Feline Dermatophytosis
Veterinary Medicine October 2003, pp845

Etiology

- *Microsporum canis* is most commonly isolated dermatophyte
- *Microsporum gypseum* and *Trichophyton* species are less common
  - Most likely to be seen in outdoor cats OR (for *Trichophyton* spp) in cats whose owners have chronic tinea pedis
- Dermatophytosis is the most common infectious skin disease in cats

Fungal Flora Isolates and Disease Prevalence

- Most common isolates from healthy cats are:
  - Alternaria, Cladosporium, Penicillium and Aspergillus species
- Clinicians should learn to recognize the gross and microscopic appearances of these species (see Fig 1A to 4B)
- *Microsporum canis* is NOT part of the normal flora of cat hair

A colony of Alternaria; note how it can be confused with appearance of pathogen

A gross colony of Cladosporium species; note the dark pigment

Gross colony of Penicillium species
Prevalence of *Microsporum canis* in adoptable cats in US animal shelters is 4%-6.5% (it is significantly higher in some other countries)

**Predisposing Host Factors and Disease Development**
- Any age or gender is susceptible
- Most often seen in younger (most likely at time of weaning) and older cats and in long-haired cats
- Concurrent disease affects susceptibility (see below)
  - Dermatophytosis is three times more likely in FIV-infected cats than in uninfected cats
- Genetic Factors
  - There is evidence in related populations of cats where increased antibody titers and different *in vitro* lymphocyte blastogenesis responses were seen in comparison to cats without dermatophyte problem
  - Breeders may be selecting for susceptibility when they breed for certain coats or other physical characteristics (e.g. more common in long-haired cats...but could be due to hair protecting spores or mats enhancing environment for development of spores)
- Grooming
  - Grooming inhibits development of dermatophyte
  - Therefore, animals in which there is decrease in grooming activity (e.g. aged, and kittens face and ears...these areas are not groomed much after weaning) may be more likely to develop dermatophytosis
- Immunity
  - A strong cell-mediated immune response is required to recover from infection
    - Increased epithelial turnover (through secretion of intrinsic growth factor)
    - Increased permeability of epidermal barrier (allowing serum- containing anti-fungal factors to penetrate keratinocytes)
    - Cats with high antibody titers but abnormal lymphocyte blastogenesis did not recover from chronic dermatophyte infection
      - It is thought that high antibody titers somehow interfere with cell-mediated immunity and predispose these cats to chronic infection
      - These cats lacked or had markedly weaker delayed intradermal skin test reactions to dermatophyte antigens
  - Therefore, humoral immunity is NOT protective
  - Cats that recover from infection may be reinfected under the right conditions (e.g. trauma to skin, or under a wound dressing, in the presence of large numbers of spores)
    - Reinfecions are less severe and of shorter durations than initial infections

**Chronic dermatophytosis in people may also result from inherited defect in cell-mediated immunity...and this may also be the case in cats**
Factors that May Affect the Pathogenesis and Transmission of Infection

• **Arthrospore Transmission**
  - **Arthrospores** are the infective state of dermatophyte organisms
    - Form from segmentation and fragmentation of fungal hyphae
  - They enter the environment when
    - Infective hair breaks/sheds
  - Exposure to contact with an infected animal, contaminated object or environment
    - Brushes, collars and casual contact with subclinically infected cats
  - Arthrospores may be carried on air currents and dust particles
  - Arthrospores may be carried on ectoparasites (e.g. fleas!!)

• **Establishing Infection**
  - Once **Arthrospores** reach the skin and establish a nidus of infection—this usually requires some sort of trauma to the skin
    - Clipping, rubbing the skin gently with a glass rod
    - Fleas, lice and mites provide sufficient trauma to permit nidus formation
  - **Increased hydration and maceration** of the skin
    - Hot humid conditions favor infection
    - Moisture favors ability to penetrate the skin and germination
    - Normal skin (desert-like?) with fungistatic serum and sebum is natural host defense
    - Sebum is distributed from high-producing areas (chin and dorsum) to other areas by grooming activity
    - Excessive bathing and grooming cats may predispose to infection by removing normal host defenses (sebum and serum) and epidermal surface cells that act as a first-line intact barrier

**Common and Uncommon Clinical Presentations**

**Pathogenesis of Dermatophytosis**
- Dermatophytes invade hair shafts and cornified epithelium
- This destroys the hair shaft and disrupts normal keratinization
- The result is hair loss and scaling

**Infection may present with any combination of the following**
- **Pruritis**: it may be non-pruritic or severely pruritic (resulting in self-mutilation)
  - Unilateral or bilateral pinnal pruritis with scaling is another un(der)recognized presentation of *Microsporum canis* infection
  - Miliary dermatitis
- **Hair-Loss**: may be subtle or dramatic, symmetric or asymmetric, inflammatory or non-inflammatory
  - Symmetrical alopecia may be seen in cats predisposed to dermatophytosis due to prior glucocorticoid administration or because the dermatophyte, itself, produced a symmetrical pattern of alopecia
Crusting and Scaling: lesions are usually exfoliative
  - In some cats scaling is severe…it could resemble *Pemphigus foliaceus*
  - Mounds of thick, adherent crust may accumulate on the face, ears, nail beds especially on long-haired cats
  - Erythema and scaling of inner and/or outer ear (with pruritis)

