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SHORT PAPER

Rhinitis and Meningitis in Two Shelter Cats Caused by *Streptococcus equi* subspecies *zooepidemicus*

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Summary

In the past 6 years there have been increasing reports describing outbreaks of a severe fatal respiratory disease associated with *Streptococcus equi* subspecies *zooepidemicus* (SEZ) in dogs maintained in shelters, research facilities and kennels. Although SEZ appears to be an emerging pathogen of dogs kept in intensively housed environments, this bacterium has not been reported as a cause of death in intensively housed cats. This report describes fatal SEZ infection in two adult cats housed in separate animal shelter facilities. Both cats had acute onset of illness, which progressed to death in less than 24 h. Post-mortem examination revealed rhinitis and meningitis and SEZ was demonstrated in the nasal cavity and brain. Polymerase chain reaction and sequence analysis of a 500 base pair region of the 16S rRNA gene confirmed the identity of the bacterium.

Keywords: animal shelter; cat; meningitis; rhinitis; *Streptococcus equi* subspecies *zooepidemicus*

Streptococcal disease is common in both animals and man. Most streptococcal species are host specific with sporadic occurrence of disease, although outbreaks can occur where people or animals are housed in close confinement such as long-term care facilities and shelters for the homeless (Musher, 2003), barns (Radostits *et al*., 2000) and animal shelters (Pesavento *et al*., 2007). *Streptococcus equi* subspecies *zooepidemicus* (SEZ), a beta haemolytic, Lancefield group C streptococcal bacterium, is reported to be a mucosal commensal with a wide host range (Gyles *et al*., 2004). This organism is most commonly isolated from horses and in this species may be associated with pneumonia, pleuropneumonia, endometritis, arthritis, neonatal septicaemia, abortion, mastitis (Radostits *et al*., 2000) and meningoencephalitis (Pusterla *et al*., 2007).

SEZ has also been causally associated with outbreaks of mastitis in dairy sheep (Las Heras *et al*., 2002) and dairy goats (Pisoni *et al*., 2009), peritonitis in a llama (Hewson and Cebra, 2001), meningoencephalitis in a goat (Gibbs *et al*., 1981) and farmed red deer (De Lisle *et al*., 1988), pneumonia and wound infection in lambs (Gyles *et al*., 2004) and cervical lymphadenitis in guinea pigs (Gyles *et al*., 2004). SEZ is an important zoonotic organism that has been reported in association with septicaemia, pneumonia, arthritis and meningitis in people consuming contaminated milk products (Bordes-Benitez *et al*., 2006; Kuusi *et al*., 2006) or who were in contact with domestic animals, especially horses (Rose *et al*., 1980; Downar *et al*., 2001; Jovanic *et al*., 2008).

Although SEZ is reported to be commensal in a wide range of animals, it is not a recognized commensal of the dog (Bailie *et al*., 1978; Devriese *et al*., 1992) or the cat (Devriese *et al*., 1992). In the past 6 years there have been numerous reports of SEZ linked to outbreaks of acute onset severe fatal respiratory disease in large numbers of dogs maintained in shelters (Chalker *et al*., 2003; Pesavento *et al*., 2008; Slavinski, 2009), research facilities (Garnett *et al*., 1982; Kim *et al*., 2007) and kennels (Sundberg *et al*., 1981), suggesting that this bacterium is an emerging pathogen of dogs that are kept in intensively housed environments.

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SEZ infection has resulted in the death of thousands of shelter dogs. However, the bacterium has only been isolated from the spleen of one cat during a shelter outbreak of canine pneumonia and no lesions associated with the recovery of SEZ from the cat were described (Pesavento *et al.*, 2008). The present report describes rhinitis and meningitis from which SEZ was cultured in two cats housed in separate shelter facilities.

Two mature cats, a neutered female (cat A) and a neutered male (cat B), maintained in two separate cat rescue shelters in the Fraser Valley east of Vancouver, British Columbia, were presented in October, 2008 and March, 2009 to the Animal Health Centre for necropsy examination. The cats had been resident in their respective shelter homes for 3 and 9 months prior to the onset of illness and had been housed in a room with 15 and 10 other cats, respectively. The cats had been tested for feline leukemia virus (FeLV) and feline immunodeficiency virus (FIV) (IDEXX Snap FIV/FeLV Combo test) at the time of admission and were found to be negative. Neither cat, nor their attendants, had any known exposure to horses. Both cats had acute onset illness with vague clinical signs (cat A) and blindness (cat B) and died within 24 h. No other cats were similarly affected before, during or immediately after the deaths of cats A and B.

On necropsy examination both cats were in good body condition. Cat A exhibited periorbital crusting, purulent exudate in the nares, nasal passages, sinuses and larynx, pulmonary congestion and diffuse reddening of the femoral bone marrow. The carcase of cat B had been frozen and a post-mortem examination was conducted following thawing of the body. Cat B also exhibited reddening of the femoral bone marrow and pulmonary congestion. No abnormalities were noted on gross examination of the brain or the nasal passages. Tissues samples were fixed in 10% neutral buffered formalin, processed routinely and stained with haematoxylin and eosin (HE).

