The Other Group G Streptococcus: Increased Detection of *Streptococcus canis* Ulcer Infections in Dog Owners[▽]

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β-Hemolytic Lancefield group G *Streptococcus dysgalactiae* and *Streptococcus canis* cannot be distinguished when only Lancefield typing is performed. Phenotypic testing and 16S rRNA gene sequencing identified *S. canis* associated with ulcer infections in dog owners. Because *S. canis* may be incorrectly identified (published biochemical descriptions are inconsistent), there may be an underestimation of the true number of infections. Identification of group G streptococci to the species level could have epidemiological and clinical implications.

CASE REPORTS

Case 1. A 53-year-old male owner of two large dogs had a history of diabetes mellitus complicated by peripheral neuropathy, impotence, retinopathy, and a previous amputation below the right knee for a nonhealing ulcer with osteomyelitis. He presented to his endocrinologist with a nonhealing left first metatarsal plantar ulcer. The 1.5-cm open ulcer had draining purulent material and was surrounded by a 2-cm rim of erythematous callused skin. The purulent material was sent for culture, and the predominant isolate was identified as *Streptococcus canis*. The ulcer was managed with multiple full-thickness debridements, continuous dermatology visits for 10 months, frequent dressing changes, and the use of a prosthetic shoe.

Case 2. An 80-year-old man, a dog owner with a history of diabetes mellitus with peripheral vascular disease, was admitted to the hospital for a gangrenous, blackened right first toe and cellulitis with associated ulcers on the adjacent toes. Significant, foul-smelling purulent material was expressed when pressure was placed on the toenail. The purulent material was sent for culture, and the predominant isolate was identified as *S. canis*. The patient was managed with vancomycin in the hospital and was discharged with 2 weeks of amoxicillin and clavulanic acid.

Case 3. A 75-year-old dog-owning man with a history of T-10 paraplegia secondary to a fall was admitted to the hospital with fever and chills. He had multiple medical problems, including bilateral lower-extremity edema with multiple open sores draining serosanguinous material and chronic osteomyelitis of the ischium secondary to a pressure sore. Attempts to cover the ischial sore with skin grafts had failed. Blood cultures drawn upon admission grew group G streptococci, which were identified as *S. canis* (susceptible to erythromycin and penicillin). Of interest, the patient had had a previous positive blood

culture for group G streptococci, which were not further identified, with the same antibiotic susceptibility pattern 2 months prior to this admission. He responded well to antibiotic therapy following treatment with clindamycin and ceftazidime.

Streptococcus canis was isolated in pure culture from the blood of patient 3, from the wound of patient 1, and associated with *Pasteurella multocida* from the wound of patient 2. Lancefield typing (Streptex; Remel Inc., Lenexa, KS); biochemical testing, which included catalase; and the Vitek 1, Vitek 2, and API 20 Strep identification systems (bioMérieux Vitek, Inc., Hazelwood, MO) were used for phenotypic identification. The Vitek 1 database, which was used in laboratories until 2005 and is still widely used, identified the first and third patients' isolates as *Streptococcus equi* subspecies *equi* at 99% probability. In contrast, the Vitek 2 system identified isolates from the first and second patients consistently as *S. canis*, with probabilities of 97% and 99%, respectively. The API 20 Strep system reported 98.7% identity (digit code, 0073005) twice to *S. canis* for the isolate from the first patient and 99.9% identity (digit code, 0273005) twice for the isolate from the second patient. These results and those reported in the literature for *S. canis* infecting animals and humans are compared in Table 1. Comparisons showed that all strains of *S. canis* were negative for the Voges-Proskauer reaction, hippuric acid hydrolysis, and production of acid from arabinose, mannitol, sorbitol, inulin, raffinose, starch, and glycogen and positive for the presence of β-galactosidase, alkaline phosphatase, leucine aminopeptidase, arginine dihydrolase, and acid production with ribose. Discrepant results occurred for the CAMP reaction, esculin hydrolysis, acid production from lactose and trehalose, and the presence of pyrrolidonyl arylamidase and β-glucuronidase.

