Case Report

Medicina Veterinária

e-ISSN 2675-6617
v. 18 n. 1 (2024)

Multidrug-resistant *Staphylococcus chromogenes* pyoderma in *Rattus norvegicus*: case report

Piodermite por Staphylococcus chromogenes multirresistente em Rattus norvegicus: relato de caso

Júlia Facchin **Tronca**, Felipe Esteves da **Silva**, Alessandra Gugel **Piccinini**, Vitória **Damin**, Gustavo **Brambatti**, Fabiane **Prusch**, André Felipe **Streck***

[1]*Universidade de Caxias do Sul, Caxias do Sul-RS, Brazil.*
**Corresponding author: afstreck@ucs.br*

Article info

Keywords
Infection
Pet rodent
Multidrug-resistant bacteria
Antibiotic use

DOI
doi.org/10.26605/medvet-v18n1-6253

Citation
Tronca, J. F., Silva, F. E., Piccinini, A. G., Damin, V., Brambatti, G. Prusch, F. & Streck, A. F. (2024). Multidrug-resistant *Staphylococcus chromogenes* pyoderma in *Rattus norvegicus*: case report. Medicina Veterinária, *18*(1), 71–76. https://doi.org/10.26605/medvet-v18n1-6253

Received: September 13, 2023
Accepted: December 23, 2023

Abstract

This case study investigated a multidrug-resistant *Staphylococcus* pyoderma infection in a pet *Rattus norvegicus*. The clinical presentation involved a range of clinical signs, including pruritus, inflammation, pustules, and crusts on the skin, indicative of bacterial pyoderma. Conventional and molecular techniques were used, and the pathogen was identified as *Staphylococcus chromogenes*. The suspected transmission route was through a bite from another rat, although the aggressor was not tested. Initial treatment with enrofloxacin proved ineffective. Subsequently, an amoxicillin + potassium clavulanate treatment resulted in temporary improvement. Nevertheless, the infection relapsed after 30 days, necessitating a repeated course of treatment. The findings underscore the importance of accurate diagnosis, appropriate testing, and adherence to prescribed treatments for bacterial infections. The zoonotic potential of multidrug-resistant *Staphylococcus* highlights the need for better education of pet owners on transmission risks and treatment compliance. Additional research is essential to explore the transmission routes of this infection, the potential risks to pet owners, and to gain a more comprehensive understanding of *Staphylococcus chromogenes* pyoderma in domestic rodents.

Resumo

Este relato de caso investigou uma piodermite por *Staphylococcus* resistente a múltiplas drogas em um *Rattus norvegicus* de estimação. A apresentação clínica envolveu uma variedade de sinais clínicos, incluindo prurido, inflamação, pústulas e crostas na pele, indicativos de infecção bacteriana. Técnicas convencionais e moleculares foram utilizadas e o patógeno foi identificado como *Staphylococcus chromogenes*. Suspeita-se que a via de transmissão tenha sido através de uma mordida de outro rato, embora o agressor não tenha sido testado. O tratamento inicial com enrofloxacina mostrou-se ineficaz. Posteriormente, um tratamento com amoxicilina + clavulanato de potássio resultou em melhora temporária. No entanto, ocorreu uma recaída após 30 dias, necessitando de repetição do tratamento. Os achados ressaltam a importância de um diagnóstico preciso, testes adequados e adesão aos tratamentos prescritos para infecções bacterianas. O potencial zoonótico de *Staphylococcus* resistente a múltiplas drogas destaca a necessidade de uma melhor educação dos tutores de animais de estimação sobre os riscos de transmissão e conformidade com o tratamento. Pesquisas adicionais são necessárias para investigar as vias de transmissão desta infecção, riscos potenciais para os tutores de animais de estimação e uma compreensão mais abrangente de piodermites por *Staphylococcus chromogenes* em roedores de estimação.

Pavaras-chave: infecção; roedor de estimação; bactéria resistente a múltiplas drogas; uso de antibióticos.

1 | Introduction

Recently, various rodent species, specially *Rattus norvegicus* (known as twister rats, mercol, or fancy rat), have gained popularity as pets due to their docile and intelligent nature. *Rattus norvegicus* is known for its meticulous grooming habits, ensuring constant fur cleanliness. Nonetheless, decreased grooming can result in various problems, such as systemic illnesses, parasitism, stress, aggression from cage mates, and infectious dermatitis (Mitchell and Tully, 2008). It is also noteworthy that these animals can host and spread a diversity of zoonotic pathogens (de Cock et al., 2023).