Microscopically, cat A exhibited a florid nasal luminal exudate of neutrophils intermixed with fibrin, sloughed epithelial cells and mucus (Fig. 1). The epithelium was intact, but attenuated in some areas. Submucosal inflammation comprised a mixed population of neutrophils, lymphocytes and plasma cells with macrophages. In some areas, the inflammatory process disrupted the underlying bone. Meningeal infiltration of neutrophils, lymphocytes, plasma cells and occasional macrophages intermixed with fibrin and oedema fluid was observed (Fig. 2). The inflammation tended to be more intense around blood vessels and extended into the underlying neuropil in some areas. In both the nasal passages and the meninges, gram-positive cocci arranged in pairs and chains

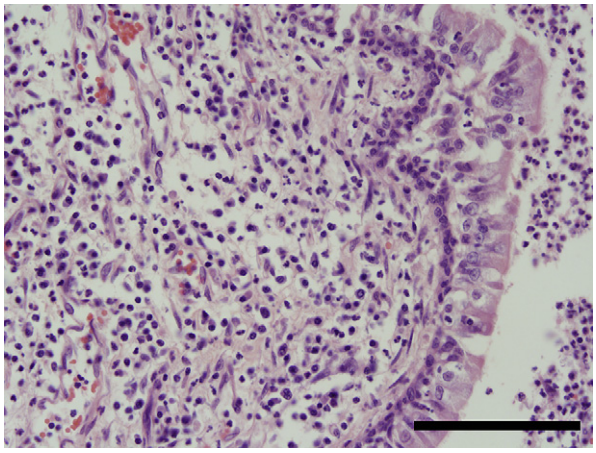

Fig. 1. Nasal cavity, cat A. Prominent mixed submucosal inflammation and suppurative luminal exudate. HE. Bar, 100 μm.

were demonstrated by Gram stain (Fig. 3). Staining of serial sections by periodic acid-Schiff (PAS) did not reveal the presence of fungi. Microscopical changes compatible with herpesvirus infection were not observed.

Microscopically, the tissues of cat B were affected by freeze artifact. Submucosal plasmacytic infiltration was observed in the nasal passages; however, there was no bone involvement or luminal exudation. Meningitis similar to that described for cat A was observed, but in cat B the meningeal inflammation also involved the optic nerve.

Organ samples including nasal swabs were cultured on blood agar. Heavy bacterial growth from the nasal passages of both cats and the brain of cat B and light growth from the lungs of both cats was identified as SEZ based on colony morphology, API 20 Strep (bioMérieux) biochemical reactions and the sequence of a 500 base pair region of the 5′ end

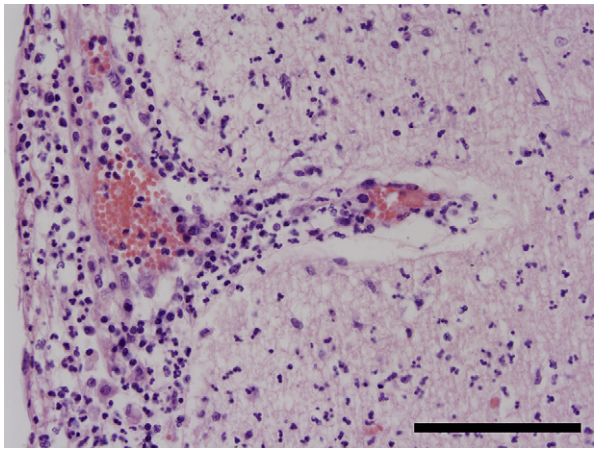

Fig. 2. Brain and leptomeninges, cat A. Diffuse expansion of the leptomeninges by a mixed inflammatory infiltrate that extends into the adjacent neuropil. HE. Bar, 100 μm.

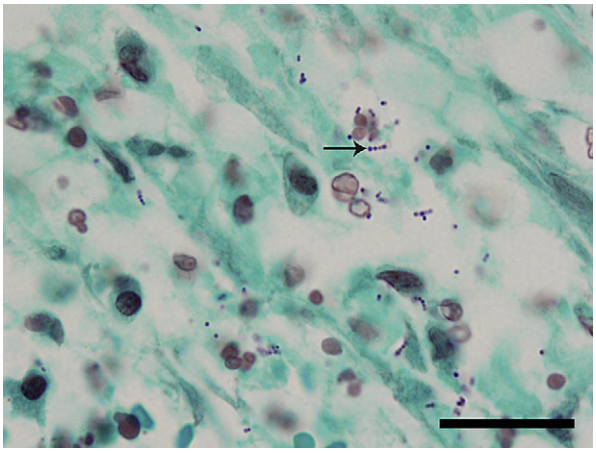

Fig. 3. Leptomeninges, cat A. Gram-positive cocci are arranged in pairs and short chains (arrow). Twort's Gram stain. Bar, 20 μm.

of the 16S ribosomal RNA gene (Lane, 1991). Brain tissue from cat A was not cultured, but gram-positive cocci in pairs and chains, typical of *Streptococcus* spp., were observed within the meningeal infiltrates (Fig. 3). Both cats were negative for feline calcivirus and feline coronavirus by conventional polymerase chain reaction (PCR) analysis of lung, nasal mucosa and brain. Cat A was positive for felid herpesvirus by conventional PCR, whereas cat B was negative.

