Dermatophytosis in cats and dogs: a practical guide to diagnosis and treatment

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doi: 10.1136/inp.l1539

Dermatophytosis is an infectious and contagious superficial fungal skin disease of dogs and cats. The disease is not life threatening and will resolve without intervention; however, treatment is recommended to shorten the course of infection and limit transmission. This article summarises the major learning points identified in a recent evidence-based review on this disease (Moriello and others 2017).

DERMATOPHYTOSIS is a superficial fungal disease of the skin and hair of cats and dogs. In small animals it is most commonly caused by *Microsporum canis*, *Trichophyton* species and *Microsporum gypseum*. *Trichophyton* and *Microsporum* are being reclassified into the genus *Arthroderma* and practitioners need to be aware of this as clinical articles are increasingly using the new nomenclature. However, this article will use the traditional names.

Prevalence

The true prevalence of dermatophytosis in small animals is unknown because the disease is not reportable. There are hundreds of studies reporting the prevalence of isolation of dermatophyte species from the hair coat, but few correlate the culture findings with true disease. In studies of confirmed disease, the prevalence is low in both cats and dogs, affecting fewer than 4 per cent of patients (Cornegliani and others 2009, Moriello and others 2017).

Risk factors

Although, overall, the prevalence of dermatophytosis in clinical practice is low, there are factors that increase the risk in certain animals (Moriello and others 2017). In general, the disease is more common in warm, humid environments as moisture is important in its pathogenesis. Dermatophytosis is a common disease of puppies and kittens. In the absence of exposure to a known infected animal, there is no evidence that elderly pets are at increased risk of infection.

As with all infectious and/or contagious diseases it is more common in animals under physiological stress and those kept at high density – for example, hoarding, disaster rescue facilities, some animal shelters, and some breeding facilities (Polak and others 2014). A seropositive status for feline leukaemia virus or feline immunodeficiency virus in cats has not been found to be a risk factor, nor has the use of immunosuppressive agents for the treatment of immune-mediated diseases (Moriello and others 2017).

Exposure to a contaminated environment can result in a positive culture status, but without concurrent microtrauma disease will not occur. Although nodular dermatophytosis is rare, Persian cats and Yorkshire terriers have been found to be at increased risk; working and hunting dogs are more likely to develop focal inflammatory lesions.

Pathogenesis

The common pathogens of dogs and cats are not part of the fungal flora of healthy animals (Philpot and Berry 1984, Moriello and DeBoer 1991). Isolation of one of these pathogens from an animal is associated with either clinical disease or with environmental exposure. For true disease to be established the following must occur (Duek and others 2004, Baldo and others 2012):

- The animal needs to be exposed to a critical mass of infective spores – this mass of spores must evade the host's protective mechanisms, including, but not limited to, the hair coat, grooming and the skin immune system.
- Some type of microtrauma is necessary for an infection to be established.
- If all of this occurs the infective spores (arthroconidia) adhere to the corneocytes and then start to germinate. Germ tubes penetrate the stratum corneum.
- Finally, there is invasion of keratinised structures and fungal hyphae grow in all directions and start shedding infective material within five to seven days of successful adherence.

Transmission

The primary mode of disease transmission is direct contact between infected animals. Transmission from contaminated fomites has been documented only when there was concurrent microtrauma (ie, traumatic inoculation). This could be from clippers or contaminated gloves. 'Scruffing' of cats using contaminated gloves can cause enough microtrauma to transmit the disease. A major finding in the recent evidence-based review was that true infection from exposure to a contaminated environment was rare (Moriello and others 2017).

Clinical signs

Location

The location of lesions tends to reflect the method of disease transmission. In working dogs, lesions first develop on the head and legs/paws/digits. Transmission via traumatic inoculation occurs in the areas where animals have been clipped, groomed or handled. In animals with flea infestations as the microtrauma trigger, lesion location reflects the 'flea pattern', eg, lumbosacral area or neck in cats. In cats/kittens, lesions often develop on

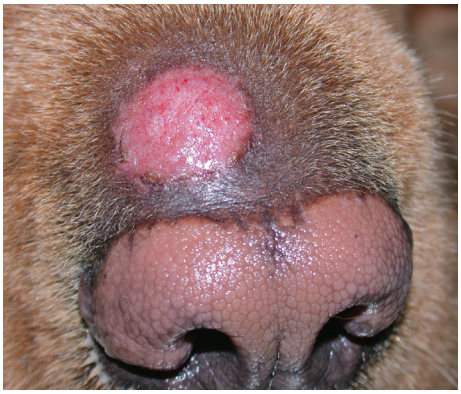

Fig 1: Nodular lesion on the nose of dog. This is an example of a 'kerion reaction'. Picture: F. Albanese

