

# GUIDELINE for Dermatophytosis, ringworm in cats

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## Key points

- Dermatophytosis, caused usually by *Microsporum (M.) canis*, is the most common fungal infection in cats and one of the most important infectious skin diseases in this species.
- *M. canis* produces arthrospores that may remain infective for about a year and are easily transmitted by direct contact or by fomites to cats, other animal species and humans.
- Many cats are infected subclinically or are fomite carriers of the arthrospores.
- Dermatophytosis may be endemic in groups of cats, especially in a poor environment, and its eradication is difficult in such cases.
- Circular alopecia, desquamation and sometimes an erythematous margin around central healing (“ringworm”) are typical lesions of this chronic skin disease.
- In many cats the disease is self-limiting, with only hair loss and scaling. In young animals and immunosuppressed adults, the outcome may be a multifocal or generalised skin disease.
- The gold standard method for the detection of dermatophytes is culture on Sabouraud agar. Wood’s lamp examination and microscopic detection of arthrospores are very good for initial screening.
- Topical treatment may be effective only in single-housed cats with mild, localized lesions. For eradication in cat groups, systemic and topical therapy must be combined and maintained for several weeks, and intensive decontamination of the environment is crucial in such cases.
- For systemic therapy itraconazole or terbinafine are the drugs of choice.
- Recommended topical treatment is twice weekly body rinses with an enilconazole solution, or miconazole with chlorhexidine.
- Safe and efficient vaccines for cats against this fungal infection are unavailable; the ABCD does not recommend vaccination.

## Agent properties

In contrast to single-celled yeasts, dermatophytes (literally: “skin plants”) are complex fungi growing as hyphae and forming a mycelium. Almost 40 species belonging to the genera *Microsporum*, *Trichophyton* and *Epidermophyton* are considered as dermatophytes. Over 90% of feline dermatophytosis cases worldwide are caused by *Microsporum (M.) canis* (Moriello and DeBoer, 2012). Others are caused by *M. gypseum*, *T. mentagrophytes*, *T. quinckeanum*, *T. verrucosum* or other agents. With the exception of *M. gypseum*, all of these fungi produce proteolytic and keratolytic enzymes that enable them to utilise keratin as the sole source of

nutrition after colonisation of the dead, keratinised portion of epidermal tissue (mostly *stratum corneum* and hairs, sometimes nails).

Dermatophytes produce arthrospores, which are highly resistant, surviving in a dry environment for 12 months or more (Sparkes et al., 1994b). In a humid environment, however, arthrospores are short-lived. High temperatures (100°C) destroy them quickly. Arthrospores adhere very strongly to keratin.

Depending on the source of infection and reservoirs, dermatophyte species are classified into zoophilic, sylvatic, geophilic and anthropophilic fungi.

## Epidemiology

### Prevalence

Though data on prevalence of dermatophytosis are limited, this condition is believed to be worldwide the most common fungal infection of cats and one of the most important infectious skin diseases in this species (Moriello et al., 2017).

*M. canis* is a typical zoophilic dermatophyte. It was generally thought that subclinical infections were very common in cats, especially in longhaired animals over 2 years of age. However, in many groups, the prevalence is relatively low. Therefore, *M. canis* should not be considered part of the normal fungal flora of cats and its isolation from a healthy animal indicates either subclinical infection or fomite carriage (Moriello and DeBoer, 2012).

### Predisposing factors

Whether an infection will lead to clinical disease depends on many factors.

Predisposing factors to dermatophyte disease in cats include: young age (first 2 years of life), immunosuppression (including immunosuppressive treatment), other diseases, nutritional deficiencies (especially proteins and vitamin A), high temperature and high humidity (Moriello and DeBoer, 2012). Very important for facilitation of infection is any kind of skin trauma resulting from increased moisture, injury by ectoparasites or scratches due to pruritus, playing or aggressive behaviour, clipping etc. In general, poor hygiene is a predisposing factor. In overcrowded feline groups, social stress may play an important role. Together with the environmental resistance of fungal spores, this can make eradication of ringworm very difficult in catteries or shelters infected with *M. canis*.

