Dermatophytosis, ringworm in cats

Published: 01/01/2013
Last updated: 01/07/2022
Last reviewed: 01/11/2022

The dermatophytosis guidelines were first published in the J Feline Med Surg 2013, 15: 598-604 by Tadeusz Frymus et al. The present guidelines were updated by Tadeusz Frymus.

Key points

- **Dermatophytosis, caused usually by *Microsporum 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 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 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).

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 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 by digging to *M. gypseum*, a geophilic fungus living in soil. 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. Whether such an infection will lead to clinical disease depends on many factors. Predisposing factors to disease include: a 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. 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 recent consensus statement, it was concluded that seropositive FIV and/or FeLV status alone does not increase the risk of dermatophytosis (Moriello et al., 2017).

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. 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-γ, 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 opsonization 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).

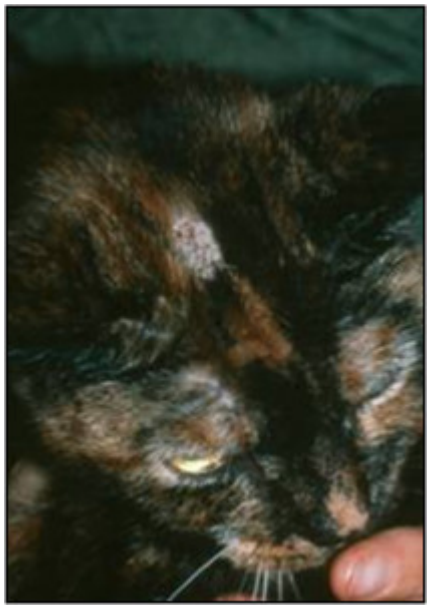

Fig. 1. Dermatophytosis lesions start on the head in many cases. Courtesy of International Cat Care (formerly Feline Advisory Bureau)

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.

