Isolation of emerging human pathogens and foodborne pathogens in clinical cases of infections from dogs and cats admitted to a veterinary clinic in northern Portugal

M. A. Rodrigues, A. C. Coelho, M. C. Fontes, A. Esteves and J. A. Costa*

Abstract

Nowadays, dogs and cats are considered family members, translating into increased proximity to humans. Studies have shown that 40-60% of owners have very close interactions e.g., sharing the same dish, face lickings, or sleeping on the same bed. This promotes the exchange of microorganisms between species. Therefore, an One Health approach should be applied to encompass both human and animal health problems. In this study, 37 cases of companion animals (54.1% dogs and 45.9% cats) in a veterinary clinic in northern Portugal were analysed, and urinary and eye infections, respiratory conditions, and dermatological problems were confirmed. According to sample type, 43.2% were from urine, 13.5% from ear exudate, 8.1% from skin exudate, 8.1% from tracheal exudate, 2.7% from vaginal exudate, 2.7% from conjunctiva exudate, 2.7% from purulent exudate, 2.7% from bronchoalveolar exudate, 2.7% from ocular exudate, and 2.7% from blood. In all, 21 pathogen species were isolated, of which *Pantoea agglomerans*, *Cronobacter sakazakii*, *Leclercia adecarboxylata*, *Sphingomonas paucimobilis* are currently considered emerging agents of human infection. The occurrence of these species was 2.4% for *Leclercia adecarboxylata* (one young male cat), 2.4% for *Pantoea agglomerans* (one adult male dog), 2.4% for *Cronobacter sakazakii* (one adult male dog), and 2.4% for *Sphingomonas paucimobilis* (one adult male dog). *Leclercia adecarboxylata* is a gram-negative bacillus of the Enterobacteriaceae family. It is a 'novel' rare human pathogen, mostly affecting immunocompromised individuals or causing polymicrobial infections in immunocompetent patients. *Cronobacter sakazakii* is an emerging foodborne pathogen that causes necrotizing enterocolitis and bacteremia in humans, *Pantoea agglomerans* is associated with a hospital-acquired infection, mostly in immunocompromised individuals with a fatal outcome. *Sphingomonas paucimobilis* is an emerging opportunistic bacterium with a particular tropism toward bones and soft tissues. The intimate relationship between humans and companion animals presents a potential risk for the transmission of zoonotic pathogens. Therefore, more research based on an One Health approach should be performed to more accurately determine the occurrence and incidence of emerging agents between species.

Key words: *bacteria; occurrence; dogs; cats; foodborne pathogens; emerging human pathogens*

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Introduction

Nowadays, dogs and cats are considered family members, translating into increased proximity with humans: several studies show that 40-60% of owners have very close interactions, e.g., sharing the same dish, face lickings, or sleeping on the same bed, and this promotes the exchange of microorganisms between species (do Vale et al., 2021).

Because 75% of human infectious diseases that have emerged or re-emerged in recent decades are zoonotic, the One Health concept has gained new relevance (McEwen and Collignon, 2017). According to World Health Organisation (2017), One Health is "an integrated, unifying approach to balance and optimize the health of people, animals, and the environment, particularly important to prevent, predict, detect, and respond to global health threats such as the COVID-19 pandemic".

From another perspective, antibiotic resistance is one of the greatest public health threats (WHO, 2020). Most classes of antimicrobials used to treat bacterial infections in humans are also used in animals (McEwen and Collignon, 2017). Frequently, pathogens acquire antibiotic resistance factors from another species, once it is present it can transfer among humans, animals, and the environment (Larsson and Flach, 2022). The drop in the antibiotic effect and ability to treat diseases may be associated with the alarming increase in antibiotic resistance (Samreen et al., 2021).

Pantoea agglomerans, Sphingomonas paucimobilis, Leclercia adecarboxylata, and *Cronobacter sakazakii* are human emerging pathogens and opportunistic agents in humans and animals (Saticioglu et al., 2018; Zeng et al., 2018; Alosaimi et al., 2020; Bavaro et al., 2020; Badawy et al., 2022). Mostly, these rare human pathogens affect immunocompromised individuals or cause polymicrobial infections in immunocompetent patients (Büyükcam et al., 2018; Makanera et al., 2018; Lepuschitz et al., 2019; Bavaro et al., 2020).