The potential immunosuppressive effect of feline immunodeficiency virus (FIV) and feline leukaemia virus (FeLV) on the prevalence of fungal infection has been investigated. The higher prevalence of *M. canis* in FIV-infected animals compared with non-infected cats reported in one survey (Mancianti et al., 1992) was not observed by another group (Sierra et al., 2000). It has been suggested that any association with FIV may be related to differences in the environment rather than to the retroviral status of the cats (Mignon and Losson, 1997). In a consensus statement, it was concluded that seropositive FIV and/or FeLV status alone does not increase the risk of dermatophytosis (Moriello et al., 2017).

### Transmission

Arthrospores are transmitted mainly through direct contact with sick or subclinically infected cats, but also dogs or other species (Moriello, 2014). In addition, uninfected cats can passively transport arthrospores on their hair, thereby acting as fomites. In sick animals, the infected hair shafts are fragile and hair fragments containing arthrospores are very efficient in spreading infection.

Risk factors include: introducing new animals into a cattery, cat shows, catteries, shelters, mating etc. Arthrospores are easily spread on dust particles, also to rooms without access for cats. Therefore, indirect contact should be considered too (via contaminated collars, brushes, toys, environments etc.), though this is seldom documented (Moriello, 2014).

*Microsporum canis* may be transmitted to other animal species and is also a zoonosis.

Outdoor cats, especially in rural areas, can be exposed to *M. gypseum*, a geophilic fungus living in soil, by digging. Cats may be infected with *T. mentagrophytes* or *T. quinckeanum* through contact with small rodents, and with *T. verrucosum* through contact with cattle.

## Pathogenesis

Healthy skin acts as an effective barrier against fungal invasion. The increased rate of regeneration of epidermal cells in response to the dermatophyte with the consequent removal of fungus from the skin surface is another protective mechanism. As dermatophytes cannot penetrate healthy skin, many cats are merely passive carriers of the arthrospores or remain subclinically infected.

The incubation period of ringworm caused by *M. canis* is 1 to 3 weeks. During this time, hyphae grow along the hair shafts through the *stratum corneum* to the follicles where they produce spores that form a thick layer around the hair shafts. As dermatophytes are susceptible to high temperatures, they cannot colonise deeper parts of the skin or the follicle itself. Therefore, the hair grows normally

but breaks easily near the skin surface resulting in hair loss. Several metabolic products of the fungus may induce an inflammatory response in the skin and may be observed mainly around the infected area, forming sometimes ring-like lesions with central areas of healing and papules on the periphery ("ringworm").

In many immunocompetent cats living in hygienic conditions these lesions are limited (e.g. to the head) and disappear after several weeks. In immunosuppressed animals, the outcome may be a multifocal or generalised skin disease with secondary bacterial infections. On rare occasions, a marked inflammatory reaction to hyphae induces a nodular granulomatous reaction involving dermis and draining on the skin surface. These so-called pseudomycetomas are more often seen in Persian cats, sometimes concurrently with classical lesions.

The pathogenesis of other dermatophyte infections is similar to that described above.

## Immunity

Naturally occurring ringworm is rarely recurrent, suggesting an effective and long-lasting immunity. Experimental studies confirm that animals express increased resistance to subsequent challenge by the homologous fungus (Moriello and DeBoer, 2012). Re-infections may occur, but require a much greater number of spores, and usually these subsequent infections are cleared more rapidly (Moriello and DeBoer, 2012). It has been suggested that for the development of full immunity, the infection must run its entire natural course, as in cats whose infection was aborted with antifungal treatment, the delayed type hypersensitivity reactions were often weaker (Moriello et al., 2003).

Although dermatophyte infection is confined to the superficial keratinised tissues, humoral and cellular immune responses are induced. Prominent activation of T helper type 2 (Th2) cells, and the corresponding cytokine profile, lead to antibody formation followed by chronic disease, whereas activation of Th1 cells stimulates a cell-mediated response characterised by interferon- $\gamma$ , interleukins 12 and 2, and leads to recovery (Sparkes et al., 1995; Moriello and DeBoer, 2012). Such cats are protected against re-infection (Sparkes et al., 1993a). The role of the humoral response in dermatophytosis is unclear, although antibodies could have a fungistatic effect by means of opsonisation and complement activation (Sparkes et al., 1994a).

## Clinical signs

In many cats, dermatophytes cause a mild, self-limiting infection with hair loss and scaling.