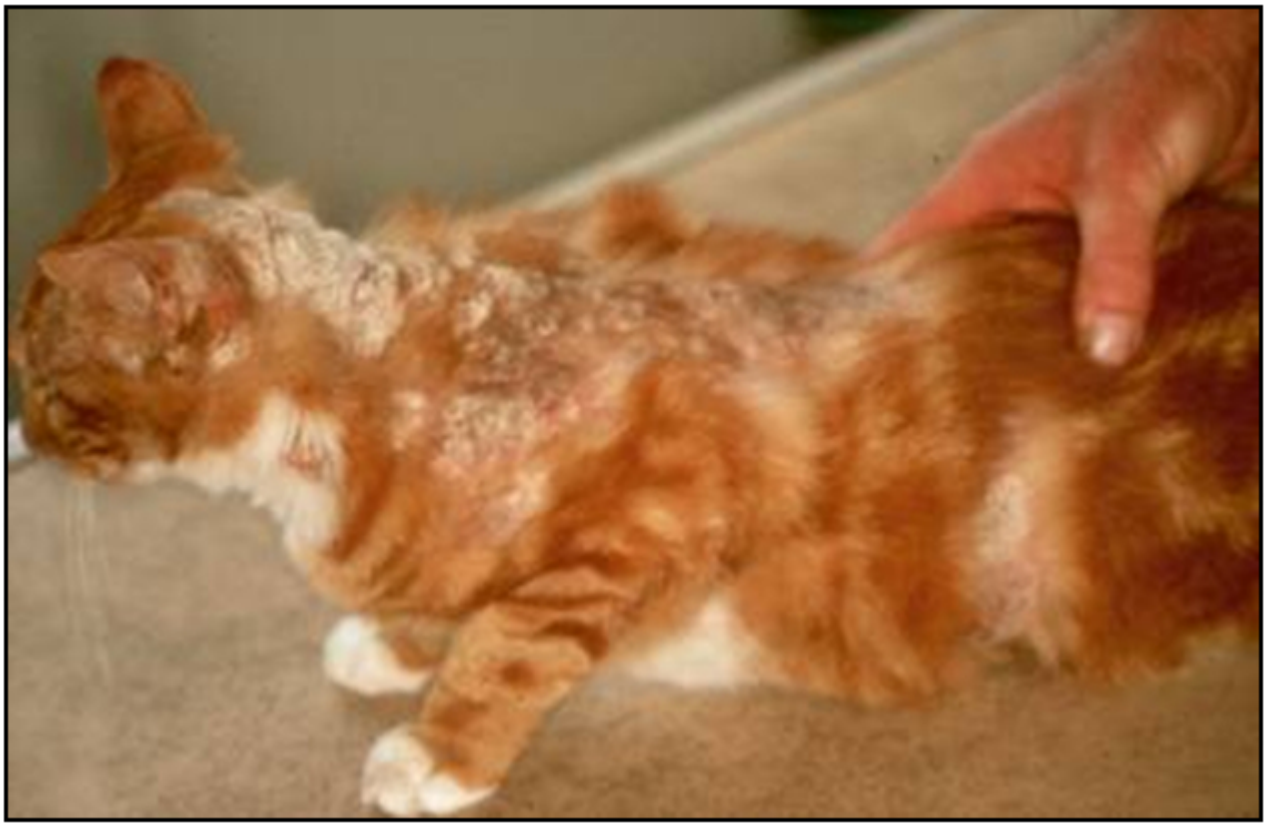

Fig. 3. Particularly in immunocompromised cats, dermatophytosis may be multifocal and even generalised. Courtesy of International Cat Care (formerly Feline Advisory Bureau)

A rare outcome is onyxis 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.

Fig. 4. Preliminary diagnosis: fluorescence under Wood's lamp illumination. Courtesy Andy Sparkes, AHT

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 presumed 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).

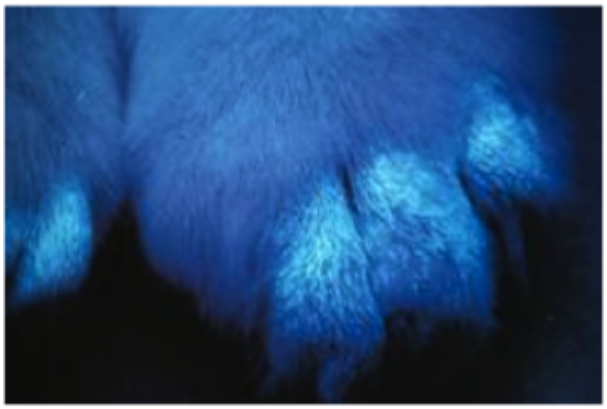

Fig. 5. Fluorescence under Wood's lamp illumination. Courtesy Andy Sparkes, AHT

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). 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 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. Recently, on 2876 *M. canis* cultures it has been shown that only 2.6% of them required >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).

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 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).

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 recently 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 lesions including a wide margin. Clipping should be gentle to avoid spreading the infection due to microtrauma. Spot treatment of lesions may be of limited efficacy; instead, whole-body shampooing, dipping or rinsing is recommended. In patients with generalised disease, longhaired cats and for cattery decontamination, clipping the entire cat may be useful to make topical therapy application easier and to allow for better penetration of the drug. This approach limits also the spread of the spores into the environment, to people and to other animals. After removing of the entire hair coat, including whiskers, all hairs 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. However, 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, instead of using clippers that may cause trauma, shortening of the hair with scissors should be considered. Scissors can also be more carefully and easily disinfected.

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 general 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). Very effective is also 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.

Recently, *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).

Other options

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.

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 against arthrospores. Those most efficient against arthrospores are 1:33 lime-sulphur, 0.2% enilconazole, and 1:10 to 1:100 household chlorine bleach (Moriello and DeBoer, 2012). Also accelerated hydrogen peroxide has been shown to be very effective (Moriello, 2019). All surfaces should be cleaned with one of these solutions. An enilconazole smoke fumigant formulation is available in many European countries.

