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Review Paper

DERMATOPHYTOSES IN DOMESTIC ANIMALS AND THEIR ZOONOTIC POTENTIAL

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Summary: Dermatophytoses in domestic animals in this article are discussed from the zoonotic and practical point of view. Data on animal infections are compared to data from human research. Latest human and veterinary research on dermatophytes is presented with special emphasis on Slovenian research. The article explains the very reason why cats, among all different domestic animals, are the main reservoir of M.canis infection for people. It also explains the reason why among all dermatophytoses M.canis infection is the most difficult to control. .

Key words: zoonoses–microbiology; dermatomycoses-epidemiology-transmissions–pathology; diseases reservoirs; infection control-methods; dogs; cats; horses

Introduction

In the scope of the zoonotic aspect it is necessary to discuss dermatophytoses being the group of the most common fungal diseases in dogs and cats. Most of them are zoonoses (1). But from the practical point of view we need to realize that dealing with the patient at the very beginning of the disease we don't know about the final diagnosis. Therefore one need to consider more than one differential diagnosis while observing the alopecia anywhere on the body. At least the most important among them will be mentioned in the article (2).

Among all very different species of domestic animals people live probably in the closest contact with dogs and cats, as they don't take a cow or a horse into their beds. Dislocated habitat of economic animals enables veterinarians to manage dermatophytoses in these groups of animals differently. Trichophytosis in cows, for example, can be managed using live vaccines but they cannot be used in pet animals because of the close contact with the people (3). Close contact is also the reason that the main source of infection to the people represents cats and less frequently dogs (2).

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Classification of dermatophytes

Fungi are omnipresent in our environment. Amidst thousands of different species of fungi only a few have the ability to cause disease in animals. The great majority of fungi are either soil organisms or plant pathogens; however, more than 300 species have been reported to be animal pathogens (1).

The term *fungus* includes yeasts (unicellular) and moulds (multicellular-filamentous). Dimorphic fungi are capable of existing in both morphologic forms that may depend on the temperature or type of the media. Dogs and cats harbour many saprophytic moulds and yeasts on their hair and skin. The most common of these fungi isolated from dogs are species of *Alternaria, Aspergillus , Aureobasidium, Chrysosporium, Mucor, Penicillium and Rhizopus*. In cats, the most commonly isolated fungi are the species of *Alternaria, Aspergillus, Chrysosporium, Cladosporium, Mucor, Penicillium, Rhodotorula and Scopulariopsis*. Most of these saprophytic isolates presumably represent repeated transient contamination by airborne fungi or by fungi in soil (2) and are important as contaminants on fungal cultures, making interpretation difficult.

Fungal skin diseases (mycoses) can be divided into superficial, subcutaneous and systemic. The superficial mycoses are fungal infections that in-

volve superficial layers of the skin, hair and claws. The organisms may be dermatophytes such as *Microsporum* and *Trichophyton* which are able to use keratin. However other fungi such as *Candida (Monilia), Malassezia (Pityrosporum)* and *Trichosporon (piedra)* may also produce superficial mycoses.

The filamentous fungi which invade skin (derma) and keratinized tissues (hair, nails, etc.) are dermatophytes. They are a group of closely related fungi, classified into three genera:

Microsporum (Nannizzia)

Trichophyton (Arthroderma)

Epidermophyton (no sexual form described yet)

The dermatophytes are traditionally placed into the *Fungi Imperfecti* but for some of them the perfect (sexual) stage has been described and they are classified as *Ascomycetes. Nannizzia* sp. is the teleomorph for *Microsporum* sp. and *Arthoderma* sp. is the teleomorph for any *Trichophyton* species.

Today near 40 species of dermatophytes are known. In the pathological processes the conidial (asexual = imperfect) form is taking part. Therefore the human-, and veterinary literature is still using the so called „imperfect" names (i.e.: *Microsporum* instead of *Nannizzia*).

Three species cause the great majority of clinical cases of dermatophytosis in dogs and cats: *Microsporum canis, Microsporum gypseum*, and *Trichophyton mentagrophytes. M.canis* and *T. mentagrophytes* are zoophilic dermatophytes that have become adapted to animals and are rarely found in soil. *M. gypseum* is a geophilic dermatophyte that normally inhabits soil. *M.canis* is in general the most common cause of dermatophytosis in cats and dogs (2).

