ATTEMPTED TREATMENT OF TIGERS (*PANTHERA TIGRIS*) INFECTED WITH *MICROSPORUM CANIS*

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Published By: American Association of Zoo Veterinarians


URL: [http://www.bioone.org/doi/full/10.1638/1042-7260%282007%29038%5B0252%3AATOTPT%5D2.0.CO%3B2](http://www.bioone.org/doi/full/10.1638/1042-7260%282007%29038%5B0252%3AATOTPT%5D2.0.CO%3B2)

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ATTEMPTED TREATMENT OF TIGERS (PANTHERA TIGRIS) INFECTED WITH MICROSPORUM CANIS


Abstract: An outbreak of dermatophytosis caused by Microsporum canis occurred in tigers (Panthera tigris) at an exotic felid sanctuary in 2003. In an attempt to find an effective, practical, safe, and affordable method for controlling this epizootic, a clinical treatment trial was conducted. Nonalopecic tigers were studied to address the inapparent carrier state observed at the facility. The efficacy of three topical and environmental treatment combinations of a 2% lime sulfur solution and a peroxide-based cleaner were evaluated in nonalopecic, culture-positive tigers (n = 18) housed in four separate enclosures. Lime sulfur solution was applied topically to all of these animals. As a control, nonalopecic but culture-positive tigers (n = 6) housed in two other enclosures were not treated. Environmental treatments included lime sulfur solution (n = 1), a peroxide-based cleaner (n = 1), and no treatment (n = 2). All solutions were applied at 2-wk intervals for seven treatments. The 2% lime sulfur solution treatments were unsuccessful in resolving infections in most tigers. Lime sulfur was effective in suppressing environmental fungal growth immediately posttreatment, whereas the peroxide-based cleaner was not effective. A follow-up survey of all study tigers and their enclosures was conducted 2 yr later, at which time 22 of 24 tigers (92%) had attained resolution, defined as two sequential negative hair cultures. Review of the culture results during the clinical trial and follow-up study suggests that nonalopecic dermatophytosis in tigers that are housed outdoors may not warrant aggressive individual or environmental treatment, as the infection may clear with time.

Key words: Dermatophytosis, lime sulfur, Microsporum canis, Oxyclean®, Panthera tigris, tiger.

INTRODUCTION

Dermatophytosis is a fungal infection of the keratinized tissues of the skin. The most common agents causing dermatophytosis in domestic cats (Felis domesticus) are Microsporum canis, M. gypseum, and Trichophyton mentagrophytes, with M. canis most frequently isolated. Clinical signs in domestic cats include alopecia, erythema, and military dermatitis, and infections may resolve without treatment. However, cats may become asymptomatic carriers, requiring fungal cultures to identify infected individuals. If all cats in infected, multi-cat households are not simultaneously treated and cured, the presence of undiagnosed infected animals may result in continuous transmission and re-infection of other cats. Additionally, spores of M. canis have been shown to persist in the indoor environment for up to 18 months. As a result, heavily infected catteries may require aggressive, multimodal treatment of cats and their environment to clear infections. Treatments used in domestic animals include topical sprays or baths, oral antifungal medications, and environmental fungicides or cleaners. Although a single case of clinical dermatophytosis caused by M. canis has been reported in a tiger, and all felids are reported to be susceptible, scant information exists on the clinical course and treatment for these infections in exotic felids.

During the early fall of 2003, three cases of dermatophytosis caused by M. canis were diagnosed in tigers (Panthera tigris) housed at an exotic cat sanctuary in eastern Tennessee. Two of these tigers presented with nondermatologic complaints. In those two cases, papular and military dermatitis, but not alopecia, were noted during physical examination. The third tiger had severe progressive alopecia. Microsporum canis was subsequently cultured from the environment in 48 of 103 (46%) inhabited cages and from 28 of 39 (72%) animals sampled during a facility-wide survey. Most of the animals in that survey were nonalopecic, indicating an inapparent carrier state existed at this facility. Because of the presence of inapparent carriers, the number of infected animals, and the infectious and zoonotic risks, a safe, effective and practical method of addressing this outbreak was needed.

