CRIMSON PUBLISHERS
Wings to the Research

Approaches in Poultry, Dairy & Veterinary Sciences

ISSN: 2576-9162

Mini Review

Dissemination of Multidrug-Resistant Bacteria in Birds

Fernanda Alda da Silva[1], Sarah Brandão Palácio[2], José Eduardo Garcia[3] and Isabella Macário Ferro Cavalcanti[1,2]*

[1]*Laboratório de Microbiologia e Imunologia, Brazil*

[2]*Laboratório de Imunopatologia Keizo Asami, Brazil*

[3]*Laboratório de Biotecnologia e Fármacos, Brazil*

***Corresponding author:** Isabella Macário Ferro Cavalcanti, Universidade Federal de Pernambuco (UFPE) Laboratório de Imunopatologia Keizo-Asami (LIKA) Av. Moraes Rego, 1235, 50670-901, Recife, PE, Brazil

Submission: March 09, 2018; **Published:** April 20, 2018

Abstract

Bacterial resistance to antimicrobials has been a major public health concern in recent years. The indiscriminate use of antimicrobials in human healthy, animal medicine and agriculture, greatly contributes to this condition. In last decade, several living organisms contaminated/infected with these antibiotic-resistant microorganisms, especially captive and wild birds, has been identified. Since birds have the ability to reach long distances through flight, especially wild birds, these animals can become agents of disseminated infection and are being considered reservoirs of resistance genes. In this context, this mini-review aims to shed light on recent findings related to the degree of contamination of these animals with resistant microorganisms as well as their potential as vectors of disease agents.

Keywords: Antimicrobial agents; Bacteria resistance; Birds; Infection

Introduction

Antimicrobials are widely used in human and veterinary medicine, as well as in agriculture, and they are an area for discussion and analysis [1-5]. The increase of resistant or multi-drug resistant microorganisms is an unavoidable consequence of the extensive use of the antimicrobial agents [1,6-10]. Although the development of bacterial resistance is a natural event in the evolutionary process of microorganisms, the irrational use of antibacterial drugs in humans and animals has accelerated this process [11,12]. In addition, the high frequency of human travel and global trade also contributes to the rapid worldwide spread of resistant microorganisms [13]. Antimicrobial resistance is a complex and multifaceted problem that involves humans and animals, as well as the environment, since resistant microorganisms were also identified contaminating the soil, food and aquatic environments, which increase the chance of a spread of these pathogens [14]. In this context, antimicrobial resistance can affect animals and humans through direct or indirect contact with the infectious agents. Birds, domestic or wild, may be contaminated/infected by resistant bacteria. These birds are known to be susceptible to several bacterial pathogens common to humans and other domestic animals, making them an agent of disseminated infection [15].

The pioneer study which reports antimicrobial resistance in wild animals revealed isolates of *E. coli* with resistance to chloramphenicol obtained from Japanese wild birds [16]. In addition, other studies have investigated the occurrence of antimicrobial resistant bacteria in animals of different geographical areas, including Methicillin-Resistant *Staphylococcus Aureus* (MRSA) [17,18], vancomycin-resistant *Enterococcus* spp. [19,20], *Salmonella spp*. [21], *Vibrio cholerae* [22] and *Campylobacter* spp. [23]. The relevance of these findings should be highlighted since wildlife animals do not tend to be directly exposed to antibiotics. For these reasons, more studies about the presence of resistant microorganisms in both domestic and wild birds are mandatory.

