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Prevalence of Acinetobacter Spp. Isolated from Clinical Samples Referred to Al-Kafeel Hospital and Their Antibiotic Susceptibility Patterns from 2017-2021

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ABSTRACT

Background and Aim: *Acinetobacter* has been considered an important nosocomial pathogen since 1970. This study aims to investigate the prevalence of *Acinetobacter* infection during 2017-2021, study the antibiogram of these bacteria, and study the impact of gender on infection.

Materials and Methods: This is a retrospective study in which data of the clinical samples received in Al-Kafeel Hospital, Kerbala, Iraq, between April 2017 and February 2021 were searched for *Acinetobacter* infection and their antibiotic susceptibility testing.

Results: The prevalence of *Acinetobacter* infection was 9.2% of cases. Male to Female ratio was 3:1, and there was a significant difference in *Acinetobacter* infection regarding gender. There were high resistance rates to major antibiotic classes. Maximum resistance was recorded for Amoxicillin (100%), followed by 3rd generation cephalosporins, including Cefotaxime (92.3%), Ceftriaxone (91.6%), Ceftazidime (91.3%), Cefixime (80%); in addition to growing resistance to carbapenems, Imipenem (42.8%) and Meropenem (62.2%). The lowest resistance rates were found to colistin sulfate (10%). There 80.7% of the isolates were multidrug-resistant MDR.

Conclusion: *Acinetobacter* spp., is considered as fast emerging opportunistic agents with evolving drug resistance. Rationale use of antibiotics is important and necessary to prevent microbial resistance. Gender is considered a risk factor for *Acinetobacter* infection.

Keywords: Acinetobacter spp., Antibiotic Susceptibility testing, Sex differences, MDR

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1. Introduction

Acinetobacter is a highly diverse genus ubiquitous in the environment **(1,2)** and has been considered a significant nosocomial pathogen since 1970 as it can survive in the hospital environment (on both dry and moist surfaces) **(3–5)**. Subsequently, the bacteria are transmitted to patients either from environmental surfaces or from the hands of health care workers that were colonized transiently by these bacteria **(6, 7)**.

The Greek word "akinetos" is the name *Acinetobacter's* origin meaning "unable to move". The term was chosen for the bacteria as they are not motile while displaying a twitching kind of motility **(8)**. The genus belongs to the family *Moraxellaceae* and comprises Gram-negative, non-motile, oxidase-negative, glucose non-fermenting, strictly aerobic, catalase-positive bacteria **(9)**.

Although there are more than 50 species within the *Acinetobacter* genus 2, most species are nonpathogenic. The most common species to cause infections is *Acinetobacter baumannii* (responsible for 90 % of human infections caused by this genus and responsible for 17% of all nosocomial infections, especially amongst immunocompromised individuals), followed by *Acinetobacter calcoaceticus* and *Acinetobacter lwoffii* **(10–12)**.

Human infections caused by *Acinetobacter* species include community-acquired infections and hospital-acquired infections, especially in critically ill patients with impaired host defenses. These infections include pneumonia, endocarditis, meningitis, skin and wound infections, peritonitis in patients receiving peritoneal dialysis, UTI, and bacteremia **(13,14)**.

There were several reasons that made this genus receive significant attention. First, this genus causes nosocomial infections. Second is the emergence of the multiresistant strains, some of which are Pan-Resistant to antibiotics, that suddenly cause an outbreak of infection involving several patients in a clinical unit. Third, some strains have the ability to produce verotoxins **(8,15)**.

Concerning susceptibility between females and males, differences have been reported dealing with vaccination, autoimmune diseases, and infectious diseases **(16–19)**. According to various studies, there is a differential immune response to infectious diseases regarding gender **(20–23)**. The innate immune response of females is typically more substantial on the topic of infection **(18)**.

With respect to the Antibiotic susceptibility pattern of *Acinetobacter*, it has been documented that susceptibility patterns may vary widely according to geographical regions and even among different units of the same hospital at different time points. This variation makes it necessary to set periodic monitoring for these pathogens to accurately select a therapy **(23,24)**.

Thus the current study aims to study the prevalence of *Acinetobacter* isolated from clinical samples collected in Al-Kafeel Hospital (2017-2021) and study the antibiotic susceptibility patterns of these isolates, and moreover, to examine the gender-related differences in *Acinetobacter* infections.

2. Methods

Following the approval of this study from the Department of Clinical Laboratories/ College of Applied Medical Sciences/ Kerbala University, retrospective study designs were conducted from December 2020 to May 2021. During this period, data of the clinical samples received in Al-Kafeel Hospital laboratory from April 2017 to February 2021 were collected. Results that showed the isolation of *Acinetobacter* spp. with their antibiotic susceptibility testing were obtained. Antibiotic susceptibility testing was done using disc diffusion methods and interpreted using CLSI guidelines **(25)**. Data were analyzed using SPSS 24 software (SPSS Inc., Chicago, Ill., USA).