This study was undertaken to determine and compare the efficacy of three combinations of lime sulfur or peroxide-based cleaner for treatment and control of nonalopecic dermatophytosis in tigers at the facility. The objective of this clinical trial was to determine a successful treatment regimen that...
could then be expanded to treat large numbers of animals at the facility.

MATERIALS AND METHODS

Animals

At the time of this study, the facility housed 190 exotic felids, including tigers, lions (P. leo), ligers (lion–tiger crossbreeds), clouded leopards (Neofelis nebulosa), leopards (P. pardus), cougars (Felis concolor), and bobcats (F. rufus) in 103 cages. These animals were obtained from various sources, including other sanctuaries, circuses, and private owners. The ancestry of most animals was unknown. All enclosures were entirely outdoors, with the exception of the clouded leopards and some black leopards, which had both indoor and outdoor areas. Enclosures consisted of chain-link fencing of appropriate height or with ceilings, depending on the species being housed (Fig. 1). The substrate was natural, consisting of soil and grass, and most enclosures contained trees and other plants. Each enclosure contained at least one wooden platform with a sloped roof, and at least one shift per animal, which ranged in size from $1 \times 2 \times 1.3$ m to $2 \times 2 \times 1.3$ m. These shifts were entirely enclosed, made of an open-wire framing with a wood floor and ceiling. All shifts were equipped with heating pads and animals were routinely contained in them while being fed or when the caretakers serviced the yard.

Twenty-four tigers, in six enclosures, were selected for participation in this study based upon the lack of outward clinical signs (i.e., broken hairs or alopecia), having one M. canis–positive hair culture from the initial survey performed 4 mo previous to this study, and the caretakers’ ability to obtain hair samples without general anesthesia (i.e., aggressive or shy animals were not chosen for this study). Four treatment groups (groups 1–4; 18 total individuals) and two control groups (groups 5 and 6; 6 total individuals) were established (Table 1). All tigers in the treatment groups were housed in single-species groups of four or five. The tigers in the control groups were housed in multi-species groups (tigers, lions, and one liger) of five or more, though the other species were not cultured or included in this study. Serum samples from at least two individuals in each group tested negative for
the presence of feline leukemia virus (FeLV) antigens and feline immunodeficiency viral (FIV) antibodies prior to the initiation of the study. The following protocol was approved by The University of Tennessee Animal Care and Use Committee (Protocol No. 1401).

**Fungal culture technique**

Environmental samples were collected by swabbing the area to be sampled with a gauze sponge, which was blotted onto dermatophyte test medium (DTM; BBL® Becton, Dickinson and Company, Sparks, Maryland 21152, USA). Each enclosure was sampled in two locations at each sampling time: a wooden platform within the enclosure and the wooden floor of a shift. These sites were chosen because the animals frequently rested in both areas and shed hair could be reliably found at each sampling time. Individual animal samples were obtained by plucking hair from the animal and placing the hair on DTM. These samples were most often obtained by plucking hair from the animal and placing the hair on DTM. These samples were most often plucked from the cheek and neck area as the tigers rubbed against wire of the shift cage, though samples were occasionally obtained from other sites on the animals’ trunk. A new exam glove was worn for collection of each sample to minimize cross-contamination.

Plates were incubated under darkened conditions at room temperature (22.2–23.9°C) for up to 2 wk. Colonies suspicious for dermatophytes (white colonies with media color change) were examined microscopically with the use of clear cellophane tape and lactol phenol blue. Colonies were identified as *M. canis*, *M. gypseum*, or nondermatophyte based on morphology of the macroconidia. Only cultures that were not overgrown and from which *M. canis* was isolated were considered positive. During the preliminary study, *M. gypseum* was not associated with clinical signs; therefore, during the present study it was considered an environmental contaminant.