Trichophyton equinum is the most common causative agent of dermatophytosis in a horse. Other agents that may cause dermatophytosis in a horse are: *T. mentagrophytes* (natural reservoir are rodents), *T. verrucosum* (natural reservoir are ruminants), *M. canis* (natural reservoir are cats) and *M. gypseum*, the latter being a geophilic dermatophyte. A horse can get infected with *M. gypseum* when coming into contact with the soil but it may exceptionally be transmitted from another infected horse as well (4).

According to the extensive research, done in people from 1995-2002 on 42494 samples from University Medical centre Ljubljana, *M.canis* was the most frequent dermatophyte isolated (46,8%), followed by *Trichophyton rubrum* (36,7%), *T. mentagrophytes var. interdigitale* (7,9%), and *T. mentagrophytes var. mentagrophytes* (4,9%), while other species, including *M. gypseum*, were isolated less frequently (5).

Pathogenesis of dermatophytoses

Dermatophytes can grow only on the hairs that are in anagen phase (6,7). In the tellogen phase follicles behave as saprophites (8). Hyphae of the fungus are embedded into stratum corneum, infundibulum of hair follicle and hair. To be successfully attached, dermatophyte should stay in the contact to the skin for about 2-3 hours (9). That's the period when people holding the infected cat, for example, can prevent infection if they act according to the common hygiene praxis. Four hours after attachment reproduction of the fungus already begins. (9). This is probably the reason as well for the difficulties researchers had encountered with while establishing experimental infection in cats that were allowed to groom. It is possible that grooming may be an under recognized host defence mechanism (10). Dermatophytes grow on the surface of the hair and migrate toward root. Proteolytic enzymes also enable them to grow in the medulla. When hair enters tellogen phase, the production of keratine slows down and finally stops. With this dermatophytes stop growing as well. Infectious arthrospores may persist on the hair for a long time (at least 18 months) but they may not re-infect the same follicle until the new hair begins to grow (6, 11).

Incubation period in animals infected with *M. canis* is not well defined. It ranges between 4 days and 4 weeks (5) in cats and 1 – 4 weeks in horses (5). The cause for such a loosely defined incubation period might be that we hardly control free roaming cats therefore the time of infection is hard to establish. Additional problem in cats are frequent asymptomatic carriers. Establishing incubation period in experimental conditions can be of great help and it was found to be between 7-14 days in cats (2, 12).

Because of their weaker specific and nonspecific immunity young animals and children become infected more often (4, 6, 13, 14, 15). One survey, done on 1011 humans being treated at University clinical centre of Ljubljana, revealed that 95,5% of dermatophyte infected were younger of 15 years old (15). We know that concurrent FIV, FeLV, Ehrlichia or Leishmania infections, cancer diseases or immunosuppressive therapy predisposes for dermatophyte infection or worsens the clinical course of the disease (6, 16, 17, 18). Dermatophytosis is three times more prevalent in cats with feline immunodeficiency virus than in uninfected cats (16). Among dog breeds surveyed in southern Italy Yorkshire terriers showed the highest positiveness (14) while

Persian cats are well known to exhibit chronic dermatophyte infections.

Clinical presentation in a dog

As the infection is almost always follicular the most consistent clinical sign in a dog is one or many circular patches of alopecia with variable scaling. Lesions occur most commonly on the face, pinnae, paws, and tail. Pruritus is usually minimal or absent. Dogs most often exhibit the classic ring lesion with central healing and fine follicular papules and crusts at the periphery. However, less common syndromes with occasionally marked pruritus are frequent enough that dermatophytosis should be considered in the differential diagnosis of any annular, papular, or pustular eruption (2).

