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Letter to the Editor

Inducible clindamycin-resistance in methicillin-resistant *Staphylococcus aureus* and methicillin-resistant *Staphylococcus pseudintermedius* isolates from dogs and cats

In veterinary medicine, reports of infections in dogs and cats caused by methicillin-resistant *Staphylococcus aureus* (MRSA) (Walther et al., 2008; Weese et al., 2006) and methicillin-resistant *Staphylococcus pseudintermedius* (MRSP) (Schwarz et al., 2008; Wettstein et al., 2008) have been described and appear to be increasingly common. In order to treat these infections, clindamycin may be selected because of its antimicrobial activity and the variety of infections it can be used to treat. However, an inducible form of clindamycin-resistance may be present in some staphylococci. These staphylococcal strains appear susceptible on routine antimicrobial susceptibility testing, but resistance can be induced during treatment, possibly resulting in treatment failure (Swenson et al., 2007; Yilmaz et al., 2007). Detection of inducible clindamycin-resistance can be performed using the *D*-test. However, to our knowledge, this test is not routinely performed in commercial veterinary diagnostic laboratories. Here we describe the first study to report the occurrence of inducible clindamycin-resistance in MRSA and MRSP isolates from dogs and cats in North America and typing data associated with inducible resistance.

Sixty-two MRSA and 46 MRSP isolates, from dogs and cats, collected from veterinary practices, diagnostic laboratories, and teaching hospitals, during 2006–2008 were investigated. All isolates were tested for susceptibility to erythromycin 15 μg (Oxoid, Hants, UK) and clindamycin 2 μg (Oxoid, Hants, UK) using the disk diffusion method (Bauer et al., 1966) as per Clinical Laboratory Standards Institute (CLSI) guidelines (NCCLS, 1999). Inducible clindamycin-resistance was evaluated by *D*-test as described by Yilmaz et al. (2007). Positive and negative controls were tested concurrently. Isolates identified with positive *D*-tests were typed via pulsed-field gel electrophoresis (PFGE) using the method described by Mulvey et al. (2001).

Results of the erythromycin and clindamycin susceptibility testing and *D*-test are presented in Table 1. Overall, a positive *D*-test was observed in 17.7% (11/62) of MRSA isolates and 0% of MRSP isolates. Fifty-eight percent (11/19) of MRSA isolates that were reported as erythromycin-resistant but clindamycin-susceptible had inducible clindamycin-resistance. All inducibly resistant MRSA isolates were the Canadian epidemic MRSA-2 (CMRSA-2) clone, a sequence type 5 clone that is also classified as USA100. For the eight erythromycin-resistant/clindamycin-susceptible isolates that were not inducibly resistant, four were CMRSA-2 (USA100) and four were CMRSA-10 (USA300).

The prevalence of inducible resistance identified in MRSA isolates in the present study (17.7%) was similar to reported rates from the human medical literature of 12.3% (Levin et al., 2005) to 24.4% (Yilmaz et al., 2007). This is not surprising considering MRSA strains found in pets tend to reflect those present in humans, and all isolates identified in animals in this study were recognized human epidemic clones. However, the prevalence of inducible resistance was considerably lower than that documented by Rich et al. (2005) of 37.5% (107/285). This disparity in the prevalence of inducible clindamycin-resistance between these two studies may be a result of the differences in the number of MRSA isolates analyzed, the possible evaluation of multiple MRSA isolates from the same animal in the earlier study, or difference in MRSA strains, since the study of Rich et al. (2005) involved isolates from the United Kingdom. The major endemic MRSA strain in pets and humans in the United Kingdom is EMRSA-15 (Moodley et al., 2006; Richardson and Reith, 1993), which is rarely found in North America, whereas, the predominant MRSA strain in Canada and the United States is CMRSA-2 (USA100) (Christianson et al., 2007; Tenover et al., 2008).

In this investigation, inducible clindamycin-resistance was present in only MRSA isolates. This study highlights the

Table 1
Susceptibility phenotypes and *D*-test results for 62 MRSA and 46 MRSP isolates from dogs and cats.

Isolates	Erythromycin-S and clindamycin-S	Erythromycin-R and clindamycin-R	Erythromycin-R and clindamycin-S, D^+	Erythromycin-R and clindamycin-S, D^-
MRSA ($n = 62$) (%)	14 (22.6)	29 (46.8)	11 (17.7)	8 (12.9)
MRSP ($n = 46$) (%)	11 (23.9)	34 (73.9)	0	1 (2.2)

MRSA, methicillin-resistant *Staphylococcus aureus*; MRSP, methicillin-resistant *Staphylococcus pseudintermedius*; S, susceptible; R, resistant; *D*, *D*-test; +, positive; −, negative.

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potential for the inappropriate use of clindamycin given the high prevalence of inducible resistance. Considering over 50% of erythromycin-resistant, clindamycin-susceptible MRSA isolates were inducibly resistant to clindamycin, it is prudent for veterinary practitioners to consider all erythromycin-resistant MRSA strains as clindamycin-resistant unless proven otherwise by *D*-test. In contrast, inducible resistance was not identified in MRSP and the use of clindamycin is reasonable in the absence of *D*-test results.

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2 March 2009
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