Streptococcal species appear to be emerging pathogens of increasing importance in dogs and cats kept in intensively housed environments. This is evidenced by the increasing frequency of reported outbreaks of streptococcal disease in sheltered dogs reviewed above. The clinical presentation of the cats reported here is similar to two outbreaks of rhinitis, sinusitis and meningitis in shelter cats reported by Pesavento *et al*. (2007) from which *Streptococcus canis* was recovered. *S. canis* is a commensal of the cat found on both the skin and mucosal surfaces and is most commonly associated with bacteraemia in kittens (Greene, 2006). In the dog, *S. canis* is the most common streptococcal respiratory commensal (Chalker *et al*., 2003) and the most common streptococcal bacterium recovered from respiratory disease (Biberstein *et al*., 1980; Angus *et al*., 1997). These observations suggest that, similar to SEZ in horses, *S. canis* is a commensal that acts as an opportunistic pathogen in dogs and cats and, as such, sporadic disease and occasional outbreaks would be anticipated.

In contrast to *S. canis*, SEZ is not an established respiratory commensal of cats or dogs. Studies of canine and feline mucosal microflora failed to isolate SEZ from tonsillar, oral or nasal cultures of dogs (Bailie *et al*., 1978; Devriese *et al*., 1992) or from tonsillar cultures of cats (Devriese *et al*., 1992). Furthermore, SEZ is rarely isolated from dogs dying from respiratory disease, other than the severe haemorrhagic pneumonia described in shelter outbreaks (Biberstein *et al*., 1980; Angus *et al*., 1997; Chalker *et al*., 2003; Pesavento *et al*., 2008) and was not isolated from cats with chronic rhinitis or sinusitis (Johnson *et al*., 2005; Demko and Cohn, 2007). Thus residence in shelters, research laboratories and other facilities where close confinement of animals occurs appears to be the major risk factor for development of SEZ associated disease (Chalker *et al*., 2003; Pesavento *et al*., 2008). Why close confinement may predispose to SEZ disease is unclear. Coinfection with other respiratory pathogens and age and health of the animal on entry to the facility was unrelated to later colonization of the respiratory tract by SEZ in dogs (Garnett *et al*., 1982; Chalker *et al*., 2003; Pesavento *et al*., 2008). The rapid onset of severe SEZ pneumonia in shelter dogs suggests the introduction of either a high challenge or a virulent clone into an environment densely populated with susceptible hosts (Pesavento *et al*., 2008).

SEZ disease in shelter dogs has clinical similarities to the findings in these two shelter cats. The cats were asymptomatic upon admission to the shelter, no concurrent disease was identified and they exhibited rapid onset of clinical signs with death following shortly thereafter. Our report differs only in that there was not an outbreak of disease in the shelters and that expression of disease involved rhinitis with spread of infection to the brain rather than a primary pneumonia. Pesavento *et al*. (2007) described an outbreak of a similar disease syndrome in shelter cats associated with *S. canis* and whether rhinitis leading to meningitis might be a species-specific expression of streptococcal disease in the cat remains to be elucidated.

Streptococcal meningitis is described in both man and animals and is thought to occur most commonly as a result of bacteraemia and breaching of the blood-brain barrier (Hirst *et al*., 2004). However, spread of the bacterium from an inflamed nasal cavity along olfactory neurons to the brain has been demonstrated in mice experimentally infected with *Streptococcus pneumoniae* (Van Ginkel *et al*., 2003). In the two outbreaks of *S. canis* meningitis in shelter cats, osteolysis of the nasal bones and the cribriform plate was demonstrated, suggesting that meningitis likely occurred secondary to an olfactory route of bacterial spread from the sinuses and nasal passages through the cribriform plate (Pesavento *et al*., 2007). In the current report, bone pathology was associated with rhinitis in cat A and the heaviest growth of SEZ from organs was from the nasal passages and brain, suggesting a probable olfactory route of infection for the meningitis.

In summary, to the authors' knowledge this is the first description of SEZ disease in cats and infection

manifested as rhinitis and meningitis. The cats were the sole animals affected by the bacterium in their respective shelters. Both cats had been resident for several months in the shelter prior to the onset of disease and no source of infection was identified. SEZ infection should now be added to the list of differential diagnoses when shelter cats are presented to veterinarians with acute illness associated with upper respiratory and/or neurological signs. While SEZ infection is uncommon in people, it can be life threatening and the zoonotic potential should be taken into consideration when handling animals with suspected SEZ infection.

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