This study had the objective to study the occurrence and antibiotic resistance of zoonotic pathogens isolated from clinical specimens of animal companion patients admitted to a veterinary clinic in northern Portugal that were subjected to culture and antibiogram exams between 2020 and 2022.

Materials and methods

In a Reference Veterinary Clinic in northern Portugal, culture and antibiogram results were collected from 2020 until mid-September 2022 on a data basis to analyse the bacterial species isolated with zoonotic potential and antibiotic resistance associated with companion animals' infections from admitted patients. All analyses were performed on animal samples with owner consent, fulfilling the relevant ethical and practical guidelines. Microbiological exams were performed in an external veterinary lab. Due to IT issues and a lack of crucial information, only 37 cases of companion animals (54.1% dogs and 45.9% cats) were suitable for analysis. Date, type of sample sent to the laboratory, animal species and breed, bacteria isolated, and results from antibiogram were sampled. The descriptive analyses were performed using Microsoft Excel Office 2019 version.

Results

In this study, 37 cases of companion animals (54.1% dogs and 45.9% cats) in a veterinary clinic in northern Portugal were analysed. Urinary and eye infections, respiratory conditions, and dermatological problems were confirmed. Among the cases 54.1% were male and 45.9% were

female. Excluding the cases without information related to age (24.3% of the sample), average patient age was 5.60±4.07 years (minimum 0.33 years old and maximum 16 years old). Among dogs, 0.5% had no information about their breed, 30.0% were from no defined breed, 10.0% were from crossed breeds, 0.5% were Transmontano Cattle Dog, 10.0% Labrador Retriever, 0.5% Pinscher, 0.5% English Setter, 0.5% Teckel, 0.5% German Shepherd, 0.5% Border Collie, 0.5% French Bulldog and 0.5% Cocker Spaniel. Among cats, 94.1% were Common European breed, and 5.9% were Persian.

Sample types were, 43.2% urine, 13.5% ear exudate, 8.1% skin exudate, 8.1% tracheal exudate, 2.7% vaginal exudate, 2.7% conjunctiva exudate, 2.7% purulent exudate, 2.7% bronchoalveolar exudate, 2.7% ocular exudate, and 2.7% from blood.

In total, 41 pathogens from 22 different species of bacteria were isolated, including *Pantoea agglomerants* (2.4%), *Cronobacter sakazakii* (2.4%), *Leclercia adecarboxylata* (2.4%), *Sphingomonas paucimobilis* (2.4%). Among the isolated bacteria, 17.1% were *Escherichia coli*, 12.2% *Staphylococcus pseudintermedius*, 4.9% *Staphylococcus aureus*, 4.9% *Staphylococcus lentus*, 14.6% *Klebsiella pneumoniae* subsp. *pneumoniae*, 9.8% *Enterococcus faecalis*, 2.4% *Staphylococcus epidermidis*, 2.4% *Serratia marcescens*, 2.4% *Enterococcus gallinarum*, 2.4% *Staphylococcus schleifer*, 2.4% *Bergeyella zoohelcum*, 2.4% *Proteus mirabilis*, 2.4% *Staphylococcus simulans*, 2.4% *Enterobacter cloacae* complex, 2.4% *Staphylococcus xylosus*, 2.4% Staphylococcus hominis subsp. hominis, and 2.4% *Staphylococcus chromogenes*. The results from culture and antibiogram exams are presented in Tables 1 and 2.

In this study, *Pantoea agglomerans*, a pathogen species concomitant to *Staphylococcus pseudointermedius* in a 4 year old male dog's ear exudate, was resistant to Cefovecin, and intermediate to Cephalotin. *Cronobacter sakazakii*, present in a 10 years old male dog's skin exudate, was resistant to Cephalothin, Cephalexin, Chloramphenicol, Ceftiofur, Cefovecin, and Cefpodoxime. *Sphingomonas paucimobilis* was present in a blood sample from a 2 year old male dog and was not resistant to any of the antibiotics tested. *Leclercia adecarboxylata*, present in a urine sample from a 1-year-old male cat, was resistant to Trimethoprim/Sulfamethoxazole.

