MRSA and the Need for a One Health Approach

SUMMARY: Methicillin-resistant Staph aureus (MRSA) is a human pathogen of great significance, and the role of animals as carriers and vectors of MRSA is still being elucidated. Recommendations have been published in both the human and veterinary literature that may not be supported by current research. A veterinary consensus document on methicillin-resistant staphylococci , including MRSA, in companion animals is being developed that will be available later in 2016.[1] Until such time, a review of the most recent literature and discussion with veterinary and One Health professionals with expertise in this field emphasizes these points:

- MRSA in pets is generally of human origin.[2,3,4,5]
- Once established in animals (whether as a carrier state or a true infection) , MRSA transmission can subsequently be bi-directional.[2,3,4,5,6,7,8]
- MRSA as a carrier state in animals tends to be transient and self-clearing.[2,3,5,6,7]
- In cases of single-event human MRSA colonization/infection, a human-based approach may be sufficient for control.[1]
- In cases of recurrent human MRSA infections, temporary isolation of pets from their owners is indicated as the most effective strategy.[1,5,8]
- The household environment and other human household members are important parts of the transmission picture and must be considered in a comprehensive One Health approach.[6,7,9,10,11,12]

Because of insufficient information regarding both screening and decolonization in veterinary patients, neither of these strategies is currently recommended as first-line approaches, though research continues.

BACKGROUND: Over the past 5-10 years, the importance of methicillin-resistant Staph aureus (MRSA) in humans has become increasingly clear. Less well understood at this time is the role of animals in the transmission of human MRSA. It is currently accepted that MRSA in household pets generally originates from humans, and it is also accepted that subsequent transmission between humans and pets can be bi-directional with both animal-to-human (zoonotic) and human-to-animal (zooanthroponotic or reverse zoonotic) transmission occurring. Further human-to-human and animal-to-animal transmission can, of course, also occur. When removed from the human source of MRSA, pets tend to clear MRSA carriage on their own. Pets can serve as fomites in MRSA transmission via fur contamination.[4,13] Pets can also be infected with MRSA, often via surgical sites or following hospitalization.[11,13,14]

A One Health approach to MRSA has been emphasized as being critical to successful intervention. This means considering animals associated with MRSA-colonized or infected human patients as well as household environments of people and pets with MRSA. The purpose of this paper is to give a brief review of recent scientific literature with regard to MRSA in animals.

RECOMMENDATIONS: Current recommendations for dealing with MRSA in pets are based on whether the human infection in question is a single-event MRSA colonization/infection or a recurrent case of MRSA. In the case of a single-event MRSA, consensus among experts is that a human-based approach may be sufficient for adequate control.[1,6] Such an approach should include emphasis on hand hygiene (washing hands BEFORE as well as after handling animals) and environmental management (e.g. not allowing pets to sleep in owners' beds, having them sleep in crates that are more easily washed and sanitized, frequent laundering of pet bedding).[4,6,7] In the case of recurrent human MRSA, the recommendation is for temporary physical isolation of pets from owners, allowing the pet to complete MRSA clearance.[1,5,8]

SCREENING QUESTIONS: While MRSA screening is regularly used in human health, it is presently less applicable in veterinary medicine. MRSA screening of therapeutic animals doing animal assisted interventions in health care facilities is not recommended.[15,16] There have been published recommendations for the testing of animals associated

with human patients who have recurring MRSA infections and also for such patients who have been found to be colonized with MRSA, but these recommendations do not provide specific protocols.[4,17] Questions which have not been definitively answered include: what animals to screen, what sites to swab, how often to screen, and what methods of diagnostic testing should be employed.

The animals most often recommended for screening are household dogs and cats, as these have figured most prominently in published reports of animals with MRSA; however, other animals have been found to be MRSA carriers. Birds, small pets, horses, pigs, and chickens have been cultured positive for MRSA.[2,3] While they have the potential to be MRSA-positive, reptiles are at this time not implicated as important carriers of MRSA, though research continues.[2,3,4,7] Pigs typically carry a livestock-origin strain of MRSA (ST398) which can be transmitted bi-directionally. Although they can be colonized by MRSA, pigs are rarely infected and thus present more of a public health situation than a veterinary medical one.[2,3,4] In the U.S., horses have been found to carry a human-origin strain of MRSA (USA500) which is currently uncommon in humans, suggesting that this strain may have become horse-adapted.[2,3,4] USA500 has been implicated in transmission to people in contact with horses.[1,3] In Europe, ST398 MRSA has been found to colonize horses.[2,3,4] As in household pets, MRSA colonization in horses is typically transient with self-clearance after some weeks, though infections have been known to occur, especially after hospitalization of colonized animals.[2,4] The role of cattle in MRSA is still unclear, with some reports or experts noting a low prevalence of MRSA among mastitis isolates and in cattle[2,3,4,24] but others pointing to the occurrence of novel strains of MRSA in cattle that are challenging from a diagnosis standpoint.[23]