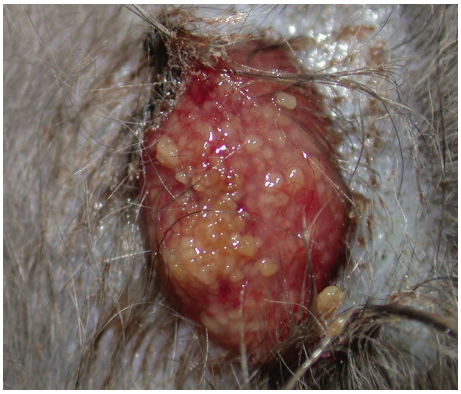

Fig 2: Non-healing wound in a cat caused by subcutaneous *Microsporum canis* infection. This is an example of a 'pseudomycetoma'. Picture: F. Albanese

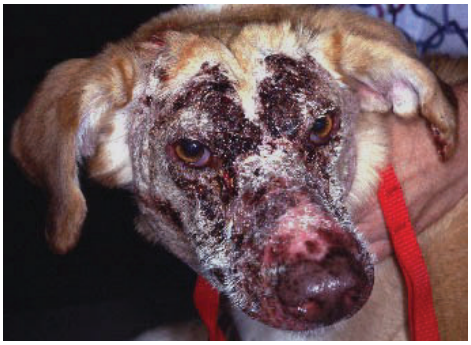

Fig 3: Diffuse well-demarcated alopecia, crusting and erythema on the face of a dog caused by *Trichophyton mentagrophytes*, resembling superficial pemphigus. Picture: C. Souza

the face, ears and muzzle and then progress to the paws and tail.

Common lesions

Lesions may be focal, multifocal or diffuse. Pruritus may vary from none to severe. In cats, pruritic lesions can resemble pyotraumatic dermatitis associated with tissue eosinophilia. Scaling, erythema and lesion induration are highly variable. Follicular plugging and hyperpigmentation are uncommon in cats and their presence should raise the suspicion of dermatophytosis. Dermatophytosis is rare in adult dogs; bacterial pyoderma is often misdiagnosed as 'ringworm'.

Uncommon presentations

Uncommon clinical presentations include inflamed nodular lesions (kerion reactions) (Figs 1, 2), symmetrical crusting suggestive of pemphigus (Fig 3), exudative paronychia and ear pruritus.

Diagnostic testing

The recent evidence review was unable to identify a 'gold standard' diagnostic test for dermatophytosis. From a practical perspective, this basically means there is no one test that can be performed without correlating it with the animal's history and clinical signs.

Diagnostics are divided into two major categories: point of care (POC) and reference laboratory (RL) testing. Complete blood counts, serum chemistry panels, urinalysis and diagnostic imaging are not helpful for confirming the presence or absence of dermatophytosis; however, these tests are helpful when evaluating a pet with a complicated infection. Only direct examination and skin biopsy confirm true infection in hairs.

Point of care – cytological examination

The only POC diagnostic test that confirms infection and

Box 1: Practice tips – how to do a direct examination of hair and scales

Equipment

- Glass microscope slides
- Coverslips
- Skin scraping spatula
- Forceps
- Mineral oil
- Wood's lamp or dermoscope (optional but helpful)

Procedure

1. Pluck hairs in the direction of growth from suspect lesions with forceps.
2. Moisten skin scraping spatula (chemistry weighing spatula) with mineral oil.
3. Perform superficial skin scraping of lesion margin to loosen scales and hairs.
4. Collect material and mount in mineral oil on a glass slide and cover with a coverslip.
5. If *Microsporum canis* is suspected, darken the room and hold the Wood's lamp over the slide (at a distance of 2 to 4 cm) to look for fluorescing hairs on the slide.
6. Examine slide at 4x magnification (move condenser down to increase contrast) and 10x to find suspect hairs. If unsure, examine at 40x.

Helpful hints

1. All cytological identification techniques require some training and practice.
2. Review picture guides of positive direct examinations if you are unfamiliar with what you should look for (see Further reading for sources or use online image banks).
3. Infected hair shafts are easily visible at 4x and 10x magnification. These hair shafts are paler and wider in comparison to normal hairs and normal detail is missing (Fig 4).
4. *M canis*-infected hairs will glow if specimens are mounted in mineral oil. Turn the lights off in the laboratory and hold a Wood's lamp so the light shines on the slide. Look through the microscope eyepieces and faint fluorescence can be seen; reposition slide for viewing.
5. Keep positive slides for review/training (seal the edges with clear nail polish).