In terms of antibiotic resistance, 42.9% of the isolated pathogens were resistant to Cephalexin, 42.9% to Ampicillin, 38.1% to Cefovecin, 23.8% to Ceftiofur, 23.8% to Tetracycline, 21.4% to Penicillin G, 19.0% to Amoxicillin/Clavulanic acid, 16.7% to Pradofloxacin, 16.7% to Doxycycline, 16.7% to Cephalothin, 14.3% to Cefpodoxime, 11.9% to Oxacillin, 11.9% to Marbofloxacin, 11.9% to Enrofloxacin, 11.9% to Clindamycin, 11.9% to Amoxicillin, 9.5% to Trimethoprim/Sulfamethoxazole, 9.5% to Erythromycin, 7.1% to Polymyxin B, 4.8% to Nitrofurantoin, 4.8% to Chloramphenicol and 2.4% of the isolated pathogens were resistant to Imipenem.

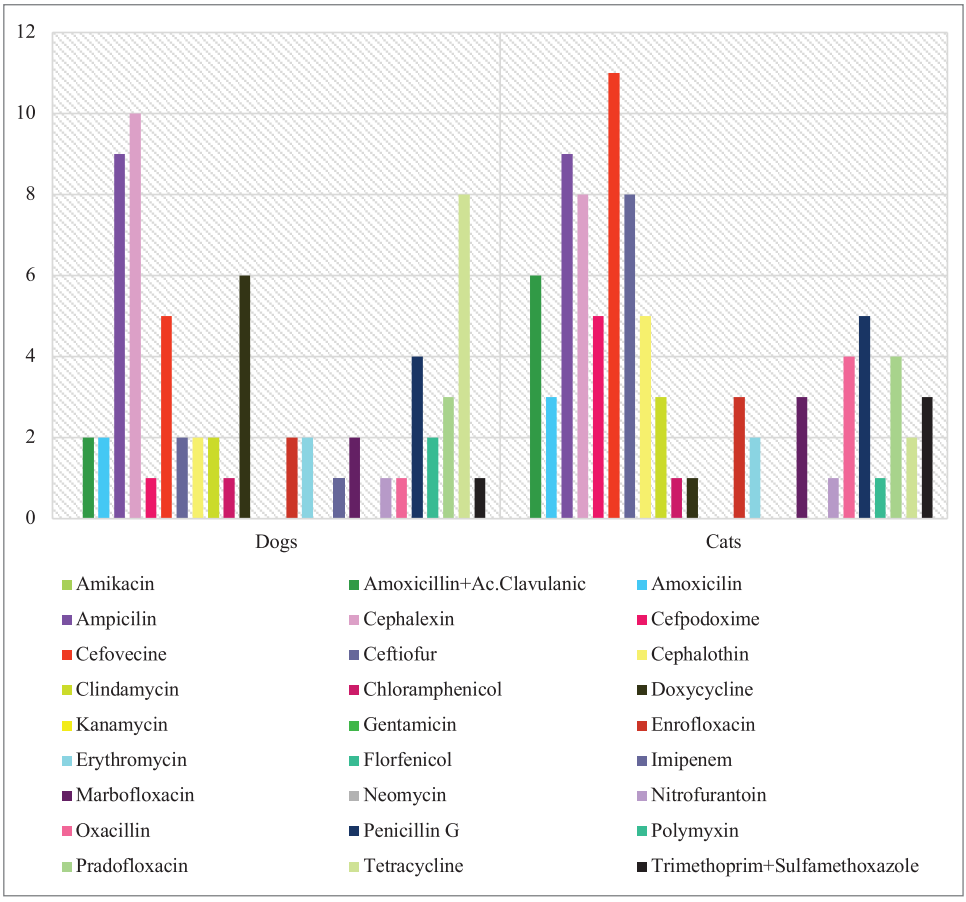

Figure 1. Antibiotic resistance of isolated pathogens (absolute frequency) according to companion animal species

Discussion

The close interaction between animals and their owners can represent a potential risk of zoonotic bacteria transmission, and of the sharing and dissemination of multidrug resistant zoonotic bacteria. Among the isolated pathogens in dogs and cat clinical samples, the human emerging pathogens *Pantoea agglomerans, Sphingomonas paucimobilis, Leclercia adecarboxylata,* and *Cronobacter sakazakii* were isolated.