In clinical examinations of these small mammals, history and environmental factors play crucial roles in differential diagnoses (Teixeira, 2014), as do complete physical examinations, as some skin issues may be secondary to systemic pathology (Miller et al., 2013). Pyoderma, a bacterial skin infection, commonly presents as pustules that rupture and form crusts and alopecia in *Rattus norvegicus* (Teixeira, 2014). For this disease, *Staphylococcus* spp. and *Streptococcus* spp. are the primary bacterial agents, both with zoonotic potential (Ge et al., 2019).

Research has shown the presence of multidrug-resistant *Staphylococcus* species in urban wild rodents (Desvars-Larrive et al., 2019; Himsworth et al., 2014a; Himsworth et al., 2014b; Lee et al., 2019). Furthermore, the transmission of multi-resistant *Staphylococcus* between humans and animals has been already identified (Ge et al., 2019), posing a significant global public health challenge due to its high environmental resistance and rapid ability to develop antibiotic resistance (Khalaf et al., 2015). Despite the evidence of multi-resistant *Staphylococcus* in wild rodents, there is limited research on its transmissibility and multi-resistance in domesticated. The aim of this study was to report a case of bacterial pyoderma caused by *Staphylococcus chromogenes* in a pet Twister *Rattus norvegicus*, tests performed, resistance rate based on antibiogram results, and treatment options.

2 | Case report

The patient was a 9-month-old Twister *Rattus norvegicus* rat, weighing 700 g, presented with crusted wounds, erythema, and alopecia on the lateral and dorsal regions of the neck and head (Figure 1), along with constant itching and agitated behavior.

