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First report of multidrug-resistant *Staphylococcus pseudintermedius* as an agent of healthcare-associated infection in a dog in Brazil

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Abstract. Healthcare-Associated Infections (HAIs) are infections acquired after procedures or hospital admissions. HAIs are of great relevance to public health due to their impact, and mainly due to the emergence of antimicrobial resistance. Some studies show the presence of HAIs in animals with reports of outbreaks and the presence of multidrug-resistant bacteria. The objective of this work is to report the first record of a multidrug-resistant strain of *Staphylococcus* pseudintermedius in a case of Healthcare-Associated Infection in a dog in Brazil. A multidrug-resistant strain of *Staphylococcus* sp. was obtained, isolated from a dog with recurrent skin infections after undergoing oncological surgeries. The isolate was identified as *Staphylococcus pseudintermedius* with a multidrug resistance pattern to Enrofloxacin, Neomycin, Gentamicin, Tobramycin, Norfloxacin, Tetracycline, Penicillin, Oxacillin, Cefoxitin, Clindamycin, Marbofloxacin, Erythromycin and Sulfamethoxazole+Trimethoprim, in addition, the presence of resistance genes *blaZ, mecA, tetM, ermB* and *norC* was detected. Therefore, it is essential to create a hospital infection control committee in the field of veterinary medicine, as well as the implementation of policies. The study highlights the importance of detecting and identifying multidrug-resistant strains, reinforcing the need for preventive approaches in veterinary medicine and ensuring the effectiveness of treatments and promoting the health of all species.
Keywords: Veterinary Hospital, MRSP, AMR.

Introduction

Healthcare-Associated Infections (HAIs) are infections acquired following medical procedures or hospital admissions, and they are of significant relevance to public health due to their impact and, particularly, their potential to contribute to the spread of antimicrobial resistance (Padoveze and Fortaleza 2014). These infections compromise animal welfare and are associated with increased hospitalizations, high costs, morbidity, and mortality, and can have adverse consequences for the veterinary clinic, both in economic terms and in the well-being of the team, due to the zoonotic risk (Willemsen 2019).

Risk factors such as the use of invasive devices, prolonged hospitalizations, immunosuppression, emergency surgical procedures, and prior exposure to broad-spectrum antimicrobials contribute to the occurrence of HAIs (Felix et al. 2023). Several studies have shown the presence of HAIs in animals with reports of outbreaks (Schaer, Aceto and Rakin 2010; Cummings 2014) and the presence of multidrug-resistant bacteria (Wieler et al. 2011; Viegas et al. 2022).

Staphylococcus spp. are opportunistic and ubiquitous bacteria that can be found colonizing the skin and mucous membranes of humans and animals (Parlet, Brown and Horswill 2019). In dogs, *Staphylococcus pseudintermedius* appears as one of the most common pathogenic species (Bertelloni, Cagnoli and Ebani 2021). In recent years, the emergence of multidrug-resistant strains of *S. pseudintermedius* has been reported, with implications for the management of infections in companion animals (Stefanetti, Passamonti and Rampacci 2024).

The identification of the etiological agent and knowledge of its sensitivity to antimicrobials are extremely important to establish prevention and treatment measures, reducing the risk of transmission and antimicrobial resistance, in

addition to ensuring the well-being of animals. This case report presents a multiresistant strain of *Staphylococcus* sp. found in a case of Healthcare-Associated Infection in a dog.

Case Presentation

A multidrug-resistant strain of *Staphylococcus* sp. was isolated from skin secretion during the investigation of recurrent infections in an 8-year-old male mixed-breed dog with a history of these infections. The dog had previously undergone oncological surgeries, including nodulectomy for a squamous cell carcinoma, scrotal urethrostomy, and total penectomy, performed at a veterinary hospital in Recife, Pernambuco, Brazil. Following these surgeries, the dog began to exhibit dehiscence of the surgical sites and developed infections. Subsequently, the dog underwent a reconstructive surgery but continued to present with infections. Across four different cultures performed, a multiresistant *Staphylococcus* spp. was consistently identified, which led to a more in-depth investigation of the isolate.

Following the isolation of the *Staphylococcus* sp. strain, further tests were conducted for its identification. This isolate was positive in catalase, coagulase, urease, ONPG, mannitol fermentation, and novobiocin sensitivity tests, indicating that it belongs to the *Staphylococcus intermedius* Group (SIG). Mass spectrometry (MALDI-TOF) further confirmed the isolate as *Staphylococcus pseudintermedius*.

To determine the antimicrobial susceptibility profile of the identified *S. pseudintermedius* isolate, disk diffusion testing was performed. Antimicrobial susceptibility testing using disk diffusion revealed resistance to Enrofloxacin, Neomycin, Gentamicin, Tobramycin, Norfloxacin, Tetracycline, Penicillin, Oxacillin, Cefoxitin, Clindamycin, Marbofloxacin, Erythromycin, and Sulfamethoxazole+Trimethoprim. The isolate showed sensitivity only to Linezolid and Chloramphenicol. Molecular analysis for antimicrobial resistance genes detected the presence of blaZ, mecA, tetM, ermB, and norC (Fig 1).

