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Research Article

Prevalence of Methicillin-Resistant *Staphylococcus Aureus* (MRSA) in Dogs and Dog Owners from Morogoro Municipality, Tanzania

Frida Richard Mgonja[1], Palesa Caroline Mphaka[2], Amina Ramadhani Issae[3] and Abdul Seleman Katakweba[3]*

[1]*Department of Veterinary Physiology, Biochemistry and Pharmacology, Morogoro, Tanzania*

[2]*Department of Veterinary Veterinary Medicine and Public Health, College of Veterinary and Biomedical Sciences (CVMBS) Sokoine University of Agriculture (SUA) Morogoro, Tanzania*

[3]*Institute of Pest Management Sokoine University of Agriculture, Morogoro, Tanzania*

Abstract

Methicillin-Resistant *Staphylococcus Aureus* (MRSA) is a significant global health concern that threatens animals and humans. This study, conducted in Morogoro Municipality, Tanzania, investigated the prevalence of MRSA in dogs and their owners. Two hundred fourteen dog-owner pairs participated in the survey, with nasal swabs collected from the dogs (124 samples) and their owners (90 samples). These swabs were cultured on selective media and subjected to antimicrobial susceptibility testing. The results revealed that 6.5% of the dogs (8 out of 124) and 3.3% of the dog owners (3 out of 90) tested positive for MRSA. The presence of MRSA in both dogs and owners was found to be statistically significant, indicating a potential transmission between the two populations. Notably, most MRSA strains were resistant to multiple antibiotics, suggesting the presence of multidrug-resistant strains. The dog isolates resisted two commonly used antibiotics, Streptomycin (1 out of 8; 12.5%) and Oxytetracycline (3 out of 8; 37.5%). Additionally, all human and dog isolates (11 out of 11; 100%) were resistant to Oxacillin, Penicillin, Erythromycin, Vancomycin, and Ampicillin. Questionnaire responses from the dog owners also revealed a need for knowledge about diseases that can be transmitted between animals and humans, as well as inadequate hygiene measures practiced after interacting with their dogs. These findings emphasize the importance of monitoring MRSA and implementing effective infection control measures. The high prevalence of MRSA in both dogs and owners raises concerns about the potential transmission of the bacteria from dogs to humans. Further research is necessary to identify the risk factors associated with MRSA colonization and transmission in dogs and their owners and assess the impact on the health of both humans and animals.

Keywords: Methicillin-resistant *Staphylococcus aureus* MRSA; Dogs; Dog owners; Prevalence; Antimicrobial resistance

Introduction

Methicillin-Resistant *Staphylococcus Aureus* (MRSA) is a strain of the bacterium *Staphylococcus aureus* that has developed resistance to the beta-lactam class of antibiotics, including methicillin and other drugs such as penicillin and cephalosporins. MRSA infections can be challenging to treat, as they often require alternative antibiotics with potentially higher risks and costs. The prevalence of MRSA has been a significant concern worldwide due to its ability to cause severe infections and its increased resistance to commonly used antibiotics. MRSA infections range from mild skin infections to more severe and life-threatening cases such as bloodstream infections, pneumonia, and surgical site infections [1]. According to a global surveillance study conducted in 2015 by the World Health Organization (WHO), MRSA infections were prevalent in healthcare and community settings. In healthcare settings, MRSA is often associated with Hospital-Acquired Infections (HAIs) and is a leading cause of nosocomial infections [2]. These infections are attributed mainly to prolonged hospital stays, invasive medical procedures, and indwelling medical devices. Multiple factors contribute to the increased prevalence of MRSA. Overuse and misuse of antibiotics, specifically the over-prescription of broad-spectrum antibiotics, has played a significant role in the emergence and spread of MRSA strains. This misuse selects resistant bacteria, allowing them to thrive and spread.

Additionally, insufficient infection control practices in healthcare settings, such as poor hand hygiene, inadequate environmental cleaning, and the improper use of medical devices, can contribute to the transmission of MRSA. In community settings, factors such as poor hygiene practices, overcrowding, and sharing of personal items can also contribute to the spread of MRSA. Surveillance studies have shown varying prevalence rates of MRSA across different regions and countries. For example, a survey conducted in the United States in 2012 estimated that approximately 80,461 invasive MRSA infections occurred, resulting in about 11,285 deaths. In Europe, the European Antimicrobial Resistance Surveillance Network (EARS-Net) reported in 2018 that the overall MRSA prevalence was around 14.5% in bloodstream infections. Over the past few decades, MRSA has emerged as a significant pathogen in both healthcare settings and the community. While MRSA has traditionally been associated with human infections, there is growing evidence of its presence in animals, including dogs. The close relationship between humans and

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***Corresponding author:** Frida Richard Mgonja, Department of Veterinary Physiology, Biochemistry and Pharmacology, College of Veterinary and Biomedical Sciences (CVMBS), Sokoine University of Agriculture (SUA), Po Box 3017, Morogoro, Tanzania

dogs raises concerns regarding the potential transmission of MRSA between the two populations. Close contact and shared environments provide opportunities for bacterial exchange, increasing the risk of colonization and infection. Furthermore, dogs in resource-limited settings may be at higher risk of acquiring and maintaining multidrug-resistant bacteria, including MRSA. More information is needed on MRSA's prevalence and molecular characteristics in dogs and dog owners in Tanzania. This study aimed to address this knowledge gap by investigating the prevalence of MRSA and its antimicrobial resistance patterns in dogs and their owners from Morogoro Municipality.