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

Very few efficacy studies on anti-*M. canis* vaccines (prophylactic or therapeutic) for cats have been performed and published. Although considerable success has been achieved in prophylactic or therapeutic use of anti-dermatophyte vaccines in cattle and fur-bearing animals, a safe and efficient vaccine for cats is still not available (Chermette et al., 2008; Lund and DeBoer, 2008; Moriello et al., 2017).

A killed *M. canis*-cell wall vaccine induced both humoral and cell-mediated immunity in experimental cats; however, these responses did not protect cats against challenge (DeBoer and Moriello, 1994). Similarly, *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 cats, this vaccine did not prevent the establishment of a challenge infection and also did not provide a more rapid cure of an established infection in vaccinated cats compared to unvaccinated controls (DeBoer et al., 2002). The product was withdrawn from the market. Other studies to develop dermatophytosis vaccines have been reviewed (Lund and DeBoer, 2008).

ABCD does not recommend dermatophytosis vaccination.

Disease control 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. 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 recently 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 (Fig. 6), the nails may also be involved (Fig. 7).

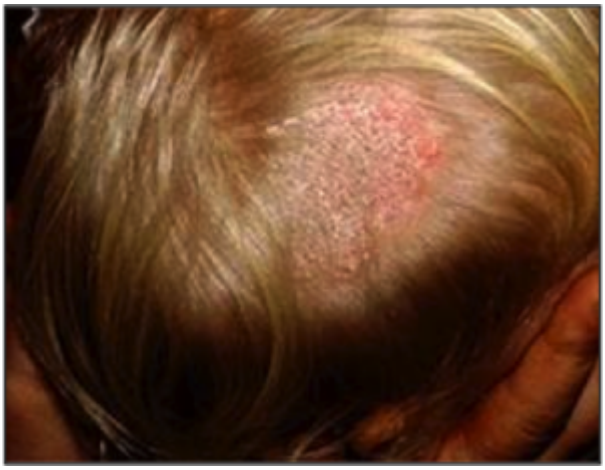

Fig. 6. Dermatophytosis on a human head. Courtesy Andy Sparkes, AHT

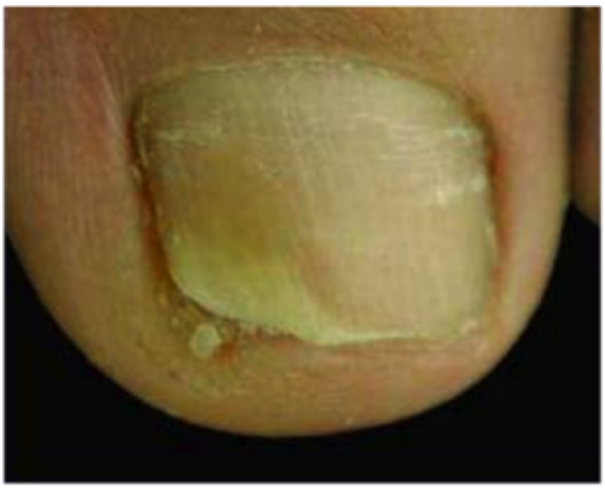

Fig. 7. Dermatophytosis on a human nail. Courtesy Andy Sparkes, AHT

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).

Acknowledgement

ABCD Europe gratefully acknowledges the support of Boehringer Ingelheim (the founding sponsor of the ABCD), Virbac and IDEXX GmbH.

References

Bianchi MV, Laisse CJM, Vargas TP, Wouters F, Boabaid FM, Pavarini SP, Ferreiro L, Driemeier D (2017): Intra-abdominal fungal pseudomycetoma in two cats. Rev Iberoam Micol 34(2), 112-115. doi: 10.1016/j.riam.2016.10.001.

Black SS, Abernethy TE, Tyler JW, Thomas MW, Garma-Aviña A, Jensen HE (2001): Intra-abdominal dermatophytic pseudomycetoma in a Persian cat. J Vet Intern Med 15, 245–248.

Carlotti DN, Guinot P, Meissonnier E, Germain PA (2009): Eradication of feline dermatophytosis in a shelter: a field study. Vet Dermatol 21, 259-266.

Chermette R, Ferreiro L, Guillot J (2008): Dermatophytoses in animals. Mycopathologia 166, 385-405.