The typical presentation of ringworm in cats is regular and circular alopecia, with hair breakage, desquamation and sometimes an erythematous margin and central healing (Chermette et al., 2008; Moriello and DeBoer, 2012). The lesions are sometimes very small, but occasionally may have a diameter of 4-6 cm. Affected areas may be single or multiple and are localised mostly on the head (Fig. 1), but also on any part of the body, including the distal parts of the legs and the tail. Young cats, in particular, display lesions localised at first to the bridge of the nose and then extending to the temples, the external side of the pinnae and auricular margins (Fig. 2). Multiple lesions may coalesce. Pruritus is variable, generally mild to moderate and usually no fever or loss of appetite is observed (Chermette et al., 2008; Moriello and DeBoer, 2012).



*Fig. 1. Dermatophytosis lesions start on the head in many cases. Courtesy of International Cat Care (formerly Feline Advisory Bureau)*



*Fig. 2. Lesions on the nose; courtesy Andy Sparkes, Animal Health Trust (AHT)*

In some cats, dermatophytosis can present as a papulo-crustous dermatitis (“miliary dermatitis”) affecting mainly the dorsal trunk.

In immunosuppressed cats, extensive lesions with secondary bacterial involvement are sometimes associated with chronic ringworm. Such patients demonstrate atypical, large alopecic areas, erythema, pruritus, exudation and crusts (Fig. 3). At this stage, dermatophytosis may mimic other dermatological conditions. Typical signs may be still visible at the margins of the lesions.



*Fig. 3. Particularly in immunocompromised cats, dermatophytosis may be multifocal and even generalised. Courtesy of International Cat Care (formerly Feline Advisory Bureau)*

A rare outcome is onychia and perionyxis, and exceptionally nodular granulomatous dermatitis (pseudomycetoma) with single or multiple cutaneous nodules, firm and not painful at palpation (Nuttall et al., 2008). Fistulisation of these nodules is possible. Pseudomycetoma occurring as an abdominal mass may be a rare complication of laparotomy in animals with cutaneous dermatophytosis (Black et al., 2001; Bianchi et al., 2017).

## Diagnosis

As dermatophytes can produce lesions similar to many feline skin diseases, they should be considered in all cats with any cutaneous disease. If possible, dermatophyte diagnosis should be undertaken before any treatment.

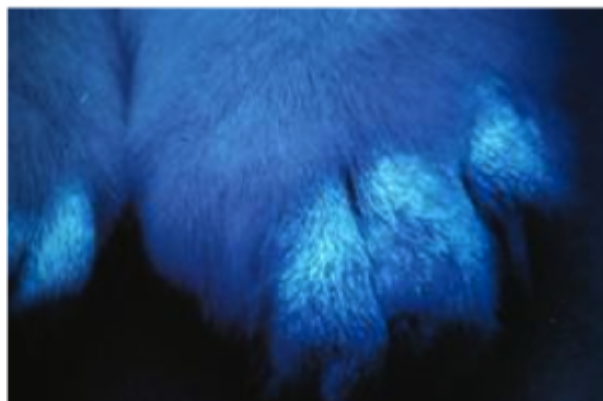
### Wood's lamp

An inexpensive and simple screening tool for *M. canis* infection is Wood's lamp examination (Figs. 4, 5). During this procedure infected hair shafts show apple-green fluorescence. It is generally believed that this method is not very sensitive as only about 50% of *M. canis* strains fluoresce and other dermatophytes do not at all (Sparkes et al., 1994c). Furthermore, debris, scale, lint and topical medications (e.g. tetracycline) can produce false positive results. Thus, Wood's lamp findings should be confirmed by other methods. However, according to findings of Moriello (Moriello, 2014) at least a part of the so called "non-fluorescing *M. canis* strains" might be cultured from cats that were in fact not infected but only passive carriers of spores (and spores do not fluoresce). Similarly, according to her experience a proper examination technique may significantly reduce the number of false positive and false negative results. She also hypothesised that discrepancies regarding the usefulness of the Wood's lamp may partially have resulted from a different quality of model available and concluded that a lamp with a central area that allows for magnification of the examined site, used by a trained observer, is a very useful first-line diagnostic test. Tips for properly using a Wood's lamp are described in a review (Moriello, 2014).