Bacterial resistance in poultry

Studies focusing on the identification of resistant bacteria in birds from slaughterhouses, such as broilers and poultry, are growing due to the great economic interest associated with it. Silva et al. [24] identified the *Enterobacteria* present in Gavião-carijó (*Rupornis magnirostris*) kept in captivity of Pernambuco, Brazil, and their susceptibility to antimicrobials. In this study bacteria from resistant strains, such as *E. coli* resistant to ampicillin, cephalothin and ciprofloxacin, *K. pneumoniae* resistant to ciprofloxacin, ceftriaxone and imipenem, and *Salmonella spp*. with resistance to both ampicillin and cephalothin. Borges et al. [25] investigated the antibiotic resistance profile in *Salmonella spp*. isolated from aviaries and humans on farms of broilers and slaughterers in northeastern Algeria. In this study, 51.11% and 26.6% of the avian isolates were resistant to ciprofloxacin and cefotaxime, respectively, whereas

strains of *Salmonella spp*. isolated from humans were less resistant to these antibiotics (13.5% for ciprofloxacin and 16.2% for cefotaxime). One of the most alarming findings was the detection of eighteen strains of extended-spectrum β-lactamase-producing *Salmonella spp*. (ESBLs) (12 avian and 6 humans).

Bacterial resistance in wild birds

Wild birds have also been studied for the isolation of bacterial strains with antimicrobial resistance. Mohsin et al. [26] have identified MultiDrug-Resistant (MDR) *E. coli* in wild birds in Pakistan. These isolates were resistant to CefoTaxime, CeftAZidime, AMpicillin, DoxyCycline, TEtracycline and SulfamethoXazole/Trimethoprim (CTX-CAZ-AM-DC-TE-SXT), representing the most common MDR pattern (76.9%). Shobrak et al. [14] also identified the resistance profile of *E. coli* and *Escherichia* vulgaris isolates in migratory and non-migratory wild birds in the provinces of Saudi Arabia. It was reported that all isolates of non-migratory birds were resistant to oxacillin, whereas in migratory birds all showed resistance to oxacillin, chloramphenicol, oxytetracycline and lincomycin (MDR).

Antimicrobial resistance studies in isolates from wild birds are relevant, since these animals, that occupy several ecological niches, can play an important role as biomarkers, being able to acquire microorganisms of human or environmental origin, reflecting the human activity and its impact on our environment. In addition, these birds can become reservoirs of antimicrobial resistant bacteria and potential disseminators of this resistance due to their large migratory capacity in a short period of time [27]. Studies that evidenced this relationship between antimicrobial resistance and migratory wild birds have been identify resistance profile in birds from remote places. Santos et al. [28] identified resistance profiles in *Enterococcus* spp. and *E. coli* of wild birds in the archipelago of the Azores, North Atlantic Ocean. Another study identified the presence of Vancomycin-Resistant *Enterococcus* spp. (VRE) in Alaska in glaucous gulls (*Larus hyperboreus*), a limited migratory bird, which indicates that antimicrobial resistant bacteria have already spread to one of the most remote areas of America [19].

Despite these identifications in remote areas, some studies indicate that resistance levels seem to correlate with the degree of human activities [29,30]. A study conducted in Chile showed that the prevalence of ESBL-producing *E. coli* among Franklin gulls (Leucophaeus pipixcan) is two- fold higher than in human samples in the same area. Seagulls and humans have also been identified as sharing specific types of gene sequences found in antimicrobial resistant bacteria, which indicate transmission. Nevertheless, seagulls also share gene sequences with clinical samples of human pathogenic bacteria from central Canada, a nesting site for seagulls, suggesting that migration could be a mechanism of bacterial resistance dissemination [31,32].

Conclusion

Antimicrobials are essential for human health, as well as for animal health, but should not be used in non-rational ways. Birds are affected by antimicrobial resistant microorganisms, including strains with sequences shared with humans, indicating the potential of transmission between them. Wild birds do not naturally come into contact with antibiotics, but they can also be colonized by resistant microorganisms. There is evidence that, in the case of wild birds, this transmission may occur from sources of environmental contamination, usually caused by human neglect. Due to the indiscriminate use of antimicrobials in hospitals and farms, for example, residues containing antimicrobials and resistance genes are discarded into the environment and can affect wild animals. In addition, the dissemination of antimicrobial resistance microorganisms can occur through the migration of wild birds, making these animals a reservoir of resistance genes. The rational use of antimicrobials is of the utmost importance and must be based on the identification of infectious agents and their antimicrobial susceptibility, apart from administration of these drugs in correct doses for the correct length of time. The correct diagnosis and prescription of antimicrobials should be achieved through continuing education of veterinarians and physicians, enlightening the population about the real indication of these medicines.

