https://doi.org/10.15446/rfmvz.v72n1.116681



# Prevalence of methicillin-resistant *Staphylococcus aureus* in surgeon gloves of a mobile veterinary surgical sterilization unit in Bogotá D.C.

*A.C. Salazar–Mahecha* [1], *M.C Gallo-Álvarez* [1], *N. Hernández-Gallo* [1], *A.P Pulido-Villamarín* [2], *M. Aranda-Silva* [3].

*Recibido: 20/09/2024 Aprobado: 26/01/2025*

## ABSTRACT

Mobile Surgical Units (MSUs) facilitate canine and feline sterilization in vulnerable areas of Bogotá, Colombia, expanding access to veterinary surgical services. Methicillin-resistant Staphylococcus aureus (MRSA) is a significant veterinary pathogen due to its role in animal morbidity and mortality, as well as its zoonotic potential. This study aimed to determine MRSA prevalence on surgeons' gloves during MSU sterilization campaigns in Bogotá in May 2024. A survey was administered, and swab samples were collected from the internal (palmar) and interdigital glove surfaces after every five animals treated across 10 sterilization campaigns in different Bogotá localities. Samples were microbiologically processed using enriched, selective, and differential media, including CHROMagar MRSA. Data were recorded in an Excel database and analyzed using a chi-square test in RStudio to assess associations between MRSA presence and factors such as animal type (canine or feline), socioeconomic stratum, surgeon's sex, and glove changes between procedures. The results indicated a 20% MRSA prevalence, with no significant correlations observed between MRSA presence and the studied variables.

**Keywords:** *Staphylococcus aureus,* prevalence, surgical procedures, Bogotá.

# Prevalencia de *Staphylococcus aureus* meticilino-resistente en guantes de cirujano de unidad móvil quirúrgica veterinaria de esterilización en Bogotá D.C.

## RESUMEN

Las Unidades Móviles Quirúrgicas (UMQ) son empleadas para procedimientos quirúrgicos de esterilización canina y felina en zonas vulnerables de la ciudad de Bogotá, Colombia, ampliando el acceso a estos servicios quirúrgicos veterinarios. *Staphylococcus aureus* meticilino-resistente (MRSA) es un patógeno de importancia en medicina veterinaria por su capacidad de causar morbilidad y mortalidad en animales, además de su

[1] Fundación Universitaria Agraria de Colombia (Uniagraria). Calle 170 n.° 54a-10, Bogotá, Colombia.

[*] Corresponding author: cami3salazar@gmail.com

[2] Pontificia Universidad Javeriana, Faculty of Sciences, Deparment of Microbiology. Cra 7 n.° 43-82, Bogotá, Colombia.

[3] Pontificia Universidad Javeriana, Faculty of Sciences, Deparment of Mathematics. Cra 7 n.° 43-82, Bogotá, Colombia.

potencial zoonótico. Este estudio buscó determinar la prevalencia de MRSA en guantes de cirujanos de las UMQ durante las jornadas de esterilización en Bogotá durante mayo de 2024. Se diligenció una encuesta y se obtuvieron hisopados de la porción interna (palma) e interdigital a los guantes de los cirujanos cada 5 animales intervenidos en 10 jornadas de esterilización de diferentes localidades de Bogotá. Las muestras se procesaron microbiológicamente utilizando medios enriquecidos, selectivos y diferenciales como el CHROMagar MRSA. Los datos se registraron en una base de datos en Excel y se realizó un análisis estadístico de chi-cuadrado por medio del programa RSTUDIO, el cual permitió evaluar la asociación entre la presencia de MRSA y factores como tipo de población (canina o felina), estrato socioeconómico, sexo del cirujano y cambio de guantes entre procedimientos. Los resultados indicaron una prevalencia de MRSA del 20% en la población analizada. No se evidenciaron correlaciones significativas entre la presencia de MRSA y las variables estudiadas.