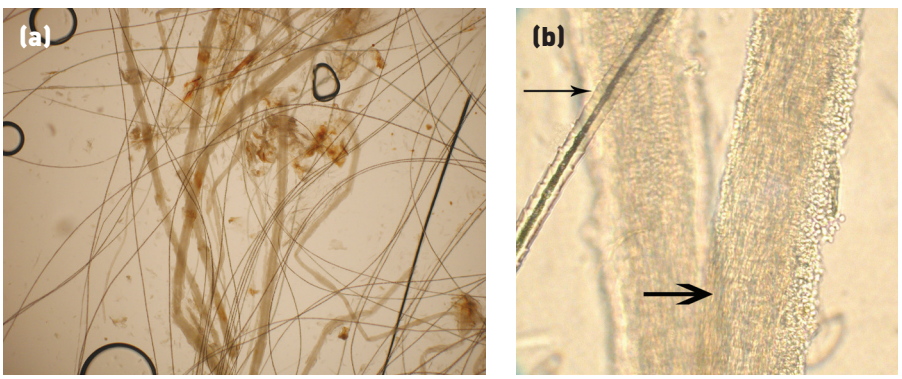

Fig 4: Direct examination of hairs at (a) 4x and (b) 40x magnification. Note that infected hairs are easily visible at 4x. Infected hairs are pale and wider. At 40x magnification, normal hairs have very clear internal structures (thin arrow) while infected hairs are wider, paler and more refractile (thick arrow)

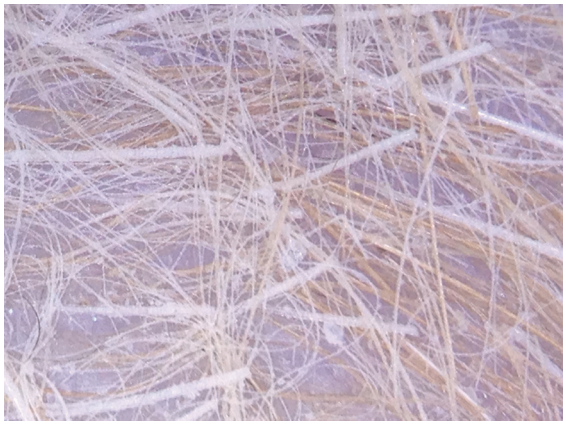

Fig 5: Infected hairs as seen via a dermoscope. The infected hairs are broad, thick and opaque. Picture: F. Scarampella

allows for treatment to be started pending species identification via fungal culture, is direct examination of hair and scales (Box 1). Finding infected hairs documents true infection. There are four techniques that can be used to find evidence of infected hairs and/or scales.

Dermoscopy

A dermoscope is a hand-held noninvasive tool that allows for magnification and illumination of the surface of the skin. Its primary use is to find abnormal hairs for direct examination and/or culture. Infected hairs are opaque, slightly curved or broken and have a homogenous thickness (Fig 5) (Scarampella and others 2015, 2017).

Wood's lamp

Contrary to common belief, Wood's lamp examination is likely to be positive in most cases of *M canis* infection (Box 2). Fluorescing hairs are most common in untreated infections (91 to 100 per cent of cases) (Moriello and others 2017). Not unexpectedly, hairs may be more difficult to find in animals that have been treated. Statements such as 'less than 50 per cent of strains fluoresce' all stem from retrospective studies of random source diagnostic tests and not from studies on spontaneous disease, experimental infection or using trained observers (Kaplan and others 1958, Wright 1989, Sparkes and others 1993, Cafarchia and others 2004).

Scraping and plucking of hairs

The best way to collect specimens for direct examination is to scrape the margin of a suspect lesion AND pluck hairs in the direction of growth. A Wood's lamp and/or dermoscope can be used to collect specimens. When skin scraping and hair plucking samples were combined, infection was confirmed in 83.7 per cent of dogs and 89.5 per cent of cats (Colombo and others 2010).

Skin cytology

Macroconidia are never seen on cytological examination of skin cytology. However, *M canis* arthrospores may be observed in animals with severe infections. This requires a high degree of confidence in cytological examination of specimens. These specimens are usually from exudative lesions (Fig 8).

Point of care – fungal culture

Fungal culture can be a POC or RL diagnostic test. If a dermatophyte infection is confirmed via cytological examination, fungal culture is used to identify the fungal species. When disease is suspected but not confirmed via cytological examination, a fungal culture or PCR test (see below) is indicated.

A recent study found good correlation between POC and RL fungal cultures for confirming the identity of fungal species. Provided that individuals performing POC testing were trained, used both gross and microscopic identification characteristics and fungal culture plates were stored and used as directed (Kaufmann and others 2016). If proper protocols were not adhered to, the false negative and false positive error risk was 20 per cent. It is now known that fungal cultures can be confirmed as negative if there is no growth at day 14 of culture (Stuntebeck and others 2018). In my opinion, POC fungal culturing should only be performed if it is done regularly by dedicated staff (Box 3).