Acknowledgement

F.A. Silva thanks the Coordination for the Improvement of Higher Level Personnel (CAPES) for a MSc scholarship.

References

1. Beovic B (2006) The issue of antimicrobial resistance in human medicine. Int J Food Microbiol 112(3): 280-287.
2. Martinez JL (2009) Environmental pollution by antibiotics and by antibiotic resistance determinants. Environ Pollut 157(11): 2893-2902.
3. Vieira PN, Vieira SLV (2018) Uso irracional e resistência a antimicrobianos em hospitais. Arquivos de Ciências da Saúde da UNIPAR 21(3): 209-212.
4. Lima MFP, Borges MA, Parente RS, Victória Júnior RC, Oliveira ME (2018) *Staphylococcus Aureus* e as Infecções Hospitalares - Revisão de Literatura. Revista Uningá Review 21(1): 32-39.
5. Arenas NE, Melo VM (2018) Producción pecuaria y emergencia de antibiótico resistencia en Colombia: Revisión sistemática. Infectio 22(2): 110-119.
6. Mateu E, Martin M (2001) Why is anti-microbial resistance a veterinary problem as well? J Vet Med B Infect Dis Vet Public Health 48(8): 569-581.
7. Aiello G, Battaglia L, Bahr Arias MV, Freitas J (2007) Determinação dos índices de infecção hospitalar em um centro cirúrgico universitário veterinário de pequenos animais. Acta Scientiae Veterinariae 35(1): 354-356.
8. Carrilho CMD de M, Grion CMC, Bonametti AM, Medeiros EAS, Matsuo T (2007) Multivariate analysis of the factors associated with the risk of pneumonia in intensive care units. Braz J Infect Dis 11(3): 339-344.
9. Guardabassi L, Jensen LB, Kruse H (2010) Guia de antimicrobianos em veterinária. Artmed. Porto Alegre: 268.
10. Ramey Andrew M, Hernandez J, Tyrlov V, Uher-Koch BD, Schmutz JA, et al. (2017) Antibiotic- Resistant *Escherichia* coli in Migratory Birds Inhabiting Remote Alaska. EcoHealth 1(1): 1-10.
11. WHO (2014) Antimicrobial Resistance: Global Report on Surveillance. World Health Organization Geneva, Switzerland.

12. Wang J, Ma Z, Zeng ZL, Yang X, Huang Y, et al. (2017) The role of wildlife (wild birds) in the global transmission of antimicrobial resistance genes. Zool Res 38(2): 55-80.

13. Laxminarayan R, Wattal C, Zaidi AK, Wertheim HF, Sumpradit N, et al. (2013) Antibiotic resistance-the need for global solutions. Lancet Infect Dis 13(12): 1057-1098.

14. Shobrak MY, Abo-Amer AE (2015) Role of wild birds as carriers of multi-drug resistant *Escherichia* coli and *Escherichia* vulneris. Braz J Microbiol 45(4): 1199- 1209.

15. Matias CAR, Pereira IA, Reis, Rodrigues DP, Siciliano S (2016) Frequency of zoonotic bacteria among illegally traded wild birds in Rio de Janeiro. Brazilian J Microbiol 47(4): 882- 888.

16. Sato G, Oka C, Asaqi M, Ishiguro N (1978) Detection of conjugative R plasmids conferring chloramphenicol resistance in *Escherichia* coli isolated from domestic and feral pigeons and crows. Zentralbl Bakteriol Orig A 241(4):407-417.

17. Zentralblatt fur Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene. Erste Abteilung Originale. Reihe A: Medizinische Mikrobiologie und Parasitologie 245 (1-2): 407-417.