**Palabras clave***: Staphylococcus aureus*, prevalencia, procedimientos quirúrgicos, Bogotá.

## INTRODUCTION

MSUs are specially equipped vehicles designed to perform surgical procedures, such as canine and feline sterilization, in vulnerable areas of Bogotá, Colombia. The ability to bring these services directly to underserved locations underscores the significance of MSUs within the One Health framework, which recognizes the interconnectedness of human, animal, and environmental health. By contributing to public health, reducing the stray dog and cat population in high-density areas, and mitigating the spread of zoonotic diseases, MSUs play a crucial role in veterinary and public health interventions. Mass sterilization procedures conducted in MSUs provide extensive coverage and accessibility to the communities of Bogotá. However, due to the nature of these procedures and the conditions in which they are performed, there is a risk of contamination of the gloves used by surgeons with pathogenic microorganisms such as *Staphylococcus aureus*, posing a potential health risk to both medical personnel and animals (Denamiel *et al.* 2009).

MRSA is a bacterial pathogen that poses a significant threat due to its resistance to multiple antibiotics. Initially identified as a predominant nosocomial pathogen in humans (García 2011), MRSA has also emerged as a leading bacterial agent in veterinary hospitals (Loeffler *et al.* 2010). Colonized veterinary patients and medical personnel may serve as sources of infection, facilitating bacterial transmission through contaminated hands. This transmission is particularly concerning in hospital and clinical settings, where inadequate hygiene practices contribute to bacterial spread, underscoring the importance of proper disinfection and personal protective equipment (Boerlin *et al.* 2001).

Previous studies have documented MRSA in various veterinary facilities, including clinics and hospitals, with prevalence rates ranging from 2% to 14%, depending on hygiene practices and the management of infected animals (Morris *et al.* 2006; Weese & Van Duijkeren 2010; Tarazi *et al.* 2015). However, no specific data are available on MRSA prevalence in MSUs, a critical factor in implementing

effective infection control measures for surgical procedures performed outside traditional veterinary operating rooms.

MRSA's ability to cause severe infections in both companion and livestock animals underscores the need for studies on its prevalence and control in veterinary environments (Porrero 2014). Methicillin-resistant strains have emerged as a growing concern, particularly in small animals and equines (Chaparro *et al.* 2005). Transmission occurs through direct contact with infected animals, contaminated surfaces, and personal protective equipment, such as surgical gloves. Studies in human hospitals have shown that MRSA can persist on gloves and other medical equipment, suggesting these items may serve as infection sources if not properly handled (García 2011).

Additionally, MRSA causes severe infections in both humans and animals, including skin infections, pneumonia, endocarditis, and septicemia, with significant morbidity and mortality. In humans, MRSA infections account for approximately 19,000 deaths annually in the United States (Klevens *et al.* 2007). In animals, infections can be fatal (Leonard & Markey 2008), particularly in veterinary settings with inadequate infection control. MRSA-associated disease is a major concern for both human and animal health due to its high morbidity and mortality (Weese *et al.* 2006). In animals, MRSA can also cause post-surgical infections, wound infections, and urinary tract infections, further increasing morbidity and mortality (Leonard & Markey 2008).

Methicillin resistance in *Staphylococcus aureus* arises primarily from the acquisition of the *mecA* gene, which encodes penicillin-binding protein 2a (PBP2a) (Kakooza *et al.* 2024). This modified protein has a low affinity for β-lactam antibiotics, allowing the bacterium to continue synthesizing its cell wall despite the presence of methicillin. As a result, MRSA strains are particularly difficult to treat, exhibiting resistance not only to methicillin but also to other β-lactam antibiotics (Kakooza *et al.* 2024). Due to this threat, the World Health Organization (WHO) has designated MRSA as a high-priority pathogen (WHO 2024).

Given these concerns, this study aimed to determine the prevalence of MRSA on surgeons' gloves during procedures in Mobile Surgical Units (MSUs) across 10 of Bogotá's 20 localities. To date, no studies have specifically examined the presence of this pathogen in MSUs.

## MATERIALS AND METHODS

### Study type and population

This cross-sectional study employed convenience sampling. Samples were collected from 10 localities in Bogotá, chosen based on accessibility and availability. Given that the number of animals sterilized daily in MSUs varied, glove swab sampling was performed after every five animals, resulting in a variable number of swabs per sampling day.

Simultaneously with sample collection, relevant data were recorded, including the animal species (canine or feline), sex (male or female), locality, socioeconomic stratum, predominant climate, sample sequence, glove changes between procedures, and the surgeon's sex (male or female).

