Panniculitis attributable to *Mycobacterium goodii* in an immunocompetent dog in Georgia

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### Case Description
A 5-year-old 38.3-kg (84.5-lb) mixed-breed dog was examined because of a 2-day history of lethargy and anorexia. The dog was overweight (body condition score, 4.5; scale, 1 to 5), but no other abnormalities were detected during physical examination. Results of hematologic analysis, including a CBC and routine biochemical analysis, were unremarkable. Because the dog was lethargic, and because the owner’s other dog had previously been treated for *Rickettsia rickettsii* (ie, Rocky Mountain spotted fever), a PCR assay was performed to detect *Anaplasma phagocytophilum*, *Anaplasma platus*, *Babesia gibsoni*, *Babesia canis*, *Bartonella henselae*, *Bartonella vinsonii*, *Borrelia burgdorferi*, *Ehrlichia spp*, *Mycoplasma hemocanis*, *Mycoplasma hematoparvum*, *Neorickettsia risticii*, and *R rickettsii*; results were negative for all organisms. Four days later, a raised, firm, warm 15 × 10-cm mass was detected in the right caudal paralumbar area. The skin and hair overlying the mass appeared grossly normal, and the lesion was only detectable by palpation. An aspirate of the

### Clinical Findings
Cephalexin treatment yielded a poor response. Formalin-fixed tissue and fluid samples from the cystic areas of the lesion were submitted for cytologic and histologic examinations, routine bacterial and mycobacterial culture, and genus identification and 16S partial sequencing via PCR assays. Cytologic examination revealed chronic pyogranulomatous inflammation. Histologic examination by use of routine, Giemsa, silver, acid-fast, and modified acid-fast stains revealed multifocal nodular granulomatous panniculitis without identifiable organisms. Mycobacteria were initially identified via PCR assay and mycobacterial culture within 3 days. *Mycobacterium goodii* was speciated by use of partial 16S RNA sequence analysis.

### Treatment and Outcome
The lesion resolved after long-term treatment with a combination of rifampin and clarithromycin and insertion of a Penrose drain. There has been no recurrence of the condition.

### Clinical Relevance
*M. goodii* is an environmental rapidly growing mycobacterium and is a zoonotic pathogen. Infections have not been previously reported in domestic animals in North America, although there are rare reports of infection in humans associated with surgery, especially surgical implants. Domestic animals are a potential sentinel for this non-tuberculous mycobacterial infection in humans, although lack of speciation in infections of domestic animals likely underestimates the potential public health importance of this pathogenic organism. Current microbiological molecular methods allow for a rapid and inexpensive diagnosis. (J Am Vet Med Assoc 2010;237:1056–1059)

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**Abbreviations**

<table>
<thead>
<tr>
<th>KB</th>
<th>Kirby-Bauer</th>
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<tr>
<td>MIC</td>
<td>Minimum inhibitory concentration</td>
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<tr>
<td>RGM</td>
<td>Rapidly growing mycobacteria</td>
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A 5-year-old 38.3-kg (84.5-lb) spayed female mixed-breed dog was examined by a veterinarian because of acute onset of lethargy and anorexia. Four days later, a raised, firm, warm 15 × 10-cm lesion was detected in the right caudal paralumbar area.

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space outlined by a thick connective tissue capsule was detected. A stab incision into the capsule released approximately 200 to 300 mL of serosanguineous fluid containing pieces of tissue. A swab specimen was collected for microbial culture and PCR assay, and a fluid sample was collected for cytologic examination. Two unstained slides of direct smears of cystic fluid were prepared. Samples of the capsule and tissue pieces contained in the serosanguineous fluid were collected and placed in neutral-buffered 10% formalin for 48 hours for histologic examination. The cyst continued to drain a substantial amount of fluid; therefore, a Penrose drain was placed to facilitate fluid removal. The Penrose drain was anchored dorsally and positioned to exit through the dependent portion of the cyst and the skin incision. The incision was closed over the Penrose drain in 3 layers.