*Fig. 4. Preliminary diagnosis: fluorescence under Wood's*

*lamp illumination. Courtesy Andy Sparkes, AHT*



*Fig. 5. Fluorescence under Wood's lamp illumination.  
Courtesy Andy Sparkes, AHT*

### Microscopic examination

Direct microscopic examination is another simple and rapid method to detect dermatophytes on hairs or scales. It is strongly recommended to pluck hairs for this purpose under Wood's lamp illumination, which is much better than obtaining them from the edge of a lesion (Moriello, 2014). The sample should be cleared with 10-20% KOH before examination, though a direct observation in a drop of mineral oil is possible (Moriello, 2014). There are a number of techniques to improve the visualisation of fungal elements on the hair shafts (Moriello and DeBoer, 2012). For example, hairs or hair fragments with hyphae and arthrospores are thicker, with a rough and irregular surface. However, direct microscopic examination may give false positive results, especially if saprophytic fungal spores are present or debris is interpreted as fungal elements. Also, the sensitivity of this technique is relatively poor and has been assessed as 59% (Sparkes et al., 1993b). Higher sensitivity (76%) has been achieved by fluorescence microscopy with calcafluor white – a special fluorescent stain that binds strongly to structures containing cellulose and chitin (Sparkes et al., 1994c).

### Culture

Culture on Sabouraud dextrose agar or other media is generally believed to be the gold standard for the detection of dermatophytes. However, improper sampling and/or inoculation technique may lead to false results (Moriello et al., 2017). This method is very sensitive and can determine the species. Samples (hairs, scales) should be collected from the margin of new lesions after gently swabbing with alcohol to reduce contamination. If a subclinical infection or passive carriage is suspected, brushing for 5 minutes with a sterile brush is the best method for collecting sample material. A brand-new toothbrush is mycologically sterile (Moriello and DeBoer, 2012). After such a procedure, the number of colonies on the plate reflects the severity of the infection and a "pathogen score" system has been adopted by some shelters for treatment monitoring (Moriello, 2014; Moriello et al., 2017). Inoculated media are generally incubated up to 3 weeks before determining no fungal growth. On 2876 *M. canis* cultures it has been shown that only 2.6% of them required more than 14 days to prove positive (Stuntebeck et al., 2018). Several in-house dermatophyte test media (DTM) based on colour change are available commercially. However, few attempts have been made to evaluate the performance of such media with veterinary samples (Chermette et al., 2008). Therefore, suspect colonies must be examined microscopically to confirm presence of a fungus (Moriello and DeBoer, 2012; Kaufmann et al., 2016). Adhesive tape impression cytology has been proposed as a quick method detecting fungal hyphae and spores in cats (Bouza-Rapti et al., 2023). It is easy to perform, inexpensive, non-invasive, minimally stressful for the animals, and can be useful as in-house testing, however its sensitivity should be confirmed.

### PCR

PCR may be helpful to confirm *M. canis* infection in a suspected cat (Nardoni et al., 2007; Moriello and Leutenegger, 2018; Jacobson et al., 2018). A commercially available real-time dermatophyte PCR panel has been shown to be highly sensitive and specific for diagnosis of *M. canis* infection compared with fungal culture, but was unreliable for identifying mycological cure, as false-positive results were common (Jacobson et al., 2018). They might result from PCR detection of dead fungal organisms or from passive carriage of spores (Moriello et al., 2017). However, a negative PCR result in a treated cat means mycological cure (Moriello et al., 2017).

### Biopsy

Rarely occurring nodular or atypical lesions should be evaluated by skin biopsy and histopathology, or a cytological examination of an



aspirate (Moriello et al., 2017).

## Disease management and treatment

In immunocompetent cats isolated lesions disappear spontaneously after 1-3 months and may not require medication. However, treatment of such cases will reduce the disease course as well as the risk for other animals, humans and contamination of the environment.

