Journal of Animal and Veterinary Advances 9 (7): 1094-1098, 2010
ISSN: 1680-5593

Methicillin Resistant *Staphylococcus aureus* (MRSA): An Emerging Veterinary and Zoonotic Pathogen of Public Health Concern and Some Studies in Malaysia

A.A. Saleha and Z. Zunita
Faculty of Veterinary Medicine, University of Putra Malaysia,
43400 UPM Serdang, Selangor, Malaysia

Abstract: A question was posed to the researchers as to whether methicillin resistant *Staphylococcus aureus* or MRSA, in animals is of public health concern. To answer the question, previous and recent studies were reviewed so as to gain insight into the occurrence of MRSA in animals, namely in food animals and pet animals, in food of animal origin, in personnel working with animals as well in pet owners. The MRSA scenario in Malaysia was also reviewed. The studies reviewed and those carried out in Malaysia showed the widespread occurrence of MRSA in animal species, which include pigs, horses, dogs, cats and chickens and in humans with several studies showed transmissions in both directions. Thus, MRSA is of great concern in both veterinary and human medicine as it can cause serious illnesses in both sets of populations.

Key words: Methicillin resistant *Staphylococcus aureus*, animals, meat, milk, transmission, Malaysia

INTRODUCTION

The researchers recalled what Waller (2005) wrote that methicillin-resistant *Staphylococcus aureus* or commonly known as MRSA is no longer restricted to humans and is emerging as an important zoonotic and veterinary pathogen. Two years later, Van Loo *et al.* (2007a) wrote about the emergence of MRSA of animal origin in humans based on their findings that MRSA from an animal reservoir (pigs and probably cows) has entered the human population and is currently responsible for >20% of all MRSA infections in The Netherlands. When MRSA infections were reported in humans around 1960s, they are considered as nosocomial pathogens, thus are termed as hospital acquired/hospital-associated or HA-MRSA, which spread in human populations worldwide causing significant illness and death. However, the last decade saw a shift in the epidemiology of MRSA infections with the causative agents transmitting from animals and the environment and known as community-associated MRSA or CA-MRSA. The reports on CA-MRSA also known as CO-MRSA (community-onset MRSA) has been rapidly increasing; defined as an isolate which has no relation to healthcare setting is usually associated with the presence of Panton-Valentine leukocidin toxin (PVL) and SCCmec types IV and V (Van Loo *et al.*, 2007b). It was also reported that CA-MRSA may arise from hospital-origin clones that are carried into the community and then transmitted between persons or from development of resistance through the acquisition of resistance factor (the mecA gene) by methicillin sensitive *Staphylococcus aureus* or MSSA (Hanselman *et al.*, 2006; Nam *et al.*, 2006). According to the two studies, the prevalence of MRSA carriage in healthy persons in the community was generally low but CA-MRSA infections are becoming increasingly widespread without any plausible relationship with the use of methicillin (oxacillin). In addition, the last few years saw an increase in the number of reports on MRSA in animals as well as on the transmission of MRSA between animals and humans.

MRSA in animals: The cases of MRSA infections in several animal species have been reported since mid 1970s (Walther *et al.*, 2008). Among domestic or farm animals, the occurrence of MRSA was reported in pigs, cattle, sheep and among companion animals, MRSA were isolated from horses, cats, dogs, rabbits and birds (Table 1). For pigs, cattle and sheep, samples were usually collected from these animals at the farms and for pet and companion animals, they were usually sampled at the veterinary clinics and hospitals upon seeking treatment. These animals were also found infected from the veterinary clinics and hospitals settings or from the staff.

The study by Lee (2003) in dairy cattle reported MRSA were isolated from milk specimens with nine showed signs of mastitis; according to the researcher, the use of antibiotics (including ampicillin and penicillin,

Corresponding Author: Saleha Abdul Aziz, Faculty of Veterinary Medicine, University of Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

rarely oxacillin and methicillin) as a dry cow treatment may contribute to the increasing occurrence of MRSA in cows with mastitis. Interestingly, upon finding two horses positive for MRSA at a veterinary hospital in Ontario in 2000, prompted an extensive study on the colonization rates in horses for the next 2 years (Khanna *et al*., 2008) of the total 79 cases, 27 (34%) were identified in horses that were hospitalized, 41 (52%) in a thoroughbred farm and the remaining 11 (14%) were from other farms in Ontario (Table 1).