Comedo-like lesions: Chin acne in young cats

Hyperpigmentation: this is an uncommon clinical finding in cats in general; however when it is present, it is most likely due to dermatophytosis

Paronychia: crusted or exudative paronychia may be the only sign of dermatophytosis in some cats

Erythema: is a common finding is early lesion…and is often accompanied by hair loss

Eosinophilic plaque: usually due to allergy, but can occur secondary …to pruritic *Microsporum canis* lesions

Military dermatitis: these lesions may be seen after clipping (due to trauma of clipping?). Is a form of folliculitis

Indolent ulcer: there is evidence that *M. canis* is an unrecognized …cause of this

Granulomatous Lesion:
  - May present as non-healing wounds or nodules (especially in long-haired cats)

Miscellaneous
  - Facial folds and periocular hair
    - Most common when treated with lime-sulfur dips…owners reluctant to apply to face
    - Animals also have facial-fold pyoderma, conjunctivitis and blepharitis

Varied lesion distribution:
  - Is not a localized disease..may be focal or multifocal
  - Even if focal, spores will be present throughout the coat, due to grooming
  - In Kittens:
    - Scaling and alopecia on the face, ears, muzzle and forelimbs
  - Older Kittens and Young Cats:
    - Irregular patches of alopecia with or without crusting
  - Other signs:
    - “excessive shedding” (is a common complaint)
    - constipation, vomiting or hairball problems

Zoonotic Considerations
  - *Feline dermatophytosis poses risk to anyone* contacting the infected cat
  - In people exposed to symptomatic or asymptomatic cats, 50% developed lesions and in ~70% of all households with an infected cat at least one person develops lesions
  - Any cat obtained from a multicat facility should be evaluated for dermatophytosis as part of the new-pet exam
A colony of Alternaria; note how it can be confused with appearance of pathogen.

Microscopic colonies of Alternaria; the microscopic organisms are pigmented.

A gross colony of Cladosporium species; note the dark pigment.

Microscopic colonies of Cladosporium.

Gross colony of Penicillium species.

Microscopic colonies of Penicillium species. Note the brushlike appearance.

1A. A gross colony of Alternaria species. Note that the colony is pale and could be confused with a pathogen without microscopic identification.
1B. Microscopic colonies of Alternaria species. The microscopic organisms are pigmented.
2A. A gross colony of Cladosporium species. Note the dark pigment.
2B. Microscopic colonies of Cladosporium species.
3A. A gross colony of Penicillium species.
3B. Microscopic colonies of Penicillium species. Note their brushlike appearance.
5A. A gross colony grown of *M. canis* on a Sab-Duet plate (Bacti-Lab).

5B. Microscopic colonies of *M. canis*. Note the canoe-shaped macroconidia typical of this pathogen.
Dermatophytosis in an 8-week-old kitten. Note the area of hair loss and erythema over the eye. Also note that the holder is not wearing gloves. Kittens or cats with lesions suggestive of dermatophytosis should be handled with gloves.
7. A Siamese kitten with hair loss and hyperpigmentation in the axillary regions from dermatophytosis. Note that the holder is not wearing gloves, which is not a recommended practice.

8. An inflammatory dermatophyte lesion on a cat’s ear. Note the alopecia, scales, and crusts. This cat was referred for nonresponsive pemphigus foliaceus. Also note that the holder is not wearing gloves; gloves should be worn whenever cats with lesions even remotely suggestive of dermatophytosis are examined.
9. A thinning coat in a longhaired cat with dermatophytosis. Note the dermatophyte lesion on the owner’s arm.

10. A dermatophyte lesion on a veterinarian’s arm. This individual also developed a hypersensitivity reaction (dermatophytid) to the *M. canis* infection, resulting in a severely pruritic generalized papular eruption.
Practical Diagnostic Testing for Dermatophytosis in Cats
Veterinary Medicine October 2003 pp859

Indications for Diagnostic Testing

- **Cats with clinical signs** (dermatophytosis is the most common infectious skin disease in cats!!)
- **Cats or kittens with skin diseases** (unless cause is obvious, e.g. fleas)
- **Debilitated cats** (especially cats that have stopped grooming)
- **Newly acquired cats** or kittens
- **Referral or 2nd opinion dermatological cases** (often there is unusual presentation for dermatophytosis!)
- **Any cat whose owner develops skin disease**
- **Cats involved in hospice or pet therapy or daycare services** (out of home)
  - Twice yearly fungal cultures
- In cattery (see last section about care/prevention in cattery)
  - Any cat added to the facility on a temporary or permanent basis
  - All cats regardless of hair length, at least once yearly (fungal culture)

In-House Diagnostic Tests

- **Wood’s Light Examination**
  - Emits long wavelength UV light (340-400nm) through nickel or cobalt glass filter
  - UV light absorbed and longer (visible) light is emitted by absorbing material
  - Half or LESS of *Microsporum canis* species will fluoresce (due to a metabolite which growing fungi secrete in hair)
  - False positives and negatives are possible
    - Topical ointments (especially those which contain tetracycline) glow bright green
    - Blue-white epidermal scales
    - Yellow areas of oily seborrhea
    - Variably colored pieces of lint and threads
    - Coral red discoloration of the skin due to topical medications and synthetic carpet fibers (e.g. scratching posts) that glow apple-green
  - Can be used to identify hairs for culture and direct examination
  - **Procedure:**
    - Battery-operated Wood’s lamp do NOT provide adequate light intensity (leading to false negatives). **USE ELECTRIC LAMPS!**
    - Turn on electric Wood’s lamp and allow to warm up for 5-10 minutes before use

*The author examined eight cats with culture and microscopic confirmed dermatophytosis which did not fluoresce with battery operated lamp...but did fluoresce with electric lamp!!*
Warm-up is important because the light’s wavelength and intensity are temperature-dependent.