Based on the history and clinical signs one make the list of differential diagnoses that in classical cases include bacterial folliculitis and demodicosis. In less commonly described clinical presentations the differential diagnoses should be as follows:

- symmetric nasal or facial folliculitis and furunculosis (diff. ▼ pemphigus complex)
- generalized infection with seborrhea-like eruptions (diff. ▼ seborrheic diseases)
- dermatophyte kerion (diff. ▼ histiocytoma)
- onychomycosis (diff. ▼ bacterial nail infection, autoimmune disease)
- dermatophytic pseudomycetoma (diff. ▼ mycetomas caused by other fungi)

Clinical presentation in a cat

Feline dermatophytosis most often appears as one or more irregular or annular areas of alopecia with or without scales. Hairs in these areas often appear broken and frayed. The alopecia may be severe and widespread, accompanied by little evidence of inflammation.

Cats occasionally have more inflammatory areas of folliculitis characterized by alopecia, erythema, scale, crust, and follicular papules.

Other clinical presentations are:

- miliary dermatitis (pruritic, papulocrustous dermatitis, diff. ▼ flea allergy dermatitis)
- chin folliculitis (diff. ▼ feline acne)
- dermatitis of the dorsal tail (diff. ▼»stud tail«)
- onychomycosis (diff. ▼ bacterial nail infection, autoimmune disease)
- generalized infection with seborrhea-like eruptions (diff. ▼ seborrheic diseases)
- exfoliative erythroderma (diff. ▼ endocrine disorders)
- eroded lesions due to self-grooming (diff. ▼ eosinophilic plaque)
- dermatophyte kerion (diff. ▼ neoplasm)
- otitis externa (diff. ▼ other causes of otitis)
- dermatophytic pseudomycetoma (diff. ▼ mycetomas caused by other fungi, neoplasm) Last feature was described only in Persian cats (19, 20).

The nature of the dermatophyte cannot be determined from the clinical presentation. Moreover, cats may often be asymptomatic carriers of the disease (8, 21): among show cats, cats from shelters and those that are often taken to the veterinarians, 6.5 to 100% has been found to be asymptomatic carriers (6). Half of the infected cats can be without clinical signs of the disease (11). In opposite, asymptomatic carriers among dogs are rarely found (22) and may represent 5% of infected dogs (23). Lately, 2.16 per cent of asymptomatic *T. mentagrophytes* carriers were found among 169 clinically healthy cats in the southeast of England. Asymptomatic animal carriers should be considered when treating humans with trichophytosis (24).

Clinical presentation in a horse

Not all horses in contact got infected (more often young and immunosupressed animals). Majority of cases occur from autumn to spring. Skin changes may vary in their appearance but are prevalent on the head, neck and extremities. Alopecic spots of different size, with or without erythema and squames are typical. Rarely pruritus or pain may be present.

When dealing with alopecic changes in a horse we need to consider differential diagnoses as follows:

- demodicosis (*Demodex Cabali, Demodex equi*)
- dermatophylosis (*Dermatophylus Congolensis*)
- bacterial folliculitis (*Staphylococcus aureus, hyicus, intermedius*)
- hypersensitivities (5).

Diagnosis of dermatophytosis

As already pointed out, one cannot establish final diagnosis merely on the base of the clinical features of the disease. In cats symptoms may often be absent and one gets the cat presented for examination because infection in humans has been confirmed. According to some data, infection of at least 1

member was confirmed in 30 to 70% of households keeping infected cat (2). In opposite, one should not exclude dermatophytosis on the fact that none of the humans in contact yet got infected. Successful infection may depend on many factors, like immune status of the recipient and the time of exposure to the contagious material. History-taking may be of limited value unless exposure is known to have occurred; this is so because clinical dermatophytosis is so variable and the incubation period is incompletely defined. The number, types, and sources of contact animals should be determined.

Wood lamp examination

For fluorescence causes only certain strains of *M. canis, M. audouinii, M. distortum, and Trichophyton schoenleinii* to produce a positive yellow-green colour on infected hairs. The Wood's lamp is an ultraviolet light with a light wave of 253.7 nm that is filtered through a cobalt or nickel filter (2). The Wood's lamp should be turned on and allowed to warm up for 5 to 10 minutes because the stability of the light's wavelength and intensity is temperature dependent (1, 25). The animal should be placed in a dark room and examined under the light of the Wood's lamp. When exposed to the ultraviolet light, hairs invaded by *M. canis* may fluoresce in about 50% of the isolates (6, 11,13, 25). Hairs should be exposed for 3 to 5 minutes because some strains are slow to show the obvious yellow-green colour. The fluorescence is due to tryptophan metabolites produced by the fungus (26). Positive fluorescence should be distinguished from false positive fluorescence due to presence of certain bacteria (*Pseudomonas aeruginosa, Corynebacterium minutissimum*), keratin, soap, petroleum, and other medication. These fluorescing hairs should be plucked with forceps and used for inoculation of fungal medium or for microscopic examination (2).