### Sample collection

Samples were collected between June and July 2024 during sterilization procedures conducted in MSUs across 10 localities in Bogotá, D.C. (figure 3). Glove swab

sampling was performed after every five animals treated, using a swab with CE Class IIa transport medium (MDD)TM (Girovet, Italy). The swabbing procedure involved rubbing the gloves used by the surgeon—including the interdigital spaces, palm, and edges—ensuring bilateral sampling. Samples were labeled, identified, and transported in Amies transport medium under refrigeration to the facilities of Universidad Javeriana.

### Sample processing

All samples underwent primary isolation on blood agar base (Oxoid, England) supplemented with 5% sheep blood and incubated for 24 hours at 37 ± 2 °C. Subsequent purification steps were performed. Based on the phenotypic characteristics of the colonies, established protocols for Gram-positive microorganisms—particularly *Staphylococcus* spp.—and/or Gram-negative microorganisms were followed (OMSA 2024).

Confirmatory biochemical tests for *Staphylococcus* spp. were conducted, including Gram staining, a catalase test, and culture on Baird-Parker agar, Mannitol Salt agar, and DNase agar (Oxoid). Once the genus was confirmed, isolates were plated on CHROMagar™ MRSA (CHROMagar Microbiology, France) for specific MRSA identification (Diederen *et al.* 2005).

Other bacterial genera present in the samples were identified using selective and differential culture media, along with additional biochemical tests, including MacConkey agar, oxidase test strips (Oxoid), and the API 20E™ panel (bioMérieux, USA).

### Data analysis

Data collected from the survey conducted during the sampling of 100 specimens (annex 1), along with laboratory results, were recorded in an Excel® database. Descriptive statistical analyses were performed, and associations were assessed using a chi-square test in RStudio (Lastre *et al.* 2019). This analysis evaluated the relationship between MRSA presence and factors such as animal population type (canine or feline), socioeconomic stratum, surgeon's sex, and glove changes between procedures.

## RESULTS AND DISCUSSION

In this study, 100 surgeon glove swabs were analyzed from MSUs during sterilization procedures conducted in 10 localities of Bogotá, D.C.

Microbial growth was observed in 48% of the samples (figure 1). Of these, 22.9% (11/48) exhibited mixed growth (more than one microorganism), while the remaining 77.1% (37/48) showed pure or axenic cultures (figure 2).

These findings are consistent with previous studies that have reported MRSA prevalence in veterinary clinics and other healthcare settings, albeit on a smaller scale (Yamauchi & Santorelli 2005).

When compared to other studies involving animals and humans, the prevalence of MRSA in clinical and surgical environments has shown an increasing trend, highlighting the need for improved infection control practices (Weese *et al.* 2006; Tarazi *et al.* 2015). In this study, the overall MRSA prevalence in the analyzed localities was estimated at 20%. Independent analysis revealed differences among localities, with Usme exhibiting the highest positivity rate at 66.7%, while Rafael Uribe Uribe had the lowest at 6.3% (figure 3). This variability may be influenced by several factors, including