DeBoer DJ, Moriello KA (1994): The immune response to *Microsporum canis* induced by fungal cell wall vaccine. Vet Dermatol 5, 47-55.

DeBoer DJ, Moriello KA, Blum JL, Volk LM, Bredahl LK (2002): Safety and immunologic effects after inoculation of inactivated and combined live-inactivated dermatophytosis vaccines in cats. Am J Vet Res 63, 1532–1537.

Foust AL, Marsella R, Akucewich LH, et al (2007): Evaluation of persistence of terbinafine in the hair of normal cats after 14 days of daily therapy. Vet Dermatol 18, 246-251.

Gabrielová A, Mencl K, Suchánek M, Klimeš R, Hubka V, Kolařík M. The Oomycete Pythium oligandrum Can Suppress and Kill the Causative Agents of Dermatophytoses. Mycopathologia. 2018 Oct;183(5):751-764. doi: 10.1007/s11046-018-0277-2. Epub 2018 Jul 2. PMID: 29967972; PMCID: PMC6156753.

Hashemi M, Tabet D, Sandroni M, Benavent-Celma C, Seematti J, Andersen C B., Grenville-Briggs L J (2022): The hunt for sustainable biocontrol of oomycete plant pathogens, a case study of Phytophthora infestans, Fungal Biology Reviews 40, 53-69, https://doi.org/10.1016/j.fbr.2021.11.003.

Hnilica KA, Medleau L (2002): Evaluation of topically applied enilconazole for the treatment of dermatophytosis in a Persian cattery. Vet Dermatol 13, 23-28.

Jacobson LS, McIntyre L, Mykusz J (2018): Comparison of real-time PCR with fungal culture for the diagnosis of Microsporum canis dermatophytosis in shelter cats: a field study. J Feline Med Surg. 20(2), 103-107. doi:10.1177/1098612X17695899.

Kaufmann R, Blum SE, Elad D, Zur G (2016): Comparison between point-of-care dermatophyte test medium and mycology laboratory culture for diagnosis of dermatophytosis in dogs and cats. Vet Dermatol 27(4), 284-e68. doi10.1111/vde.12322.

Lund A, DeBoer DJ (2008): Immunoprophylaxis of dermatophytosis in animals. Mycopathologia 166, 407-424.

Mancianti F, Giannelli C, Bendinelli M, Poli A (1992): Mycological findings in feline immunodeficiency virus-infected cats. J Med Vet Mycol 30, 257–259.

Mignon BR, Losson B (1997): Prevalence and characterization of *Microsporum canis* carriage in cats. J Med Vet Mycol 35, 249-256.

Moriello K (2014): Feline dermatophytosis: aspects pertinent to disease management in single and multiple cat situations. J Feline Med Surg 16, 419-431. doi: 10.1177/1098612X14530215.

Moriello KA, DeBoer DJ (2012): Dermatophytosis. In: Greene CE (ed): Infectious diseases of the dog and cat. 4th ed. Elsevier, pp 588-602.

Moriello KA, DeBoer DJ, Greek J, Kukl K, Fintelman M (2003): The prevalence of immediate and delayed-type hypersensitivity reactions to *Microsporum canis* antigens in cats. J Feline Med Surg 5, 161-166.

Moriello KA, Coyner K, Paterson S, Mignon B (2017): Diagnosis and treatment of dermatophytosis in dogs and cats. Clinical Consensus Guidelines of the World Association for Veterinary Dermatology. Vet Dermatol 28(3), 266-e68. doi: 10.1111/vde.12440.

Moriello KA, Leutenegger CM (2018): Use of a commercial qPCR assay in 52 high risk shelter cats for disease identification of dermatophytosis and mycological cure. Vet Dermatol 29(1), 66-e26. doi: 10.1111/vde.12485.

Moriello KA (2019): Decontamination of 70 foster family homes exposed to Microsporum canis infected cats: a retrospective study. Vet Dermatol 30(2), 178-e55, doi: 10.1111/vde.12722.