- **Turn off or greatly dim the room lights**...then allow several minutes for your eyes to adapt to dimmed lighting conditions.
  - During this adaptation period, expose the lesional area to lamp for 3-5 minutes.
    - For best results, hold light within 1-2 inches of the lesion.
  - **Glowing hairs can often be found under crusts**
  - Gently avulse/remove crusts to locate infected hairs
    - Pay special attention to ear hairs, ear margins, lips, muzzle and nail beds
  - **May find fluorescent hairs in these regions in cats that are clinically normal** but have positive culture results

  - **Interpretation**
    - Remember that Wood’s light is only a screening tool!!!; it does not rule in or out a positive infection!!!! (do culture and microscopic hair examination)
    - The most commonly observed color in a positive area is apple-green fluorescence or yellow fluorescence
    - During active or early infection, the entire hair will glow
    - As infection resolves, the more distal areas of the hair will glow
    - During late stages of infection, only the tips of the hair shafts will glow and the number of glowing hairs will decrease
    - In some cases, hairs may fluoresce blue-green
    - Most common in long-haired cats with oily coats
    - **False positives**
      - Topical ointments (especially those which contain tetracycline) glow bright green
      - Blue-white epidermal scales
      - Yellow areas of oily seborrhea
      - Varibly colored pieces of lint and threads
      - Coral red discoloration of the skin due to topical medications
      - Synthetic carpet fibers (e.g. scratching posts) that glow apple-green

  - **Uses**
    - As screening tool (not diagnostic tool)
    - Monitoring response to treatment

- **Direct Examination of Hairs**
  - Involves direct examination of hairs for fungal spores (arthroconidia) and hyphae and hair morphology
  - Takes practice...and is time consuming unless there is a glowing strain of Microsporum canis.
    - A clearing agent is recommended (see Table 1..below)
      - KOH (10%-20%)
      - KOH + Calcofluor white stain
• Chlorphenolac solution
  • **A mineral oil suspension can be used without clearing**, but samples are harder to evaluate (more debris in background)

**Indications**

• **When fluorescent hairs are found, these are plucked and examined.** If fungal spores are present, a positive diagnosis is made (and treatment can be started)
  • A fungal culture is still recommended…even when spores are found

**Procedure**

• **Pluck glowing hairs in the direction of growth** (usually glowing and non-glowing hairs are plucked)
  • If a large amount of hair is plucked, use the Wood’s lamp to identify glowing hairs.
• **Add a drop or two of clearing agent** *(Table 1 below)* then a glass cover slip
  • KOH requires 30 minutes to fix...
    • This can be hastened by gently heating the slide with a match for 10-30 seconds
    • OR…warm and fix slide by placing it on the microscope lamp for 5-10 minutes
  • Chlorphenolac preparations can be viewed immediately and produced few artifacts

**View slides**

• First at low power 4X or 10X
• Turn off microscope’s light and room lights
• Use Wood’s lamp to help find the glowing hairs on the slide
• Move the slide’s stage so that glowing hairs are in position under the objective
  • If Wood’s lamp is held beneath the stage or even at its side, glowing hairs should be visible through the objective (it looks like a green-blue light stick)
• Once the glowing hairs are located and beneath the objective, turn the microscope’s light on and examine the slide for arthrospores…under low then high power (see left…and below for larger version )

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Fig1A-1B. Examination of *M. canis*-infected hairs with clearing agent Chlorphenolac. The normal hair is in the lower left corner (1A at 10X). The infected hairs are noticeably wider and filamentous-looking because of ectothrix spores.

Fig2. High power view of *M. canis* ectothrix spores that for large cuffs around hairs. These hairs shed in the environment, where they can infect other susceptible animals and people.

Fig3. Microscopic appearance of normal hair and a pigmented spore artifact (Larger version of this figure on the next page…)
Interpretation

- Low power allows viewer to identify infected hairs
- Infected hairs are wider than normal hairs, swollen, frayed, fuzzy and almost filamentous (see Figure 1A, above)
  - Appearance is caused by mass of ectothrix spores or fungal hyphae in hair (see Figure 1B)
- Examine hair bulbs...the infected hairs are more distorted than normal hairs
• High power to view arthroconidia (Figure 2 above) or fungal hyphae

Table 1

<table>
<thead>
<tr>
<th>Stain or Reagent</th>
<th>Use</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral oil</td>
<td>Can be used as a mounting media for microscopic examination of hairs.</td>
<td></td>
</tr>
<tr>
<td>Potassium hydroxide (10% or 20%)</td>
<td>A clearing agent that allows for easier visibility of fungal elements.</td>
<td>The slide must be allowed to fix for 30 minutes before examination. The slide can be heated with a match or microscope lamp to speed up this process. Artifacts are common.</td>
</tr>
<tr>
<td>0.5% Calcofluor white stain (Becton, Dickinson and Company)</td>
<td>A fluorescent brightener that binds to polysaccharides such as cellulose and chitin; fungal walls will fluoresce brilliantly.</td>
<td>An equal mix of calcofluor white and potassium hydroxide is placed on a slide and used as a clearing agent. This mixture detaches fungal elements but requires a fluorescent microscope (a Wood's light can be used as a light source).</td>
</tr>
<tr>
<td>Chlorphenol®</td>
<td>A clearing agent that allows for easier visibility of fungal elements.</td>
<td>Allows for immediate sample examination with minimal artifacts.</td>
</tr>
</tbody>
</table>

*Chlorphenol must be compounded by a specialty pharmacy. Ingredients: 50 g chloral hydrate added to 25 ml liquid phenol and 25 ml liquid lactic acid. It may take several days before the crystals go into the solution.

