. In our experience, problem facilities are usually in old homes or buildings. In these facilities, the rooms are too small to

room. Even central heating and cooling units and the attached duct work can become contaminated. Adequately disinfecting ventilation systems, fans, or in-room units is impossible with common disinfectant techniques.

The kennels used to house animals in poor facilities are usually selected based on cost rather than ability to clean and disinfect. Even when high-quality stainless-steel cages are used, they are often arranged in a manner that makes them difficult or impossible to clean properly. The cages are typically placed to allow maximum housing space. This usually makes them impossible to remove for thorough washing with a pressure washer. In addition, the cage tops are often used for storing papers or other materials, making thorough cleaning even more difficult (Figure 1). The stored materials are often contaminated and become a source of repeated infection.

Proper hygienic cleaning methods are generally lacking in most facilities with chronically infected animals. The most common method of cleaning animal cages involves the caretaker moving an animal to a different cage and then cleaning its cage. The caretaker usually

**Figure 1. Animal shelters with excessive storage close to possibly infected animals.**

moves a different animal to the cage that was just cleaned. Although this makes the cleaning process more efficient, it encourages the spread of contagious diseases from cage to cage and animal to animal. In addition, we have not found a contaminated facility that requires caretakers to wear protective clothing or change clothes when cleaning and caring for animals in the isolation area. In general, humans and supplies move freely between areas within a facility and there is a lack of knowledge regarding basic infection-control practices.

Many facilities allow animals to have access to other work areas within the facility. At one animal shelter, a cat was the mascot and was allowed free access to the office and visiting areas. The cat's favorite place to rest was on top of the office copy machine. This improved employee morale, but when the asymptomatic cat tested positive for dermatophytosis via culture, the staff was faced with a dilemma. The cat had contaminated the entire office, including the copy machine. In the same facility, the dogs that had been diagnosed with dermatophytosis were isolated from the other dogs by keeping an empty kennel between the two groups. Unfortunately, one of the infected dogs was able to climb the kennel fence to move between kennels (Figure 2). During our visit, the dog moved several times between the isolated kennel and the kennel containing uninfected dogs. The movement of animals, humans, and supplies between areas in a facility is responsible for much of the cross contamination in contaminated facilities.

Catteries often present a unique set of problems. Operators of these breeding facilities often lack medical knowledge and do not understand basic hygiene practices. Catteries with chronically infected animals often have operators who are unwilling to adhere to protocols necessary to control and eliminate dermatophyte infection. Cats in these facilities are typically moved in and out for shows or as a normal part of the trade in breeding animals. The presence of pregnant queens and young kittens complicates any treatment protocol. When animals are introduced into facilities, they are almost never isolated or evaluated for dermatophyte infection. In our experience, these facilities usually consist of a single room containing all of the animals. Usually, only males are confined and several animals (the owner's favorites) are allowed access to other areas of the home. If a dermatophyte infection develops, the entire facility and operator's home are usually contaminated. Because the primary objective is breeding, operators are unwilling to stop breeding and continue to actively show and sell their animals. Aggressive therapy often includes frequent topical treatments and systemic therapy for 6 to 12 months, but most operators of contaminated facilities elect to "manage" the problem rather than aggressively treat it to eliminate the disease. We worked with a particular cattery operator who was reluctant to pay for the labor-intensive treatments and finally decided to sell her home and move to a new "clean" house. This raises serious ethical concerns, and it is undoubtedly only a matter of time before the new facility becomes as contaminated as the previous one.



## TREATMENT PROTOCOLS THAT WORK

### Assessment

The initial step in successfully treating dermatophytosis in multianimal facilities is to determine the extent of the infection (see box on page 570). This involves culturing samples from every animal in the facility, including all other pets (e.g., dogs, ferrets, rabbits) capable of being infected with dermatophytes. The clinical signs of dermatophytosis are extremely variable and mimic many other dermatoses. Infected animals can be completely asymptomatic, have symmetric alopecia, or appear to have pemphigus or an allergy; therefore, clinical appearance becomes irrelevant when identifying infected animals. Hairs from all skin lesions should be sampled. A new toothbrush can be used to brush asymptomatic animals. Alternatively, 4 × 4-inch gauze squares are usually readily available and can be used to wipe animals for sample collection. If after samples from every haired animal in the facility have been cultured and only one or two animals are infected, the infections can likely be managed individually, thereby avoiding massive treatment protocols designed to treat an entire colony. However, most animals are likely to have positive fungal culture results. In addition, household pets are often infected and facilitate the spread of organisms.