**Clinical trial**

All cats in groups 1–4 were treated topically with 2% lime sulfur solution (1.9–3.8 L/tiger; LymDyp®, DVM Pharmaceuticals, Inc., Miami, Florida 33137, USA), repeated every 2 wk for seven treatments, while the animals were confined in their shift. Treatments were applied until the hair was thoroughly wet and animals were not released from the shifts until their hair had air-dried. The first four treatments were applied with the use of a pump-action garden sprayer (Ortho® Grab & Go® sprayer, The Scotts Co., Marysville, Ohio 43041, USA). Because of rapid deterioration of the sprayers from the lime sulfur solution, the final three treatments were applied with the use of a pesticide sprayer attached to the end of a hose (Ortho® Dial-N-Spray® Multi-use Hose End Sprayer, The Scotts Co., Marysville, Ohio 43041, USA). Treatments were discontinued after the seventh treatment because of the onset of cold weather.

Environmental treatments were as follows: Group 1—entire enclosure was treated with the 2% lime sulfur solution (0.1–0.2 L/m³); group 2—entire enclosure was treated with OxyClean® (0.1–0.2 L/m³; Orange Glo International, Inc., Littleton, Colorado 80161, USA), a peroxide-based disinfectant, at a concentration of 28 mg/L; group 3—enclosure was not treated, but animals were moved to an uncontaminated enclosure (confirmed by negative culture results prior to moving the animals) after the third treatment; and group 4—no environmental treatment was performed. Environmental treatments for groups 1 and 2 were applied with the use of the same sprayers used for individual animal treatments (Table 1). Neither the individual tigers nor the enclosures of the control groups were treated.

Individual hair and enclosure environmental samples were obtained and incubated as described above just prior to treatment every 2 wk. To further evaluate the efficacy of these environmental treatment products, additional environmental samples were collected as previously described immediately posttreatment, for groups 1 and 2, following the fifth and sixth treatments. Resolution, for both individual animals and enclosures, was defined as two sequential samples in which *M. canis* was not isolated.

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Table 1. Age ranges and treatments for six groups of tigers (*Panthera tigris*) in a treatment trial for *Microsporum canis* infection.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of individuals</th>
<th>Ages (yr)</th>
<th>Topical treatment</th>
<th>Enclosure treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>LSS*</td>
<td>LSS</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>1–9</td>
<td>LSS Oxyclean®</td>
<td></td>
</tr>
<tr>
<td>3*</td>
<td>5</td>
<td>1.5</td>
<td>LSS None</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>3</td>
<td>LSS None</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>1.5</td>
<td>None None</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>1.5</td>
<td>None None</td>
<td></td>
</tr>
</tbody>
</table>

* Two percent lime sulfur solution (LymDyp®, DVM Pharmaceuticals, Inc., Miami, Florida 33137, USA).

* OxyClean® (Orange Glo International, Inc., Littleton, Colorado 80161, USA) applied at a concentration of 28 mg/L.

* This group was moved to a noncontaminated enclosure after the second treatment.
Table 2. Presence of *Microsporum canis* in the environment and hair samples from a group of tigers (*Panthera tigris*; group 4) individually treated topically with a 2% solution of lime sulfur solution every 2 wk for seven treatments. No treatment of their environment was performed.

<table>
<thead>
<tr>
<th>Sample source</th>
<th>Pretreatment</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Jul 30&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Tiger 1</td>
<td>Pos&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Ov&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Tiger 2</td>
<td>Pos</td>
<td>Pos</td>
</tr>
<tr>
<td>Tiger 3</td>
<td>Pos</td>
<td>Pos</td>
</tr>
<tr>
<td>Tiger 4</td>
<td>Pos</td>
<td>Pos</td>
</tr>
<tr>
<td>Deck</td>
<td>Pos</td>
<td>Pos</td>
</tr>
<tr>
<td>Shift</td>
<td>NS&lt;sup&gt;e&lt;/sup&gt;</td>
<td>Ov</td>
</tr>
</tbody>
</table>

<sup>a</sup> Sample date—samples were obtained 2 wk after each topical treatment in 2004.