Typically recommended animal sites to swab have included nares (or nasal planum), inguinal region, perineum, and rectum. A recent report by a One Health group based at the Johns Hopkins Bloomberg School of Public Health stressed the importance of including oral (pooled tongue and hard palate) swabs as they found the mouth to be the most sensitive site for sampling in their study.[18]

Longitudinal screening vs. single point screening would appear to be important in testing animals associated with human patients with MRSA. It is generally agreed that colonization of animals with MRSA tends to be transient and frequently lasts no longer than two to three weeks before being self-cleared. Together with the fact that there is no recognized decolonization protocol for animals, the importance of conducting longitudinal testing for animals becomes obvious: so that animals that are indeed transiently colonized can be identified as such, and those few that are colonized longer-term can also be identified and handled appropriately. Moreover, since animals can become reinfected from humans as well as humans becoming reinfected from animals, continued surveillance of all parties is logical.[6,10,19]

Perhaps the most important unanswered question is the proper screening method. We are currently unaware of any major veterinary diagnostic lab that performs MRSA screening as an inexpensive fee-for-service item. Instead, these labs might combine aerobic culture and (multiple) sensitivity tests with a single molecular technique such as Pulsed Field Gel Electrophoresis (PFGE).[19,20] Even this level of testing can impose a significant financial burden on pet owners, and it falls well short of a research gold standard that could involve multiple strain typing methods or even whole genome sequencing in order to be certain that MRSA strains identified in humans and animals are, indeed, identical.[14]

DECOLONIZATION: To further compound the problem, there is currently no recognized protocol for decolonization of veterinary patients.[3,8] Application of intranasal mupirocin ointment on a prolonged basis could range from impractical to dangerous, while chlorhexidine baths/shampoos are of untested value.[1,3] Additionally, the question has been raised of the wisdom of employing these approaches in veterinary medicine vs. reserving them solely for human use for this serious pathogen.[3,21]

ENVIRONMENT: In keeping with the One Health approach to MRSA, the importance of environmental surface testing/cleaning must also be stressed when MRSA patients, whether human or veterinary, are diagnosed. Several recent reports have found that environmental surfaces contamination, including pet bedding, can play an important role in the maintenance and thus likely the transmission of MRSA in a household.[7,8,10,11,12,18] Another area currently being explored is the question of pet fur contamination and the feasibility of chlorhexidine shampoos to address this question.[1]

No discussion of MRSA in animals is complete without some mention of other staphylococci. While MRSA has certainly been cultured from pets, *Staph aureus* is not a typical pathogen of small companion animals. The related *Staph pseudintermedius*, formerly *Staph intermedius*, is a common veterinary pathogen which behaves in a fashion similar to MRSA: there are drug resistant strains of *Staph pseudintermedius* denoted as MRSP which are typically dog and cat pathogens but which can be spread zoonotically to humans. As with MRSA in pets, humans can become transiently colonized with MRSP, though this occurs infrequently.[3,4,7] In a final parallel, humans can also become infected with MRSP, with dog bites being the most commonly implicated source of the bacteria.[1,2,3] While it is something that small animal practitioners may be combating daily, the complex interrelationship of MRSP with methicillin sensitive *Staph pseudintermedius* (MSSP) and various coagulase negative staphs (CNS) and the possibility of drug resistance transference between these organisms is beyond the scope of this paper.

Backgrounder written by Eileen M. Wolfe, D.V.M. 11-19-15
Chair, One Health Task Force; Vermont Veterinary Medical Association

References:

1. Davis, M, Personal Communication, November 6, 2015
2. Weese J. 2010. Methicillin-resistant Staphylococcus aureus in animals. Institute for Laboratory Animal Research Journal [cited 2015 Oct 29] Vol 51(3):233-244. Available from: http://ilarjournal.oxfordjournals.org
3. Weese J, van Duijkeren E. 2010. Methicillin-resistant Staphylococcus aureus and Staphylococcus pseudointermedius in veterinary medicine. Veterinary Microbiology [cited 2015 Oct 29] 140 (2010) 418–429. Available from: doi:10.1016/j.vetmic.2009.01.039
4. Cohn L, Middleton J. 2010. A veterinary perspective on methicillin-resistant staphylococci. Journal of Veterinary Emergency and Critical Care [cited 2015 Oct 29] 20 (1) 2010, pp 31–45. Available from: doi:10.1111/j.1476-4431.2009.00497.x
5. American Veterinary Medical Association. MRSA and Animals FAQ [Internet]. Schaumburg (IL): American Veterinary Medical Association; [2014 June 14, cited 2015 Oct 30]. Available from: https://www.avma.org/KB/Resources/FAQs/Pages/MRSAHHPFAQs
6. Bender J, Waters K, Nerby J. 2012. MRSA Isolated from Pets Living in Households with MRSA-Infected Children. Clinical Infectious Diseases [cited 2015 Oct 30] 2012:54 (3): 449-450. Available from: doi:10.1093/cid/cir714
7. Davis M, Iverson S, Baron P. 2012. Household transmission of meticillin-resistant Staphylococcus aureus and other staphylococci. [cited 2015 Oct 28] Vol 12 September 2012:703-716. Available from: www.thelancet.com/infection
8. American Veterinary Medical Association. 2015 May 13. MRSA FAQ [Internet] Schaumburg(IL):American Veterinary Medical Association; [cited 2015 Oct 30]. Available from: https://www.avma.org/public/PetCare/Pages/MRSAFAQs
9. Davis M, Baron P, Price L. 2012. Dry Collection and Culture Methods for Recovery of Methicillin-Susceptible and Methicillin-Resistant Staphylococcus aureus Strains from Indoor Home Environments.