Table 2

Comparisons of commercially available fungal culture media

<table>
<thead>
<tr>
<th>Fungal Culture Medium</th>
<th>Ingredients</th>
<th>Color Indicator</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sabouraud's dextrose agar</td>
<td>Contains no drugs to inhibit the growth of contaminants</td>
<td>None</td>
<td>Available commercially as one side of a dual-compartment plate or in a Petri dish. Overgrowth of contaminants is a problem; this medium should be used in conjunction with dermatophyte test medium or to subculture suspect pathogens.</td>
</tr>
<tr>
<td>Dermatophyte test medium</td>
<td>Sabouraud's dextrose agar and antimicrobials (cycloheximide, gentamycin, chlorotetracline)</td>
<td>Yes—phenol red; potential pathogens turn medium red as they grow</td>
<td>Widely available in glass screw-top plates, dual-compartment plates, and Petri dishes. The color indicator can affect the gross and microscopic appearance of the fungal pathogens. Suspect colonies should be subcultured onto plain Sabouraud's dextrose agar.</td>
</tr>
<tr>
<td>Mycosel Agar, Mycosel Agar (Becton, Dickinson and Company)</td>
<td>Sabouraud's dextrose agar and cycloheximide and chloramphenicol</td>
<td>No</td>
<td>Useful for isolating pathogens when there is heavy contamination of the sample. This medium will inhibit the growth of contaminants but will not alter the gross and microscopic colony morphology of pathogens.</td>
</tr>
<tr>
<td>Sab-Duet (Bacti-Lab)</td>
<td>Dermatophyte test medium and Sabouraud's dextrose agar</td>
<td>Yes—phenol red</td>
<td>Dual-compartment plate with dermatophyte test medium on one side and plain Sabouraud's dextrose agar on the other. This plate is easy to inoculate and is commonly used by veterinary dermatologists.</td>
</tr>
<tr>
<td>Derm Duet (Bacti-Lab)</td>
<td>Dermatophyte test medium and rapid sporulating medium</td>
<td>Yes—glucose and bromothymol blue; suspect dermatophytes turn the medium blue-green</td>
<td>Dual-compartment plate with dermatophyte test medium on one side and rapid sporulating medium on the other. It is used to enhance conidial development.</td>
</tr>
</tbody>
</table>

NOTE: Clearing agents should NEVER touch a lens (will ruin!)
A variety of culture plates are also available**

The dual-compartment plate (lower left, Figure 4) is most cost-effective and easiest to use.

Even though side of test medium (DTM) side turned red at 10 days, the pigmented colony indicates that this is not a pathogen (but is Penicillium contaminant).

**The appearance of various isolates on Saboroud's agar is listed below, in Table 3.)

- The dual-compartment plate (Figures 4 and 8) is most cost-effective and easiest to use

**Procedure:**
- Hair sampling:
  - For generalized lesions, comb with sterile (sealed in cellophane) toothbrush...at least 30 strokes, til full of hair and scale
  - For individual lesions, sample area with toothbrush as above or pluck individual hairs
  - For suspected carriers, wipe cat with damp towel, or put in a clean cage for several days, then perform a culture
- Firmly but gently press sample (on toothbrush) onto surface of culture media; do NOT imbed material!
• If large amount of hair is obtained from an assymptomatic cat (subclinical or carrier), using the toothbrush, then stab the bristles into the agar
• In assymptomatic cat, most likely places to sample are face, forelimbs, limbs, nailbeds, hair in ears, inner and outer pinnae and ear folds. (see above, also...applying damp towel, e.g.)

- Incubate at 72.2º F to 80.6º F in the dark (e.g. in a cardboard box)...not at room temperature (as previously recommended) upside down (to prevent moisture from collecting on the surface)
- Place small dish of water in the culture area to provide humidity...to prevent dehydration of the media...OR...seal the plates with wax-coated film
- Examine cultures daily for 21 days

**Interpretation:**
- Examine cultures daily
- Pathogens are pale or white colonies
  - If color indicator is used, color change will be seen around the colonies (e.g. red if DTM is used)
- Contaminants tend not to cause color changes (but see Figure 6, above) and are often heavily pigmented or have colored colony growth
- Bacteria and yeast contaminants produce glistening colonies
- Cats with fluctuating culture results (e.g. positive→negative→positive), especially when there are fewer than 5-7 colonies when positive culture is obtained, are usually carriers!!
Microscopic Evaluation (of suspicious colonies)