The use of a Wood's lamp and direct hair examinations are not sufficiently reliable to be used in the assessment process. If the strain of *M. canis* is one of the few that demonstrates positive fluorescence, a Wood's lamp can be used to select hairs for culturing and quick monitoring but should not be relied on to determine a



**Figure 2.** An infected dog demonstrating the difficulty in isolating some animals. This patient frequently climbed the fence dividing infected and uninfected animals, resulting in spread of the infection.

Gauze squares are readily available, economical, and disposable. If the clinician folds the square, the sampled material can be easily touched to the culture plate. Storage areas should be inspected to assess the likelihood of contamination of food bags, cage papers, and other commonly used materials. Particular attention should be paid to ventilation units because they can efficiently disseminate fungal organisms. By mapping the areas of contamination, operators can gain an appreciation for the severity of the infection and realize the need to use good hygiene. The facility should also be surveyed to determine the methods used to clean cages and disinfect surfaces. Depending on the severity of contamination, the operator can be given an estimate of the effort, cost, and time necessary to clean the facility.

*Aggressive therapy often includes frequent topical treatments and systemic therapy for 6 to 12 months.*

mycologic cure. Only fungal cultures are sufficiently reliable to provide an accurate assessment.

Animals should be evaluated for underlying diseases that may be perpetuating the infection and may make them more susceptible to reinfection. A thorough physical examination of every animal usually identifies several individuals that require additional diagnostic testing. All animals should be screened for parasitic infections, and cats should be screened for viral infections.

To fully evaluate the extent of environmental contamination, samples should be obtained from multiple sites and surfaces throughout the entire facility. A folded 4 × 4-inch gauze square works well in wiping an area to be sampled.

To thoroughly evaluate a facility and all of its animals, numerous cultures must be obtained. The expense of obtaining a large number of cultures can be minimized by finding a local source for culture plates. Many hospitals, universities, and community colleges have a microbiology media laboratory that routinely makes culture plates and may be willing to sell large quantities at a reasonable price. Dermatophyte test medium provides a relatively reliable color indicator that increases the efficiency of screening numerous culture plates. In difficult situations, the operator of the facility can be trained to screen culture plates by looking for the immediate color change as soon as the nonpigmented fungal colony

## Steps to Assessing the Extent of Infection

### Tour the facility to assess current practices

- Animal housing
  - Individual cages
  - Common areas
- Movement of animals within the facility
- Movement of humans
- Storage areas
- Methods of cleaning cages
- Animal bathing and treatment areas
- Isolation facility
- Hygiene practices (e.g., handwashing, food baths, coveralls)
- Disinfectants used

### Culture samples from the animals

- Collect hairs and crusts from any skin lesions
- Use a new toothbrush or folded 4 × 4-inch gauze square to wipe all asymptomatic animals
- Be sure to culture samples from the operator's pets or facility mascots
- Methodically label each plate with the animal's name
- Create a chart of each animal's location within the facility

### Culture samples from the facility

- Use a folded 4 × 4-inch gauze square to wipe the surface of numerous areas
  - Cages
  - Walls
  - Floors
  - Countertops
  - Fans
  - Ventilation ducts
  - Stored materials
  - Common areas
- Create a chart of each culture sample's location to map the extent of contamination

### Use the collected information to:

- Identify the species of dermatophyte being treated
- Determine the number and location of infected animals
- Determine the areas of environmental contamination
- Identify the problems unique to the facility that contribute to contagion
- Educate the operator regarding the severity of the infection
- Create a treatment plan for the animals and facility
- Estimate the effort, cost, and time needed to resolve the infection

appears. Although this approach is not ideal and usually requires much instruction regarding hygiene and culture-handling techniques, it may provide an economical alternative.