18. Loncaric I, Kübber-Heiss A, Posaut A, Stalder GL, Hoffmann D, et al. (2013) Characterization of methicillin-resistant Staphylococcus spp. carrying the mecC gene, isolated from wildlife. J Antimicrob Chemother 68(10): 2222-2225.

19. Porrero CM, Valverde A, Fernandez-Llario P, Díez-Guerrier A, Mateos A, et al. (2014) *Staphylococcus Aureus* carrying mecC gene in animals and urban wastewater, Spain. Emerg Infect Dis 20(5): 899-901.

20. Drobni M, Bonnedahl J, Hernandez J, Haemig P, Olsen B (2009) Vancomycin-resistant enterococci, point barrow, Alaska, USA. Emerg Infect Dis 15(5): 838-839.

21. Sellin M, Palmgren H, Broman T, Bergstrom S, Olsen B (2000) Involving ornithologists in the surveillance of vancomycin-resistant enterococci. Emerg Infect Dis 6(1): 87-88.

22. Lee K, Iwata T, Nakadai A, Kato T, Hayama S, et al. (2011) Prevalence of Salmonella, Yersinia and *Campylobacter* spp. in feral raccoons (Procyon lotor) and masked palm civets (Paguma larvata) in Japan. Zoonoses Public Health 58(6): 424-431.

23. Aberkane S, Compain F, Barraud O, Ouédraogo A, Bouzinbi N, et al. (2015) Non-O1/Non-O139 *Vibrio cholerae* avian isolate from france cocarrying the blaVIM-1 and blaVIM-4 genes. Antimicrob Aqents Chemother 59(10): 6594-6596.

24. Weis AM, Storey DB, Taff CC, Townswnd AK, Huang BC, et al. (2016) Genomic comparison of *Campylobacter* spp. and their potential for zoonotic transmission between birds, primates, and livestock. Applied and Environmental Microbiology 82(24): 7165-7175.

25. Silva EFA, Barros JFS, Fraga KB, Magalhães CP, Garcia JE, et al. (2016) Cloacal *Enterobacteria* isolated from captive roadside hawks (*Rupornis magnirostris*, GMELIN, 1788) and their antimicrobial susceptibility profile. Braz J Vet Res Anim Sci São Paulo 53(2): 207-213.

26. Borges CA, Cardozo MV, Beraldo LG, Oliveira ES, Maluta RP, et al. (2017) Wild birds and urban pigeons as reservoirs for diarrheagenic *Escherichia* coli with zoonotic potential. J Microbiol 55(5): 344-348.

27. Mohsin M, Raza S, Schaufler K, Roschanski N, Sarwar F, et al. (2017) High prevalence of CTX-M- 15-type ESBL-producing *E. coli* from migratory avian species in Pakistan. Front Microbiol 8(2476): 1-9.

28. Bonnedahl J, Järhult JD (2014) Antibiotic resistance in wild birds. Ups J Med Sci 119(2): 113-116.

29. Santos T, Silva N, Igrejas G, Rodrigues P, Micael J, et al. (2013) Dissemination of antibiotic resistant *Enterococcus* spp. and *Escherichia* coli from wild birds of Azores Archipelago. Anaerobe 24(1): 25-31.

30. Allen HK, Donato J, Wang HH, Cloud-Hansen KA, Davies J, et al. (2012) Call of the wild: antibiotic resistance genes in natural environments. Nat Rev Microbiol 8(4): 251-259.

31. Skurnik D, Ruimy R, Andremont A, Amorin C, Rouquet P, et al. (2006) Effect of human vicinity on antimicrobial resistance and integrons in animal faecal *Escherichia* coli. J Antimicrob Chemother 57(6): 1215-1219.

32. Hernandez J, Johansson A, Stedt J, Bengtsson S, Porczak A, et al. (2013) Characterization and comparison of Extended-Spectrum β-Lactamase (ESBL) resistance genotypes and population structure of *Escherichia* coli isolated from Franklin's gulls (Leucophaeus pipixcan) and humans in Chile. PLoS One 8(9): e76150.