Microscopic examination

One perform microscopic examination by adding 20 % KOH to the hair, scales, and claw material on microscope slide, adding the cover slip and heating (but not boiling) the sample for 15-20 seconds. Instead of heating the preparation may be allowed to stand for 20 minutes at room temperature (6). Alternatively to KOH, lactophenol can be used without heating (11).

Direct examination may reveal hyphae and arthrospores in 40-50% of the cases (6, 11) but cannot distinguish between different dermatophyte species (26). When the result is positive it is a definitive evidence of dermatophytosis (6).

Microscopic examination with fluorescent microscope

Material (hairs) is placed on the microscopic slide, 2 drops of 10 % KOH solution are added and then mixed. Then 2 drops of calcofluor sre added, mixed and slide covered. Calcofluor is colorless fluorescent stain that fixes to B1-3 and B1-4 polisaccharides that build in the cellulose and chitine. Stained preparation is then exposed to ultraviolet light and green fluorescent fungal elements can be seen. (11).

Microscopic examination with fluorescent microscope is rarely used because of the need of special equipment but it can be useful. According to some data it can be efficient in more than 50% of cases (11).

Fungal culture

Fungal culture is needed for species of dermatophyte to be identificated (11). Collecting the hairs may be done by plucking the damaged hairs from the margin of the alopecic lesion or by brushing the haircoat all over the body, whenever asymptomatic infection. One should avoid taking hairs from all over the body if skin modifications are detected. Collecting the hairs in this manner encourages contamination of the specimen with saprophitic fungi.

Sabouraud's dextrose agar and dermatophyte test medium (DTM) are traditionally used in clinical veterinary mycology for isolation of fungi (2). SDA is a classical Sabouraud's dextrose agar containing penicillin and streptomycin that most of fungi grow on it. The antibiotics are added to prevent growing of bacterial contaminants. Sabouraud's dextrose agar containing chloramphenicol and actidion (SCA) is a selective culture plate because chloramphenicol prevents growing of most of the bacteria and actidion prevents growing of most of the saprophytic fungi (11). Dermatophyte test medium (DTM) is essentially a Sabouraud's dextrose agar containing cycloheximide, gentamicin, and chlortetracycline as antifungal and antibacterial agents. The pH indicator phenol was added. Dermatophytes first use protein in the medium with alkaline metabolites turning the medium from yellow to red. When the protein is exhausted the dermatophytes use carbohydrates giving off acid metabolites. The medium changes from red to yellow. The majority of other fungi use carbohydrates first and proteins only later; they too may produce a change to red in DTM – but only af-

ter a prolonged incubation (10 to 14 days or longer). Consequently, DTM cultures should be examined daily for the first 10 days. Fungi such as *Blastomyces dermatitidis, Sporothrix schenkii, H. capsulatum, Coccidioides immitis, Pseudoallescheria boydii,* and some *Aspergillus* species may cause a change to red in DTM, therefore microscopic examination is essential to avoid an erroneous presumptive diagnosis (2).

Skin scrapings, claws, and hair should be inoculated onto Sabouraud's dextrose agar and DTM. Desiccation and exposure to ultraviolet light hinder growth. Therefore, cultures should be incubated in the dark at 30° C with 30% humidity. A pan of water in the incubator usually provides enough humidity. Cultures should be incubated for 10-14 days and should be checked daily for fungal growth. Proper interpretation of the DTM culture necessitates recognition of the red colour change simultaneously with visible mycelial growth (2). One study showed that increased incubation temperature (24-27°C) had resulted in a more rapid colour change on a DTM developed for animals and suggested that incubation at room temperature might account for false negative culture results (27). The interpretation of the positive fungal culture results should be taken with care since dermatophytes are also isolated from the hair coats and skin of normal dogs. It is likely that dermatophytes isolated from normal dogs and cats – such as *M.gypseum, T.mentagrophytes* – simply represent recent contamination from the environment. This is particularly true in outdoor animals or hunting dogs (6). In one study anthropophilic dermatophytes were isolated from about 10% of the stray cats in various animal shelters indicating that cats can automatically carry human pathogens. *M. canis*, however, is undeniably present as a persistent infection in many asymptomatic infected cats (2).