Procedure:
- Gently press sticky side of clear acetate tape to margin of suspect colony (Figure 9)
- Then press tape down on a drop of Lactophenoll Cotton Blue (Figure 10)
- Add a second drop of above stain on top of the tape
- Then add cover slip (Figure 11)
- If no macroconidia or microconidia are seen, resample the colony in 48-72 hours

Interpretation:
- Pathogens are never heavily pigmented...hyphae or spores
- Diagnosis is made by matching colony morphology with microscopic morphology (Figures 12 and 13, below, next page)
Gross colony of *M. canis* on Sab-Duet plate

Gross colony of *M. gypseum* on Sab-Duet plate

Microscopic view of *M. canis* macroconidia

Microscopic view of *M. gypseum* macroconidia

Microscopic view of *Trichophyton* species

Histopathological exam of skin granulomatous lesion in cat. Intense granulomatous inflammation seen in kerion reactions, fungal furunculosis and fungal granuloma lesions...cat had symmetric alopecia
- **Skin Biopsy**
  - Biopsy may be necessary when lesions present as something dramatic...deep pyoderma, granulomatous skin disease, non-healing wounds, masses, severe crusting and scaling.
  - In these instances, when lesions that should heal are not healing, then dermatophytosis should be on differential diagnosis list.
  - **Procedure:**
    - Be sure to submit several samples of adequate size, since infection may be difficult to see.
    - Be sure to include attached crusts...diagnostic spores and hyphae are most likely in the superficial layers.
    - If crusts become dislodged, be sure and request that they be processed anyway (separately)...and to look for dermatophytes.
    - Alert pathologist of suspicion so that pathologist may employ special stains to reveal characteristic findings.
  - If diagnosis is made by histopathology, then culture on saboroud’s dextrose agar medium) should be done to identify species...if necessary, culture skin biopsy material, as well as hairs, from tooth brush or plucking.

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**Table 3: Gross and Microscopic Properties of Common Dermatophytes on Sabouraud's Dextrose Agar**

<table>
<thead>
<tr>
<th>Organism</th>
<th>Colony Morphology</th>
<th>Microscopic Morphology</th>
<th>Wood's Light Examination</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsporum canis</td>
<td>White; cottony to woolly cotton; flat; center may be depressed; with time, yellow-orange reverse pigment develops on the undersurface</td>
<td>Spindle-shaped macroconidia (canoe-shaped); usually six or more cells in mature cells; thick walls; spines are present and often more numerous on end; terminal knob; microconidia are rare</td>
<td>Infected hairs may glow apple-green, yellow-green, or blue-green</td>
<td>Easily isolated in-house</td>
</tr>
<tr>
<td>Microsporum gypseum</td>
<td>Rapid-growing, flat colonies that resemble face powder; may be cinnamon-brown; yellow to tan reverse pigment on the undersurface</td>
<td>Cells are more row-boat-shaped in comparison with M. canis; thin walls; no terminal knobs; macroconidia are usually less than six cells; microconidia are one-celled</td>
<td>No fluorescence</td>
<td>Easily isolated in-house</td>
</tr>
<tr>
<td>Trichophyton species</td>
<td>Variable colony morphology; usually flat and white to cream; tan to brown to red reverse pigment on the undersurface may be seen</td>
<td>Microconidia are common and macroconidia are rare and cigar-shaped; spiral hyphae are most common with these species</td>
<td>No fluorescence</td>
<td>Depending on the species, the growth may be rapid or slow; some species require higher temperatures and special nutrient requirements. Submission to a diagnostic laboratory may be helpful in isolation and identification.</td>
</tr>
</tbody>
</table>
Feline Dermatophytosis: Topical and Systemic Treatment Recommendations
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General
- A toothbrush culture cannot distinguish between carriers and infected cats (and the culture, not the hair exam or Wood's lamp exam, is the "gold standard" for diagnosing dermatophytosis)
- Dermatophytosis will spontaneously resolve in most healthy cats (but treatment is recommended because the disease is highly contagious and zoonotic)
- The endpoint of treatment is two (or three if multiple cats are involved) negative fungal culture (at 1-2 week intervals) and complete decontamination of the premises
  - Cats will show clinical cure before they show culture-negative results
  - Environments can remain contaminated for 18 months under optimal conditions
  - The more cats involved, the longer the treatment and the longer it takes to decontaminate

Overview of Treatment Strategies
- Treatment of carrier or infected cats requires clipping the cat (see more below), topical and/or systemic antifungal therapy and treating the premises
- The use of topical alone or systemic alone depends on the cat, severity of infection, finances and available drugs. Some important considerations:
  - Does any risk of environmental contamination pose a serious threat to people or other cats? (Environment may be an overriding concern in certain circumstances...e.g. day care facility)
  - Does cat live with, or frequently come in contact with children, elderly, immunocompromised individuals or individuals with other health concerns, health-care workers (including veterinarians and vet techs), teachers

If answer to either of these is “yes” then aggressive therapy is recommended regardless of cat’s hair length or severity of lesions

Note: Dermatophyte infections in cats usually resolve without treatment in 60-100 days if the cat has a competent immune system. Cats receiving topical and systemic treatment usually show marked improvement in 2-4 weeks
Clipping the Hair