MRSA in food of animal origin: A number of studies have detected MRSA in food of animal origin, namely in meat and milk. From 1634 samples of milk, dairy products, meat and meat products, 3.75% (or 6) were mecA MRSA positive (Normanno *et al*., 2007) of these, four were in bovine milk and two in dairy products. In another study (Walther *et al*., 2008) on different types of meat in retail markets, MRSA was detected in 0.22% (4.190) chicken meat whereas none in pork (0.75) and beef (0.75). Also, meat sampled from 31 supermarkets and butcher shops was unable to detect any MRSA in beef (0.15) but found 1.6% (1.64) in pork (Van Loo *et al*., 2007b) . It has been suggested that although the finding of MRSA in food is low, it does showed that MRSA has made its way into the food chain.

MRSA in personnel working with animals as well in pet owners: There is an increase in the number of reports on the transmission of MRSA between humans and animals. These reports highlighted the close association or contact of humans and animals either through the nature of their occupations, such as in pigs and cattle farming, through sports activities such as horse riding or racing or keeping animal as pet cause a person to be at risk. Although in most cases MRSA isolated from such animals and the humans involved were indistinguishable, however, the direction of transmission-animal to human or human to animal could not be proven.

The study on MRSA in pig farming in The Netherlands showed evidence of transmission of MRSA between pigs and pig farmers, between pig farmers and their family members and between a nurse and a patient in a Dutch hospital (Voss *et al*., 2005). In another study, it was also demonstrated that 20% (5 out of 25) of pig farmers were colonized with MRSA and that there were correlation between presence of MRSA in pigs and pig farmers. The first putative case of direct transmission of MRSA between cows and humans in Hungary was documented by Juhasz-Kaszanyitsky *et al*. (2007). The MRSA isolated from milk samples collected from cows with subclinical mastitis and from one of the 12 workers on the farms were found epidemiologically related. However, the direction of transmission could not be shown.

In Equine Hospital, University of Liverpool (Liverpool) where 16% of the horses were positive for MRSA carriage, it was found that 18.2% (2 of 11) of the staff were also positive (Baptiste *et al*., 2005). In a study which found 79 MRSA positive horses, it too found 27 personnel colonized or infected with MRSA with 17 (63%) were from the veterinary hospital and 8 (30%) from the thoroughbred farm (Weese *et al*., 2005). In Ontario Veterinary College Veterinary Teaching Hospital (OVCVTH), University of Guelph (Guelph) a foal infected with MRSA skin infection caused clinical skin infections in 8.3% (3 of 36) of Foal Watch personnel and subsequently nasal colonization in 9.7% (10 of 103) of other staff of the hospital (Weese *et al*., 2006a). In this outbreak, transmission of MRSA infection to veterinary personnel can still occur despite a short-term contact (through a 4 h shift) even with standard protective barriers. In Ireland, animals with respiratory, urinary tract or wound infections or those subjected to surgical procedures in 16 private veterinary clinics and a veterinary hospital were investigated and MRSA were detected in 25 animals eight each in dogs and horses, one each in cat, rabbit and

Table 1: Prevalence of MRSA in animals as reported in some countries other than Malaysia