In our laboratory, the aspirate swab specimen was placed on blood agar and MacConkey agar plates and Lowenstein-Jensen slants, which were then incubated aerobically at 37°C. Three days after inoculation, there was light growth of pigmented colonies on the slants. Growth was not observed in any other media used for microbial culture. Special stains were used to confirm the colonies were formed by gram-positive acid-fast rod-shaped organisms. The mycobacterium pure isolate derived from the growth visible on the mycobacterial media; DNA was extracted by use of the DNA isolation kit.* The resulting sequences were analyzed by use of sequencing software. Both strands (forward and reverse) had high similarity (99%) with the 4 Mycobacterium goodii sequences (AF513815.1, EU868812.1, AY457079.1, and Y12872.1) contained in the GenBank database. Further confirmation was deemed necessary, and mycobacterial samples were sent to a human laboratory facility. Results for 16S partial sequencing (different primers; data not shown) revealed an exact match (100%) with that for M. goodii.3

Direct smears were routinely stained with a modified Wright stain for cytologic examination, which revealed high cellularity with a mixed population of cells composed primarily of degenerate neutrophils and macrophages. Macrophages were individual (rather than in sheets or clusters) and variably vacuolated, and leukophagia was evident in a few macrophages (Figure 1). An occasional plump fibrocyte was detected. A few pleomorphic lymphocytes and plasma cells were seen. The background contained blood and lysed cells, but infectious organisms were not found. The cytologic diagnosis was chronic pyogranulomatous inflammation.

Formalin-fixed tissues were routinely processed for histologic examination, which revealed that the tissue contained primarily adipose tissue that was being replaced and infiltrated by a mixture of inflammatory cells arranged in coalescing nodules. Inflammatory cells were a mixture of neutrophils, plasma cells, and macrophages, with few mast cells (Figure 2). There were multiple areas of fibrosis that dissected through adipose tissue or surrounded areas of hemorrhage. One small area of skeletal muscle was detected within the adipose tissue; the skeletal muscle had scattered inflammatory cells in the endomysial space between myofibers. All special stains for fungal, yeast, mycobacterial, and bacterial agents, specifically Giemsa, silver, acid-fast, and modified acid-fast stains, yielded negative results. The histopathologic

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Table 1—Results of antimicrobial susceptibility tests for Mycobacterium goodii determined by use of the KB and broth microdilution methods.

<table>
<thead>
<tr>
<th>Antimicrobial</th>
<th>KB zone (mm/interpretation)*</th>
<th>Microdilution ([µg/mL]/interpretation)†</th>
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<tbody>
<tr>
<td>Ertapenem‡</td>
<td>ND</td>
<td>4/I</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>30/S</td>
<td>≤ 0.12/S</td>
</tr>
<tr>
<td>Linezolid</td>
<td>ND</td>
<td>2/S</td>
</tr>
<tr>
<td>Imipenem</td>
<td>54/S</td>
<td>4/S</td>
</tr>
<tr>
<td>Meropenem†</td>
<td>24/S</td>
<td>4/S</td>
</tr>
<tr>
<td>Cefoxitin</td>
<td>24/S</td>
<td>8/S</td>
</tr>
<tr>
<td>Amikacin</td>
<td>&gt; 40/S</td>
<td>≤ 1/S</td>
</tr>
<tr>
<td>Sulfamethoxazole</td>
<td>ND</td>
<td>≤ 2/S</td>
</tr>
<tr>
<td>Doxycycline</td>
<td>58/S</td>
<td>≤ 0.25/S</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>40/S</td>
<td>0.5/S</td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole</td>
<td>50/S</td>
<td>≤ 0.25 and 4.75/S</td>
</tr>
<tr>
<td>Moxifloxacin</td>
<td>ND</td>
<td>≤ 0.08/S</td>
</tr>
<tr>
<td>Tigecycline</td>
<td>ND</td>
<td>0.06/NA</td>
</tr>
<tr>
<td>Minocycline</td>
<td>50/S</td>
<td>ND</td>
</tr>
<tr>
<td>Ofloxacin</td>
<td>30/S</td>
<td>ND</td>
</tr>
<tr>
<td>Kanamycin</td>
<td>&gt; 40/S</td>
<td>ND</td>
</tr>
<tr>
<td>Sulfadoxine</td>
<td>60/S</td>
<td>ND</td>
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* This is not a Clinical and Laboratory Standards Institute (CLSI) standardized method. † This method and the breakpoints have been approved by the CLSI. ‡ The MIC is interpreted by use of CLSI criteria for bacteria because susceptibility is not standardized for mycobacteria.