Topical therapy is a necessary part of management because it is the only way to kill spores on the hair coat (Moriello, 2014). However, as a treatment it is generally less effective in cats compared to humans due to poor penetration of the medicines through the hair coat, lack of tolerance of this procedure by many cats and the possible existence of unnoticed small lesions. Thus, therapeutic measures should include a combination of systemic and topical treatment, maintained for at least 10 weeks. Generally, cats should be treated not only until the lesions completely disappear, but until the dermatophyte can no longer be cultured from the hairs on at least 2 sequential brushings 1-3 weeks apart. It has been suggested that in cats where there had been high compliance with environmental cleaning, as well as topical and systemic treatment recommendations, two consecutive negative fungal cultures may not be necessary to determine mycological cure. If good sampling technique is followed, the first negative culture in an otherwise healthy cat likely indicates elimination of the agent (Stuntebeck and Moriello, 2019). Similarly, a negative PCR result in a treated cat means mycological cure (Moriello et al., 2017).

### Topical therapy

In cats with a limited number of lesions, hair should be clipped away from the periphery of the lesions to include a wide margin. All clipped fur should be wrapped and disinfected before disposal. Chemical or heat sterilisation of instruments is essential. Cats should not be clipped in veterinary clinics to avoid environmental contamination. The best place for clipping is in the cat's own household, where the environment is already contaminated. Clipping should be gentle to avoid spreading the infection due to microtrauma, and lion-clipping of the entire body is contra-indicated. There are reports that clipping of the entire cat resulted in spreading of dermatophytosis to uninfected sites of the skin and worsening of the severity of the disease (Moriello et al., 2017). Therefore, shortening of the hair with scissors should be considered rather than using clippers that may cause severe stress and trauma. Scissors can also be more carefully and easily disinfected.

Spot treatment of lesions may be of limited efficacy; instead, whole-body shampooing, dipping or rinsing is recommended. Topical antifungal drugs differ widely in their efficacy. One of the most effective procedures is a whole-body treatment with a 0.2% enilconazole solution performed twice weekly (Moriello and DeBoer, 2012). Local or generalised side effects are very seldom reported, provided that grooming is prevented (with a soft Elizabethan collar) until the cat is dry (Hnilica and Medleau, 2002). Also very effective is 2% miconazole with 2% chlorhexidine as a twice weekly body rinse or shampoo (Moriello and DeBoer, 2012; Moriello et al., 2017). In the USA, lime-sulphur (mixture of calcium polysulfides) solution is commonly used with very good results. A study performed on isolated spores suggested that the best protocol seems to be twice weekly application of enilconazole and lime sulfur, and application of adjuvant focal topical therapy daily or every other day (Moriello, 2020).

*Pythium oligandrum* has been proposed as a novel biological treatment of dermatophytosis. The oomycete *P. oligandrum*, being a parasite of many fungi (and other oomycetes), is licensed and widely used in plant protection, and also as sprayed products (Hashemi et al., 2022). It shows also a strong antifungal activity *in vitro* against *M. canis*, *M. gypseum* and *Trichophyton mentagrophytes* cultures (Načeradská et al., 2017). Furthermore, during a study on eradication of dermatophytosis in a shelter, topical treatment of cats with *P. oligandrum* seemed to be more efficient to systemic medication with itraconazole, and was much better tolerated (Načeradská et al., 2021). Promising effects with this agent have also been seen in a pilot clinical study on humans suffering from dermatophytosis (Gabrielová et al., 2018).

### Systemic therapy

#### Itraconazole

Though relatively expensive, itraconazole is currently the preferred drug in feline dermatophytosis and is licensed for this indication (Moriello and DeBoer, 2012). It is comparable (or superior) in efficacy to ketoconazole or griseofulvin and is much better tolerated by cats. The only adverse reaction occasionally reported is anorexia. The embryotoxicity and teratogenicity of itraconazole also seem to be lower than those of ketoconazole. Nevertheless, its administration in pregnancy is not recommended. However, use in kittens as young as 6 weeks is possible. Most veterinary dermatologists use itraconazole as so-called pulse therapy, which is also suggested by the manufacturer. This protocol is effective and also reduces the cost of treatment. A pulse administration of 5 mg/kg/day orally for one week, alternating with one week without treatment, for 5 weeks reduced the time to mycological cure and increased both mycological and clinical cure rates compared with untreated controls (Puls et al., 2018). An earlier study demonstrated that there were sufficient levels of itraconazole in the plasma and the fur of cats with ringworm that had been given three cycles of treatment consisting of one

week with treatment (5 mg/kg/day) and one week without. A 25-30% reduction in levels was observed after the week without treatment, but the concentrations were still high enough even two weeks after the last administration (Vlaminck and Engelen, 2004). These data illustrate that such a treatment schedule (3 x 7 days of dosing interspersed by 7 days of no treatment) provides actual coverage of at least 7 weeks.