Countries/veterinary hospitals	Species	Occurrence rates of MRSA	References
Korea	Dairy cattle, chickens	15 MRSA isolates from 1913 samples-12 from dairy cattle	Lee, 2003
	beef, cattle pigs	and 3 in chickens. None in beef cattle and pigs	-
Netherlands	Pigs	209 (39%) of 540 pigs carried MRSA in their nares	De Neeling *et al*., 2007
Canada	Pigs	71 (25%) of nasal and rectal swabs from 285 pigs carried MRSA	Khanna *et al*., 2008
	-	9 (45%) of 20 pig farms were positive for MRSA	-
	Horses	MRSA isolated from79 horses (2 in year 2000, 5 in 2001 and 72 in 2002)	Weese *et al*., 2005
Small Animal Clinic,	-	27 of 869 animals were infected with MRSA with 77.7% through wounds.	Walther *et al*., 2008
Vet. Fac., Free U.,	-	-	-
Berlin, Germany	Dogs	18	-
	Cats	4	-
	Guinea pig, rabbit,	1 each (= 5)	-
	turtle, bat, parrot	-	-
Small Animal Hospital and	Horses	11 (16%) of 67 were positive for MRSA carriage	Baptiste *et al*., 2005
Equine Hospital, U. of	Dogs, cats	0% of 55 dogs and 50 cats	-
Liverpool, Liverpool, UK	-	-	-

seal and also in 11 personnel (O'Mahony *et al*., 2005). They found two types of MRSA strains were found circulating in the veterinary practices in Ireland with one may have risen from human hospitals and the other has yet to be determined. In yet another report (Weese *et al*., 2006b) on six cases of clinical MRSA infections in pet dogs andcats, it was shown to be due to in contact with infected owners and veterinary personnel (Weese *et al*., 2006b).

In a study which screened 80 veterinary students and 99 veterinarians attending a conference on livestock, it found 4.6% (two students and five veterinarians) positive for MRSA (Wulf *et al*., 2006). In this same study, 27 students who had reported no contact with livestock were all negative for MRSA carriage.

MRSA in malaysian scenario: A number of studies have been carried out on the occurrence of MRSA in animals in Malaysia, include in cats, dogs, horses, chickens and pigs as shown in Table 2.

The studies, although limited to certain locations, showed the presence of MRSA in various animal species and could be present or colonized in animals in other parts of the country. Research was also done in human populations. One study observed a higher number of the pet owners carried MRSA (30%) compared to those not in contact with pet animals (20%) (Saleha *et al*., 2006). One of the five personnel who looked after the horses (where 23% of the horses were positive for MRSA) was also colonized with MRSA (Zunita *et al*., 2008).

The isolation of MRSA was first reported in Malaysia in 1978 (Jamal *et al*., 1983). Over the years, the number of isolations has increased particularly in hospital settings. An update on the prevalence rates of MRSA infections in humans in the major state hospitals in Malaysia in 2007 showed they varied from 6.8-44.1%, with the present overall rate of 28% compared to 31.5% in 2006 (Norazah, 2008), it was also reported that CA-MRSA has emerged in the country with thus far there were 20 cases identified since July 2006-2008. Nor-Shamsudin *et al*. (2008) did a study among 100 university students, found three (3%) positive for MRSA and identified all the three isolates as putative CA-MRSA (Mariana *et al*., 2008).

Is MRSA in animals of a public health concern?: Today, from the numerous research works and studies worldwide in both humans and animals, there is no doubt that the question can be answered that MRSA is an emerging and important zoonotic pathogen especially in pet animals. The presence of MRSA in humans and animals strongly suggestive of interspecies transmission that it therefore, can be in both directions. It was suggested that MRSA is more likely to be transmitted from humans to farm animals and pets (Guardabassi *et al*., 2004; Lee, 2003; Seguin *et al*., 1999; Oughton *et al*., 2001). Once interspecies transfer has occurred, these organisms can become widespread in the animal environment. Moreover, the MRSA infections are frequently observed between pet animals and humans. Many studies showed the similarity between pet and human isolates which led to speculation that pet MRSA is closely linked to human MRSA and that the source of MRSA in pets may often be colonized or infected humans (Vitale *et al*., 2006). In the United States (USA), there were reports on MRSA infections in owners or households linked/associated with pet dogs. A first known case of human-to-dog transmission of MRSA in The Netherlands (Van Duijkeren *et al*., 2004) : a nurse who had psoriasis was identified as MRSA carrier, then treated and tested negative. Few weeks later, when she became colonized again, the family (husband, daughter, mother), house environment and pet dog were examined; the daughter and the dog were positive and typing of the isolates found them identical. They were promptly treated and when later examined all were found negative. Another very recent report, also on human-to-dog transmission of MRSA this time in USA, found an elderly man with a number of ailments had developed cellulitis from which MRSA was isolated; he was treated, discharged but was later hospitalized again and found positive for MRSA. At about the same time, his dog had extensive neck swelling with ulcerations and purulent discharge and MRSA was isolated; due to septic shock, the dog was humanely euthanised.