3. Results

During the study period, results of 1784 reports for different clinical samples received in the laboratory of Al-Kafeel Hospital were collected. Out of 135 (7.5%), samples were examined by direct methods (gram stain and Acid Fast stain), and 1649 were cultured on MacConkey and Blood agar as requested. After overnight incubation, no growth or growth of nonpathogenic bacteria (i.e., considered as culture-negative cases) was observed in 970 (58.8%), while 111 (6.2%) cases were cultured for the presence of Fungi. A total of 568 cases were reported to have bacterial isolates. Antibiotic susceptibility testing was performed using manual methods for the samples that revealed the presence of pathogenic bacteria in the culture plates (i.e., culture-positive cases). Culture-positive reports were searched for the isolation of *Acinetobacter* spp. A total of of 52 reports were documented the growth of *Acinetobacter* spp. (9.2%) from culture-positive cases (Table 1). *Acinetobacter* species were found to be associated with increased mortality rates **(26)** due to their ability to infect healthy hosts and their propensity to develop resistance to the broad spectrum Antibiotics **(27)**. Lower prevalence rates were reported by Al-Sehlawi *et al.*, who documented a 6.8% of isolates to be identified as *A. baumannii* from clinical samples referred to three hospitals in Al-Najaf, Iraq **(28)**. Another study in Kerbala, Iraq, reported higher incidence rates **(29)**. While other studies have accounted for 12.9% (30), 4.8% **(23)**, *and* 3.36% **(24)** of *Acinetobacter* isolates from total infected samples. The observed differences in prevalence rate might be due to variation in the study design, methodology, and study time.

Table 1. Prevalence of infection with Acinetobacter species.

Type of Bacteria	Frequency	Percent
Acinetobacter	52	9.2
Other types of Bacteria	516	90.8
Total	568	100

Regarding sex, 13 reports for clinical samples were taken from females, and 39 for males, and M/ F ratio was 3/1. There was a significant association between infections with *Acinetobacter* spp. and sex, as shown in Table 2. Similarly, previous studies documented that Acinetobacter infection was more prevalent in males **(32,33)**. This may be due to male and female differences in immunological responses. In general, stronger innate and adaptive immune responses are reported regarding adult females compared with males.

Sex differences are visible in different species. Exposure to a wide range of stimuli (including bacteria, viruses, parasites, fungi, and vascular trauma) can severely reduce tissue function or lead to its loss in women compared to men **(18, 20)**. Men were less compliant than females to hand-hygiene recommendations which made them more prone to infection **(34)**. Furthermore, men were more likely to be affected by hospital-acquired infections **(35, 36)**, which may be caused by higher hospitalization rates, especially in older age groups.

Table 2. Distribution of infection with *Acinetobacter* species among gender

Type of Bacteria	Gender		Total
	Female	Male	
Acinetobacter spp.	13	39	52
Other types of Bacteria	195	321	516
Total	208	360	568
Fisher's Exact test (1-sided)		0.045	

Concerning the clinical samples, *Acinetobacter* was isolated from swabs **(24)** followed by urine samples **(8)**. There was no significant association between the type of sample and Acinetobacter infection, Table 3. In other previous studies, *Acinetobacter* isolation was predominating in urine (21-27%) and tracheobronchial secretions (24.8, 48.8%, respectively) **(30)**. Another study reported the predominant isolation of *Acinetobacter* from blood (36.9%) followed by Pus **(22.55)**, respiratory samples (14.4%), urine (11.7%), and other body fluids (9%). An increase in *Acinetobacter* occurrence in blood cultures is reported in some hospital departments **(24, 31)**.

Table 3. Association of infection with Acinetobacter and type of clinical sample

Type of Bacteria	Sample type						Total
	Blood	Fluid	Sputum	Swab	Urine	Other samples	
***Acinetobacter* spp.**	5	7	4	24	8	4	52
Other types of Bacteria	84	66	30	198	111	27	516
Total	89	73	34	222	119	31	568
P-value				0.588			

The frequency of *Acinetobacter* isolation during the years in the current study revealed a high frequency of isolation in 2020 (53.8%) in comparison to other years, Table 4. This might reflect the increase in the incidence of *Acinetobacter* infection due to its colonization and survival features **(37)**.

Table 4. Distribution of Acinetobacter infection during 2017-2021

Year	Frequency (Percentage)
2017	3 (5.8)
2018	4 (7.7)
2019	9 (17.3)
2020	28 (53.8)
2021	5 (9.6)
Total	49 (94.2)

Antibiotic Susceptibility Patterns

The susceptibility testing for the isolated *Acinetobacter* showed high rates of resistance to most antibiotics used. Maximum resistance was recorded for Amoxicillin (100%), followed by 3rd generation cephalosporins, including Cefotaxime (92.3%), Ceftriaxone (91.6%), Ceftazidime (91.3%), and Cefixime (80%). There was growing resistance to carbapenems, Imipenem (42.8%), and Meropenem (62.2%). The lowest resistance rates were found to colistin sulfate (10%) (Table 5).