## Deciding to Treat

Based on the initial assessment, extent of environmental contamination, number of infected animals, and identification of unique issues contributing to the persistence of the infection, the facility operator must decide how to proceed. Because of the zoonotic nature of *M. canis*, the continued sale or adoption of infected animals is an ethical and legal issue. It may be best to depopulate and close the facility, remembering that the premises will remain contaminated for years. The labor and cost of treating a multianimal facility can be extreme, and only committed operators should be encouraged to invest the resources. If the treatment protocol is discontinued before complete elimination of the infection, a relapse will be inevitable. In addition, if prevention methods are not adopted as normal operating procedures, a relapse is likely. In general, partial treatment attempts are unsuccessful, necessitating an "all or nothing" decision to eliminate the active infection. In our experience, most facility infections can be successfully treated with sufficient effort and duration.

## Disinfecting the Facility

One of the most important steps in successfully eliminating dermatophytosis in a multianimal facility is thorough disinfection and decontamination (see box on page 572). After the facility has been surveyed using fungal cultures, the contaminated areas will be known. These areas should receive special attention; however, the entire facility should be managed to decrease the spread of fungal organisms.

If the facility is globally contaminated, all nonessential items should be disposed of properly. The more thoroughly the facility is cleared of clutter and stacks of stored items, the easier it will be to disinfect. In general, areas where animals are housed should be sparse and completely void of carpet, porous surfaces, and storage areas. All stored materials needed for the facility should be kept in a separate area that is off limits to the animals. If contaminated materials continue to be used, there is very little chance of successfully eliminating the infection.

Caretakers should be educated about basic infection-control methods, contamination, and practical hygiene methods. The movement of animals and humans between areas within the facility should be limited. Ide-

### Disinfecting the Facility

- Discard clippers used on infected cats
- Remove and discard all nonessential items
- Remove all stored material from areas where animals are housed
- Eliminate the free movement of animals and humans throughout the facility
- Assign each animal to a specific cage
- Provide hand and foot wash stations between separate areas
- Use disposable smocks or coveralls that caretakers can change as they move between areas
- Establish a three-room quarantine method
  - Move all actively infected animals to one isolation area
  - Move all clinically normal animals with negative culture results to a distant area
  - Establish an intermediate area for clinically normal animals for which treatment is complete or culture results are pending
- Dispose of portable fans
- Clean the ventilation ducts and install high-efficiency filters
- Vacuum or steam clean all carpets and fabric surfaces (then discard the vacuum)
- Wipe all surfaces (e.g., counters, cages, floors, walls, appliances) with bleach every 1–3 days
- Install a dehumidifier
- Do not admit new animals into the facility until the infection has been resolved
- Discontinue the sale or adoption of animals until the infection has been resolved

ally, each discrete area should be set up to allow caretakers to change into coveralls and boots for that area. If this is not possible, disposable shoe covers and smocks should be provided to prevent transfer of organisms between areas in the facility. All clothing should be laundered and cleaning tools bleached daily. I (K.A.H.) have treated facilities that lacked running water sufficient to wash the caretaker's hands or equipment. Awareness of good hygiene and contagion-control techniques is essential to any treatment protocol.

If possible, all infected animals should be isolated in a building separate from uninfected animals. Each animal should be housed in an assigned cage. If animals are effectively limited to their own areas within the facility, treatment of the animals and disinfection of the facility will be more efficient and effective. Protocols eliminating the movement of animals between cages should be developed and enforced. Ideally, infected animals should be removed from the cage or kennel and treated while the cage is properly cleaned and disinfected. The treated animal should then be placed in the clean cage. Only animals that have been tested via culture and determined to be free of organisms should be allowed into common areas.