Načeradská M, Fridrichová M, Kellnerová D, Peková S, Lány P. Antifungal effects of the biological agent Pythium oligandrum observed in vitro. J Feline Med Surg. 2017 Aug;19(8):817-823. doi: 10.1177/1098612X16658690. Epub 2016 Jul 1. PMID: 27418287.

Načeradská M, Fridrichová M, Kolářová MF, Krejčová T. Novel approach of dermatophytosis eradication in shelters: effect of Pythium oligandrum on Microsporum canis in FIV or FeLV positive cats. BMC Vet Res. 2021 Sep 1;17(1):290. doi: 10.1186/s12917-021-03001-w. PMID: 34470629; PMCID: PMC8409471.

Nardoni S, Franceschi A, Mancianti F (2007): Identification of *Microsporum canis* from dermatophytic pseudomycetoma in paraffin-embedded veterinary specimens using a common PCR protocol. Mycoses 50, 215-217.

Nuttall TJ, German AJ, Holden SL, Hopkinson C, McEwan NA (2008): Successful resolution of dermatophyte mycetoma following terbinafine treatment in two cats. Vet Dermatol 19, 405-410.

Puls C, Johnson A, Young K, Hare J, Rosenkrans K, Young L, Moriello K. Efficacy of itraconazole oral solution using an alternating-week pulse therapy regimen for treatment of cats with experimental Microsporum canis infection. J Feline Med Surg. 2018

Oct;20(10):869-874. doi: 10.1177/1098612X17735967. Epub 2017 Oct 13. PMID: 29025320; PMCID: PMC6158682.

Sierra P, Guillot J, Jacob H, Bussiéras S, Chermette R (2000): Fungal flora on cutaneous and mucosal surfaces of cats infected with feline immunodeficiency virus or feline leukemia virus. Am J Vet Res 61, 158–161.

Sparkes AH, Gruffydd-Jones TJ, Shaw SE, Wright AI, Stokes CR (1993b): Epidemiological and diagnostic features of canine and feline dermatophytosis in the United Kingdom from 1956 to 1991. Vet Rec 133, 57-61.

Sparkes AH, Stokes R, Gruffydd-Jones TJ (1993a): Humoral immune response in cats with dermatophytosis. Am J Vet Res 54, 1869–1873.

Sparkes AH, Stokes R, Gruffydd-Jones TJ (1994a): SDS-PAGE separation of dermatophyte antigens, and western immunoblotting in feline dermatophytosis. Mycopathologia 128, 91–98.

Sparkes AH, Stokes R, Gruffydd-Jones TJ (1995): Experimental *Microsporum canis* infection in cats: correlation between immunological and clinical observations. J Med Vet Mycol 33, 177–184.

Sparkes AH, Werrett G, Stokes CR, Gruffydd-Jones TJ (1994b): *Microsporum canis*: inapparent carriage by cats and the viability of arthrospores. J Small Anim Pract 35, 397-401.

Sparkes AH, Werrett G, Stokes CR, Gruffydd-Jones TJ (1994c): Improved sensitivity in the diagnosis of dermatophytosis by fluorescence microscopy with calcafluor white. Vet Rec 134, 307-308.

Stuntebeck R, Moriello KA, Verbrugge M (2018): Evaluation of incubation time for Microsporum canis dermatophyte cultures. J Feline Med Surg 20(10), 997-1000. doi: 10.1177/1098612X17729286.

Stuntebeck RL, Moriello KA (2019): One vs two negative fungal cultures to confirm mycological cure in shelter cats treated for Microsporum canis dermatophytosis: a retrospective study. J Feline Med Surg 3. doi: 10.1177/1098612X19858791.

Vlaminck KMJA, Engelen MACM (2004): Itraconazole: a treatment with pharmacokinetic foundations. Vet Dermatol 15, 8.

Westhoff DK, Kloes M-C, Orveillon FX, Farnow D, Elbers K, Mueller RS (2010): Treatment of feline dermatophytosis with an inactivated fungal vaccine. Open Mycology J 4, 10-17.