Thus, the concern over pet and companion animals is that they can become household reservoirs of MRSA for subsequent infections or re-infections of household

Table 2: Occurrence of MRSA in animals in Malaysia

References	Occurrence Rates of MRSA
Saleha *et al*., 2006	11.7% in 60 cats and dogs
Ng *et al*., 2005	1.9% (7 of 364) cats and dogs possessed *mec*A genes
Kersenemayer, 2004	19.6% of pet dogs and 17.4% of stray dogs were positive for MRSA
Abdulkadir *et al*., 2007	9 of 50 (18%) feathers from chickens in a poultry farm were found to carry MRSA.
Zunita *et al*., 2008	23% (3 of 13) horses in an equestrian unit were found colonized with MRSA. 11.8% (2 of 17) horses in a unit with uniform, positive for MRSA
Khairina *et al*., 2007	123 *Staphylococcus aureus* were isolated from 100 piglets in five pig farms, 2.4% (3) were MRSA

contacts because of their close proximity should such contact works in a healthcare setting then it is possible for he or she to transmit to patients. Food animals can spread MRSA to farm personnel or vice versa. Veterinary personnel can acquire MRSA from animals in the farms, clinics or hospitals and in turn may transmit to persons or contacts who may be at higher risk of developing MRSA infection or to their other patients.

The contamination of food animal products-whether of animal origin (at production or processing level) or of human origin (usually at processing, retail or preparation level) is very plausible) (Lee, 2003) and can be a potential threat to those who handle meat and other food as well as those who consume raw or inadequately cooked or improperly prepared food (Van Loo *et al*., 2007b). A new MRSA strain that could not be typed was reported; it was found to be associated with cattle and pig and termed as nontypable or NT-MRSA; those persons working or living in close contact with animals carrying these organisms are said to be at increased risk. The infections can be severe as indicated by high hospital admission rate (Van Loo *et al*., 2007a).

CONCLUSION

The presence of MRSA in animals and humans in Malaysia and other countries worldwide is of both veterinary and public health concern and strongly suggest there are interspecies transmissions, animal-to-human and human-to-animal. The epidemiology of MRSA in pets may take a parallel course to that in humans (Vitale *et al*., 2006). Given such cases as above, when an infected or hospitalized person found positive for MRSA, it is necessary to seek information regarding his or her association with animal.

This is because failure to detect and treat infected or colonized pets can result in recurrent MRSA colonization or infections in humans (Weese *et al*., 2005). Hence, it must be emphasized that there is a need to monitor the presence of MRSA in both food and pet animals similar to that being done in humans so as to prevent further spread of MRSA in both sets of populations.

ACKNOWLEDGEMENTS

This review was requested by The Organising Committee of National Seminar and Workshop on Molecular Diagnosis and Typing of Bacterial Pathogens 2008 (Special Focus on MRSA), Faculty of Medicine and Health Sciences, UPM, Serdang, Selangor, Malaysia.

REFERENCES

Abdulkadir, M.M., Z. Zunita, Y.M. Goh, A.A. Saleha and R. Son, 2007. Occurrence of methicillin-resistant *Staphylococcus aureus* (MRSA) in chickens. Proceeding of 19th Veterinary Association Malaysia Congress, Aug. 3-5, Malaysia, pp: 182-185.

Baptiste, K.E., K. Williams, N.J. Williams, A. Wattret and P.D. Clegg *et al*., 2005. Methicillin-resistant *Staphylococcus aureus* in companion animals. Emergncy Infect. Dis., 11: 1942-1944.