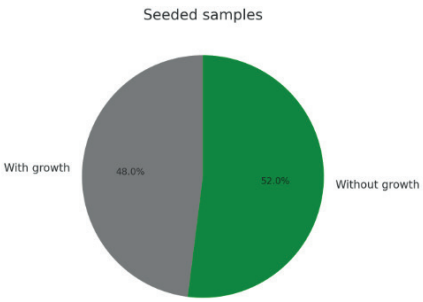


**FIGURE 1.** Graphical representation of growth obtained after seeding.
Source: own elaboration.

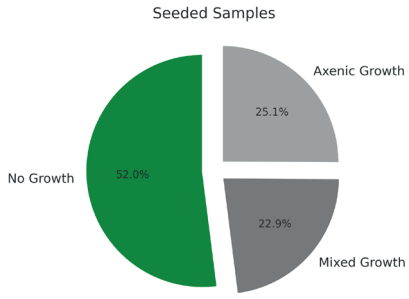


**FIGURE 2.** Detail of mixed axenic growth obtained from seeded samples.
Source: own elaboration.

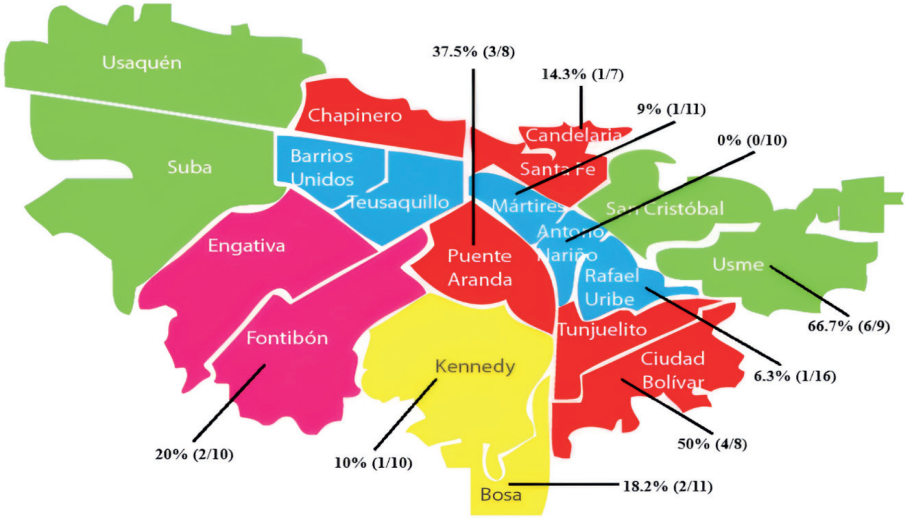


**FIGURE 3.** Estimated prevalence in 10 localities of Bogotá.
Source: http://www.lacandelaria.gov.co/mi-localidad/mapas

the less controlled working conditions in MSUs compared to traditional veterinary hospitals. Previous studies suggest that inadequate glove rotation and potential cross-contamination between animals and surgeons could contribute to these differences (Otter *et al.* 2013; Rubin *et al.* 2011).

The findings of this study align with the global trend of increasing MRSA infections in both human and veterinary medical settings (Weese *et al.* 2006). The lack of specific studies on MRSA prevalence in surgical gloves used in MSUs represents a gap in the literature that this study seeks to address.

Chi-square test results indicated no statistically significant difference in MRSA presence between using new gloves and reusing gloves ($p = 0.24$). Additionally, no significant correlation was found between

MRSA presence and the recorded study variables, including surgeon sex (male/female) (p = 0.82), animal species (dog/cat) (p = 0.33), weather conditions (rainy/sunny) (p = 0.14), animal sex (male/female) (p = 0.99), and socioeconomic stratum (1/2/3) (p = 0.86). However, a significant difference was observed across localities (p = 0.00199), suggesting that local context and specific practices within each area may influence MRSA prevalence.

Few studies report on MRSA prevalence in veterinary clinics and hospitals; however, previous research indicates a prevalence ranging from 2% to 16% (Yamauchi & Santorelli 2005). Outside hospital settings, reported prevalence rates include 5.3% in canines and 5.0% in humans who had contact with infected dogs, with strong associations observed between isolates from these hosts (Tarazi *et al.* 2015). These findings underscore the zoonotic and anthropozoonotic potential of *S. aureus* and highlight the critical need to enhance infection control measures, regardless of the setting.

The presence of MRSA can be inferred given that MSUs operate under less controlled conditions compared to traditional veterinary hospitals, potentially increasing the risk of cross-contamination. Additionally, hygiene practices and glove rotation between procedures may not be optimal, facilitating the persistence and transmission of MRSA (Otter *et al.* 2013). Similar studies have indicated that improper handling of personal protective equipment, such as gloves, can serve as a significant vector for MRSA spread (Rubin *et al.* 2011). Reports suggest that MRSA infections in both humans and animals are associated with high morbidity and mortality rates, underscoring the importance of effective preventive measures. According to the Centers for Diseases Control and Prevention (CDC 2018), MRSA infections can be severe and challenging to treat due to their antibiotic resistance, increasing the risk of serious complications and community transmission.

In relation to the findings of this study, previous research has highlighted how environmental factors and management practices influence MRSA prevalence in shared human-animal environments. Bullone *et al.* (2024) found that frequent antimicrobial treatments in stables significantly increase the risk of carrying these pathogens in both animals and caretakers, while appropriate environmental conditions, such as proper ventilation, act as protective factors. This perspective underscores the necessity of implementing surveillance programs and control strategies under the One Health approach to mitigate the risks associated with MRSA transmission.