The best method of handling infectious diseases incorporates a three-room isolation protocol.<sup>11</sup> In this approach, one room should be dedicated to animals that are not infected based on multiple cultures. The movement of humans and animals in this room should be strictly controlled to limit

**Table 1. Effective Products for Treating *M. canis* Infection**

Drug	Dose	Frequency	Adverse Effects	Cost
<b>TOPICALS</b>				
Enilconazole (not approved in the United States)	0.2% solution	Twice weekly	Corneal ulcers with concentrate Hepatitis Must use E-collar Contact reactions	Inexpensive
Lime sulfur	4 oz/gal	q3–7d	Odor Gastrointestinal signs Must use E-collar Contact reactions	Inexpensive
Chlorhexidine combined with miconazole or ketoconazole	Shampoo or rinse (Malaseb, DVM Pharmaceuticals)	Before dips	Contact reactions	Moderate
<b>ORAL SYSTEMICS</b>				
Itraconazole	10 mg/kg	q24h or pulsed q24h for 1–4 weeks, then either 2 or 3 consecutive days each week or a week on and a week off	Anorexia Hepatitis Vasculitis	Expensive
Fluconazole	2.5–5 mg/kg	q24h	Anorexia Hepatitis	Moderate
Terbinafine	20–40 mg/kg	q24h or pulsed No available trials, but likely to be effective	Hepatitis	Expensive
Ketoconazole (dogs only)	10 mg/kg	q24h	Hepatitis High rate of adverse signs in cats	Moderate
<b>ENVIRONMENTAL DISINFECTANTS</b>				
Bleach	1:10 dilution	q3d	Contact reactions	Inexpensive
Enilconazole (not approved in the United States)	0.2% solution	q3d	Contact reactions Corneal ulcers with concentrate Do not mist or vaporize	Inexpensive

the inadvertent introduction of infected materials or animals. A second room should be used for animals that are being transitioned into the clean room. Animals in this room may have been infected and successfully

treated but may have follow-up cultures pending and are thus still suspect. A third room should be used to house all infected animals and animals new to the facility. These animals are considered contagious and should be

### Ineffective Products<sup>14</sup> for Treating *M. canis* Infection<sup>a</sup>

- Chlorhexidine as a sole therapy
- Miconazole as a sole therapy
- Captan
- Iodine compounds
- 70% alcohol
- Instant hand sanitizer (chlorhexidine combined with alcohol)
- 20% alkyl dimethyl benzyl ammonium chloride
- 21.7% quaternary ammonium chloride
- Potassium monosulfate
- Lufenuron

<sup>a</sup>See Table 1 on page 573 for effective treatments.

undergoing treatment. The key to successful implementation of this approach is vigilant culturing of every animal, along with strict control of animals, materials, and humans between rooms. Unfortunately, most chronically contaminated facilities have insufficient space or resources to implement the three-room isolation protocol and must rely on a more global approach.

The ventilation system should be evaluated and altered to prevent dispersal of organisms through the air. Any fan or ventilation unit that can be easily removed should be disposed of and replaced once the facility has been decontaminated. Central ventilation units should be turned off

product is difficult to contain and can easily leak into adjacent areas.<sup>13</sup> Inadvertent exposure of animals, humans, and unintended areas makes enilconazole smoke products impractical and even dangerous.

### Selecting a Disinfectant

Very few agents effectively kill *M. canis* in the environment (Table 1 and box on this page). Research by Moriello et al<sup>14,15</sup> identified only three highly effective ingredients (i.e., bleach, 1% formalin, enilconazole). Chlorhexidine, miconazole, and iodine products have only minimal efficacy as topical disinfectants<sup>14,15</sup> (Table 1). Enilconazole and lime sulfur are the most effective products, but their use is often limited because of the label indication and lack of acceptance by operators.<sup>14,15</sup> Bleach is the most widely available and commonly used disinfectant with reasonable efficacy against *M. canis*, although it can be irritating to the skin and mucous membranes. Undiluted bleach is not suitable for application to carpeting, furniture, or clothing. We suggest using dilute (1:10) bleach or enilconazole. All surfaces (e.g., counters, cages, floors, walls, windows, ceilings, fans) within contaminated areas should be wiped with a disinfectant (to mechanically remove the debris) as often as possible but at least twice weekly. The disinfectant should be allowed to set for 10 minutes to provide optimal efficacy. It is possible to disinfect contaminated facilities; however, prolonged periods of diligent effort are often necessary.