ELISA diagnostic method

ELISA diagnostic method has been developed for the diagnostics purposes of *M. canis* infection in cats. Antibodies against *M.canis* were measured in the group of naturally infected cats and compared to the group of healthy cats that were brought to the clinic for vaccination or sterilisation purpose. Significantly higher antibody titres had been measured in the group of infected cats compared to the group of healthy cats. The presence of certain amounts of the antibodies in the blood of healthy cats had been explained with possible cross-reactions with saprophytic fungi or the possibility that reactive animals had recovered from infection in the past (28, 29 30). The method that has been developed at Veterinary faculty of Ljubljana exhibited 75,0% of sensitivity and 91,7% of specificity. Prediction value for the negative result was 68,8% and represented the possibility that the animal was healthy if the test was negative. Prediction value for the positive result was 93,8 % and meant the possibility, that the animal was infected if the test positive. Using this method one would be able to treat presumably infected cat before getting the fungal culture results with the minimal risk of misdiagnosis if ELISA test would be positive (30). Unfortunately the test is not routinely available.

Clinical management of dermatophytosis

Dermatophytosis in healthy dogs and short-haired cats often undergoes spontaneous remission within 2 months (dogs) to 4 months (cats) (8, 31). Dermatophytosis in a horse with a few solitary lesions is often a self-limiting disease. When treated it usually takes 6 – 8 weeks to resolve. Kos and Kramarič reported on 4 cases that were clinically solved after 3 - 10 weeks of treatment (32).

Cats infected with *M. canis*, however, can undergo chronic infection and usually require aggressive therapy. Cats represent the main host for this fungus and *M. canis* is well adapted to them therefore when infected only minor inflammatory reaction evolves in the majority of cases. This is probably attributed to the fact that cats are often asymptomatically infected (1, 8, 25). Even longhaired cats can undergo spontaneous resolution but it may take 1.5 - 4 years (2). The goals of therapy are (1) to maximize the patient's ability to respond to the dermatophyte infection (by the correction of any nutritional imbalances and concurrent disease states and by the termination of systemic anti-inflammatory and immunosuppressive drugs), (2) to reduce contagion (to the environment, other animals, and humans), and (3) to hasten resolution of the infection. A critical feature of clinical management is the treatment of all dogs and cats in contact with the infected animal and the treatment of the environment (2).

Every confirmed case of dermatophytosis should receive topical therapy (2). In cats and dogs it is instructed that hair should be clipped from a wide margin (6 cm) surrounding all lesions. Although clipping may worsen and/or spread the lesions it is more important to get rid of infected hairs (8). Owners should use clippers at home since clipping in

the veterinary practice may contaminate the room (2). Clipping is not routinely instructed when treating dogs and cats at Veterinary faculty of Ljubljana. Although it is not necessary in all cases of dermatophytosis, clipping of the hair coat is optimum (10).

A wide variety of topical antifungals is available and there is no particular advantage of one product over another. Creams and lotions are available for use on focal lesions. For dogs with multifocal or generalized skin involvement and always in cats and horses, antifungal rinses (dips) are indicated. Rinses are preferred because the entire body surface can be treated, rubbing of the hair coat is minimized, and the antifungal agent can be allowed to dry on the skin. Lime sulphur (1:16), enilconazole and miconazole have been consistently effective and captan, chlorhexidine (as a single agent), and povidone iodine have been consistently ineffective antifungal agents. Sodium hypoklorite has shown mixed results (10). Chlorhexidine in combination to miconazole, however, expressed synergistic effect to *M. canis* (33). Topical medicaments should always be continued until two or preferably three fungal cultures at weekly intervals are negative (2).