MRSA transmission not only affects animal health but also poses a zoonotic threat to humans, particularly in environments with frequent human-animal contact (Weese *et al.* 2006; CDC 2018). The presence of other pathogens, such as *Acinetobacter* spp. and *Klebsiella* spp., further emphasizes the urgency of enforcing strict aseptic protocols in MSUs to prevent the spread of these infections in both animals and humans (WHO 2024). The recent update by the WHO of its priority pathogen list highlights the significance of these microorganisms due to their high resistance to critical antibiotics (WHO 2024).

Although identifying the accompanying microbiota was not an objective of this study, the analysis of all collected samples revealed the presence of additional

microorganisms in the following proportions: α-hemolytic *Streptococcus* (12%), *Acinetobacter* spp. (7%), *Micrococcus* spp. (5%), *Pseudomonas* spp. (4%), coryneform Gram-positive bacilli (1%), and *Escherichia coli* (3%). Additionally, β-hemolytic *Streptococcus*, *Klebsiella* spp., *Staphylococcus* spp., and *Candida* spp. were each detected in 1% of the samples (figure 4).

As previously mentioned, antimicrobial resistance (AMR) complicates the treatment of infectious diseases, increasing healthcare costs for both animal and human patients and negatively impacting public health. The detection of other pathogens, such as *Acinetobacter* spp., although not initially within the scope of this study, warrants attention given the recent findings by WHO. The 2024 update to the WHO priority pathogen list classifies *Acinetobacter baumannii*, *Enterobacterales* (including *Escherichia coli* and *Klebsiella* spp.), and *Pseudomonas aeruginosa* as critical- and high-priority pathogens due to their resistance to carbapenems and third-generation cephalosporins. Additionally, Group A and B *Streptococcus* are classified as medium-priority pathogens due to their resistance to macrolides (WHO 2024).

The findings of this study provide valuable data that could inform the development of public health policies aimed at reducing the transmission of MRSA and other pathogens in these environments.

## CONCLUSION

The prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) was found to be 20%; however, no statistically significant association was observed between the presence of the pathogen and the studied variables.

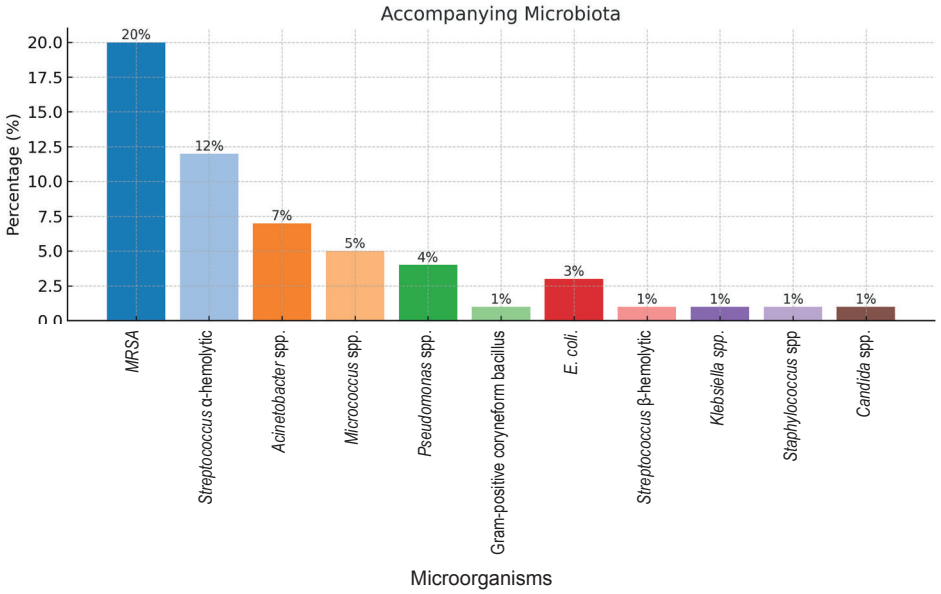


**FIGURE 4.** Identified accompanying microbiota.
Source: own elaboration.

## AUTHOR CONTRIBUTIONS

All authors made equal contributions to data analysis and manuscript preparation.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

## ETHICS COMMITTEE APPROVAL

Since no direct interaction with animals occurred during this study, ethics committee approval was not required.