### *Resolution of the infection and decontamination of the facility can be monitored only through repeated cultures.*

and the ductwork cleaned and disinfected. High-efficiency air filters placed at both the intake and blowout vents may help reduce the circulation of organisms. If ventilation is needed, using a fan that pulls air through the facility and exhausts it outside allows air circulation without blowing organisms throughout the facility. Using a dehumidifier may help reduce the ambient humidity, thus preventing the ideal growing condition for *M. canis*.<sup>9</sup>

An enilconazole smoke product (Clinafarm smoke, Janssen Animal Health) is available to disinfect areas and machinery that are difficult to treat with liquid enilconazole; however, the use of an enilconazole smoke product in companion animal facilities is off label and not approved in the United States. In addition, the

Mechanical removal of infectious organisms is an efficient method of speeding the disinfection process. Because of the contagious nature of *M. canis*, only vacuum cleaners with Hepa filters or commercial steam-cleaning services should be used. If a vacuum cleaner is used, a new bag should be installed before every use, and when the environmental cultures indicate that the facility is being cleared, the entire vacuum cleaner should be discarded because decontaminating the fan unit is impossible. Wet-dry vacuums with high-efficiency air filters are a reasonable alternative because these units can be disinfected reasonably well; however, samples from wet-dry vacuums should be cultured periodically to prevent the inadvertent spread of organisms. Commercial steam-cleaning services



## The Authors' Treatment Suggestions

### Topical treatment

- It speeds clinical response and prevents environmental contamination and zoonosis.
- Apply lime sulfur (4 oz/gal) to the entire haircoat every 3 days with a dip, sponge, or pressure sprayer.

### Alternatives:

- Bathing with a miconazole–chlorhexidine or ketoconazole–chlorhexidine shampoo or leave-on rinse may be beneficial but requires additional cost, time, and effort.
- Topical 0.2% enilconazole is well tolerated, highly efficacious, and economical when applied every 3 days.<sup>a</sup>

### Systemic treatment

- Administer itraconazole (10 mg/kg/day PO) until two or three negative culture results have been obtained (griseofulvin or ketoconazole can be used but is less practical and may have more adverse effects).

### Options:

- The daily dose of itraconazole can be lowered to 5 mg/kg/day; however, the absorption of itraconazole in dogs and cats is variable, making higher doses more reliable.
- Pulse-dosing of itraconazole has been used successfully in several different protocols:
  - Administer itraconazole daily for 28 days, followed by 7 days without treatment, followed by 7 days of daily treatment (loading daily dose for 28 days, then daily dosing for 1 week off, 1 week on).
  - Administer itraconazole for 15 days, followed by 15 days without treatment (2 weeks on, 2 weeks off).<sup>22</sup>
  - To prevent adherence of organisms before a known exposure, administer 10 mg/kg/day for 1–3 weeks before and 1 week after the exposure.<sup>29</sup>

<sup>a</sup>Enilconazole is EPA regulated in the United States, and off-label use of the drug is prohibited.

that use a van-mounted unit can be used, but attention should be given to the location of contaminated water discharged from the unit. Smaller self-contained steam-cleaning units should not be used because cross contamination of reservoir tanks may spread organisms. Regardless of the type of steam cleaner used, the temperature of steam is insufficient to kill organisms, but the mechanical removal may provide some benefit.<sup>1,11</sup> Steam cleaning transiently increases humidity in the environment; however, the benefit of the mechanical removal of organisms outweighs the transient increase in humidity.

## Treating the Animals

Every infected animal in a facility should be aggressively treated with both topical and systemic therapies<sup>1–3,13,16–26</sup> (see box on this page). Topical treatments speed the resolution of clinical lesions and may help prevent zoonotic contagion. Systemic therapies that have prolonged residual activity in the skin and hair are most effective. Treatments should continue until two or three cultures have negative results, and patients should be monitored for several months to identify relapses. An animal can be considered cured only after it has had several cultures with negative results over several months.

Infected hairs that are shed and carried throughout a facility on fomites and air currents are the primary source of contagion. Clipping infected animals can dramatically reduce the number of infectious organisms on the haircoat. However, because of the risk of spreading active infection (i.e., lesions), contaminating the facility and clippers, and zoonosis, an animal should receive at least two treatments before being clipped. Clipping an infected animal can heavily contaminate an entire room. If clipping is required, the animals should be removed from the facility and clipped in a well-ventilated area, preferably outdoors and away from all animals and human foot traffic. The clipped hair should be collected and disposed of immediately. Ideally, inexpensive clippers should be used and discarded after the animal has been clipped. It is almost impossible to effectively disinfect electric clippers contaminated with *M. canis*. Continuing to use contaminated clippers is an efficient means of spreading dermatophytosis. We do not clip infected animals unless they have long hair that is matted.