## Terbinafine

Terbinafine administered orally 30-40 mg/kg once daily is also very effective (Nuttall et al., 2008; Moriello and DeBoer, 2012; Moriello et al., 2017). It seems also suitable for pulse therapy. After 14 days of administration, terbinafine persisted in the hair of cats at inhibitory concentrations for 5.3 weeks (Foust et al., 2007). Occasional vomiting and intensive facial pruritus have been observed as side effects.

## Ketoconazole

Ketoconazole has been used orally 2.5-5 mg/kg twice daily. However, cats are relatively susceptible to side effects with this drug which include liver toxicity, anorexia, vomiting, diarrhoea, and suppression of steroid hormones synthesis. Ketoconazole is also contraindicated in pregnant animals.

## Griseofulvin

In some countries, griseofulvin is still used. However, now it is generally not recommended as safer and more effective preparations are available. It is administered orally for at least 4-6 weeks at 25-50 mg/kg once to twice daily. Griseofulvin is poorly soluble in water and micronised formulations, as well as administration with fatty meals, enhance absorption. Adverse reactions include anorexia, vomiting, diarrhoea, and bone marrow suppression, particularly in Siamese, Himalayan and Abyssinian cats. The use of griseofulvin is contraindicated in kittens younger than 6 weeks of age and in pregnant animals as the compound is teratogenic, particularly during the first weeks of gestation. There are a few reports suggesting that FIV infection predisposes cats to griseofulvin-induced bone marrow suppression. Therefore, cats should be tested for this infection prior to therapy. If griseofulvin is chosen, monthly CBCs should be carried out to detect possible bone marrow suppression.

## Lufenuron

Lufenuron is a chitin synthesis inhibitor, used for the prevention of flea infestations in dogs and cats. As chitin is also a component of the fungal cell wall, an antifungal activity of lufenuron has been expected. However, studies in cats did not demonstrate an antifungal effect and therefore lufenuron is not recommended for the treatment of dermatophytosis (Moriello and DeBoer, 2012; Moriello et al., 2017).

## Environmental decontamination

Thorough (daily) vacuuming and mechanical cleaning are essential to remove infective material (no visible hairs should be present), especially in households with one or a few cats where disinfection is impractical. However, in catteries or shelters, disinfection is very important, and should be performed at least twice weekly (Moriello et al., 2017). Most disinfectants labelled as "antifungal" are fungicidal against mycelial forms of the dermatophyte or macroconidia but not always against arthrospores (Moriello and DeBoer, 2012). After aggressive removal of contaminated material, those most efficient against arthrospores are 1.84% sodium hypochlorite, 0.3% quaternary ammonium, 3.2% lactic acid, and 0.5% hydrogen peroxide (Moriello et al., 2013). Also accelerated hydrogen peroxide has been shown to be very effective against spores (Moriello and Hondzo, 2014; Moriello, 2019). All surfaces should be cleaned with one of these solutions. An enilconazole smoke fumigant formulation is available in many European countries.

**Arthrospores can resist in the environment for up to one year; temperatures in washing machines and dishwashers should be at least 60°C to eliminate them.**

Detailed decontamination procedures, as well as the management of infected catteries and shelters during treatment, are described elsewhere (Carlotti et al., 2009; Moriello and DeBoer, 2012; Moriello, 2014; Moriello et al., 2017).

## Vaccination

In cattle and fur-bearing animals, immunotherapy with anti-dermatophyte vaccines, is believed to reduce the lesions and to accelerate their disappearance. Although *M. canis* vaccines have been marketed for treatment of affected cats, controlled studies demonstrating efficacy of this procedure in cats are hard to find. Results of a placebo-controlled-double-blind study performed on 55 cats with severe dermatophytosis caused by *M. canis* or *T. mentagrophytes* have been published (Westhoff et al., 2010). An inactivated vaccine containing antigens of *M. canis*, *M. canis* var. *distortum*, *M. canis* var. *obesum*, *M. gypseum* and *T. mentagrophytes* was given three times intramuscularly to sick animals. A trend of improvement in all cats following therapeutic vaccination was observed, although this



improvement was not significantly different from that in the placebo treated cats, questioning efficacy.