Pantoea agglomerans is an opportunistic gram-negative, aerobic bacillus, rod-shaped, yellow-pigmented, non-spore-forming, motile bacteria from the Enterobacteriaceae family (Mardaneh et al., 2013; Büyükcam et al., 2018; Satici oglu et al., 2018). It may be a cause of endophthalmitis, periostitis, endocarditis, and osteomyelitis in humans, leading to severe local and systemic opportunistic infections in neonates, and has also been associated with abortion, interstitial pneumonia, and other clinical signs of illness in some animals (*i.e.*, dogs, horses, and fish) (Satici oglu et al., 2018; Tardon

Table 1. Isolated bacteria from dog samples and their antibiotic susceptibility

Specie	Sample	Bacterial species isolated	Antibiotic Resistance		
			Resistant	Susceptible	Intermediate
Canis familiaris	Ear exudate	*Staphylococcus pseudointermedius*	CLI	PNG, OXA, NEO, KAN, GEN, CLO, TET, DOX, ERI, TRI/SUL, ENR, CFF, MAR, CFV, FLO, PRF	
		Pantoea agglomerans	CFV	AX/AC, CFL, NEO, GEN, CLO, TET, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFD, PRF	CFT
	Penile injury exudate	*Staphylococcus epidermidis*	PNG, OXA, TET, DOX, ERI, CLI, CFF, CFV	NEO, KAN, GEN, CLO, TRI/SUL, ENR, MAR, PRF	
	Skin exudate	*Serratia marcescens*	AX/AC, CFT, CFL, TET	NEO, GEN, CLO, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFV, PRF	
		Enterococcus gallinarum	PNG, CLO, TET, DOX, ERI, CFV	ENR, MAR	
	Urine	*Escherichia coli*	DOX, ENR	AX/AC, CFL, NIT, IMI, GEN, TRI/SUL, AMI, CFF, MAR, CFV, CFD, PRF	AMP, CFT, CLO, TET
	Urine	*Escherichia coli*	AMP, CFL	AX/AC, CFT, NIT, IMI, GEN, CLO, TET, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD, PRF	
		Klebsiella pneumoniae subsp. Pneumoniae	AMP, CFL, TET, DOX, ENR, MAR, PRF	AX/AC, CFT, IMI, GEN, CLO, TRI/SUL, AMI, CFF, CFV, CFD	NIT
	Urine	*Enterococcus faecalis*	MAR	PNG, AMP, AMO, AX/AC, NIT, CLO, TET, DOX, ERI	ENR
	Ear exudate	*Klebsiella pneumoniae subsp. pneumoniae*	AMP, CFT, CFL, TRI/SUL, CFF, CFV, CFD, PRF	IMI, NEO, GEN, CLO, TET, DOX, AMI, PLMB, ENR, MAR, Florfenico	
	Skin exudate	*Staphylococcus aureus*		PNG, AMP, AMO, AX/AC, OXA, NEO, KAN, GEN, CLO, TET, DOX, ERI, CLI, TRI/SUL, ENR, CFF, MAR, CFV, PRF	
	Urine	*Staphylococcus pseudointermedius*		PNG, OXA, NEO, KAN, GEN, CLO, TET, DOX, ERI, CLI, TRI/SUL, ENR, CFF, MAR, CFV, FLO, PRF	
	Tracheal lavage	*Enterococcus faecalis*	TET, CFV	PNG, AMP, AMO, AX/AC, CLO	DOX, ERI, ENR, MAR
		Escherichia coli	AMP, TET	AX/AC, CFL, IMI, NEO, GEN, CLO, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD, PRF	CFT