De Neeling, A.J., M.J.M. van den Broek, E.C. Spalburg, M.G. van Santen-Verheuvel and W.D.C. dam-Deisz *et al*., 2007. High prevalence of methicillin-resistant *Staphylococcus aureus* in pigs. Vet. Microbiol., 122: 366-372.

Guardabassi, L., S. Schwarz and D.H. Lloyd, 2004. Pet animals as reservoirs of antimicrobial-resistant bacteria. J. Antimicrob. Chemother., 54: 321-332.

Hanselman, B.A., S.A. Kruth, J. Rousseau, D.E. Low, B.M. Willey, A. McGeer and J.S. Weese, 2006. Methicillin-resistant *Staphylococcus aureus* colonization in veterinary personnel. Emergency Infect. Dis., 12: 1933-1938.

Jamal, F., H.K. Shong and T. Mahamooth, 1983. Septicaemia caused by methicillin and gentamicin *Staphylococcus aureus* in caes of burn. J. Perubatan UKM, 5: 53-58.

Juhasz-Kaszanyitsky, E., S. Janosi, P. Somogyi, A. Dan, L.van der Graaf-van Bloois, E. van Duijkeren and J.A. Wagenaar, 2007. MRSA transmission between cows and humans. Emerg. Infect. Dis., 13: 630-632.

Kersenernayer, S.N., 2004. Prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) on human and animal skin. DVM Final Year Thesis, Faculty of Vet. Medicine.

Khairina, A.K., Z. Zunita and P.T. Ooi, 2007. Methicillin-resistant *Staphylococcus aureus* in pigs. Proceedings of the 3rd Seminar on Veterinary Sciences, January 11-19.

Khanna, T., R. Friendship, C. Dewey and J.S. Weese, 2008. Methicillin-resistant *Staphylococcus aureus* colonization in pigs and pigs farmers. Vet. Microbiol., 128: 298-303.

Lee, J.H., 2003. Methicillin (oxacillin)- resistant *Staphylococcus aureus* strains isolated from major food animals and their potential transmission to humans. Applied Environ. Microbiol., 69: 6489-6494.

Mariana, N.S., S. Zamberi, A. van Belkum and V. Neela, 2008. First community-acquired methicillin-resistant *Staphylococcus aureus* in Malaysia. J. Med. Microbiol., 57: 1180-1181.

Nam, H.K., T.P. Kun, K.J. Woo, Y.Y. Hwa and Y. Lee *et al*., 2006. Characteristics of methicillin-resistant *Staphylococcus aureus* isolated from chicken meat and hospitalized dogs in Korea and their epidemiological relatedness. Vet. Microbiol., 117: 304-312.

Ng, W.S.J., Z. Zunita, Y.M. Goh and A.R. Raha, 2005. Occurrence of methicillin-resistant *Staphylococcus aureus* (MRSA) in cats and dogs. Proceedings of 17th Veterinary Association Malaysia Congress, July 27-30, Universiti Putra Malaysia Press, pp: 43-45.

Nor-Shamsudin, M., S. Zamberi, A. van Belkum and V. Neela, 2008. First community-acquired methicillin-resistant *Staphylococcus aureus* in Malaysia. J. Med. Microbiol., 57: 1180-1181.

Norazah, A., 2008. Updates on MRSA in Malaysia. Proceedings of the National Seminar and Workshop on Molecular Diagnosis and Typing of Bacterial Pathogens, November 24.

Normanno, G., M. Corrente, G. la Salandra, A. Dambrosio and N.C. Quaglia *et al*., 2007. Methicillin-resistant *Staphylococcus aureus* (MRSA) in foods of animal origin product in Italy. Int. J. Food Microbiol., 117: 219-222.

Oughton, M.T., H.L.N. Dick, B.M. Willey, S. Brown, A, McGreer, B. Kreiswith and D.E. Lowe, 2001. Methicillin-resistant *Staphylococcus aureus* as a cause of infections in domestic animals: Evidence for a new humanotic disease?. Can. Bact. Surv. Network Newsletter, April, 1-2.

