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Distribution of Some Antibiotic Resistance Genes Among Carbapenem-Resistant *Acinetobacter Baumannii* Isolated From Patients Lying ICU in AL-Najaf /Iraq

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RESEARCH ARTICLE

Distribution of Some Antibiotic Resistance Genes Among Carbapenem-Resistant *Acinetobacter Baumannii* Isolated From Patients Lying ICU in AL-Najaf /Iraq

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ABSTRACT

Acinetobacter baumannii is a significant nosocomial pathogen, affecting immunocompromised and critically ill patients in intensive care units (ICUs). The emergence of carbapenem-resistant *A. baumannii* (CRAB) poses a threat due to its resistance to multiple antibiotics. This study investigates the prevalence of carbapenemase-encoding genes among CRAB isolates from ICU patients at AL-Sadder hospital/ Najaf. Eight sputum specimens were collected from ICU patients suspected of *A. baumannii*. The isolates were identified through morphological, biochemical tests and the Vitek 2 Compact system. Antibiotic sensitivity was determined by the Vitek 2 Compact system (using AST card). only 5 *A. baumannii* isolates have been identified and all isolates were resistant to most antibiotics and these isolates were detected as CRAB. minocycline and doxycycline showed the lowest resistance, while no resistance to colistin. Phenotypically, all isolates were MBL producers, while none of the isolates had the ability to produce carbapenemase. PCR results showed the prevalence of $bla_{OXA51\text{-}like}$ (100%), followed by $bla_{OXA24\text{-}like}$ (80%) and bla_{NDM} (40%) while bla_{GES} was detected in 20% of isolates. All CRAB isolates were lacking bla_{KPC}. Sixty percent of MBL producer CRAB were possessed both $bla_{OXA51like}$ and $bla_{OXA24\text{-}like}$, while 20% of MBL producer CRAB possessed $bla_{OXA51\text{-}like}$, $bla_{GES,}$ bla_{NDM}, and $bla_{OXA24\text{-}like}$, whereas other 20% isolates possessed $bla_{OXA51like}$ and bla_{NDM}. The study highlights the high prevalence of carbapenemase genes among CRAB isolated from ICU patients. These findings underscore the need for effective infection control measures and novel treatment strategies to combat multi-drug resistant *A. baumannii* in ICU settings.

Keywords: Acinetobacter baumannii, Carbapenemase genes, Carbapenem-resistant, Metallo-β-lactamase, PCR

Introduction

Acinetobacter baumannii, a Gram-negative coccobacillus, is a significant opportunistic pathogen that causes infections in hospitals, especially in immunocompromised patients and critically ill patients who have certain risk factors, to stay in an intensive care unit.[1,2] *A. baumannii* is responsible for the rapid spread of severe nosocomial infections, including ventilator-associated pneumonia, skin and soft tissue infections, urinary tract infections, and bloodstream infections. Several studies have highlighted hospital intensive care units, neonatal regions, and burn units as environments that are very helpful to the rapid transmission of *A. baumannii* among patients.[3,4]

Gram-negative bacilli emerge drug resistance, which is attributed to the production of AmpC beta-lactamases, extended-spectrum beta-lactamases (ESBL), and metallo-beta-lactamases (MBL), so it has become increasingly common.[5] Researchers have found a strong link between infections caused by carbapenem resistance *A. baumannii* (CRAB) and longer stays in the intensive care unit (ICU), higher costs for patients, and the use of antibiotics.[6] CRAB isolates

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typically exhibit resistance to commonly used antibiotics, including aminoglycosides, ß-lactams, and fluoroquinolones.[7] The antibiotic resistance mechanisms, including target alteration, efflux pumps, antibiotic-hydrolyzing enzymes, and deficiency of porin, work together in a synergistic manner. *A. baumannii* becomes resistant to carbapenems by inactivating or breaking down carbapenems using carbapenemases encoding genes including $bla_{OXA51\text{-}like}$, $bla_{OXA\text{-}24\text{-}like}$, bla_{GES}, bla_{KPC}, and bla_{NDM},[8,9] So, this study aimed to investigate the prevalence of some carbapenemase encoding genes among CRAB isolated from patients in the ICU of AL-Sadder hospital/ Najaf. The resistance to carbapenems is most often related to the acquisition of Carbapenemases. (i) oxacillinases carbapenem-hydrolyzing class D β-lactamases (CHDLs) distributed into the following: $OXA_{51\text{-like}}$ and acquired $OXA_{24\text{-like}}$. The overexpression of OXA genes (chromosomal or plasmid encoded) enables *A. baumannii* to pose resistance against carbapenem.[10] (ii) metallo βeta-lactamases (MBLs) Like: NDM is the most concerning among MBLs due to its resistance to carbapenems (iii) Carbapenemases of Ambler class A as KPC and some variants of GES.[11] The quick and efficient dissemination of bla_{KPC} genes is due to their usual location within transposable elements, mainly Tn4401 in conjugative plasmids[12] and GES (Guiana Extended Spectrum) βeta- lactamase, which confers penicillin and cephalosporin resistance, but has carbapenemase activity.[13]

Materials and methods

Bacterial Isolates and Antimicrobial Susceptibility Testing: From September 2023 to November 2023, five sputum specimens were collected from patients who were lying in the ICU in AL-Sadder Hospital/ Najaf. All specimens were cultured on blood base and MacConkey agar and incubated at 40°C for 24 hours. A suspected *A. baumannii* isolate was cultured on Chrome agar to confirm identification of isolates. Vitek 2 Compact system have been used to confirm identification of *A. baumannii* isolates using GN-ID card contains more than 67 biochemical tests and detection of antibiotic susceptibility pattern by using AST 222 card.[6] It performs susceptibility tests for antibiotics, which are based on 18-22 antibiotics, and each antibiotic has a 3-4 concentration to obtain the MIC (minimum inhibitory concentration) value.