Zoniton^{R} (enilconazole) solution for topical treatment is used at Veterinary faculty of Ljubljana. Though it is not registered for use in cats it has yet been in use for years. Clinically any serious side effects were noted. In two studies enilconazole was evaluated as a sole topical therapy (post whole body clipping) for the treatment of naturally occuring *M.canis* infection in Persian cats. The treatment twice a week has resolved infection in 4-5 weeks, whereas l' of placebo treated cats were still culture positive at end of 10 weeks of monitoring. Enilconazole was well tolerated but may have been associated with hypersalivation, anorexia, weight loss, emesis, idiopathic muscle weakness, and slightly elevated serum alanine aminotransferase (ALT) concentrations (34, 35).

Dogs and cats that have multifocal lesions, all longhaired animals, and those in multiple animal settings should receive systemic antifungal therapy. Animals that are not responding to topical therapy after a 2 to 4 week course of treatment should also receive systemic therapy (2). It is rarely necessary that systemic treatment should be used in a horse (4).

Griseofulvin is still the drug of choice in US but it has lately not been available in Slovenia. In Slovenia the registration for ketokonazole that is active against many fungi and yeasts, including dermatophytes, *Candida*, *Malassezia*, and numerous dimorphic fungi responsible for systemic mycoses has expired as well.

Itraconazole is a triazole and compared with ketokonazole, has increased potency, decreased toxicity, and wider spectrum of action. At low doses it is fungistatic and at higher doses fungicidal. Susceptible organisms include dermatophytes, *Candida* spp., *Malassezia*, those causing many intermediate and deep mycoses, *Aspergillus, Sporotrichum*, and the protozoans *Leishmania* and *Trypanosoma*. Doses for cats are 10mg/kg q12h-20mg/kg q48h. Doses for dogs are 5-10mg/kg/day. In two studies, using itraconazole as a sole therapy, 13 of 14 cats, either naturally or experimentally *M. canis* infected, were cured after 56 days (8 weeks) of therapy. One (naturally infected) cat has been cured after 70 days of therapy (36, 37). Anorexia, nausea, and hepatotoxicity are the primary side effects, while teratogenic effects haven't appeared at therapeutic doses. In Slovenia itraconazole in 100 mg capsules or 10 mg/ml oral solution (Sporanox^{R}) is available. In Austria veterinary product Itrafungol (10mg/ml) is available as an oral solution for dogs and cats.

Terbinafine is an allylamine that is well absorbed orally in the presence or absence of food. Terbinafine is active against dermatophytes, *Candida* spp., *Sporotrichum*, and *Aspergillus* spp. Latest research in dogs shows the activity against Malassezia yeasts as well (38, 39). The major side effects are gastrointestinal. No embryonic or fetal toxicity or teratogenicity has been demonstrated. Effect of terbinafine in humans is fungicydal while terbinafine in veterinary infections exhibits primary cidal activity against only 66% of *Microsporum canis* isolates but almost complete cidal effect in *Trichophyton* (40).

In our study done at Veterinary faculty of Ljubljana three groups of cats were experimentally infected with *M. canis* and monitored for 120 treatment days. Two doses of terbinafine were compared with each other and untreated control group. There was no difference when low dose terbinafine (10-20 mg/kg) was compared with the untreated control group. The cats receiving high dose terbinafine (30-40 mg/kg) were considered cured after > 120 days (16 weeks) of therapy (41). Eleven of 12 naturally infected cats, treated with terbinafine 30 mg/kg once daily for 14 days, were cured in 60-90 days (8-12 weeks) (42). In one study 41 naturally *M. canis* infected dogs and 24 naturally *M. canis* infected cats were treated with terbinafine at a dose of 10-30 mg/kg once daily. The mean length of therapy for mycological cure for

dogs was 53 days (21-126) and 63 days (28-84 days) for cats (43). Even in prolonged treatments with terbinafine no resistance of fungi is expected (42). One should use higher doses (30-40 mg/kg every 24 h) and expect longer treatment courses in *M.canis* infection compared to other dermatophytoses, as it should be expected also in children with tinea capitis (12 weeks of treatment with 60% healed) (10, 44).