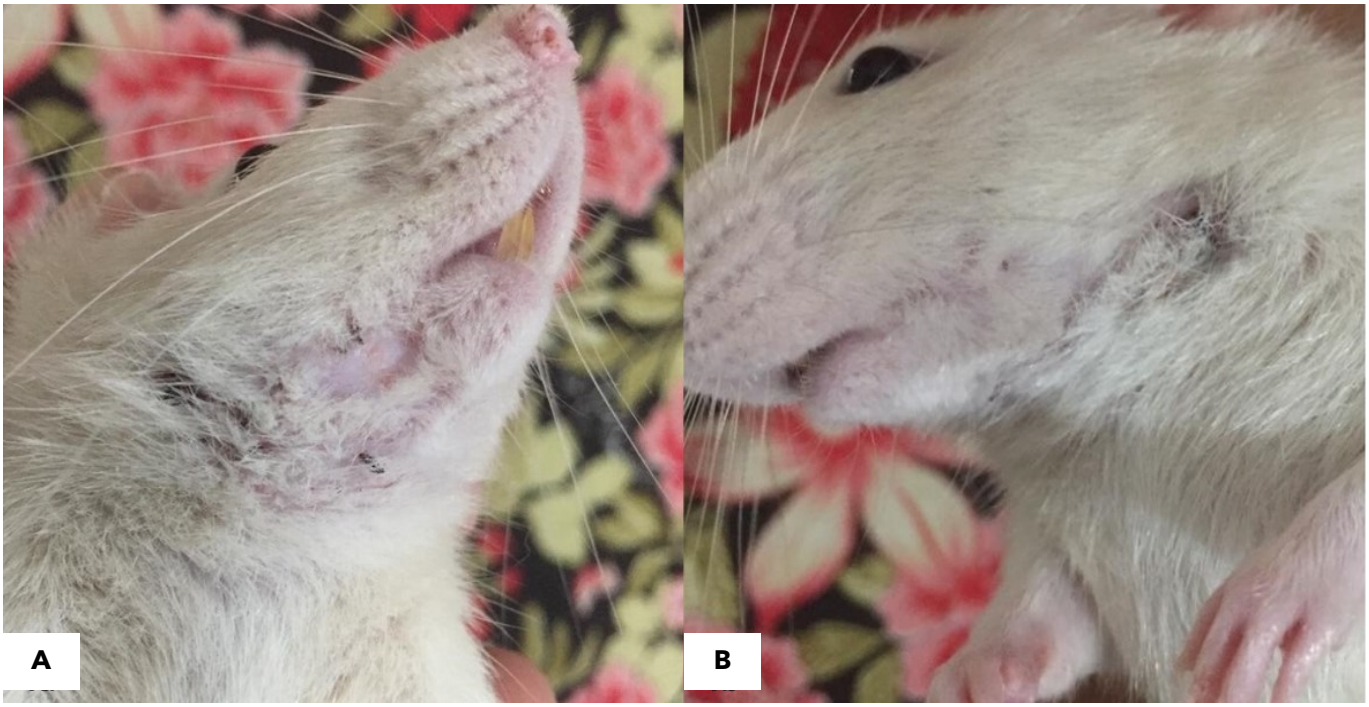

Figure 1. Alopecic lesions and crusts in the intermandibular, mandibular (A), and masseteric (B) regions of the ventral side of the head, distributed across both the right and left antimeres, were observed in a *Rattus norvegicus* with a suspected bacterial pyoderma.

During the clinical examination, the animal displayed typical physiological signs for its species: heart rate fluctuating between 250 and 450 beats per minute, respiratory rate of 70 to 150 breaths per minute, and a temperature of 38°C, plus normal hydration, and a good body score. No changes in appetite were reported, and the rat was alert, agitated, and non-aggressive. The mucous membranes were pink, with no alterations or manifestations of other skin or fur signs beyond those previously mentioned. Nasal and ocular discharge with the presence of porphyrin was observed.

Regarding management, the animal was reported to live alone in a cage measuring 57 cm in width, 51 cm in length, and 34 cm in height, with a grated floor to avoid contact with feces and urine. According to the owner, the substrate used was pelletized sawdust, with a metal feeder and a plastic water bottle. In the cage, the animal had access to a shelter (made of cardboard and replaced periodically) and environmental enrichment, such as PVC pipes and a net. The diet provided was specific for Twister rats, in addition to fruits and vegetables such as raw green corn, apple, and banana. Biscuits and loose dog food pellets were also offered as treats.

The laboratory diagnosis was carried out through swab collection from the lateral and dorsal neck regions. The material was stored at 4°C in Stuart transport medium. On the same day, the sample was plated on blood agar and incubated in a bacteriological culture incubator at 37°C for 24 hours. Initially, through the Gram staining method, Gram-positive cocci were identified. The isolated bacterial sample was then seeded on Mannitol Salt Agar, remaining in the color of the agar (red).

To differentiate between streptococci and staphylococci, a catalase test was performed, which involved adding 3% hydrogen peroxide to a small inoculum of the bacterium and evaluating bubble formation. Through the release of oxygen, it was considered that the sample was likely from the genus *Staphylococcus* spp. For the coagulase test, liquid BHI medium was used, added to rabbit plasma in a 1.5 mL tube. The bacterium analyzed in this study was negative for the coagulase test (methods adapted from ANVISA, 2013).

Subsequently, an antibiogram of the sample was performed using the disk diffusion method. The analysis of bacterial susceptibility to antibiotics began with the standardized dilution of the bacterium in saline solution with a turbidity of 0.5 on the McFarland scale. The sample was then uniformly inoculated on Müller-Hinton agar, and antibiotic-containing disks were placed. After incubation for 24 hours at 37°C in an incubator, the diameters of the inhibition zones and the consequent bacterial resistance to the tested antibiotics were verified. The results obtained are listed in Table 1.

Additionally, genetic sequencing was requested to confirm the species of *Staphylococcus* sp. causing the lesion. First, the sample was standardized in saline solution and kept refrigerated for DNA extraction. The extraction was performed using a silica-based method, utilizing the NewGene Prep and NewGene Preamp kits (NewGene, Brazil). The PCR technique employed primers for the amplification of the 16S rRNA gene, which primarily aims to identify the genus of the bacterial species of clinical importance (Janda and Abbott, 2017). The pure culture underwent analysis using the Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) technique, as previously described by Nonnemmann et al. (2019). The Byotiper 4.0 software was used for the identification of ion profiles.

Through the sequencing performed, it was confirmed to be a bacterium of the genus *Staphylococcus*, obtaining 97% identification with *Staphylococcus chromogenes*. The same identification was returned using the MALDI-TOF MS method.