Lime sulfur (4 oz/gal [25 mg/L] applied q3–7d) and 0.2% enilconazole (applied twice weekly) are the only active ingredients that have repeatedly demonstrated high efficacy in clinical studies.<sup>13,16,17,27</sup> Enilconazole is available only in the United States as a poultry facility disinfectant, and off-label use of it is not permitted by the EPA. Lime sulfur is readily available and nontoxic. Because of its noxious odor, many facility operators refuse to use it. Other active ingredients have demonstrated some benefit. Products that combine the antifungal agents miconazole or ketoconazole with chlorhexidine to produce a synergistic effect are particularly noteworthy.<sup>18</sup> These products may help physically remove organisms and provide antifungal activity.

Systemic antifungals are highly efficacious and provide the best treatment modality. Many systemic antifungals that demonstrate good efficacy against *M. canis*

are available<sup>1-3,19-26</sup> (Table 1). *M. canis* is particularly difficult to treat, with some strains demonstrating an elevated minimum inhibitory concentration when common antifungals are used.<sup>28</sup> New-generation imidazole antifungals demonstrate excellent activity and are the preferred treatment. Itraconazole and terbinafine are particularly effective and well tolerated, even in cats.<sup>19,21-26</sup> Both of these drugs have prolonged residual levels in the epidermis and hair and may help prevent adherence of organisms to skin.<sup>29,30</sup> This allows flexible drug dosing (pulse dosing) while maintaining antifungal tissue levels.<sup>21,22</sup> Unfortunately, to date, itraconazole and terbinafine are relatively expensive treatments. Ketoconazole is widely available as a generic but is not well tolerated by cats.

Lufenuron has received recent attention as a possible treatment of *M. canis* infection.<sup>31,32</sup> In the original study,<sup>31</sup> high doses demonstrated remarkable efficacy in both dogs and cats with dermatophytosis. In more recent trials and anecdotal reports, lufenuron therapy has not provided sufficient antifungal activity to warrant its use as a sole therapeutic agent.<sup>33</sup> Lufenuron may provide some benefit but should be used as an adjunct to topical and systemic therapy.

*M. canis* vaccines have been repeatedly evaluated in the hope that patients' immune systems could be stimulated to prevent infection, speed resolution of an active infection, and prevent relapse. Unfortunately, vaccine trials have not been successful and a vaccine is not currently available in the United States.<sup>34-37</sup>

## When to Stop Treatment

Every animal and the facility should be treated until two or three fungal cultures produce negative results (see box on this page). Repeated environmental cultures should be conducted throughout the treatment period to monitor the disinfection process. Six to 12 months are often required to completely eradicate infectious organisms from a facility. Once treatments have been discontinued, animals should be monitored for several months to ensure complete resolution. Samples from newly acquired animals should be cultured and isolated until their infection status is known. Empirical topical treatments can be used while culture results are pending to prevent inadvertent contamination of the facility and spread of infection. The facility should be continually cleaned and disinfected to prevent recurrence of contamination. In general, infections of relatively short duration (i.e., months) can be cleared within 12 months (and

## Monitoring Animals and Facilities with Dermatophytosis

### Short-Term Monitoring

- To minimize cost, **repeat cultures monthly** until several cultures have demonstrated no growth
- **Culture samples** from:
  - Animals in which clinical lesions have resolved
  - Asymptomatic animals from the contaminated area that are being considered for movement to the uncontaminated area of the facility
  - The facility (focus on several of the most frequently used areas and ventilation units)
  - Fomites that are used on more than a single animal
  - New animals
  - Random animals in the uncontaminated area to confirm their culture status
  - Asymptomatic animals in the transition area
- **Over 6–12 months, the animals and facility will slowly begin to clear the infection**
  - As the animals become clinically normal, move them from the isolation area to the transition area
  - As the clinically normal animals test negative via culture (repeated two or three times), move them from the transition area to the uncontaminated area
- **Disinfect the facility** according to the directions in the box on p. 572
  - When the incidence of positive culture results has decreased, the frequency of cleaning can be reduced to once weekly