- Clipping the hair is optimal in every case

- Hair shafts are made fragile by infection and as they break, infective spores are shed into the environment AND onto the cat’s coat.
- **Clipping the hair removes most infected hair** and minimizes continued shedding of spores.
- **Clipping the hair also makes topical therapy more effective**.
- Clipping shortens the duration (and thus the cost) of treatment.
- **HOWEVER**:
  - Clipping can temporarily worsen the infection because it causes microtrauma to skin.
  - Clipping can contaminate the environment if appropriate efforts to capture infected hair are not taken.
- **Clipping is necessary in ALL long-haired with dermatophytosis cats (regardless of severity of infection) and in short-haired cats with generalized dermatophytosis.**

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**Guidelines for Treating Dermatophytosis in Cats**

1. **The infected cat is the only cat in the household:**
   - If the cat is shorthaired and has less than five focal lesions, clip the hair around the lesions. In all other cases, clip the hair on the entire body.
   - Administer topical and systemic antifungal therapy until you achieve a mycological cure (two or three consecutive negative culture results at weekly or biweekly intervals).
2. **The infected cat is in a household with up to four other cats:**
   - If the infected cat is shorthaired and has less than five focal lesions, clip the hair around the lesions. In all other cases, clip the hair on the entire body.
   - Administer topical and systemic antifungal therapy until you achieve a mycological cure (two or three consecutive negative culture results at weekly or biweekly intervals).
3. **The infected cat is part of a cattery or a show cat:**
   - The cat is at high risk for transmitting the disease to other animals, so treat it aggressively.
   - Perform a toothbrush culture in all the cats in the cattery.
   - Administer whole-body topical therapy in all the cats in the cattery pending culture results and until all the cats have three consecutive negative culture results at weekly or biweekly intervals.
   - Clip the coat of all cats that have positive culture results.
   - Administer topical and systemic antifungal therapy in all cats that have positive culture results until you achieve a mycological cure (three consecutive negative culture results at weekly or biweekly intervals).

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Monitor treatment by performing fungal cultures four weeks after starting therapy, and continue the therapy until a mycological cure is achieved.

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*It may take months for the entire coat to regrow if infection is severe; however, with treatment, there is a noticeable decrease in pruritis, scaling, erythema and hyperpigmentation, with hair regrowth following shortly thereafter.*
**TECHNIQUE:**
- Use number 10 blade and clip to less than 2cm in length
- In short-haired cats with focal (not generalized) lesions, a scissor can be used to clip hairs (resulting in a WIDE margin) around lesions
  - If the strain is strongly fluorescent, use a Wood’s lamp to locate hairs for removal

**Topical Therapy**

**Advantages:**
- Decreased length and cost of treatment
- Minimized spread of infective spores in the environment
- Removal of infected crusts and scales

**Disadvantages:**
- Cats generally hate it!
- Is labor-intensive
- Topical antifungal agents are irritating to people and cats

**Appropriate Usage:**
- Is recommended in ALL cats with positive fungal cultures (after clipping)
- Is recommended in ALL cats in contact with infected cats

**WHOLE BODY TOPICAL ANTIFUNGAL THERAPY**

**Effective products:**
- **Lime-sulfur** (LymDyp® -DVM Pharmaceuticals, use 8 oz per gallon)
  - This is therapy of choice (if enilconazole is not available)…is consistently effective
  - Is administered twice weekly…can be sponged on
  - Is irritating to mucus membranes…cat’s should be prevented from grooming the wet solution afterwards
  - It stinks…but odor rapidly diminishes when it dries (DO NOT RINSE OFF!)
  - Stains white cats yellow or green
  - Owners should wear protective gloves and a mask and should apply the dip in a well-ventilated room

- **Enilconazole** (Imaverol® –Janssen Pharmaceuticals…a 10% concentrated solution) is NOT licensed in the USA
  - Apply twice weekly as dip for 5-10 weeks
  - Well tolerated, but associated with hypersalivation, anorexia, emesis, idiopathic muscle weakness, elevated ALT

- **Enilconazole** (Clinafarm EC® a 0.2% emulsion Janssen Pharmaceuticals)…is licensed in the USA
  - Mix 55.6ml with gallon of water and apply as topical dip (sponge)
  - Is technically illegal to use, since it is EPA approved (not FDA approved)

- **Miconazole Shampoo** (Malaseb® -DVM Pharmaceuticals
  - Used alone or in combination with chlorhexidine (chlorhexidine is ineffective, however for dipping!)

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**If topical therapy is the sole therapy, clip and use lime-sulfur, not the other products**

**Note that LOCAL topical therapy with lotions and ointment is INEFFECTIVE feline dermatophytosis**
• Miconazole shampoo needs a contact time of 10 minutes

**Bleach 1:10 dilution**
- Is NOT recommended as a topical antifungal agent because it is too irritating to be used safely
- At this concentration, it represents a human health hazard because of its potent irritancy