Box 2: Practice tips – using a Wood's lamp

Equipment

- Plug in medical grade Wood's lamp with UV spectrum 320 to 400 nm wavelength
- Glass microscope slides and coverslips
- Mineral oil
- Forceps and/or skin scraping spatula

Procedure

1. The lamp does not need to warm up, but your eyes need light to adapt to darkness.
2. IMPORTANT – hold the lamp CLOSE to the hair coat (2 to 4 cm); this minimises false fluorescence.
3. Start at the head and SLOWLY examine the face, muzzle, ear, etc.
4. Lift crusts and look underneath for green fluorescing on hair shafts (Fig 6).

Helpful hints

1. Keep a 'positive control' slide for training, reviewing and for determining if your eyes have light adapted. This is easily made by pressing clear acetate tape to an area with fluorescing hairs, pressing it to a dry, clean glass microscope slide and sealing the edges with clear nail polish. Hairs will retain fluorescence for more than 10 years.
2. Do not use battery-operated Wood's lamps; this results in false negatives.
3. Use a Wood's lamp with built-in magnification (Fig 7) as this allows you to hold the lamp close to the hair/skin for examination with the added benefit of magnification.
4. Only hair shafts fluoresce, not scales or crusts. Lift crusts to find hairs.
5. Dust on the hair coat will appear as blue-white.
6. Sebum will fluoresce a yellow-green and this is most common in areas of high sebum concentration such as near the ears, chin, etc.
7. Newly infected hairs are often very short; these can be collected by superficial skin scraping into mineral oil.
8. If concerned about false fluorescence, pluck hair and examine the hair shaft (see Box 1).

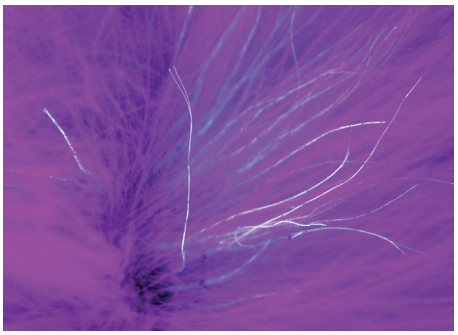

Fig 6: Fluorescing hair shafts. Picture: F. Albanese

Fig 7: Plug in Wood's lamp with built-in magnification

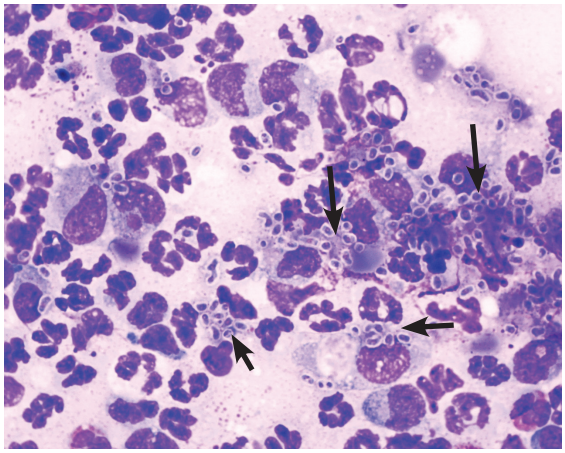

Fig 8: Cytological specimen showing *Microsporum canis* arthroconidia (arrows) from an exudative lesion. Note the 'clear space' around the organism. Picture: F. Albanese

Reference laboratory – diagnostic PCR

The availability of commercial diagnostic PCR testing for dermatophytes is increasing. The major advantage over fungal culture is the rapid turnaround time of days rather than weeks.

There are several important things to remember about PCR testing. The first is to use a RL that has established laboratory protocols for PCR testing of specimens from animals. The second is that PCR is very sensitive and will detect both viable and non-viable DNA. It has the same weaknesses as toothbrush fungal cultures in that sample acquisition is critical and, like toothbrush fungal cultures, it cannot distinguish between fomite carriage and true disease.

Negative test results in truly infected animals are uncommon but inadequate specimen submission can lead to false negatives. If PCR is the diagnostic test of choice, it is important to sample only the target lesion (do not comb the hair coat!) ensuring hairs and hair bulbs are collected. Alternatively, scrape or avulse crusts and submit them for examination.

In one field study, the qPCR assay for *Microsporum* species was more useful for initial disease confirmation while the qPCR *M canis* assay was more useful for determining mycological cure (Moriello and Leutenegger 2018). When using this test to monitor for mycological cure, it may be helpful to bathe and dry the hair coat before sampling to minimise the chances of a positive PCR test from detection of non-viable DNA. The use of cycle thresholds was found not to be helpful for diagnosis or for determining mycological cure (Jacobson and others 2018).