Clinical management of dermatophytoses in ruminants is successfully implemented through chemoprophylaxis. Vaccines that are most often used in Slovenia nowadays for this purpose are Trihoben^{R} (Bioveta, Chech Republic) and InsolTrichophyton^{R} (Intervet, Netherlands).

Optimum treatment protocol for dogs and cats

According to recommendations the optimum treatment protocol for dogs or cats with dermatophytosis involves a combination of clipping of the hair coat, twice a week topical antifungal therapy, concurrent systemic antifungal therapy, and environmental decontamination. Fungal culture monitoring should be performed every 2-4 weeks until mycological cure (two or three negative consecutive fungal cultures) (10).

Prevention of infection

After resolution of infection animals and humans remain immune to re-infection for the certain period of time. The longest immunity persists at the skin of the previous infected site (45) while general immunity in cats can last at least 8 months (46). Based on the results of one study delayed intradermal testing (IDT) with *M. canis* extract can be used to asses the cellular immune response of cats with dermatophytosis (47). For prevention as resolution polymorphonuclear neutrophils and macrophages are undoubtedly responsible (3). Unfortunately killed or recombinant vaccines don't protect animals against experimental infection nor they allow the vaccinated animals to recover more quickly than the control ones (3).

Several commercial vaccines against feline dermatophytosis are available but their prophylactic efficacy has not been reported (10). In contrast vaccination against ringworm in other species (cattle, horses, fur-bearing animals) has been spectacularly successful in many countries. Their use has reduced the incidence of the disease in these animals considerably and indirectly contributed to the reduction of human infections. However these attenuated vaccines frequently induce small lesions at the injection site and subsequent dissemination of arthrospores into the environment. In a farm or a ranch situation, this may be of negligible consequence as long as all animals are included in the vaccination programme. However for cats which are generally housed indoors and have frequent and close contact with their owners, a live-fungus vaccine, able of producing active lesions, is highly undesirable because of the zoonotic hazard (3).

Environmental contamination can be important source of recurrent or persistent infection in one household. In one survey 100% environmental contamination of air and surfaces was found where infected cats were kept but less than 50% environmental contamination was found where infected dogs were kept, showing that infected cats appear to cause substantial environmental contamination, and provoke a substantial presence of viable airborne fungal elements (48).

In the household harbouring infected dog or cat one can prevent spreading of infection to other inhabitants by strict environmental disinfection and personal hygiene measures (see treatment chapter). A part of routine management of a cat that have been found and adopted, should always be fungal culturing. Adopted animal should be quarantined till the results of culturing are obtained.

Environmental treatment

Environmental treatment is as important as animal treatment since fungal arthrospores can remain viable and contagious on infected hairs at least 18 months (6, 49). For environmental treatment of cats' and dogs' habitat chlorhexidine or enilconazole was prooved effective. In Slovenia chlorhexidine is available as a powder (Virkon-S^{R}, Krka) mixed in a 5% solution with water. We can also use enilconazole (Zoniton^{R}, Krka) mixed 20 ml with 1 L of water. The first treatment is more cost-effective. The textiles should be washed at minimum 50°C if possible (6).

Environmental treatment of stables and farm facilities is best executed with fungicydal desinfectants, like 3% kaptan, 3% kresol or 50% kalii peroxisulphate (Virkon-S^{R}, Krka) (32).

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DERMATOFITOZE PRI DOMAČIH ŽIVALIH S STALIŠČA ZOONOZ

T. Kotnik

Povzetek: V članku avtorica obravnava dermatofitoze pri domačih živalih s stališča zoonoz in s praktičnega stališča. Podatke o okužbah pri živalih primerja z izsledki raziskav pri ljudeh. Obravnava novejše humane in veterinarske raziskave o dermatofitozah s poudarkom na slovenskih. Članek razlaga, zakaj so od vseh vrst domačih živali ravno mačke glavni rezervoar okužbe za ljudi. Članek tudi pojasni, zakaj je mikrosporoza najteže obvladljiva med vsemi vrstami dermatofitoz.

Ključne besede: zoonoze–mikrobiologija; dermatomikoze–epidemiologija–prenos–patologija; rezervoarji okužbe; infekcija, nadzor–metode; psi; mačke; konji