Similarly, studies did not confirm efficacy of a prophylactic vaccination of cats. A killed *M. canis*-cell wall vaccine induced both humoral and cell-mediated immunity in experimental cats; however, these responses did not protect them against challenge (DeBoer and Moriello, 1994). In another study, *M. canis* antigens combined with a live *Trichophyton* vaccine did not induce protective immunity against a topical challenge with *M. canis* (DeBoer et al., 2002).

A commercial vaccine consisting of killed *M. canis* components in adjuvant was licensed in the USA for treatment of cats rather than prevention. However, in experimental animals, this vaccine did not prevent a challenge infection and also did not provide a more rapid cure of dermatophytosis in vaccinated cats compared to unvaccinated controls (DeBoer et al., 2002). This product was withdrawn from the market. Other studies to develop dermatophytosis vaccines have been reviewed (Lund and DeBoer, 2008).

As a safe and efficient vaccine for cats is still not available (Chermette et al., 2008; Lund and DeBoer, 2008; Moriello et al., 2017), ABCD does not recommend dermatophytosis vaccination.

## Disease control and prevention in specific situations

In catteries and shelters, dermatophyte infection is very difficult to eradicate and is time-consuming and expensive. Good compliance with the owner is therefore essential. A treatment program is necessary, together with complete separation of infected and uninfected animals and intensive cleaning and decontamination of the environment. This will necessitate interruption of breeding programs and shows. It is reasonable to group cats into 3 categories:

- sick animals (both lesion and culture positive, usually Wood's lamp positive)
- subclinically infected (lesion-free, culture positive, usually Wood's lamp positive)
- fomite carrier cats (lesion-free, Wood's lamp negative and initially positive but after a few days turning to negative on fungal culture)

All animals in the cattery should be treated, however the fomite carriers are treated topically only, which avoids long-term expensive and unnecessary systemic therapy.

Since antifungal treatment is stressful to cats, it is important not to confuse fomite carriers with infected cats. In a retrospective study, 584 of 5644 shelter were dermatophyte culture positive, but only 94 cats culture positive cats had lesions; the remaining 490 culture-positive cats were fomite carriers (lesion-free and negative on repeat fungal culture) (Moriello, 2014). The strategy for dermatophyte prevention used in three Canadian shelters was to screen 400 cats within 48 hours of entry to the shelters, using a standard toothbrush and culture technique, although none were found to be positive (Mozes et al., 2017).

A cat-friendly approach to treat *M. canis* was used in a shelter in the Czech Republic using the mycoparasitic fungus *Pythium* (*P. oligandrum*, (Načeradská et al., 2021): a solution of *P. oligandrum* (Ecosin, BARD) was applied gently by stroking the cats with a glove soaked in the product two days on, two days off, for six weeks (Načeradská et al., 2021). Substances soaked in the product were also placed in the entrance to the outdoor areas in order to apply the product containing *P. oligandrum*. In this way, cats contacted the product when passing through the entrance, including non-socialized cats for which normal handling was impossible. Therefore, timid cats did not have to be bathed in the product, since bathing is a very stressful procedure for cats (Načeradská et al., 2021).

Decontamination of premises is essential for dermatophytosis control and need not be expensive or complicated: 70 foster family homes where *M. canis* infected cats had lived were successfully decontaminated by cleaning with over-the-counter household detergents and rinsed. Hard surfaces were disinfected with 1:100 concentration household bleach or accelerated hydrogen peroxide (Moriello, 2019).

Special hygiene measures should be taken when handling infected animals in order to prevent infection of humans (gloves, disinfection of cat scratches or any other injury).

Further advice for the management of infected cat groups have been published in the Clinical Consensus Guidelines of the World Association for Veterinary Dermatology "Diagnosis and treatment of dermatophytosis in dogs and cats" (Moriello et al., 2017).

## Zoonotic risk

In humans, clinical signs manifest as skin lesions (Figs. 6a and b), the nails may also be involved.



*Figs. 6a and b. Dermatophytosis in humans. Provided by Séverine Tasker*

*M. canis* infection in humans is a curable skin disease. In immunocompromised patients the treatment time may be prolonged, but serious complications are extremely rare (Moriello et al., 2017).

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