Reference laboratory – skin biopsy

Histological examination of skin biopsy specimens is helpful in two clinical situations. The first is when the disease is manifesting in an unusual set of clinical signs. In both dogs and cats, pustular dermatophytosis can resemble pemphigus. The second is when an animal has a non-healing wound or nodule (eg, kerion reaction). Long-haired cats are at risk of developing subcutaneous nodules of dermatophytosis. Usually these cats have a history of having or having had *M canis* dermatophytosis.

When taking a skin biopsy, take a sample of at least 6 to 8 mm, or an excisional biopsy of a mass, to ensure the pathologist

Box 3: Practice tips – performing dermatophyte culture*

Equipment

- Fungal culture plate with a surface area that will allow for toothbrush inoculation of cultures and counting of colony-forming units (cfu) – standard petri dishes (≥90 mm) or dual compartment plates are recommended.

Procedure

1. Inoculate plates by stabbing the toothbrush bristles on to the surface in four or five areas. A 'stab' pattern should be visible.
2. Incubate the plates at 25°C to 30°C, storing them medium side up in individual plastic bags to prevent dehydration.

Fig 9: *Microsporum canis* growth on Dermatophyte Test Medium. It is important to remember that pathogens are pale and never heavily pigmented. A colour change occurs around pathogens as they grow due to a change in the pH of the medium. The colour change is not diagnostic of a pathogen but simply helps identify fungal colonies for microscopic examination

3. Monitor daily and record growth (Fig 9) once weekly. Record:
   - Contaminant growth
   - Heavy contamination (if the plate is overgrown it is worth considering re-culturing)
   - Suspect growth
   - *Microsporum* or *Trichophyton* (identified by microscopic examination)
4. When a pathogen is identified, count the number of colonies on the plate. The following semiquantitative system will reflect the severity of the growth, similar to what is done for cytology or bacterial cultures:
   - Pathogen score 1 (P1): 1–4 cfu/plate
   - Pathogen score 2 (P2): 5–9 cfu/plate
   - Pathogen score 3 (P3): >10 cfu/plate

Helpful hints

1. Do not over-inoculate plates as this will result in competition for growth, delaying the development of characteristic macro- and microconidia. Competition for growth is characterised by rapid growth and unsporulated hyphae on microscopic examination.
2. Untreated pets with active infections tend to have a starting score of P3. Early in treatment, P3 cultures commonly show confluent growth. As treatment progresses and the infection is eradicated in the hair follicle and the hair coat is disinfected, the density of growth will decrease as will the number of cfu/plate (and the corresponding pathogen score). This is a strong and consistent indicator of a positive response to treatment. Cured animals will have no growth, contaminant growth or P1 scores.
3. Cultures fluctuating from negative growth (no growth or contaminant growth) and P1 is a common pattern in animals exposed to fomite contamination.
4. A sudden increase in P score (ie, P1 or P0 to P3) is commonly caused by:
   - Inadequate disinfection of the hair coat, particularly around the face and ears; this is commonly seen in pets that have not been adequately treated due to concerns about applying topical treatments
   - Development of new lesions, commonly on the face and ears
   - Fomite exposure
5. Persistent P2/P3 scores when clinical cure is apparent may be due to:
   - Lack of disinfection of the hair coat
   - Subclinical infection, most commonly on the face and/or ears
   - Fomite carriage on the hair coat from contact with an inadequately cleaned environment
8. Persistent P2/P3 scores in the presence of persistent lesions may be due to:
   - Too short a period of treatment (continue treatment)
   - Concurrent systemic illness
   - Treatment compliance problems

* Adapted from Moriello and DeBoer (2013)

Box 4: Information to include on a client handout on cleaning and disinfection

Key points

1. Spores do not multiply in the environment.
2. Spores do not invade home structures like mildew or 'black mould'.
3. Spores are easily removed via routine cleaning.
4. Spores are very susceptible to moisture; they die quickly.
5. Spores are 'dormant' natural structures, they do not 'live'.
6. Infection from the environment is rare and difficult.
7. The purpose of cleaning is to minimise fomite carriage on the hair coat which can prolong treatment because it interferes with accurate determination of mycological cure.
8. Environmental sampling is not cost effective and not recommended unless there is concern about fomite contamination.

Cleaning mantras

- 'If you can wash it, you can decontaminate it.'
- 'Clean as if company is coming.'