<sup>b</sup> Pos—*M. canis* cultured.

<sup>c</sup> Ov—Overgrown culture plate.

<sup>d</sup> Neg—Sample negative for *M. canis*.

<sup>e</sup> NS—Sample not obtained.

Follow-up survey

Two years after the initial survey, two sequential cultures of individual hair samples were obtained from all animals that participated in the clinical trial, and two sets of environmental samples were obtained from each of their current enclosures. Sampling technique was identical to that used for the clinical trial. Groups 2 and 4 were housed in the same enclosures as during the clinical trial, and groups 1, 3, 5, and 6 were housed in different enclosures.

RESULTS

Clinical trial

No tigers or enclosures in groups 1, 2, 3, 5, or 6 attained resolution during the study, but there were 12 of 215 (6%) sporadic negative or overgrown cultures obtained from these groups. Three individuals in group 4 (no environmental treatment group) did attain resolution; however, one of these animals subsequently cultured positive for *M. canis* during the study (Table 2). Environmental samples for group 4 were consistently negative for *M. canis* after the fourth treatment (Table 2). The majority of the individual tigers tolerated the topical lime sulfur spray well and was easily treated. One cat did become quite agitated by the topical spraying, but it was still possible to complete the treatments.

Immediate posttreatment environmental samples of the group 1 (lime sulfur) enclosure were negative, but both posttreatment samples from the group 2 (Oxyclean<sup>®</sup>) enclosure were positive for *M. canis*.

One individual in one of the control groups (group 5, tiger 21, 2.5 yr old) became severely alopecic 1 yr after the conclusion of the clinical trial. *M. canis* was cultured from hair samples, and the animal was treated with itraconazole (Itacon, Unison Laboratories Co., Ltd., Bangkok, Thailand; 5 mg/kg p.o.) daily for 2 wk, then twice per week for 3 mo, with some improvement of its clinical signs. In addition, the other animals in that enclosure, although not alopecic, were also culture positive for *M. canis* at that time and were treated with itraconazole for 4 wk (5 mg/kg p.o., twice per week). No other animal in the study became alopecic or was treated for dermatophytosis between the end of the clinical trial and the follow-up survey.

Follow-up survey

Both sets of hair sample cultures were negative for *M. canis* in all but two individuals. Each of these cats was in a control group, one each from groups 5 and 6 (tigers 21 and 23). One environmental sample from the group 5 enclosure and one from the group 4 enclosure were also positive for *M. canis*. All other environmental samples were negative.

DISCUSSION

Though this is a limited study of one facility, some subjective conclusions may be drawn. Treating the outdoor environment may not be necessary in controlling this type of outbreak. Over the course of the clinical trial, fewer cats in group 4 cultured positive, and less contamination of the enclosure was found, despite no environmental treatment. Conversely, in the other treatment groups, which did not attain resolution, *M. canis* was consistently found in the enclosure regardless of environmental treatment. In addition, nearly all environmental samples were culture negative at the 2-yr follow-up study when >90% (22 of 24 animals) of the...
individuals’ cultures were also negative. The single positive culture from the group 4 enclosure when all animals in that cage were negative is difficult to explain, though it may represent a contaminant from a nearby enclosure containing culture-positive animals. Thus, in this facility, the culture status of the environment appears to be a reflection of the status of the animals housed in the enclosure, and may not be an important source for reinfection. This finding is similar to at least one study of M. canis infections in domestic cats. It is, however, in contrast to similar outbreaks in Persian cat catteries, where treating the environment is essential for eliminating clinical cases. One explanation for this difference is that the tigers in the current report are all housed outdoors, where wind, rain, freezing, and sunlight may facilitate dispersal or destruction of fungal spores, thereby decreasing the incidence of reinfection.