Ear exudate	*Staphylococcus schleifer*	PLMB	PNG, AMP, AMO, AX/AC, OXA, NEO, KAN, GEN, CLO, TET, DOX, ERI, CLI, TRI/SUL, ENR, CFF, MAR, CFV, FLO, PRF	
Skin exudate	*Staphylococcus pseudintermedius*		PNG, AMP, AMO, AX/AC, OXA, NEO, KAN, GEN, CLO, TET, DOX, ERI, CLI, TRI/SUL, ENR, CFF, MAR, CFV, PRF	
Urine	*Staphylococcus aureus*	PNG, AMP, AMO, AX/AC, TET	OXA, NIT, KAN, GEN, CLO, ERI, CLI, TRI/SUL, ENR, CFF, MAR, CFV, PRF	DOX
Urine	*Escherichia coli*	AMP, PRF	AX/AC, CFL, NIT, IMI, GEN, CLO, TET, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD	CFT
Penile ulcerative lesion	*Bergeyella zoohelcum*		AMP, AX/AC, CFL, IMI, GEN, CLO, TET, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD, PRF	
Ear exudate	*Staphylococcus pseudintermedius*	PNG, AMP, AMO, PLMB	AX/AC, OXA, NEO, KAN, GEN, CLO, TET, DOX, ERI, CLI, TRI/SUL, ENR, CFF, MAR, CFV, FLO, PRF	
Blood	*Sphingomonas paucimobilis*		GEN, CLO, TET, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFV, FLO	
Skin exudate	*Klebsiella pneumoniae ssp pneumoniae*	AMP, TET, DOX	AX/AC, CFT, CFL, IMI, NEO, GEN, CLO, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD, PRF	
Urine	*Proteus mirabilis*	AMP, CFL, NIT, IMI, DOX	AX/AC, CFT, GEN, CLO, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD, PRF	
Skin exudate	*Cronobacter sakazakii*	CFT, CFL, CLO, CFF, CFV, CFD	AX/AC, IMI, NEO, GEN, TET, DOX, TRI/SUL, AMI, ENR, MAR, PRF	

AMI (Amicacin); AX/AC (Amoxicillin+Ac.Clavulanic); AMP (Ampicillin); CFL (Cephalexin); CFD (Cefpodoxime); CFV (Cefovecin); CFF (Ceftiofur); CFT (Cephalotin); CLI (Clindamycin); CLO (Chloramphenicol); DOX (Doxycycline); KAN (Kanamycin); GEN (Gentamicin); ENR (Enrofloxacin); ERI (Erythromycin); FLO (Florfenicol); IMI (Imipenem); MAR (Marbofloxacin); NEO (Neomycin); NIT (Nitrofurantoin); OXC (Oxacillin); PNG (Penicillin G); PLM (Polymyxin); PRF (Pradofloxacin); TET (Tetracycline); TRI/SUL (Trimethoprim+Sulfamethoxazole).

Table 2. Isolated bacteria from cat samples and their antibiotic susceptibility

Specie	Sample	Bacterial species isolated	Antibiotic Resistance		
			Resistant	Susceptible	Intermediate
Felis catus	Pus	*Staphylococcus lentus*	PNG, OXA, CLI, CFF, CFV	NEO, KAN, GEN, CLO, TET, DOX, ERI, TRI/SUL, ENR, MAR, PRF	
	Conjunctiva Exudate	*Staphylococcus simulans*	PNG, OXA, CLI, CFF, CFV	NEO, KAN, GEN, CLO, TET, DOX, ERI, TRI/SUL, ENR, MAR, PRF	
	Urine	*Escherichia coli*	AMP, CFL	AX/AC, CFT, IMI, NEO, GEN, CLO, TET, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD, PRF	
	Urine	*Escherichia coli*	AMP, CFL	AX/AC, CFT, NIT, IMI, GEN, CLO, TET, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD, PRF	
	Vaginal exudate	*Escherichia coli*	AMP, CFL	AX/AC, CFT, IMI, NEO, GEN, CLO, TET, DOX, TRI/SUL, AMI, ENR, CFF, MAR, CFV, CFD, PRF	
	Urine	*Klebsiella pneumoniae subsp. Pneumoniae*	AMP, AX/AC, CFT, CFL, TRI/SUL, ENR, CFF, MAR, CFV, CFD, PRF	NIT, IMI, NEO, GEN, CLO, TET, DOX, AMI	
	Urine	*Staphylococcus lentus*	CLI	PNG, AMP, AMO, AX/AC, OXA, NIT, KAN, GEN, CLO, TET, DOX, TRI/SUL, ENR, CFF, MAR, CFV, PRF	ERI
	Urine	*Klebsiella pneumoniae subsp. Pneumoniae*	AMP, AX/AC, CFT, CFL, TRI/SUL, CFF, CFV, CFD, PRF	IMI, GEN, CLO, TET, DOX, AMI, ENR, MAR	NIT
	Urine	*Klebsiella pneumoniae subsp. Pneumoniae*	AMP, AX/AC, CFT, CFL, NIT, ENR, CFF, MAR, CFV, CFD, PRF	GEN, CLO, TET, DOX	
	Tracheal lavage	*Enterobacter cloacae complex*	AX/AC, CFT, CFL, ENR, CFF, MAR, CFV, CFD, PRF	IMI, NEO, GEN, TET, DOX, TRI/SUL, AMI	CLO
	Urine	*Staphylococcus pseudintermedius*	PNG, AMP, AMO	AX/AC, OXA, NEO, KAN, GEN, CLO, TET, DOX, ERI, CLI, TRI/SUL, ENR, CFF, MAR, CFV, PRF	
	Tracheal lavage	*Staphylococcus xylosus*	PNG, AMP, AMO, AX/AC, OXA, CFF, CFV	NEO, KAN, GEN, CLO, TET, DOX, ERI, CLI, TRI/SUL, ENR, MAR, PRF	