Although the beta-hemolytic Lancefield group G and group C streptococci are often separated into large-colony (*Streptococcus canis* and *Streptococcus dysgalactiae*) or minute-colony (the "*Streptococcus milleri* group") types, the colony sizes of our isolates of *S. canis* were smaller than most *S. dysgalactiae* colonies both on primary plates and on subculture.

For all three strains, the rRNA gene sequence of the first 500 bp, obtained by the standard MicroSeq method, matched the type strain of *S. canis* at 99.6% (MicroSeq 500; Applied Biosystems Inc., Foster City, CA) (19).

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TABLE 1. Biochemical properties of *S. dysgalactiae* subsp. *equisimilis* and patient strains of *S. canis* and those reported in the literature for animal- and human-infecting strains of *S. canis*

Organism	Biochemical test result ^a							
	CAMP	ESC	PYRA	α-GAL	β-GAL	β-GUR	LAC	TRE
<i>S. canis</i> (patient 1)	—	—	—	—	+	—	—	—
<i>S. canis</i> (patient 2)	—	—	—	+	+	—	—	—
<i>S. canis</i> infecting animals (reported) ^b	+	+	—	+	+	V	V	V
<i>S. canis</i> infecting humans (reported) ^c	NR	—	+	+	+	—	+	—
<i>S. dysgalactiae</i> subsp. <i>equisimilis</i> ^d	—	+	—	—	—	+	NR	+

^a Abbreviations and symbols: CAMP, CAMP reaction; ESC, esculin hydrolysis; PYRA, pyrrolidonyl arylamidase; α-GAL, α-galactosidase; β-GAL, β-galactosidase; β-GUR, β-glucuronidase; LAC, acidification lactose; TRE, acidification trehalose; +, positive reaction; —, negative reaction; V, variable reactions reported in the literature; NR, not reported in the literature reviewed.

^b Adapted from references 9 and 10.

^c Adapted from references 1 and 18.

^d Adapted from references 9 and 18.

Antibiotic susceptibility testing with the Kirby-Bauer disk diffusion tests for bacitracin, rifampin, vancomycin, gentamicin, clindamycin, erythromycin, and imipenem and Etests for the MICs of penicillin G, ceftriaxone, and gatifloxacin were performed. The zone diameters and MICs of vancomycin, imipenem, clindamycin, erythromycin, bacitracin, penicillin G, ceftriaxone, and gatifloxacin were interpreted according to guidelines set by the Clinical and Laboratory Standards Institute (CLSI) for streptococcal species that are not *Streptococcus pneumoniae*. The zone diameters for rifampin and gentamicin were interpreted according to the guidelines set by the CLSI for staphylococcal species. The *S. canis* strains in this study were susceptible to erythromycin, vancomycin, imipenem, clindamycin, penicillin G, ceftriaxone, gatifloxacin, and rifampin, results which are similar to the antibiotic profiles of other group G streptococci (12, 16). In addition, our isolate from the first patient was resistant to gentamicin, while the isolate from the second patient was susceptible.

Large-colony-forming beta-hemolytic group G streptococci have been traditionally divided into human strains, which include *Streptococcus dysgalactiae* subspecies *equisimilis* (7), and animal strains, such as *Streptococcus canis* (4) and *Streptococcus dysgalactiae* subspecies *dysgalactiae*. Human group G streptococci have been extensively studied and have been found to cause pharyngitis, skin and soft tissue infections, arthritis, osteomyelitis, respiratory tract infections, endocarditis, meningitis, puerperal infection, neonatal sepsis, and bacteremia (12).

