



# Dissemination of Multidrug-Resistant Bacteria in Birds



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## 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  $\beta$ -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.

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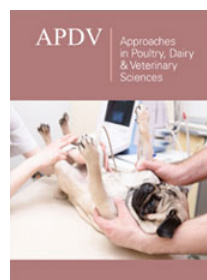
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