Ear exudate	*Staphylococcus hominis spp hominis*	PNG, AMP, AMO, AX/AC, OXA, ERI, PLMB, CFV	NEO, KAN, GEN, CLO, TET, DOX, CLI, TRI/SUL, ENR, MAR, FLO, PRF
Ocular exudate	*Staphylococcus chromogenes*		PNG, AMP, AMO, AX/AC, OXA, NEO, KAN, GEN, CLO, TET, DOX, ERI, CLI, TRI/SUL, ENR, CFF, MAR, CFV
Bronchoalveolar exudate	*Enterococcus faecalis*	TET, CFV	PNG, AMP, AMO, CLO, ENR, MAR, FLO DOX, ERI
Urine	*Leclercia adecarboxylata*	TRI/SUL	NEO, GEN, CLO, TET, DOX, ENR, CFF, MAR, PRF, AX/AC, CFL, CFV, IMI, CFT, AMI
Urine	*Enterococcus faecalis*	CFV, TET, DOX, ERI	PNG, CLO, AX/AC, NIT, AMP,

AMI (Amicacin); AX/AC (Amoxicillin+Ac.Clavulanic); AMP (Ampicillin); CFL (Cephalexin); CFD (Cefpodoxime); CFV (Cefovecin); CFF (Ceftiofur); CFT (Cephalotin); CLI (Clindamycin); CLO (Chloramphenicol); DOX (Doxycycline); KAN (Kanamycin); GEN (Gentamicin); ENR (Enrofloxacin); ERI (Erythromycin); FLO (Florfenicol); IMI (Imipenem); MAR (Marbofloxacin); NEO (Neomycin); NIT (Nitrofurantoin); OXC (Oxacillin); PNG (Penicillin G); PLM (Polymyxin); PRF (Pradofloxacin); TET (Tetracycline); TRI/SUL (Trimethoprim+Sulfamethoxazole).

et al., 2021). This agent was previously isolated from blood, wounds, and urine (Mardaneh et al., 2013). Considering the available information concerning *Pantoea agglomerans* antimicrobial susceptibility studies in human and animal cases, it was found to show resistance to Ciprofloxacin, Piperacillin, Clavulanic acid, Clindamycin, Cephalothin, Ampicillin, Ceftazidime, Gentamicin, Imipenem, Meropenem, Tobramicin, Carbenicillin, Mezlocillin, Cefoperozone, Cefepime, Levofloxacin, and Amikacin (Büyükcam et al., 2018; Satici̇oglu et al., 2018; Tardon et al., 2021). Some studies in humans reported susceptibility to aminoglycosides, Cefuroxime, Cefamandole, and Cefoxitine (Satici̇oglu et al., 2018). In this study, it recorded resistance to Cefovecin, which has not been reported in the resistance list of recent studies.

Sphingomonas paucimobilis is an aerobic bacillus, non-fermenting gram-negative, yellow or orange-pigmented, motile bacteria from the Sphingomonadaceae family (El Beaino et al., 2018; Bavaro et al., 2020). This ubiquitous agent, associated with nosocomial infections and immunosuppressed patients, that may be underestimated in infections in immunocompetent patients, has been isolated from hospital devices and equipment, human blood, urine, bone marrow, wounds, and cerebral spinal fluid (El Beaino et al., 2018; Bavaro et al., 2020). In a study of an outbreak, *Sphingomonas paucimobilis* bacteriemia occurred in three patients sharing the same dialysis room affected by renal disease and the isolated bacteria were resistant to Cefotaxime and Piperacillin/Tazobactam and susceptible to Amikacin, Ceftazidime, Ciprofloxacine, Gentamicin, and Meropenem (Bavaro et al., 2020). Other recent studies reported resistance to Ceftriaxone, Gentamycin, Amikacin, Piperacillin/Tazobactam, Cefazolin, Ceftazidime,