Methods and Methodology

Study site

The study was conducted in Morogoro Municipality in the Morogoro region of Tanzania. The area is situated at latitude 5.7 to 10˚S and longitude 39.5˚E and is about 200 km west of Dar es Salaam. Annual rainfall ranges between 500 and 1800 mm. The average altitude of Morogoro is about 58 m above sea level. The region has a bimodal rain pattern, with about 83% of the rain falling between late February and the end of early June and short rains between October and January. The average humidity ranges between 60 % to 80 %, and the day temperature ranges between 27˚C and 31˚C with a minimum night temperature of 14˚C in the most incredible month. Administratively, Morogoro Municipality is divided into 29 wards, each with several streets.

Experimental design

A cross-sectional study in Morogoro Municipality, Tanzania, involved 214 samples from dogs and dog owners. Thrusfield (2005) calculated the sample size using the formula with a 95% confidence level for 175 dogs and 175 dog owners. However, 124 dogs were sampled and 90 dog owners. Dog owners were questioned regarding their demographic information, characteristics, and potential risk factors associated with MRSA transmission. For dogs, the recorded biodata included their name, age, sex, weight, and breed. Following that, a clinical examination was conducted to determine the health status of the dogs. This examination focused on health parameters such as temperature, pulse, respiratory rate, heart rate, and the body score of each animal. Nasal swabs were collected from both dogs and their owners using sterile swabs, and the samples were stored in cool boxes with ice packs. The swabs were transported to the laboratory and cultured on selective media. MRSA isolates were subjected to antimicrobial susceptibility testing using the disc diffusion method.

Isolation of *S. aureus*

The swabs were placed onto sheep Blood Agar (BA) and then incubated at 37˚C for 24 hours. Further examination was done on colonies suspected to be *S. aureus* on BA, which exhibited round shapes with distinct borders, a raised appearance, a golden-yellow color, and a 1 mm to 4 mm diameter. These colonies were also surrounded by zones of beta-hemolysis on BA. Additional tests were conducted on these colonies for confirmation. The identification process involved Gram's stain, which revealed *S. aureus* as Gram-positive cocci in clusters resembling grapes. Biochemical characterization was carried out through the catalase and coagulase tests. The tube coagulase test served as the confirmatory test to distinguish *S. aureus* (coagulase positive) from Coagulase Negative Staphylococcus (CONS).

Determination of antibiotic susceptibility of isolated *S. aureus*

The disc diffusion method was performed to determine the antibiotic susceptibility of *S. aureus* isolates. The procedure was performed on Muller Hinton (MH) Agar using the Kirby-Bauer disk diffusion method described by [3]. Each of the *S. aureus* suspension samples was prepared in a sterile normal saline, and the suspensions were adjusted to a turbidity equivalent to a 0.5 McFarland standard. Sterile cotton-tipped swabs were used to transfer the inocula onto Mueller-Hinton plates to produce a confluent lawn of bacterial growth. After the inocula on the plates dried, the antibiotic discs constituting antibiotics commonly used in Tanzania will be distributed over the inoculated plates using sterile forceps and incubated at 37°C for 24 hours. Diameters of inhibition zones were measured with a ruler and interpreted as resistant, intermediate, and susceptible according to the Clinical and Laboratory Standards Institute (2013) guidelines.

Ethical clearance

Permission to carry out this study was sought from the Executive Director of Morogoro Municipality and the National Institute of Medical Research (NIMR). The dog owners were issued verbal and written consent to participate in this study. Participation was voluntary, and the questionnaire and laboratory results were kept confidential.

Results

Prevalence of *S. aureus*

Out of the 214 samples, only 11 (5.14%) of them tested positive for coagulase. Among these 11 samples, 3 out of 90 (3.33%) were from human nasal samples, and 8 out of 124 (6.45%) were from dog nasal samples. No *S. aureus* was found in dog anal samples. Figure 1 represents the distribution of *S. aureus* positive isolates based on the species and location.