Cleaning specifics

1. Laundry: wash twice in the washer in hot or cold water, bleach is not necessary.
2. Rugs: keep pets off rugs and/or vacuum daily. Can be disinfected using 'steam cleaning' or washing twice with a beater brush carpet scrubber.
3. Keep pets in easily cleaned rooms, but DO NOT OVER CONFINE. Close closets and drawers, and remove knick-knacks. Remove debris and pet hair daily. Mop floors two or three times each week.
4. Disinfectants do not take the place of mechanical cleaning and washing; spores are like dust and are easily removed via mechanical cleaning.
5. Mechanical cleaning: remove debris, wash with a detergent cleaner, rinse, remove excess water. This alone can decontaminate surfaces.
6. Disinfectants are needed for spores not removed by cleaning. For safety, only use ready-to-use commercial disinfectants labelled as efficacious against *Trichophyton* species. Thoroughly wet target non-porous surfaces, let dry.
7. Clean transport cages.

has adequate tissue. Fixation causes specimens to shrink by 30 to 50 per cent (Reimer and others 2005). It is important to tell the pathology laboratory that dermatophytosis is suspected because routine stains (ie, haematoxylin and eosin) are not as sensitive as periodic acid-Schiff or Gomori's methenamine silver for detecting fungal elements in tissue.

In addition, tissue (6 mm punch or wedge) should be submitted to a RL for fungal culture.

Treatment

Clinical signs, global health and planning of treatment

The overall global health of a dog or cat determines the severity of clinical signs and the treatment plan and this will determine the length of treatment. There is no evidence to suggest that some strains of dermatophytes are inherently more 'virulent'. Based on clinical experience in shelters with infected dogs and cats, I have recognised three clinical presentations of practical value:

- Simple infections;
- Complicated infections;
- Culture-positive, lesion-free animals.

Simple infections occur in otherwise healthy animals and these animals respond rapidly to treatment. Complicated infections may or may not be severe and diffuse but are those that occur in an animal with concurrent illness or any factor that makes treatment a challenge, including, but not limited to: previous treatment, poor body condition, concurrent illnesses, long hair, bathing challenges or poor client compliance.

Minimising disease transmission and environmental contamination

Clipping the hair coat

Clipping the hair coat is not necessary in every case of dermatophytosis. In most cases, extensive clipping requires sedation to minimise patient injury and fear. It is important to remember that electric clippers can become hot and thermal contact injuries are common and often not obvious for days to weeks following clipping. Clipping of the hair coat can also spread the infection to other uninfected sites. The following is recommended:

- Only use children's blunt-tipped metal scissors;
- Clip mats from the hair coat to facilitate bathing and topical therapy;
- Scissor clip margins of focal lesions if this can be done safely and easily;
- DO comb the hair coat before using topical therapy to remove broken and shed hairs.

Confinement

The main reason for confining an infected pet is to decrease the area that requires cleaning during the treatment period when contaminated hairs are likely to be shed. Cleaning is necessary to prevent positive fungal culture or PCR test results due to fomite contamination. However, the primary mode of transmission is via direct contact, not from the environment.

Confinement needs to be considered with care and for the shortest time possible. This disease is treatable and curable, but behaviour problems and socialisation problems can be lifelong if young or newly adopted animals are not properly socialised. Veterinarians need to consider animal welfare and quality of life when making this recommendation.

Cleaning

Evidence-based studies have shown that it is easy to decontaminate exposed environments. My mantra is 'If you can wash it, you can decontaminate it' (Box 4). The key to decontamination is mechanical removal of debris, washing of the surface with a detergent until visibly clean, rinsing to remove detergent residue, and removal of excess water. I have consistently decontaminated objects via simple washing alone. A recent study of 70 homes found that decontamination was easily done with routine cleaning measures (Moriello 2019). The purpose of any subsequent disinfectant step is to kill any infective agent not mechanically removed by washing. My disinfectant of choice is any over-the-counter bathroom disinfectant that is labelled as efficacious against *Trichophyton* species. Using an over-the-counter, ready-to-use product minimises dilution errors and irritant reactions.

Whole body topical antifungal treatments

Topical therapy is the most important way of minimising disease transmission and environmental contamination. Infection is transmitted via contact with infective materials on the hair coat making it critical to disinfect the hair coat. In addition, in a recent study, proper cleaning combined with topical therapy resulted in homes being free of infective material within one week of starting treatment and remaining so throughout the study (Nardoni and others 2017).

Fig 10: Wood's lamp positive hairs in a kitten with *Microsporum canis* dermatophytosis. This kitten was 'failing to cure' but once otic antifungals were used, cured rapidly

Topical antifungal therapy is discussed in more detail below.

Eradication of infection

Dermatophytosis is a self-limiting disease in otherwise healthy animals. Treatment of infected animals helps shorten the course of the disease as a whole.

Topical antifungal treatments

Topical antifungal therapy is equally as important as systemic therapy in the treatment of dermatophytosis. Topical therapy eradicates infective spores from the hair shafts. This is important because infective material will remain on the hair shaft long after the infection has been eradicated from within the hair follicle. Lack of proper disinfection of the hair coat is the most common reason encountered in second opinion cases of 'failure to cure' or 'resistant ringworm'.