On the report of the World Health Organization (WHO) published in 2017, there was an urgent need for new antibiotics for 12 pathogens called the ESKAPE (ESKAPE is the acronym for the group of bacteria that include *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *A. baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* spp.) **(38,39)**.

Showing an increasing resistance to β-lactams aminoglycoside antibiotics, *Acinetobacter* has been considered a reservoir of antibiotic-resistant genes in a hospital environment **(40)**. This is confirmed by our results which showed high resistance rates to most antibiotics used. The high resistance rates recorded in the current study are likely to be associated with a wide range of empirical and therapeutic use of antibiotics at hospitals. The employed selective pressure by this results in MDR strains emerging, which in turn may have led to the genes encoding resistance mechanisms **(41)**. Being exposed to certain antibiotics has an advantage to a few resistant organisms in patients already colonized. It makes them become pathogens at the first opportunity **(40)**.

Of the isolates, 42 (80.7%) were MDR isolates (resistant to at least one antibiotic in three or more classes of Antibiotics: Penicillin, Cephalosporin, Aminoglycoside, Fluoroquinolone, Carbapenem. Gupta *et al.* reported that 39.6% of isolates were MDR **(24)**. Higher rates of MDR *A. baumannii* isolates were reported by Yadav *et al.* **(32)**. Whereas, in the study by Al-Sehlawi *et al.,* 50 % of the isolates were resistant to major antibiotic classes **(28)**. Apparently, *Acinetobacter* tends to develop antibiotic resistance quickly. This might be due to its long-term evolutionary exposure to antibiotic-producing organisms in the soil environment **(42)**. Facilitated by complex factors, the spread of resistance included mobile genetic elements, the misuse of antimicrobial drugs, poor infection control practices, and increased international travel **(43)**.

Table 5. Antibiotic Susceptibility patterns among Acinetobacter spp. isolates

Antibiotic	Antibiotic Class	Number of tested isolates	R (%)	I (%)	S (%)
Cefotaxime (30 µg)	3rd generation Cephalosporins	39	36 (92.3)	-	3 (7.6)
Ceftriaxone (30 µg)	3rd generation Cephalosporins	48	44(91.6)	-	4(8.3)
Ceftazidime (30 µg)	3rd generation Cephalosporins	46	42(91.3)	2 (4.3)	2 (4.3)
Cefixime (10 µg)	3rd generation Cephalosporins	21	17 (80.9)	1 (4.7)	3 (14.2)
Ciprofloxacin (5 µg)	fluoroquinolones	52	38 (73.0)	4(7.6)	10 (19.2)
Levofloxacin (5 µg)	fluoroquinolones	51	13(25.4)	18(35.2)	20(39.2)
Gentamicin (30 µg)	Aminoglycoside	51	34(66.6)	1(1.9)	16(31.3)
Amikacin (30 µg)	Aminoglycoside	50	37(74)	2(4)	11(22)

Antibiotic	Antibiotic Class	Number of tested isolates	R (%)	I (%)	S (%)
Tetracycline (30 µg)	Tetracyclines	45	28(62.2)	1(2.2)	16(35.5)
Imipenem (10 µg)	Carbapenems	49	21(42.8)	6(12.2)	22(44.8)
Meropenem (10 µg)	Carbapenems	44	27 (61.3)	3(6.8)	14(31.8)
Amoxicillin (25 µg)	Penicillin-like antibiotics	7	7(100)	-	-
Trimethoprim (5 µg)	Others	37	27(72.9)	5(13.5)	5(13.5)
PipracillinTazobactam (110 µg)	Beta lactam -Beta lactamase inhibitors	27	17(62.9)	4(14.8)	6(22.2)
Colistin sulfate (10 µg)	Polymyxin	10	1(10.0)	2(20.0)	7(70.0)
Cefipeme (30 µg)	Cephalosporin antibiotic	20	13(65.0)	1(5.0)	6(30.0)

4. Conclusion

Acinetobacter is an important opportunistic and emerging pathogen that can lead to severe infections. Spreading easily in the environment, these organisms infect or colonize patients and are able to persist in that environment for several days, a factor that might explain their tendency to cause extended outbreaks.

This study reported a high rate of antibiotic resistance by *Acinetobacter* isolates, indicating that new antibiotic using standards are better to be set in health centers to prevent the occurrence of bacteria resistance. Thus, to prevent microbial resistance, rational use of antibiotics is essential and new protocols are needed.

Awareness is needed to control the environment, and tasks such as equipment decontamination and strict attention to hand washing should be undertaken to prevent the spread of *Acinetobacter* in hospitals.

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Conflict of Interest

The authors declared no conflict of interest.

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