## DECLARATION ON THE USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) tools were used to facilitate data visualization and develop the graphs presented in this study.

## FUNDING SOURCES

This research was conducted using personal funds without external funding. However, academic and experimental support was provided by the Agricultural Research Unit (UNIDIA) at Pontificia Universidad Javeriana.

## DATA AND MATERIAL AVAILABILITY

All data and materials are available from the corresponding author upon request. However, the sampling methods are proprietary to Pontificia Universidad Javeriana.

## ACKNOWLEDGMENTS

We extend our sincere gratitude to Dr. Adriana and Dr. Moisés for their invaluable guidance, dedication, and support throughout the development of this research project. Their expertise, patience, and continuous encouragement were instrumental to the successful completion of this study.

## REFERENCES

Bhat AH. 2021. Bacterial zoonoses transmitted by household pets and as reservoirs of antimicrobial resistant bacteria. Microbial Pathogenesis. 155:104891. https://doi.org/10.1016/j.micpath.2021.104891

Boerlin P, Eugster S, Gaschen F, Straub R, Schawalder P. 2001. Transmission of opportunistic pathogens in a veterinary teaching hospital. Vet Microbiol.82(4):347-59. https://doi.org/10.1016/s0378-1135(01)00396-0.

CDC. 2018. Methicillin-Resistant Staphylococcus aureus (MRSA). Availaible in: https://www.cdc.gov/mrsa/index.html

Bullone M, Bellato A, Robino P, Nebbia P, Morello S, Marchis D, Tarducci A, Ru G. 2024. Prevalence and risk factors associated with nasal carriage of methicillin-resistant staphylococci in horses and their caregivers. Veterinary Research. 55:108. https://doi.org/10.1186/s13567-024-01364-0

Chaparro J, Hernández Y, Castellanos V. 2005. Aislamiento, identificación y antibiograma de las bacterias presentes en el centro médico quirúrgico veterinario Universidad Cooperativa de Colombia. Revista Colombiana de Ciencias Pecuarias. 18(4):381-383. https://doi.org/10.17533/udea.rccp.323980

Denamiel G, Puigdevall T, Más J, Albarellos G, Gentilini E. 2009. Prevalencia y perfil de resistencia a betalactámicos en estafilococos de perros y gatos. InVet [online]. 11(2):117-122. Available in: https://www.redalyc.org/pdf/1791/179116775006.pdf.

Diederen B, Van Duijn I, Van Belkum A, Willemse P, Van Keulen P, Kluytmans J. 2005. Performance of CHROMagar MRSA Medium for Detection of Methicillin-Resistant *Staphylococcus aureus*. Journal of Clinical Microbiology. 43(4):1925-7. https://doi.org/10.1128/JCM.43.4.1925-1927.2005.

García C. 2011. *Staphylococcus aureus* meticilino resistente adquirido en la comunidad. Acta Médica Peruana. 28(3):159-162. Available in: http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S172859172011000300007&lng=es&tlng=es.

Kakooza S, Eneku W, Nabatta E, Wampande EM, Ssajjakambwe P, Wanyana M, Munyiirwa DFN, Ndoboli D, Namuyinda D, Athieno G, Kayaga E, Okwasiimire R, Tsuchida S, Ushida K, Sakurai K, Mutebi F. 2024. Integrating multi-wet laboratory diagnostics to study staphylococci in animals in Uganda. BMC Microbiology. 24 :298. https://doi.org/10.1186/s12866-024-03442-x.

Klevens RM, Morrison MA, Nadle J, Petit S, Gershman K, Ray S, Fridkin SK. 2007. Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. JAMA. 298(15):1763-177. https://doi.org/10.1001/jama.298.15.1763.

Lastre D, Santana MP, Tumbaco OL. 2019. Análisis estadístico de tablas de contingencia y chi cuadrado para medir el flujo migratorio en el Ecuador en el 2018. Ecuadorian Science Journal. 3(1) :23-30. https://doi.org/10.46480/esj.3.1.24.