Topical therapy involves twice-weekly whole body treatment from the time of diagnosis until mycological cure. Lime sulphur and enilconazole are preferred as these products have residual activity; however, miconazole/ketoconazole/climbazole-chlorhexidine shampoos are alternatives (Moriello and others 2017). These shampoo-based products can be used to treat exposed but uninfected family pets.

In addition, it is now recommended that focal lesions in difficult-to-treat locations such as the face and ears should receive additional specific topical therapy. Lesions on the face and periocular area can be treated safely with 2 per cent miconazole cream (Gyanfosu and others 2018). This cream is used to treat fungal keratitis. Lesions in and around the ears can be treated with otic cleansers that contain miconazole, ketoconazole or clotrimazole (Fig 10).

Systemic antifungal treatments

Systemic antifungal therapy eradicates the infection within the hair follicle. The treatment of choice for cats is orally administered itraconazole 5 mg/kg once daily using a week on/week off pulse schedule for three cycles. Cats with complicated infections or cats that have not reached mycological cure need as many repeat cycles as necessary until cured. For dogs, I currently recommend itraconazole 5 mg/kg orally once daily or terbinafine 30 to 40 mg/kg orally once daily until mycological cure. Compounded or reformulated itraconazole should not be used as studies in both dogs and cats have shown poor bioavailability (Mawby and others 2014, 2018).

Regarding safety, the evidence-based review of clinical trials and treatment studies using itraconazole or terbinafine in dogs or cats found the drugs to be safe and well tolerated (Moriello and others 2017). No deaths were reported or serious adverse effects. Vomiting or soft stools were the most commonly reported side effects. Serious adverse effects of itraconazole administration were not associated with its use to treat dermatophytosis. Animals experiencing vasculitis or other serious side effects were treated for long periods of time (months) with high doses (>10 mg/kg) for intermediate or deep mycoses.

Table 1: Use of lesions, Wood's lamp, and colony forming units (cfu) to monitor response to treatment (Moriello and others 2017)*

Pathogen score	Clinical examination	Wood's lamp examination of		Interpretation	Plan	Comments
		Hair shafts	Hair tips			
P3 (>10 cfu/plate)	Lesional/non-lesional	Positive/negative	Positive/negative	High risk/not cured	Treat or continue treatment	A single infected hair can produce a P3 culture; examine carefully
P2 (5-9 cfu/plate)	Lesional	Positive/negative	Positive/negative	High risk/not cured	Treat or continue treatment	
	Non-lesional	Positive	Positive/negative	High risk/not cured	Treat or continue treatment	
	Non-lesional	Negative	Positive/negative	Low risk/cured	Reexamine, apply whole body antifungal treatment then repeat culture when dry	Likely represents a 'dust mop' scenario†
P1 (1-4 cfu/plate	Lesional	Positive/negative	Positive/negative	High risk/not cured	Treat or continue treatment	
	Non-lesional	Positive	Positive/negative	High risk/not cured	Treat or continue treatment	
	Non-lesional	Negative	Positive/negative (glowing tips are common in cured animals)	Low risk/cured	Reexamine, apply whole body antifungal treatment then repeat culture when dry	If a 'dust mop' cat, a repeat culture will be negative

*Adapted from the treatment and monitoring procedures used in the 'Felines in treatment' programme at Dane County Humane Society, Madison, Wisconsin, USA
†'Dust mop' refers to a cat that is mechanically carrying spores from environmental contamination
cfu Colony-forming unit

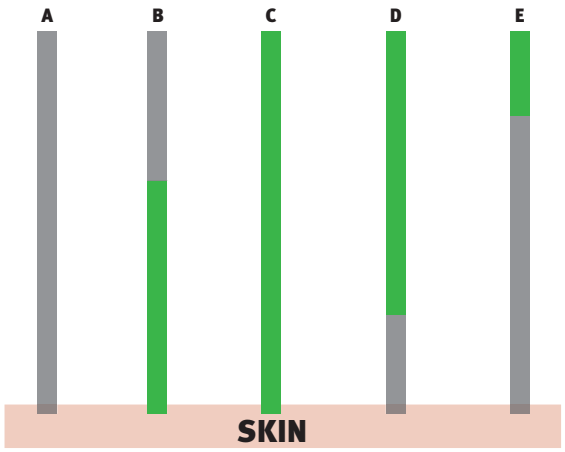

Fig 11: Schematic of Wood's lamp-positive hairs. (A) Uninfected hairs show no hair shaft fluorescence. (B) Early infected hairs show fluorescence in the proximal part of the hair. (C) As the infection progresses the entire hair shaft will fluoresce. (D) When the infection has been eradicated in the hair follicle, the proximal portion of the hair shaft will no longer fluoresce. This is an indication of a good response to treatment. (E) Cured cats will often have some residual 'glowing tips' because the pigment is retained in the medulla or cortex.