### Long-Term Monitoring (after the infection has been cleared [i.e., after two or three rounds of negative culture results])

- **Culture samples** from:
  - New animals
  - Random animals to verify fungal-free status
  - The facility and fomites every few months (see above)
  - Animals returning from shows
- **Maintain strict isolation of new animals** until culture results are known
- **Prophylactically treat animals attending shows** with itraconazole to help prevent organism adherence (10 mg/kg/day for 1 week before and 1 week following the show)
- **Prophylactically treat returning animals** with topical treatments to decontaminate the haircoat
  - Assume all returning animals are infected, and maintain strict isolation of them until culture results are known

often after 6 months). Persian catteries or facilities with chronically (i.e., years) infected animals require much longer periods of aggressive treatment, possibly as long as 1 to 2 years. Facilities that are not responding after 6 months of aggressive therapy should be closed.

To prevent future reinfection, the facility and animals should be periodically monitored through random culturing of samples from the environment and animals. In addition, new animals or animals returning from an outside event (i.e., a show or breeding loan) should be assumed to be infected and isolated until culture results have been determined. Topical treatments can be initiated to prevent contamination and contagion. Anecdotal evidence suggests that treatment with itraconazole before and after exposure to *M. canis* can prevent adherence of the organisms, thereby preventing infections.<sup>29</sup> The ideal dosing protocol is unclear because it may take 3 weeks to reach steady-state levels within the tissue.<sup>30</sup> We suggest treating for 1 to 3 weeks before possible exposure and for 1 week after, combined with one or two topical treatments after the animal returns to the facility.

## CONCLUSION

With aggressive, persistent treatment, most multianimal facilities can be cleared of dermatophytosis; however, the process may require over 1 year to complete. Good communication and patience are essential in helping clients navigate the many therapeutic options and frustrations.

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## ARTICLE #1 CE TEST



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- 1. If a facility has multiple animals with dermatophytosis, to what extent is the environment contaminated?**
  - a. minimally
  - b. moderately
  - c. extensively
  - d. no contamination
- 2. Which fomites are a common source of reinfection but are often overlooked?**
  - a. grooming utensils
  - b. bedding
  - c. litterboxes
  - d. ventilation systems
- 3. Which is the best method of determining the extent and precise location of facility contamination?**
  - a. Wood's lamp
  - b. culture
  - c. proximity to bedding
  - d. dust accumulation
- 4. The most compelling reason(s) to mandate aggressive management of contaminated facilities and infected animals is(are)**
  - a. zoonosis.
  - b. contagion in any mammal.
  - c. litigation.
  - d. all the above
- 5. Which step is important but often overlooked in managing multianimal facilities contaminated with dermatophytosis?**
  - a. culture samples from the environment
  - b. culture samples from the animals
  - c. biopsies of skin lesions
  - d. blood work
- 6. Successful treatment of a contaminated facility and infected inhabitants can be achieved but often takes as long as \_\_\_\_ months.**
  - a. 2
  - b. 6
  - c. 12
  - d. 36
- 7. The role of topical therapy in treating dermatophytosis is to**
  - a. be the main treatment in resolving the infection.
  - b. eliminate the organisms in the environment.
  - c. speed resolution of clinical signs.
  - d. prevent contagion to other animals and humans.
- 8. The role of systemic therapy in treating dermatophytosis is to**
  - a. be the main treatment for resolving the infection.
  - b. eliminate the organisms in the environment.
  - c. speed resolution of clinical signs.
  - d. prevent contagion to other animals and humans.
- 9. The most effective, readily available disinfectant for cleaning an environment contaminated with dermatophytosis is**
  - a. lime sulfur.
  - b. iodine.
  - c. chlorhexidine.
  - d. bleach.
- 10. Treatment can be considered effective and can therefore be stopped when**
  - a. multiple cultures have had negative results.
  - b. clinical signs resolve.
  - c. no new infections have occurred.
  - d. 12 months have passed.