O'Mahony, R., Y. Abbott, F.C. Leonard, B.K. Markey and P.J. Quinn *et al*., 2005. Methicillin-resistant *Staphylococcus aureus* (MRSA) isolated from animals and veterinary personnel in Ireland. Vet. Microbiol., 109: 285-296.

Saleha, A.A., M. Shamzarina, F. Othman and Z. Zunita, 2006. Methicillin-resistant *Staphylococcus aureus* (MRSA) isolated from pet animals and pet and non-pet owners. J. Vet. Malaysia, 18: 13-16.

Seguin, J.C., R.D. Walker, J.P. Caron, W.E. Kloos and C.G. George *et al*., 1999. Methicillin-resistant *Staphylococcus aureus* outbreak in a Veterinary Teaching Hospital: Potential human-to-animal transmission. J. Clin. Microbiol., 37: 1459-1463.

Van Duijkeren, E., M.J.H.M. Wolfhagen, A.T.A. Box, M.E.O.C. Heck, W.J.B. Wannet and A.C. Fluit, 2004. Human-to-dog transmission of methicillin-resistant *Staphylococcus aureus*. Emerg. Infect. Dis., 10: 2235-2237.

Van Loo, I., X. Huijsdens, E. Tiemersma and A. de Neeling, 2007a. Emergence of methicillin-resistant *Staphylococcus aureus* of animal origin in humans. Emerg. Infect. Dis., 13: 1834-1839.

Van Loo, I.H.M., B.M.W. Diederen, P.H.M. Savelkoul, J.H.C. Woudenberg and R. Roosendaal *et al*., 2007b. Methicillin-resistant *Staphylococcus aureus* in meat products, the Netherlands. Emerg. Infect. Dis., 13: 1753-1755.

Vitale, C.B., T.L. Gross and J.S. Weese, 2006. Methicillin-resistant *Staphylococcus aureus* in cat and owner. Emerg. Infect. Dis., 12: 1998-2000.

Voss, A., F. Loeffen, J. Bakker, C. Klaassen and M. Wulf, 2005. Methicillin-resistant *Staphylococcus aureus* in pig farming. Emerg. Infect. Dis., 11: 1965-1966.

Waller, A., 2005. The creation of a new monster: MRSA and MRSI-important emerging veterinary and zoonotic diseases. Vet. J., 169: 315-116.

Walther, B., L.H. Wieler, A.W. Friedrich, A.M. Hanssen, B. Kohn, L. Brunnberg and A. Lubke-Becker, 2008. Methicillin-resistant *Staphylococcus aureus* (MRSA) isolated from small and exotic animals at a university hospital during routine microbiological examinations. Vet. Microbial., 127: 171-178.

Weese, J.S., F. Caldwell, B.M. Willey, B.N. Kreiswirth, A. McGreer, J. Rousseau and D.E. Low, 2006a. An outbreak of methicillin-resistant *Staphylococcus aureus* skin infections resulting from horse to human transmission in a veterinary hospital. Vet. Microbiol., 114: 160-164.

Weese, J.S., H. Dick, B.M. Willey, A. McGeer, B.N. Kreiswirth, B. Innis and D.E.Low, 2006b. Suspected transmission of methicillin-resistant *Staphylococcus aureus* between domestic pets and humans in veterinary clinics and in the household. Vet. Microbiol., 115: 148-155.

Weese, J.S., M. Archambault, B.M. Willey, H. Dick and P. Hearn *et al*., 2005. Methicillin-resistant *Staphylococcus aureus* in horses and horse personnel, 2002-2002. Emerg. Infect. Dis., 11: 430-435.

Wulf, M., A. van Nes, A. Eikelenboom-Boskamp, J. de Vries, W. Melchers, C. Klaassen and A. Voss, 2006. Methicillin-resistant *Staphylococcus aureus* in veterinary doctors and students, the Netherlands. Emerg. Infect. Dis., 12: 1939-1941.

Zunita, Z., M. Abdulkadir, Y.M. Goh, A.A. Saleha and R. Son, 2008. Occurrence of methicillin-resistant *Staphylococcus aureus* (MRSA) in horses from Selangor. Proceeding of 20th Veterinary Association Malaysia Congress, August 15-17.