Despite its name, *S. canis* has been isolated from animals other than dogs, including cats, harbor porpoises, cows, mice, rats, and rabbits (3, 4, 10, 11). In healthy dogs, *S. canis* is found as commensal flora of the skin, oropharynx, genital urinary tract, and anus (5, 13, 17). However *S. canis* colonization is not completely benign, as it has also been implicated in canine diseases, including urinary tract infections, abortion, vaginitis, metritis, skin infections, necrotizing fasciitis, and a toxic shock syndrome (6, 14).

Rare cases of *S. canis* infection in humans have been reported in the literature (1, 15, 18). The portal of entry in one case was through a dog bite (15), while in a second case the portal of entry was suspected to be through leg ulcers of a dog owner (1). However, in the clinical setting, group G strepto-

cocci are not usually identified to the species level (9). In addition, laboratory tests have only recently been able to accurately identify *S. canis*. Thus, the true incidence of *S. canis* infection is unknown.

Although biochemical identification of *S. canis* can be problematic, as published results are inconsistent (different methods are used) and databases are incomplete, human “group G streptococci” are said to differ from animal strains in biochemical tests for β-galactosidase, α-galactosidase, β-glucuronidase, fermentation of trehalose, and CAMP reaction (7, 9, 18), which is in agreement with our patients’ strains. However, when the published results for human and animal strains of *S. canis* were compared to our patients’ strains, considerable variation existed. Most notably, the CAMP reaction; esculin hydrolysis; the presence of β-glucuronidase, α-galactosidase, and pyrrolidonyl arylamidase; and acid production from lactose and trehalose were variable. Facklam reported the biochemical profile for nonhuman strains of *S. canis* infections only and stated that it was unknown whether human strains have the same phenotypic characteristics (9). Similarly, Whatmore et al. separated their human isolates from animal-infecting strains of *S. canis* in a phenotypic comparison study. The nature of domestic animal contact for their patients was unknown, and they were unsure whether there could be particular isolates that preferentially infected humans rather than animals (18). Because we found phenotypic variation among our patient strains as well as with published results for *S. canis* strains infecting humans and animals, we speculate that there is no clear difference between the human and animal isolates. We believe that this is a zoonotic disease-causing organism. This is also supported by the fact that these infections were found in dog owners.

With the enhanced detection methods afforded by Vitek 2 and the API 20 Strep identification system, more wound infections due to *S. canis* are expected to be identified. For example, we isolated one *S. canis* organism during the period in which we reported 99 *S. dysgalactiae* subsp. *equisimilis* isolates. Of these 99 cases, 41 were from wounds; of these, 75% were identified as group G. Thus, about 3 to 4% of the group G isolates from wounds were *S. canis*. This increase in the number of *S. canis* wound infections may be misleading, resulting in the false conclusion that there is an emerging epidemic or an increase in the virulence of this organism.

In addition to phenotypically profiling our patient strains of *S. canis*, we examined their antibiotic susceptibility patterns. Although our test strains of *S. canis* were susceptible to erythromycin, several studies examining antibiotic susceptibilities in group G streptococci noted erythromycin resistance, with one study reporting a resistance rate as high as 23.5% (2, 8, 20). These studies identified their strains as group G streptococci based on serotyping through agglutination tests alone. In addition, one of our isolates was resistant to gentamicin, while a second isolate was susceptible. Although gentamicin is not a first-line antibiotic for streptococcal infections, resistance or intermediate sensitivity to gentamicin, as well as tetracycline, has been reported in *S. canis* animal infections (10). Thus, the true erythromycin and gentamicin resistance rates for *S. canis* are unknown at this time. While we do not recommend routine susceptibility testing of all *S. canis* isolates, the potential for resistance, especially with macrolides, may indicate the need for periodic surveillance for antibiotic resistance. The identification of *S. canis* could have epidemiological implications for antibiotic usage.

Finally, the identification of *S. canis* may have clinical implications for the care of patients with wounds, especially ulcers, as these patients should be counseled to avoid or minimize contact with dogs.

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