The presence of immune-suppressing diseases, such as FeLV and FIV, may impede an animal’s ability to resolve dermatophytosis. Though not all tigers in the study were sampled, no evidence of the presence of either of these diseases was present in the tigers of this study. In addition, no other, nonstudy animal at this facility has tested positive for FeLV or FIV. Thus, it is unlikely either of these diseases influenced the course of dermatophytosis described in this report.

The lions and liger housed with the tigers of the control groups were not included in this study, as the preliminary facility-wide survey suggested dermatophytosis was more prevalent in tigers than in other species housed at the facility. In addition, the only cases of alopecia were in tigers (Sykes, unpubl. data) and some lions housed with culture-positive tigers were culture negative. The nontigers housed with the control groups could have served as additional nonapparent carriers, which may be an explanation for the lack of resolution in the control tigers. However, as all tigers in the study, control or treated, seem to clear the infection at a similar rate, it does not seem likely that the presence of nontigers in the control groups affected the results of this study.

Lime sulfur killed this strain of M. canis, as evidenced by the negative immediate posttreatment environmental samples, whereas Oxyclean, using the same criterion, was apparently ineffective. However, topical lime sulfur applied every 2 wk was unsuccessful in treating most infected tigers in this study. This failure may be due to the potentially inadequate duration of treatment, the long interval between treatments, inefficacy of the product as the sole topical therapy, incomplete application or penetration of the product, continuous reinfection via fomites or wild animals, or the young age of the subjects.

The strategy used in this study was chosen for practical, cost, and safety concerns. Lime sulfur has been shown to be effective in killing M. canis spores in vitro, is safe enough to use on kittens, and is readily available and inexpensive. The original goal was to determine a method of treatment that could then be expanded to the entire facility. As no successful treatment was found, and no animals were alopecic the summer following the clinical trial, treatment of the entire facility was not pursued. Alternative treatment options considered for this study included more frequent topical application of lime sulfur solution, systemic administration of antifungal medications, or some combination of topical and systemic treatments. In retrospect, more frequent application of the product may have been more effective, but was not initially pursued due to time constraints of the caretakers and the concern that frequent application would irritate the animals, resulting in their refusal to enter the shifts. Shaving the animals may have provided deeper penetration of the product, but would have required general anesthesia and was considered unpractical on a large-scale basis. Systemic antifungal medications are either expensive (e.g., itraconazole and terbinafine) or carry significant risks of adverse effects (e.g., ketoconazole or griseofulvin), and thus were not practical options for treating large numbers of large cats.

In cases where animals were culture positive for M. canis, but no alopecia was noted, simply waiting for the infections to clear without treatment seems to have been successful. This success is most likely due to the aging of young cats in the collection, although an alternate explanation is that all cats simply cleared the infection on their own with time, regardless of their age at the time of infection. Disadvantages of this strategy include a continued risk of zoonotic infection, infection of young animals added to the collection, contamination of medical supplies or hospital areas when treating inapparent carriers, and the potential for reinfection via fomites or wild animals. Currently, only alopecic animals are treated at this facility, as described above for Tiger 21, with satisfactory resolution of clinical signs in most affected individuals. Caretakers and veterinary staff are advised to wear protective clothing and avoid unnecessary physical contact with suspected infected individuals.

Acknowledgments: We thank Mary Lynn Roberts, Deborah Wilkins, and the entire staff at Tiger
Haven for their support of this project. LymDyp® was generously donated by DVM Pharmaceuticals, Inc., Miami, Florida. Thanks to Dr. Sargent and Dr. Hnilica for assistance and advice during the initial investigation and to the Microbiology Laboratory at The University of Tennessee College of Veterinary Medicine, particularly Polly Giffen, for providing the culture media and diagnostic support.

LITERATURE CITED


Received for publication 16 August 2006