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Figure 1—Photomicrograph of a cytologic specimen obtained from a raised, firm lesion in the right caudal paralumbar area of a dog with acute onset of lethargy and poor appetite. Inflammatory cells are primarily degenerate to pyknotic neutrophils with few foamy macrophages. Notice the leukophagocytic macrophage (arrow). Modified Wright stain; bar = 10 µm.
diagnosis was multifocal to coalescing nodular pyogranulomatous panniculitis with reactive fibroplasia.

On the basis of results of the MIC testing, the dog was administered a regimen of rifampin (16 mg/kg [7.3 mg/lb], PO, q 24 h) and clarithromycin (15 mg/kg [5.9 mg/lb], PO, q 12 h). The dog responded well to treatment, with gradual and continuous improvement of the draining tract. After the dog had received the rifampin and clarithromycin for 11 weeks, the Penrose drain was removed; the lesion healed completely 2 weeks later. Antimicrobial treatment was continued for 9 months. The dog has not had a recurrence of the condition or any clinical signs of infection or immunosuppression.

**Discussion**

Mycobacteria are aerobic non–spore-forming nonmotile gram-positive acid-fast bacillary organisms. Classification of infection in dogs is generally divided into 3 categories on the basis of growth in culture: slow-growing organisms, organisms that cannot be cultured, and RGM that readily multiply. The latter cause nontuberculous clinical disease, most commonly mycobacterial panniculitis but also pyogranulomatous pneumonia, or, more rarely, disseminated systemic disease in immunocompromised animals. Mycobacterial panniculitis attributable to RGM is uncommon, with a total of 20 affected dogs reported in the literature. Various organisms have been implicated in mycobacterial panniculitis, and these differ by geography. A total of 9 animals with mycobacterial panniculitis in Australia included 5 with Mycobacterium smegmatis, 3 with Mycobacterium fortuitum, and 1 with M. goodii and concurrent hyperadrenocorticism. The 11 affected animals in the United States comprised 6 with M. fortuitum and 5 with Mycobacterium chelonae. To our knowledge, infection with M. goodii has not previously been reported in a dog in North America.

In contrast to most other mycobacterial species, RGM are ubiquitous and can be isolated from soil, dirt, or water (including tap water). They are generally considered to be of low virulence in mammals, and most infections are attributed to local trauma in an immunocompetent host. Most infections in dogs are characterized as nonpainful chronic nonhealing wounds that do not respond to conventional antimicrobial treatment. Affected dogs are not typically systemically ill, but they may have a history of local trauma or a recent injection in sites such as the neck, shoulders, flank, or dorsum. Similar to most mycobacteria, RGM have a preference for lipid-rich tissues; therefore, subcutaneous panniculitis and infection are more common in obese dogs.

The dog reported here had a slightly unusual medical history for mycobacterial panniculitis. The dog was extremely overweight (body condition score, 4.3/5) but did not have a history of local trauma or an injection. The clinical course was more rapid than typically reported, and the dog had systemic signs of illness (including lethargy and anorexia) prior to the development of a cutaneous lesion. However, similar to the situation in other affected animals, the infection responded to treatment with a combination of surgical intervention and prolonged use of appropriate antimicrobials.

Treatment for RGM may or may not involve surgery for debulking of the lesion but always requires long-term appropriate antimicrobial therapy. Response to treatment is variable, dependent on available medications, known species susceptibilities, and MIC on culture, but often is quite treatable with complete clinical resolution. Outcome was reported in 14 of the 20 previously listed cases, of which 11 were cured, 2 were lost to follow-up, and 1 had a recurrence. The solitary case report of cutaneous M. goodii infection in a dog completely resolved after surgical intervention, antimicrobial treatment, and treatment for concurrent Cushing’s disease.