The initial treatment with enrofloxacin proved ineffective. Following the antibiogram results, a new treatment with amoxicillin + potassium clavulanate, oral suspension, at a dosage of 20 mg/kg, twice a day (BID) for 14 days, proved effective, resulting in the complete remission of clinical signs. This was evidenced by the improvement in the general condition of the skin and fur, complete absence of itching or behavioral changes. Approximately 30 days after the end of the treatment, the animal exhibited a relapse of the initial clinical signs, and wound formation occurred again due to intense itching. The treatment was repeated, and as of the conclusion of this study (30 days afterwards), the animal had not experienced another relapse.

Table 1. Inhibition halos and antibiotic resistance of *Staphylococcus chromogenes* isolated from *Rattus norvegicus*

Antibiotic and concentration used	Sample inhibition halo (in millimeters)	Bacterial susceptibility recommended	Result
Sulfamethoxazole + Trimethoprim - 25µg	10 mm	≥16 mm – ≥10 mm*	Resistant
Amoxicillin + clavulanate - 30µg	19 mm	≥25 mm – ≥19 mm**	Intermediate
Ceftriaxone - 30µg	10 mm	≥28 mm – ≥22 mm**	Resistant
Enrofloxacin - 5µg	14 mm	≥23 mm – ≥16 mm***	Resistant
Cephalexin - 30µg	14 mm	≥37 mm – ≥29 mm**	Resistant
Gentamicin - 10µg	10 mm	≥15 mm – ≤12 mm*	Resistant
Oxacillin - 1µg	6 mm	≥25 mm – ≤24 mm*	Resistant
Azithromycin - 15µg	8 mm	≥18 mm – ≤13 mm*	Resistant
Neomycin - 30µg**	8 mm	≥26 mm – ≤18 mm***	Resistant
Penicillin - 10UI	16 mm	≥29 mm – ≥ 28 mm*	Resistant
Tetracycline - 30µg	13 mm	≥19 mm – ≥14 mm*	Resistant
Erythromycin - 15µg	9 mm	≥23 mm – ≥13 mm*	Resistant

*Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. Wayne, USA, 2020.

** Inhibition halo according to the manufacturer's guidance (SENSIFAR/MULTIFAR CEFAR®, BrCAST section).

***Clinical and Laboratory Standards Institute. Performance standards for antimicrobial disk diffusion and dilution susceptibility tests for bacteria isolated from animals. Wayne, USA, 2008.

3 | Discussion

Bacterial pyodermas are relatively common in routine clinical care for rodents, but the performance of complementary tests is sporadic (Teixeira, 2014). Diagnosis typically relies on clinical suspicion, cutaneous imprints, and occasionally microbiological culture (Quinton, 2005). Clinical signs and lesions associated with this pathology can vary in severity and include itching, inflammation, pustules, crusts, and alopecia (Summers et al., 2014).

Bacteria belonging to the genera *Streptococcus* sp. and *Staphylococcus* sp. are among the primary causes of pyodermas (Khalaf et al., 2015). These opportunistic pathogens colonize the dermis of animals and humans, causing various infections when an immunological imbalance occurs in these species (Ge et al., 2019). *Staphylococcus chromogenes* is a known agent that causes subclinical mastitis in livestock animals with broad antibiotic resistance (Foster, 2012). In canines, it was already isolated from the skin of healthy animals and in cases of pyoderma (Hauschild and Wójcik, 2007). However, to our knowledge, this is the first report in companion rats.

The initial treatment administered by the owner, consisting of injectable enrofloxacin, was ineffective. Although treatment based on presumptive diagnosis can sometimes yield positive results, it often leads to relapses and a worsening clinical condition. Complementary tests to identify the causative agent of pyoderma are needed to increase the chances of successful treatment (Himsworth et al., 2014a). After conducting a culture and antibiogram, treatment with amoxicillin + potassium clavulanate was initiated and proved effective. Nevertheless, a relapse of symptoms was observed 30 days later, with the animal exhibiting itching and new lesions. The treatment with amoxicillin + potassium clavulanate was repeated for another 14 days, and no further relapses have been observed to date.

Despite exhibiting intermediate susceptibility in the antibiogram, the choice to

perform an extended treatment course with amoxicillin + potassium clavulanate yielded success. An intermediate antimicrobial can be used in body sites with physiological drug concentration or when a higher-than-normal dosage of a drug is feasible (Turnidge and Paterson, 2007). Therefore, this strategic decision, notwithstanding encountering intermediate resistance, underscores the importance of prolonged treatment durations with high dosage to ensure the elimination of the causative agent.