- **Ineffective Products**
  - Capstan
  - Povidone Iodine
  - Chlorhexidine

**Systemic Therapy**
- Is treatment approach of choice
- Systemic drugs should not be used in kittens less than 8 weeks of age
- **Drugs:**
  - **Grisofulvin**
    - **MOA:** inhibits nucleic acid synthesis and cell mitosis by interfering with spindle microtubules
    - **Absorption is enhanced with fatty meal**
    - **Is a teratogen...**do NOT use in pregnant animals and in breeding male animals because it also interferes with spermatogenesis
    - **Do NOT use in cats with FIV infection** because of propensity to cause severe neutopenia in these animals
    - **Common adverse side effects are vomiting, diarrhea and anorexia** (which can be managed with dividing to twice-daily dosing)
    - **Dose: (using microsize):** 25-50 mg/kg PO SID or divided, BID
    - **Dose (using ultrasize):** 5-10 mg/kg SID or divided, BID
  - **Itraconazole**
    - **First choice systemic drug**
    - **MOA:** alters fungal wall permeability by inhibiting ergosterol synthesis. Is fungistatic at low doses, fungicidal at high doses
    - **Vomiting and diarrhea are most common side effects...**but drug is well tolerated by most cats (side effects are dose-dependent)
    - **Dose(1):** 10 mg/kg SID
    - **Dose(2):** 10 mg/kg SID for 28 days then on alternate week therapy at this dose
    - **Dose(3):** (Short term cycle therapy): 10 mg/kg SID for 15 days followed by fungal cultures 10-15 days after treatment. If the culture is positive, the cycle is repeated. These 15 day treatment cycles are effective in multi-cat situations
  - **Terbinafine** (Lamisil® Tablets, Novartis)
    - **MOA:** suppresses the biosynthesis of ergosterol by inhibiting the fungal enzyme squalene epoxide. Is fungicidal vs dermatophytes

None of these products used as sole agent are effective topical treatment for dermatophytosis; chlorhexidine is not even a decent environmental decontamination solution!
- Is well tolerated by cats; vomiting is the most common side effect
- **Dose(1):** 30-40 mg/kg once daily
- **Dose(2):** 30-40 mg/kg SID for 28 days then on alternative week therapy at this dose
- **Dose(3) (Short-term cycle therapy):** 30-40 mg/kg SID for 15 days, then fungal culture 10-15 days after last treatment
  - **Lufenuron** (Program®)
    - **MOA:** benzoylphenylurea---disrupts chitin synthesis (chitin is a critical component in the outer cell wall of fungi)
    - Various studies indicate that this drug is NOT efficacious using a variety of protocols. It is not recommended!

- **Vaccines**
  - **FelO-Vax MC-K** (fort Dodge) …availability is uncertain…is only vaccine
    - In general, fungal vaccines are NOT protective against challenging exposures and are not at all useful as sole therapy for ongoing infection
    - However, vaccination is associated with temporary reduction in clinical signs of dermatophytosis
    - When combined with appropriate topical and systemic therapy, vaccination may be a useful adjuvant therapy
    - Fungal vaccination may be a practical alternative to topical therapy when topical therapy can not be used
      - This recommendation assumes that the coat is clipped and that appropriate systemic antifungal therapy and environmental decontamination procedures are used
Monitoring Treatment and Preventing Reinfection in Cats with Dermatophytosis
Veterinary Medicine October 2003 pp887
(A summary of approach is shown in Table 2, last page)

**Most Common Causes of Treatment Failure**

- **Incorrect diagnosis**
  - Occurs when clinical signs alone are used to make the diagnosis

- **Reinfection**
  - Cats are repeatedly exposed to other (subclinically infected/carrier) cats (with positive culture results)
  - Contaminated environments
  - Resistant organisms
    - The frequency of resistance is unknown
  - Poor compliance (and often unwillingness to clip cat’s hair)
  - Incorrect drug dosages
  - Drug intolerance (consider dividing dose)

- **Concurrent Illnesses can complicate resolution**
  - Hyperthyroidism
  - Diabetes
  - CRF
  - Neoplasia
  - Chemotherapy
  - Demodecosis
  - Felv
  - FIV

Always culture to make definitive diagnosis!
Each of these causes should be investigated before making changes in antifungal therapy.
**Monitoring Therapy**

- Begin monitoring therapy 4 weeks after initiation treatment, then at two week intervals.

- **Owner should transport cat in a disinfected, covered (in a pillow case?) cat carrier** and go directly into exam room to minimize hospital contamination.

- **Wood’s lamp (if positive):**
  - If fluorescence on face, ears or muzzle is seen, then owner may have difficulty applying topical medication to these areas OR, in a multicat household, the cat is exposed to another infected cat (muzzle-to-muzzle and head rubbing are common).

- **Fungal culture:**
  - First is at four weeks, then at two week intervals
  - Use toothbrush technique
  - Hold cultures for 21 days
    - Fungal spores may grow slowly during (successful) treatment
  - If a negative culture (after 21 days incubation) is obtained, begin weekly cultures; two consecutive negative cultures are sufficient to deem treatment successful in a single-cat household. Three consecutive negative cultures in a multicat household is sufficient to deem treatment successful.
If consecutive negative cultures are obtained in a multicat household, as just described, then discontinue all therapy if the cat can be housed in a clean environment (away from the other cats); continue topical therapy if the cat is still exposed to other cats in the house who do not have 3 consecutive negative fungal cultures.

In a cattery or multicat environment, it may be desirable to culture the environment after “successful” treatment.