In contrast to other mycobacterial conditions in dogs, such as leproid granulomas and tuberculosis, identification of organisms during cytologic and histologic examinations is uncommon. In other reports, cytologic examination was performed in 11 of the 20 affected animals and organisms were identified by use of an acid-fast stain only once. Histologic examination was performed in 12 affected animals, with organisms identified by use of an acid-fast stain in only 5 of those animals, including the one that had a positive result for the cytologic examination. In the solitary report of infection with M. goodii, organisms were identifiable by use of a Ziehl-Neelsen acid-fast stain during histologic examination, but organisms were not identifiable by use of acid-fast or Gram stains during cytologic examination. In the dog reported here, organisms were not detected during cytologic or histologic examinations despite multiple examinations of numerous tissue sections and use of a variety of special stains.

Infections with RGM in humans are not common and often are associated with wound infections, surgery, prosthetics, and implants. Improvements in molecular techniques and technological advances such as PCR assays and 16S RNA speciation have resulted in changes in taxonomy and the identification of more species of RGM, including M. goodii. Molecular tests such as PCR assays can be extremely specific and sensitive, which allows for detection and speciation of mycobacteria in clinical samples. Furthermore, these molecular techniques are becoming more user-friendly and cost-effective, which allows them to be used on a more regular basis in veterinary diagnostic laboratories.

The direct zoonotic risk from RGM is small, with only 1 clinical report of M. chelonae in a dog associated with subcutaneous implantation of the dog’s hair into the owner’s ankles as a result of chronic vigorous rubbing. That dog was never ill, and it was not determined...
whether the dog's hair in the subcutaneous tissues of the owner acted as a fomite or whether the dog's hair was actually colonized with mycobacteria. However, young, old, and immunocompromised humans are at increased risk for infection. Post-surgical wound infections attributable to RGM are often associated with implants, and a potential for zoonotic infection does exist.

Because of their close and prolonged physical contact with humans, dogs and cats are also a potential sentinel for epidemiological changes in mycobacterial infections in the human population as well as for changes in virulence and antimicrobial susceptibility. However, infections in domestic animals are not routinely specified, nor are cultured mycobacteria routinely tested for antimicrobial susceptibility in veterinary species. This is likely a result of a combination of cost and lack of a perceived need for treatment. However, speciation and antimicrobial susceptibility testing are essential for monitoring the epidemiological implications and potential public health impact of RGM.

Molecular identification of RGM is a rapid and reliable manner for identification of these organisms with regard to their species or group. The availability of cheap, fast, and reliable sequencing makes it the choice for veterinary laboratories, where there is a wide array of host species and clinical manifestations. In the dog reported here, results were obtained 7 days after submission of samples to the laboratory.

The antimicrobial susceptibility profile of the isolate of our report differs from that of other isolates cultured from humans and dogs in that the isolate of our report was susceptible to clarithromycin. Susceptibility to clarithromycin, although reported previously, is not common and has been used by some diagnostic laboratories to aid in the phenotypic identification of RGM. In the dog of our report, treatment with clarithromycin in combination with rifampin was tolerated well and had a favorable outcome. This highlighted the importance of identification of all mycobacteria to the species level as well as antimicrobial susceptibility testing to yield an appropriate treatment scheme.

To our knowledge, this is the first report of mycobacterial infection by M. goodii in any veterinary species in North America. Mycobacterial panniculitis is an extremely uncommon condition in dogs, but it is often amenable to surgical and medical management with complete resolution after appropriate and prolonged antimicrobial treatment. Because of their close contact with humans, dogs can serve as sentinels for organisms that cause infections in humans and for monitoring public health. Speciation of microbial isolates via modern techniques such as PCR assays and 16S rRNA partial sequencing is necessary for epidemiological studies of emerging diseases and should be encouraged in veterinary species with infections of potential zoonotic importance.

References