Applied and Environmental Microbiology [cited 2015 Oct 29] 0099-2240/12:2474-2476. Available from: http://aem.asm.org

10. Fritz S, Hogan P, Singh L. 2014. Contamination of Environmental Surfaces with Staphylococcus aureus in Households with Children Infected with Methicillin-Resistant S. aureus. JAMA Pediatrics. [cited 2015 Oct 28] 168(11);1030-1038. Available from: doi:10.1001/jamapediatrics.2014.1218
11. Morris D, Lautenbach E, Zaoutis T. 2012. Potential for Pet Animals to Harbour Methicillin-Resistant Staphylococcus aureus When Residing with Human MRSA Patients. Zoonoses and Public Health. [cited 2015 Oct 30] 59 (2012): 286-293. Available from: doi:10.1111/j.1863-2378.2011.01448.x
12. Knox J, Uhlemann A, Miller M. 2012. Environmental Contamination as a Risk Factor for Intra-Household Staphylococcus aureus Transmission. PLOS One [Internet]. [cited 2015 Oct 29] Vol 7(11) e49900: 1-8. Available from: doi:100.1371/journal.pone.0049900
13. Lefebvre S, Weese J. 2009. Contamination of pet therapy dogs with MRSA and Clostridium difficile. Journal of Hospital Infection. [cited 2015 Nov 13] Vol 72 (3),268-269. Available from: doi:10.1016/j.jhin.2009.02.019
14. Davis M, Misic A, Morris D. 2015. Genome sequencing reveals strain dynamics of methicillin-resistant Staphylococcus aureus in the same household in the context of clinical disease in a person and a dog. Veterinary Microbiology [cited 2015 Oct 29] 180 (2015) 304–307. Available from: http://dx.doi.org/10.1016/j.vetmic.2015.09.007
15. Lefebvre S, Golab A, Christensen E. et al 2008. Guidelines for animal-assisted interventions in health care facilities. American Journal of Infection Control. [cited 2015 Oct 28] 2008 Mar;36(2):78-85. Available from: doi:10.1016/j.ajic.2007.09.005
16. Lefebvre S, Peregrine A, Golab G. 2008. A veterinary perspective on the recently published guidelines for animal-assisted interventions in health-care facilities. Journal of the American Veterinary Medical Association [cited 2015 Oct 30] Vol 233(3); 394-402. Available from: http://avmajournals.avma.org/loi/javma/
17. MacAllister C, Bradley K. 2014. Methicillin-resistant Staphylococcus aureus (MRSA) Infections in Animals. Oklahoma Cooperative Extension Fact Sheets [cited 2015 Nov 13] VTMD-9133. Available from: http://osufacts.okstate.edu
18. Iverson S, Brazil A, Ferguson J. 2015. Anatomical patterns of colonization of pets with staphylococcal species in homes of people with methicillin-resist ant Staphylococcus aureus (MRSA) skin or soft tissue infection (SSTI). Veterinary Microbiology [cited 2015 Oct 28] 176 (2015) 202–208. Available from: http://dx.doi.org/10.1016/j.vetmic.2015.01.003
19. Centers for Disease Control and Prevention. Testing for MRSA [Internet]. Atlanta(GA):USA.gov; [2013 Sept 11, cited 2015 Oct 29]. Available from: http://cdc.gov/mrsa/lab/
20. Thompson, B Personal Communication November 4, 2015
21. Loeffler A, Baines S, Toleman M. 2008. In vitro activity of fusidic acid and mupirocin against coagulase-positive staphylococci from pets. Journal of Antimicrobial Chemotherapy [cited 2015 Oct 30] 62,1301-1304. Available from: doi:10.1093/jac/dkn398
22. Laarhoven L, de Heus P, van Luijn J. 2011. Longitudinal Study on Methicillin-Resistant Staphylococcus pseudintermedius in Households. PLOS One [cited 2015 Nov 14] Vol 6 (11):e27788. Available from: DOI: 10.1371/journal.pone.0027788
23. García-Álvarez L, Holden M, Lindsay H. 2011. Meticillin-resistant Staphylococcus aureus with a novel mecA homologue in human and bovine populations in the UK and Denmark: a descriptive study. The Lancet Infectious Diseases [cited 2015 Nov 17] Vol11 (8):595-603. Available from: doi: 10.1016/S1473-3099(11)70126-8
24. Ruegg, P Personal communication, 2014 February 9