This therapeutic approach is documented in specialized literature on small mammal medicine, which recommend the use of amoxicillin + potassium clavulanate orally for at least two weeks (Quinton, 2005). This treatment has also been reported in humans who develop infections after being bitten by free-living urban rats of various species. Given the polymicrobial nature of such bites, broad-spectrum antimicrobials are generally recommended (Morgan, 2005).

The close relationship between companion animals and their owners provides favorable conditions for the transmission of multidrug-resistant bacteria, either through direct contact or within the home environment (Guardabassi et al., 2004). Moreover, the exchange of multidrug-resistant genes is enhanced, as bacteria originating from humans can acquire resistance from the commensal skin flora of pets and vice versa. Studies on free-roaming animals reveal that urban rats harbor identical strains of Methicillin Resistant *Staphylococcus aureus* (MRSA) found in local human and/or animal populations, suggesting transmission from external sources (Himsworth, et al., 2014a, Gerbig et al., 2023).

To minimize the transmission of multidrug-resistant bacteria, pet owners should be advised to follow strict hygiene practices when handling their pets and cleaning their living environment (Weese, 2010). This includes frequent handwashing, using disposable gloves when handling infected animals, and regularly disinfecting the animal's living space (Stull et al., 2015). Additionally, pet owners should be informed about the importance of responsible antibiotic use and advised to strictly adhere to treatment protocols, as overuse or misuse of antibiotics can contribute to the emergence of multidrug-resistant bacteria (Smith, 2018).

4 | Conclusion

Due to the limited number of reports on *Staphylococcus chromogenes* pyoderma in *Rattus norvegicus* when kept as companion animals, further studies are needed on the agent and the disease, its transmission routes, and potential risks to pet owners. In conclusion, appropriate antibiotic use is essential in the treatment of infections caused by multidrug-resistant bacteria. Clinicians should carefully consider the selection of antibiotics and use them judiciously to reduce the development and spread of antibiotic resistance.

5 | Declaration of Conflict of Interest

The authors declare no conflict of interest.

6 | References

ANVISA. Agência Nacional de Vigilância Sanitária (Brasil). Microbiologia Clínica para o Controle de Infecção Relacionada à Assistência à Saúde. In: Agência Nacional de Vigilância Sanitária. Módulo 6: **Detecção e identificação de bactérias de importância médica.** Brasília: Anvisa, 2013. p.1-150.

Clinical and Laboratory Standards Institute. **Performance standards for antimicrobial disk diffusion and dilution susceptibility tests for bacteria isolated from animals**. 5th Edition. CLSI, 2008.

Clinical and Laboratory Standards Institute. **Performance standards for antimicrobial susceptibility testing**. 30th Edition. CLSI, 2020.

de Cock, M.P.; de Vries, A.; Fonville, M.; Esser, H.J.; Mehl, C.; Ulrich, R.G.; Joeres, M.; Hoffmann, D.; Eisenberg, T.; Schmidt, K.; Hulst, M.; van der Poel, W.H.M.; Sprong, H.; Maas, M. Increased rat-borne zoonotic disease hazard in greener urban areas. **Science of the Total Environment**, 896: 165069, 2023.

Desvars-Larrive, A.; Baldi, M.; Walter, M.; Frei, R.; Radziejewska-Lebrecht, J. Urban brown rats (*Rattus norvegicus*) as possible source of multidrug-resistant Enterobacteriaceae and Methicillin-resistant *Staphylococcus* spp., Vienna, Austria, 2016 and 2017. **Eurosurveillance**, 24(32): 1900149, 2019.

Foster, A.P. Staphylococcal skin disease in livestock. **Veterinary dermatology**, 23(4): 342–e63, 2012.

Ge, J.; Wang, Y.; Li, X.; Li, Y.; Hua, D. Methicillin-resistant *Staphylococcus aureus* among urban rodents, house shrews, and patients in Guangzhou, Southern China. **BMC Veterinary Research**, 15: 260, 2019.

Gerbig, G.R.; Piontkivska, H.; Smith, T.C.; White, R.; Mukherjee, J.; Benson, H.; Rosenbaum, M.; Leibler, J.H. Genetic characterization of *Staphylococcus aureus* isolated from Norway rats in Boston, Massachusetts. **Veterinary Medicine and Science**, 9(1): 272-281, 2023.