This study was not submitted to the Ethics Committee on the Use of Animals (CEUA) for review, since the samples analyzed were sent to the Veterinary Hospital for exclusively diagnostic purposes, within the context of routine clinical practice. The biological material was subsequently provided by the Laboratory of Infectious Diseases of Domestic Animals (LDIC) for complementary laboratory analyses. There was no additional intervention or direct experimental manipulation of the animals for research purposes; only previously collected samples were used, without any additional invasive procedures.

Discussion

The frequency of isolation of *Staphylococcus* spp. in dogs is high, being the most isolated bacterium from skin infections, and can cause serious infections, especially in animals with weakened immune systems, as in the case in question. This is the first documented case of *S. pseudintermedius* resistant to multiple drugs, including methicillin, identified as an agent of healthcare-associated infection in a dog in Brazil.

In the reported case, the isolated *S. pseudintermedius* strain was confirmed as methicillin-resistant (MRSP), with a multidrug resistance profile associated with the presence of the *mecA*, *blaZ,tetM*, *ermB* and *norC* genes. Methicillin resistance, determined by the presence of the *mecA* gene located in the staphylococcal chromosomal cassette (SCCmec), makes the bacteria resistant to beta-lactams, including oxacillin and cephalosporins (Couto et al. 2014).

In a previous study carried out in the same sector of the veterinary hospital, the isolation and identification of *S. pseudintermedius* carrying the *mecA* gene (MSRP) had already been carried out in healthy female dogs undergoing ovariohysterectomy (Trajano et al. 2022) and *Staphylococcusaureus* carrying the *mecA* gene in a feline (Leite et al. 2023). This may indicate a continuity or expansion of the problem since the presence of resistant strains can increase the risk of HAIs.

These findings reflect the epidemiological importance of non-aureus *Staphylococcus* isolates, as well as the possibility of transfer of these genes between bacteria, since evidence has been found for the transfer of AMR between different species of *Staphylococcus* of human and canine origin (Frosini et al. 2020). Documented cases, such as that of an immunocompromised man who developed a wound infection after contact with his dog, illustrate the zoonotic potential of MRSP (Moses et al. 2023). Veterinary healthcare workers are also vulnerable, with colonization rates of 3.9% among exposed veterinarians (Santana et al. 2023).

In addition to clinical implications, environmental contamination by MRSP increases the risk of transmission within veterinary hospitals, since the bacteria can survive on surfaces for prolonged periods, facilitating its spread (Stull and Weese 2015). This environmental persistence requires rigorous biosafety protocols, including cleaning, disinfection, and isolation of infected patients. The rational use of antimicrobials based on antibiograms is also essential to reduce selective pressure and prevent the spread of resistance genes.

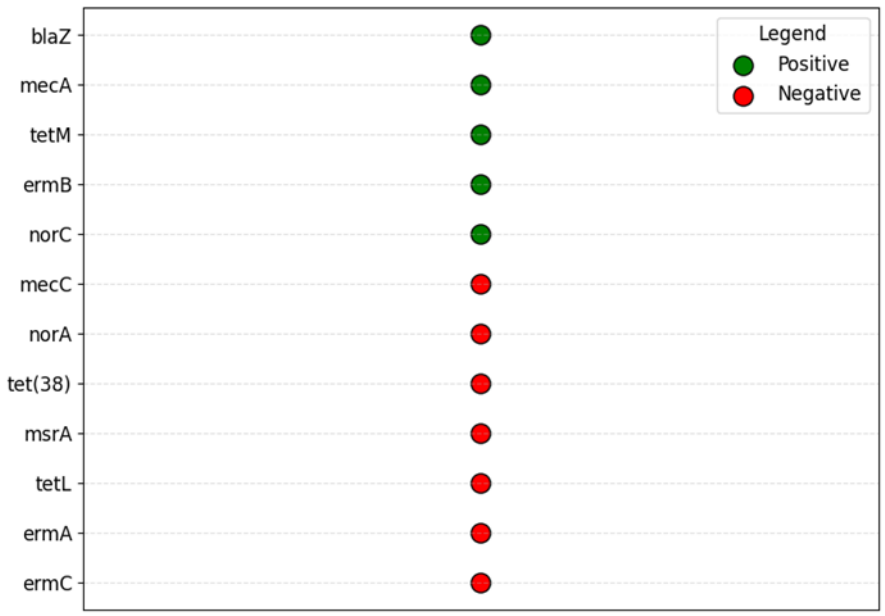

Figure 1. Distribution of antimicrobial resistance genes in Staphylococcus pseudintermedius.

Conclusion

The reported case highlights the urgent need for preventive and therapeutic strategies to combat antimicrobial resistance. Promising alternatives, such as phage therapy, antimicrobial peptides, and nanotechnology, are being explored, but face regulatory and economic challenges for their clinical implementation. While these technologies are not widely available, hospital infection control, epidemiological surveillance, and rational use of antimicrobials remain the pillars to mitigate the impacts of antimicrobial resistance and preserve the health of animals, humans, and the environment.

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