Leonard FC, Markey BK. 2008. Methicillin-resistant *Staphylococcus aureus* in animals: a review. Veterinary Journal. 175(1):27-36. Available in: https://www.sciencedirect.com/science/article/abs/pii/S1090023306002474

Loeffler A, Lloyd DH. 2010. Companion animals: A reservoir for methicillin-resistant *Staphylococcus aureus* in the community? Epidemiology & Infection. 138(5):595-605. https://doi.org/10.1017/S0950268809991479

Morris DO, Mauldin EA, O'Shea K. 2006. Clinical, microbiologic, and molecular characterization of methicillin-resistant *Staphylococcus aureus* infections of cats. American Journal of Veterinary Research. 71(6):825-830. https://doi.org/10.2460/ajvr.67.8.1421.

Organización Mundial de la Salud (OMS). 2024. La OMS pone al día la lista de bacterias farmacorresistentes más peligrosas para la salud humana. Available in: https://www.who.int/es/news/item/17-05-2024-who-updates-list-of-drug-resistant-bacteria-most-threatening-to-human-health.

Organización Mundial de la Sanidad Animal (OMSA). 2024. Manual de las Pruebas de Diagnóstico y de las Vacunas para los Animales Terrestres, decimotercera edición 2024. Available in: https://www.woah.org/es/que-hacemos/normas/codigos-y-manuales/acceso-en-linea-al-manual-terrestre/

Otter JA, French GL, Harbarth S. 2013. Community-associated meticillin-resistant Staphylococcus aureus: The case for a genotypic definition. Journal of Hospital Infection. 85(2):144-148. https://doi.org/10.1016/j.jhin.2012.04.009

Porrero MC. 2014. Detección y caracterización de *Staphylococcus aureus* procedentes de animales y aguas (Doctoral dissertation, Universidad Complutense de Madrid). Available in: https://docta.ucm.es/rest/api/core/bitstreams/e0a09a2c-3d79-42e3-8594-ccd871e7853d/content

Rubin JE, Ball KR, Chirino-Trejo M. 2011. Antimicrobial susceptibility of *Staphylococcus aureus* and *Staphylococcus pseudintermedius* isolated from various animals. Canadian Veterinary Journal. 52(2):153-158. Available in: https://pmc.ncbi.nlm.nih.gov/articles/PMC3022451/pdf/cvj_02_153.pdf

Tarazi YH, Almajali AM, Kheer-Ababneh MM, Ahmed HS, Jaran AS. 2015. Molecular study on methicillin-resistant *Staphylococcus aureus* strains isolated from dogs and associated personnel in Jordan. Asian Pac J Trop Biomed. 5(11):902-908. http://dx.doi.org/10.1016/j.apjtb.2015.06.015

Weese 2010. Methicillin-resistant *Staphylococcus aureus* and *Staphylococcus pseudintermedius* in veterinary medicine. Veterinary Microbiology JS, Dick H, Willey BM, McGeer A, Kreiswirth BN, Innis B, Low DE. 2006. Suspected transmission of methicillin-resistant *Staphylococcus aureus* between domestic pets and humans in veterinary clinics and in the household. Veterinary Microbiology. 115(1-3):148-155. https://doi.org/10.1016/j.vetmic.2006.01.004.

Weese JS, Van Duijkeren E.. 140(3-4):418-429. https://doi.org/10.1016/j.vetmic.2009.01.03

World Health Organization. (2024). *WHO updates list of drug-resistant bacteria most threatening to human health.* Retrieved from https://www.who.int/news/item/17-05-2024-who-updates-list-of-drug-resistant-bacteria-most-threatening-to-human-health

Yamauchi T, Santorelli F. 2005. Recoveryof methicillin-resistant *Staphylococcus aureus* (MRSA) from dogs and cats. American Journal of Infection Control. 105(2):213-219. https://doi.org/10.1016/j.ajic.2005.04.225.

**Forma de citación del artículo:**

Salazar–Mahecha, A.C., Gallo–Álvarez, M.C., Hernández–Gallo, N., Pulido–Villamarín, A.P., Aranda–Silva, M. (2025). Prevalence of Methicillin-resistant Staphylococcus aureus in surgeon gloves of a mobile veterinary surgical sterilization unit in Bogotá D.C. Rev Med Vet Zoot. 72(1): e116681. https://doi.org/10.15446/rfmvz.v72n1.116681