Griseofulvin was the first oral antifungal but it is not now recommended because of the superior efficacy of terbinafine and itraconazole. Fluconazole should not be used as it has poor efficacy against dermatophytosis. Ketoconazole is effective in dogs but its use should be avoided in cats due to intolerance. Lufenuron has no efficacy against dermatophytosis.

Treatment of nodular dermatophytosis

In dogs, the most common nodular reaction is a focal area of granulomatous inflammation (ie, kerion reaction). These lesions cure rapidly with or without treatment (Cornegliani and others 2009). Nodular subcutaneous lesions are more difficult to treat and the prognosis is often guarded. These lesions have been most successfully treated with wide surgical excision. Histological confirmation and fungal speciation is important to help determine the best course of treatment. Terbinafine and itraconazole used concurrently are synergistic in deep fungal infections and may be lifesaving in these cases (Mukherjee and others 2005).

Monitoring and cure

Clinical cure will precede mycological cure. A lack of resolution of clinical signs and/or development of new lesions indicates a treatment problem or misdiagnosis. Wood's lamp examinations can be used to monitor cats for resolution of *M canis* infections (Table 1 and Fig 11).

In most animals systemic antifungal treatment is needed for four to eight weeks (ie, until clinical resolution of lesions). Topical antifungal therapy should be continued until mycological cure. There is no scientifically established definition of mycological cure but a negative PCR test is compatible with mycological cure. For *M canis* infections, a negative fungal culture and a negative Wood's lamp examination (except for glowing tips) are compatible with mycological cure.

Public health considerations

Dermatophytosis is a zoonosis and veterinarians have a responsibility to inform clients of this risk. Key aspects to communicate to clients are listed in Box 5.

Box 5: Information to include in a client handout on the zoonotic aspects of dermatophytosis

- Dermatophytosis is a low-level zoonotic disease meaning it is treatable, curable and not life threatening.
- Dermatophytosis is one of many animal-associated zoonotic skin diseases; other common examples include *Sarcoptes*, *Cheyletiella* and fleas.
- Dermatophytosis is a common skin disease in people, most commonly it is referred to as 'toe nail fungus' or 'athlete's foot fungus'.
- It's the same disease in animals, just different pathogens.
- Transmission from animals to people is via direct contact with lesions.
- Topical antifungal therapy, especially enilconazole or lime sulphur helps prevent transmission.
- In animals, dermatophytosis is treatable and curable and euthanasia is not necessary.
- The most common complication of animal-associated infections in people is a prolonged treatment time.

Conclusion

Although dermatophytosis in dogs and cats will resolve without any therapeutic intervention, accurate diagnosis and the institution of appropriate treatment and environmental decontamination will shorten the duration of infection. This will benefit the welfare of the affected animal itself and also reduce the risk of transmission to other animals and to its owners.

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Further reading

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Self-assessment quizzes

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Self assessment: Dermatophytosis in cats and dogs: a practical guide to diagnosis and treatment

1. Which of the following diagnostic tests conclusively confirms a dermatophyte infection in hair?
   a. Wood's lamp examination
   b. Histopathology
   c. Direct examination
   d. Fungal culture
   e. Histopathology and direct examination

2. When is the earliest time you can finalise a 'no growth' Dermatophyte Test Medium fungal culture plate?
   a. After seven days
   b. After 10 days
   c. After 14 days
   d. After 21 days
   e. After 30 days

3. Current research has shown that Wood's lamp examinations are most likely to be positive (>90 per cent) in . . .
   a. Dogs with *Trichophyton* infections
   b. Untreated animals with *Microsporum canis* infections
   c. Dogs or cats with *Microsporum gypseum* infections
   d. Persian cats with chronic dermatophytosis
   e. Kerion and pseudomycetoma infections

4. Which of the following systemic antifungal treatments should not be used to treat dermatophytosis?
   a. Terbinafine
   b. Itraconazole
   c. Compounded itraconazole
   d. Lufenuron
   e. Compounded itraconazole and lufenuron

5. Which of the following statements is true?
   a. Contrary to earlier statements in the literature, Wood's lamp examinations are very likely to be positive in untreated animals
   b. Infections from the environment are uncommon in the absence of concurrent microtrauma
   c. Topical therapy and systemic therapy are equally important in eradicating a dermatophyte infection
   d. The primary purpose of environmental cleaning is to prevent fomite contamination and problems determining mycological cure
   e. All of the above are true

Answers: (1) e, (2) c, (3) b, (4) e, (5) e