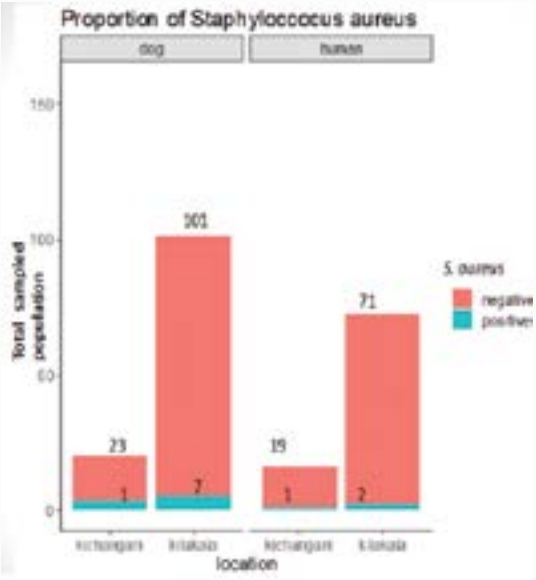

Figure 1: Proportion of *S. aureus* from the total sampled population.

The proportion of *S. aureus* from the total sampled population

Of 214 samples tested, 1 out of 23 (4.35%) from Kichangani and 7 out of 101 (6.93%) samples from dogs tested positive for S aureus, from Kilakala from dogs and 1 out of 19 (5.26%) and 2 out of 71 (2.81%) from human were tested positive of *S. aureus* (Table 1).

Antibiotic sensitivity test for isolated *S. aureus*

Results showed that 12.5% of the *S. aureus* isolates were resistant to streptomycin, and 37.5% were resistant to oxytetracycline. All isolates from humans and dogs are resistant to Oxacillin, Penicillin, Erythromycin, Vancomycin, and Ampicillin.

Results from the questionnaire showed that residents of Kilakala and Kichangani keep dogs primarily for security. Dogs are kept free roaming or kenneled during the day and let loose at night. The dogs are taken care of by children between the ages of 10 and 14. Regarding zoonotic diseases, the residents know only about rabies (100%), and most dogs have been vaccinated against rabies Table 2. However, the residents were not aware of Staphylococcus or any other bacterial zoonoses (100%).

Table 1: Prevalence of *S. aureus*.

Source of samples	Number of samples	S. aureus positive	Prevalence (%).
Dog nasal	124	8	6.5
Dog anal	124	0	0
Human nasal	90	3	3.3
Total	214	11	5

Table 2: Antibiotic profiles of *S. aureus* isolates.

Antibiotic type	Dog (n=8)		Human (n=3)	
Oxacillin (OX)	8	-100	3 (100)	
Cefoxitin (FOX)	0		0	
Penicillin (P)	8 (100)		3	-100
Sulfur (STX)	0		0	
Streptomycin (S)	1	-12.5	0	
Gentamycin (GN)	0		0	
Erythromycin (E)	8	-100	3	-100
Vancomycin (VA)	8	-100	3	-100
Chloramphenicol (C)	0		0	
Ciprofloxacin (CIP)	0		0	
Oxytetracycline (OTC)	3	-37.5	0	
Ampicillin (AMP)	8	-100	3	-100

Discussion

The results indicate that *S. aureus* is rare in the sampled population of Kilakala and Kichangani. Out of the 214 samples tested, only 5.14% were positive for *S. aureus*. This prevalence is lower than the rates reported in previous studies by [4,5]. Understanding the dynamics of *S. aureus* nasal colonization and implementing strategies for prevention and control can benefit from these findings [6].

Regarding species and location, *S. aureus* was more prevalent in dog nasal samples than human nasal samples. The prevalence in dog nasal samples was 6.45%, while in human nasal samples, it was only 3.33%. No *S. aureus* was detected in dog anal samples, suggesting that this strain is not present in the anal area of dogs in these areas. This prevalence is lower than the rates observed in the study by [7]. Although rare, it is essential to note that dog MRSA infections have been reported [8]. When analyzing the proportion of *S. aureus* in the total sampled population, dogs had a higher prevalence of *S. aureus* compared to humans. Of the 101 dog samples, 6.93% tested positive for *S. aureus*. Meanwhile, only 2.81% of the human samples were positive for *S. aureus*. This suggests that dogs may carry *S. aureus*, with a higher risk of transmission than humans in these areas.

The antibiotic sensitivity test results revealed that all *S. aureus* isolates from humans and dogs were resistant to multiple antibiotics, including Oxacillin, Penicillin, Erythromycin, Vancomycin, and Ampicillin. This indicates that *S. aureus* in these populations may have acquired resistance to commonly used antibiotics. Additionally, 37.5% of the isolates were resistant to oxytetracycline, while only 12.5% were resistant to streptomycin.

Conclusion

Furthermore, the questionnaire results showed that residents in Kilakala and Kichangani primarily keep dogs for security purposes, and the dogs are often free roaming during the day and let loose at night. The care of the dogs is mainly handled by children aged 10 to 14. Although the residents were aware of rabies and most dogs were vaccinated against it, they lacked awareness of Staphylococcus and other bacterial zoonoses. This highlights the need for education on preventing the transmission of zoonotic diseases from dogs to humans. These findings demonstrate the low prevalence of *S. aureus* in the sampled populations of Kilakala and Kichangani. However, antibiotic resistance is a concern requiring further research and education. Additionally, raising awareness about zoonotic diseases in these communities is crucial.

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