Cefepime, Ciprofloxacin, Cotrimoxazole, Aztreonam, Meropenem, and susceptibility to Gentamicin, Levofloxacin, Meropenem, Tobramycin, and Trimethoprim/Sulfamethoxazole (Walayat et al., 2018; Saboe et al., 2021). In the present study, *Sphingomonas paucimobilis* was susceptible to all the antibiotics tested: Gentamicin, Chloramphenicol, Tetracycline, Doxycycline, Trimethoprim/Sulfamethoxazole, Amikacin, Enrofloxacin, Ceftiofur, Marbofloxacin, Cefovecin, and Florfenicol.

Leclercia adecarboxylata is a motile bacillus, gram-negative, facultative-anaerobic bacteria from Enterobacteriaceae family (Alosaimi et al., 2020; Li et al., 2021). Widely distributed in nature, it has been isolated from food and other environmental sources, and is a normal part of gut microbiota in animals and humans. *Leclercia adecarboxylata* can lead to immunocompromised patients though this is rarely reported in humans (Choudhary et al., 2018; Alosaimi et al., 2020; Li et al., 2021). It can cause a range of conditions, including septicemia, urinary tract infection, peritonitis, and polymicrobial infections (Alosaimi et al., 2020; Li et al., 2021). In other studies, sensitivity was reported to Ciprofloxacin, Gentamicin, Amikacin, Meropenem, Trimethoprim/sulfamethoxazole, Imipenem, Cefazoline, Enrofloxacin, Ceftiofur, Cefotaxime, Ampicillin, Amoxicillin/Clavulanic acid, Cotrimoxazole, Oxytetracycline, and Doxycycline (Choudhary et al., 2018; Makanera et al., 2018; Alosaimi et al., 2020; Tardón et al., 2021). Resistance was found to Erythromycin, Amoxicillin/clavulanate, Ampicillin, Ceftriaxone, Piperacillin/tazobactam, Clindamycin, Gentamicin, Amikacin, Methicillin, Rifampicin, Pefloxacin, and Vancomycin (Choudhary et al., 2018; Makanera et al., 2018; Alosaimi et al., 2020; Tardón et al., 2021). In this study, *Leclercia adecarboxylata* was resistant to Trimethoprim/Sulfamethoxazole.

Cronobacter sakazakii is an emerging foodborne pathogen, gram-negative, motile, rod-shaped, yellow-pigmented bacteria from Enterbacteriaceae family, and is a life-threatening pathogen in newborns and premature children (Lepuschitz et al., 2019; Chauhan et al., 2020; Badawy et al., 2022). This agent has been implicated in numerous outbreaks linked to the contamination of powdered infant formula, and related with cases of meningitis, sepsis, and enterocolitis, especially in low-birth-weight and premature infants, with a fatality rate of 40–80% (Zeng et al., 2018; Lepuschitz et al., 2019; Chauhan et al., 2020; Badawy et al., 2022). In a work conducted to study antibiotic resistance profiles of *Cronobacter sakazakii* in a Diarrheic Haemorrhagic outbreak in Mexico found that it was resistant to Cephalothin, and susceptible to Levofloxacin, Cefepime, Cefotaxime, Trimethoprim/Sulfamethoxazole, Ampicillin, Ceftriaxone, Nitrofurantoin, Netilmicin, Gentamicin, Amikacin, and Chloramphenicol (Parra-Flores et al., 2018). In some recent studies, isolated *Cronobacter sakazakii* was resistant to Ampicillin, Cefotaxime, Gentamicin (intermediate), Moxifloxacin, Trimethoprim/Sulfamethoxazole, Penicillin, Tetracycline, Ciprofloxacin, and Nalidixic Acid (Lepuschitz et al., 2019; Abebe, 2020). In a study performed in 2022, *Cronobacter sakazakii* isolates were highly resistant to Amoxicillin/Clavulanic acid, Amoxicillin, Ampicillin, Cefoxitin, Cefepime, Erythromycin, Ceftriaxone, Ciprofloxacin, Chloramphenicol antibiotics, and susceptible to Gentamicin, Tetracycline, Norfloxacin, and Azithromycin (Pakbin et al., 2022). Isolated strains in other studies showed susceptibility to Imipenem, Penicillin G, Erythromycin, Amikacin, Streptomycin, Gentamicin, Vancomycin, Sulfamethoxazole/trimethoprim, Levofloxacin, Ampicillin, Tetracycline, and Chloramphenicol

(Abebe et al., 2020; Badawy et al., 2022). In the present study, *Cronobacter sakazakii* was resistant to Cephalothin, Cephalexin, Chloramphenicol, Ceftiofur, Cefovecin, and Cefpodoxime.