Environmental Controls: Introducing new cat into household

- Spores can survive in the environment for at least two years; they are easily carried in air currents and contaminated dust, through heating ducts and vents.
- The amount of contamination is directly related to the number of cats in the environment.
- If a new cat is obtained from a shelter and is positive for dermatophytosis, keep the cat in a small, easily cleaned/disinfected enclosure (e.g. a bathroom) that does not have carpeting. In a single-cat dwelling:
  - The cat should be quarantined this way until it has received systemic antifungal therapy for at least 15 days and a minimum of four whole body dips in lime-sulfur (after complete clipping).
  - The cat can then be allowed to roam, preferably in uncarpeted areas of the house.
  - Repeated vacuuming and scrubbing of the surfaces should prevent contamination of the home.
- Cat beds and blankets should be washed daily in hot water and bleach.
- Disinfect bathrooms and non-porous surfaces with bleach, 1:10 dilution.
- These routine measures should continue until the cat is mycologically “cured” (two consecutive negative fungal cultures in a single-cat dwelling, three consecutive negative fungal cultures in a multicat dwelling).
- When a new cat is introduced into a multicat household, social interactions take weeks to develop, so more than likely, the infected (new) cat will have lesions first.
  - Screening cultures of housemates will indicate how contaminated the environment is.
  - If only the new cat has a positive culture, then environmental contamination is probably low.
  - If one or more of the other cats develops a positive fungal culture the AGGRESSIVE decontamination must ensue.

Environmental Disinfectants

- Good fungicidal (for dermatophyte spores) are:
  - Lime Sulfur (1:33)
  - Enilconazole (20 µl/ml)
    - (Clinafarm SG—American Scientific Labs, Janssen Pharmaceuticals)
    - The spray or fogger should be used as recommended with respect to human exposure & precleaning the environment. The product is corrosive and potentially fatal if ingested.
  - Bleach (1:10)

Do not use chlorhexidine or Vikon S (Antec International). In one study the Lime Sulfur and Enilconazole were still effective when diluted to ¼ of recommended dilution.

Preventing Reinfection
Indoor-only cats are most likely infected when new cats are introduced into the household or exposure at a boarding or grooming facility.

A healthy outdoor cat that routinely grooms itself should be able to mechanically remove a low exposure load.

ALL NEW CATS AND DOGS should be screened for dermatophytosis

- If the pet originates from a pet store or shelter, it should be treated with topical lime-sulfur (twice weekly) until the culture results are known.

For CATTERIES

- Randomly obtain cultures from cats and the environment monthly
  - If positive results are found, then culture each cat!
- Obtain cultures from all cats returning from cat shows, breeding loans, or exchanges
  - Also, bathe these cats (preferably in miconazole shampoo with 10 minute contact time) OR rinse in water then dip them in lime-sulfur before returning them to the colony
  - If a cat has been gone for more than a few days OR if cat is long-haired, consider quarantine until culture results are known.
- All new additions should have negative culture results within the last month before being added to the cattery
  - Obtain fungal culture from these cats upon entry
  - Treat with topical antifungal solution (lime-sulfur) and isolate until fungal culture results are known.
- Follow strict cleaning and disinfecting protocols
  - Intermittent fogging with enilconazole is recommended (if permitted)
  - Visitors to cattery should wear protective clothing and should not be allowed to contact cats if there is ANY risk of exposure to mechanically –carried spores.

General outline of this gist of this chapter is shown in the table in the next page.
TABLE 2
Environmental Decontamination Recommendations for Cat Owners

Initial Disinfection Protocol
- Discard all cat rugs, blankets, collars, brushes, and fabric toys. Discard any other object that cannot be repeatedly vacuumed, scrubbed, and disinfected. Purchase a new vacuum cleaner with hose attachments that can be thoroughly cleaned. Because the vacuum cleaner will ultimately be discarded at the end of the treatment, buy a reasonably priced model.
- Remove and clean all drapes and decorations. In multicat households, and especially catteries, also remove and clean all heating duct and vent plates. Install disposable house dust filters behind the duct plates before replacing them. These can purchased at home improvement stores and will help keep spores out of the heating ducts. Commercial cleaning of heating and cooling ducts may be needed in some catteries.
- If possible, put a fan in the window so it draws air out of the room to the outside. Thoroughly vacuum all surfaces of the room. Dust all surfaces and ledges with a disposable electrostatic cloth (e.g. Swiffer—Procter & Gamble; Grab-It—S.C. Johnson & Son). These disposable cloths can be used regularly to trap spores and dust missed by the vacuuming process.
- Scrub all surfaces with a detergent that is safe to use around cats. Rinse all surfaces well; ideally, use a wet vacuum to remove the dirty water. Apply a 1:10 dilution of bleach to all nonporous surfaces or, where permitted, use emiconazole (Clinafarm EC Solution—American Scientific Laboratories, Janssen Pharmaceutica). Leave the bleach solution on for at least 10 minutes for maximal fungicidal action; see the label for contact time when using other products. Always use appropriate ventilation. And use a portable dehumidifier in cat rooms to keep humidity low, because humid environments favor spore viability.

Daily and Weekly Disinfection Measures
- Every day, vacuum all surfaces, and use disposable electrostatic dust-trapping cloths to remove dirt and spores. Depending on the number of cats in a room, wash floors and any surfaces contacted by cats with a detergent safe for use around pets.
- On a weekly basis, perform the above and apply a disinfectant to all surfaces. Disinfectants can be used daily, but they are often harsh and irritating to people and cats.

Additional Control in Catteries
Place plastic sheeting on the inside of doorways to prevent spores from escaping. Wear disposable trash bags over your clothing when treating cats and cleaning rooms. Change your shoes before and after leaving cat treatment areas. And do not run air conditioners in the room if this blows air throughout the house.