Guardabassi, L.; Schwarz, S.; Lloyd, D.H. Pet animals as reservoirs of antimicrobial-resistant bacteria: Review. **Journal of Antimicrobial Chemotherapy**, 54(2): 321–332, 2004.

Hauschild, T; Wójcik, A. Species distribution and properties of staphylococci from canine dermatitis, **Research in Veterinary Science**, 82: 1-6, 2007.

Himsworth, C.G.; Parsons, K.L.; Feng, A.Y.T.; Kerr, T.; Jardine, C.M.; Rosta, L. Carriage of Methicillin-Resistant *Staphylococcus aureus* by Wild Urban Norway Rats (*Rattus norvegicus*). **Plos One**, 9(2): 1-9, 2014a.

Himsworth, C.G.; Parsons, K.L.; Jardine, C.; Patrick, D.M. Bacteria isolated from conspecific bite wounds in Norway and black rats: implications for rat bite–associated infections in people. **Vector-Borne and Zoonotic Diseases**, 14(2): 94-100, 2014b.

Janda, J.M.; Abbott, S.L. 16S rRNA Gene sequencing for bacterial identification in the diagnostic laboratory: pluses, perils, and pitfalls. **Journal of Clinical Microbiology**, 45: 2761-2764, 2017.

Khalaf, S.K.; Al-Asadi, M.A.K.; Al-Sultan, A.A.; Al-Musawi, S. S. Isolation of methicillin resistant *Staphylococcus aureus* (MRSA) from *Rattus rattus* from Adhamiyah district in Baghdad governorate. **Mirror of Research in Veterinary Sciences and Animals**, 3(4): 9-23, 2015.

Lee, M.J.; Taylor, M.J.; Gibson, G.; Clifton-Hadley, F.A. Methicillin-resistant *Staphylococcus aureus* in urban Norway rat (*Rattus norvegicus*) populations: Epidemiology and the impacts of kill-trapping. **Zoonoses and Public Health**, 66(3): 343-348, 2019.

Miller, W.H.; Griffin, C.E.; Campbell, K.L. **Muller and Kirk's Small Animal Dermatology**. 7th ed. St. Louisi: Saunders Elsevier, 2013. 948p.

Mitchell, M.A.; Tully, T.N. **Manual of exotic pet practice-e-book**. St. Louis: Saunders Elsevier, 2008. 560p.

Morgan, M. Hospital management of animal and human bites. **Journal of Hospital Infection**, 61(1): 1-10, 2005.

Nonnemann, B.; Lyhs, U.; Svennesen, L.; Kristensen, K.A.; Klaas, I.C.; Pedersen, K. Bovine mastitis bacteria resolved by MALDI-TOF mass spectrometry. **Journal of Dairy Science**, 102(3): 2515-2524, 2019.

Quinton, J.F. **Novos animais de estimação: pequenos mamíferos**. São Paulo: Roca, 2005. 280p.

Smith, M. Antimicrobial resistance in companion animals. **Journal of Small Animal Practice**, 59(9): 517-526, 2018.

Stull, J. W.; Brophy, J.; Weese, J. S. Reducing the risk of pet-associated zoonotic infections. **Canadian Medical Association Journal**, 187(10): 736-743, 2015.

Summers, J.F.; Hendricks, A.; Brodbelt, D.C. Prescribing practices of primary-care veterinary practitioners in dogs diagnosed with bacterial pyoderma. **BMC Veterinary Research**, 10(1): 1-10, 2014.

Teixeira, V.N. Roedores exóticos (rato, camundongo, hamster, gerbilo, porquinho-da-índia e chinchila). In: Cubas, Z.S.; Silva, J.C.R; Catão-Dias, J.L (Ed.). **Tratado de animais selvagens: medicina veterinária**. São Paulo: Roca, 2014. p.1317-1318.

Turnidge, J.; Paterson, D.L. Setting and Revising Antibacterial Susceptibility Breakpoints. **Clinical Microbiology Reviews**, 20(3): 391–408, 2007.

Weese, J.S. Infection control and zoonotic disease risk in the veterinary clinic. **The Canadian Veterinary Journal**, 51(11): 1219-1222, 2010.