Conclusion

This study aimed to identify the potential risk of spread of zoonotic agents related to the interaction between animals and their owners. A second aim is to raise awareness of the importance of the One Health approach that should be applied to encompass both human and animal health problems to advance the therapeutic approaches in human and animal relations and improve our understanding of multidrug resistance. The intimate relationship between humans and companion animals presents a potential risk for the transmission of zoonotic pathogens. Therefore, more research based on the One Health approach is needed to more accurately determine the occurrence and incidence of emerging agents between species.

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Izolacija emergentnih ljudskih patogena i patogena koji se prenose hranom u kliničkim slučajevima infekcija od pasa i mačaka zaprimljenih u veterinarsku kliniku u sjevernom Portugalu

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U današnje vrijeme, psi i mačke smatraju se članovima obitelji, što podrazumijeva sve veću bliskost s ljudima. Nekoliko studija pokazalo je da 40-60 % vlasnika ima vrlo blizak odnos, npr. dijeljenje iste hrane, lizanje lica ili spavanje na istom krevetu. To potiče razmjenu mikroorganizama među vrstama. Iz tog je razloga potrebno primijeniti pristup Jednog zdravlja da bi se obuhvatili i ljudski i životinjski zdravstveni problemi. U ovoj je studiji analizirano 37 slučajeva kućnih ljubimaca (54,1 % pasa i 45,9 % mačaka) u veterinarskoj klinici u sjevernom Portugalu. Kazuistika je uključivala infekcije urinarnog trakta i očiju, respiratorna stanja i dermatološke probleme. Prema vrsti uzoraka, 43,2 % su bili iz urina, 13,5 % iz eksudata iz uha, 8,1 % iz eksudata iz kože, 8,1 % iz eksudata iz dušnika, 2,7 % iz vaginalnog eksudata, 2,7 % iz eksudata iz sluznice, 2,7 % iz gnojnog eksudata, 2,7 % iz bronhoalveolarnog eksudata, 2,7 % iz očnog eksudata i 2,7 % iz krvi. Izolirani su patogeni 21 različite vrste, od čega se *Pantoea agglomerans*, *Cronobacter sakazakii*, *Leclercia adecarboxylata*, *Sphingomonas paucimobilis*, trenutno smatraju emergentnim uzročnicima ljudske infekcije. Pojavnost ovih vrsta bila je 2,4 % za *Leclercia adecarboxylata* (jedan mladi mačak), 2,4 % za *Pantoea agglomerans* (jedan mladi pas), 2,4 % za *Cronobacter sakazakii* (jedan mladi pas) i 2,4 % za *Sphingomonas paucimobilis* (jedan mladi pas). *Leclercia adecarboxylata* je gram-negativni bacil iz obitelji enterobakterija. To je rijedak „novi" ljudski patogen koji uglavnom pogađa

imunokompromitirane pojedince ili prouzroči polimikrobne infekcije u imunokompetentnih bolesnika. *Cronobacter sakazakii* je emergentni patogen koji se prenosi hranom, a koji prouzroči nekrotizirajući enterokolitis i bakterijemiju u ljudi, *Pantoea agglomerans* povezana je s bolničkom infekcijom, uglavnom kod imunokompromitiranih pojedinaca sa smrtnim slučajevima. *Sphingomonas paucimobilis* je emergentna oportunistička bakterija s posebnim tropizmom za kosti i meka tkiva. Bliski odnos između ljudi i ljubimaca predstavlja potencijalni rizik prijenosa zoonotskih patogena. Iz tog je razloga potrebno provesti dodatna istraživanja na temelju pristupa Jednog zdravlja, da bi se preciznije odredila pojavnost i incidencija emergentnih uzročnika među vrstama.

Ključne riječi: *bakterije, pojavnost, psi, mačke, patogeni koji se prenose hranom, emergentni ljudski patogeni*