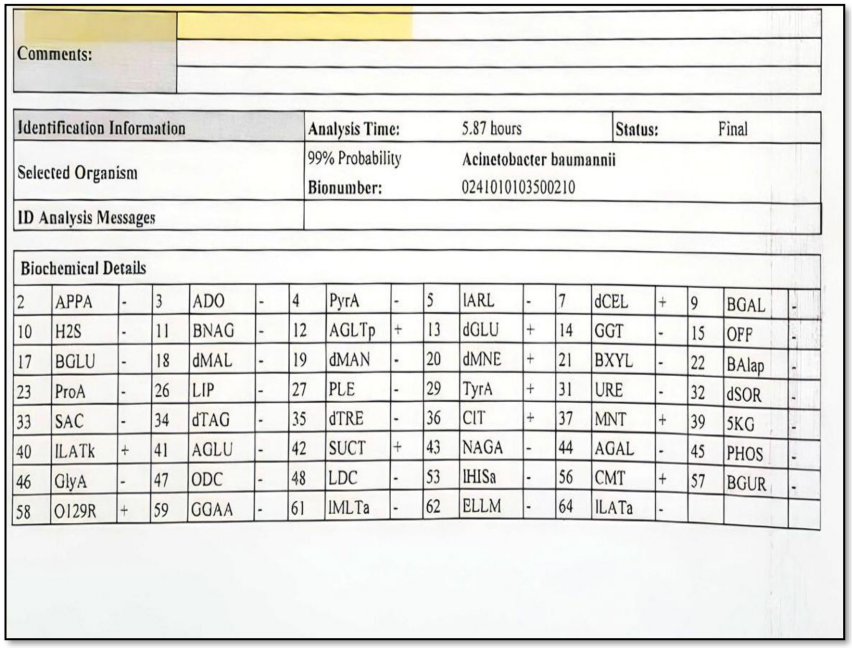
Detection of Metallo - β –Lactamases: All the isolates were tested for metallo-beta-lactamase (MBL) synthesis using the Kirby Bauer disc diffusion method according to CLSI 2023 guideline[14] using imipenem (10 g) discs (Himedia/India). Briefly, tested bacterial isolates were inoculated into Muller-Hinton Agar (MHA) plates. Imipenem disc (10 g) and Imipenem with EDTA disc were placed on the surface of plates with 20 mm distance between them. The plates were incubated at 37°C for 24 hours. If the inhibition zone of Imipenem-EDTA combination disc is raised by 5 mm, the isolates are identified as MBL producers in comparison to the Imipenem disc alone.

The Modified Hodge Test: A technique described by the CLIS 2023 guideline[14] was utilized where MHA plates were inoculated with *E. coli* ATCC 25922 equal (optical density as 0.5 McFarland standard tube). Then, an imipenem disk (10 μg) was placed at the center of plates. *A. baumannii* (2–5 colonies) was streaked in a linear form starting at the disk's periphery to imipenem disk. The plates were incubated for 16 to 20 hours at 35 °C. The results will be positive in cases accompanied by increased growth showing a clover-leaf indentation.

Polymerase Chain Reactions: DNA of all isolates was extracted using boiling techniques as described previously.[15] The genes encoding antibiotic resistance, including $bla_{OXA51\text{-}like}$, $bla_{OXA24\text{-}like}$, bla_{GES}, bla_{NDM} and bla_{KPC} were detected by monoplex PCR technique using a set of primers Table 1. Fifty microliters of reaction mixture consist: 5μL of PCR Master Mix (2x PCR MIX Taq Polymerase, GOS BIO, China). 2μL of each forward and reverse primers, 4μL of DNA template, and 17μL of DNase/RNase-free water were mixed. Amplification was performed using a thermocycler (QLS, UK) with primary denaturation

Table 1. The sequences of synthesis oligonucleotid (Macrogen, Korea).

Genes	Sequences 5' 3'	Size (bp)	Annealing (°C)	References
bla_{GES}	ATGCGCTTCATTCACGCAC CTATTTGTCCGTGCTCAGGA	863	55.6	8
bla_{KPC}	ATGTCACTGTATCGCCGTCT TTACTGCCCGTTGACGCCCA	881	50.3	9
bla_{NDM}	GGGCCGTATGAGTGATTGC GAAGCTGAGCACCGCATTAG	825	55.6	9
$bla_{OXA51\text{-}like}$	TAATGCTTTGATCGGCCTTG TGGATTGCACTTCATCTTGG	353	55.6	9
$bla_{OXA24\text{-}like}$	ATACTTCCTATATTCAGCAT GATTCCAAGATTTCTAGCG	809	55.6	9



Comments:

Identification Information	Analysis Time:	5.87 hours	Status:	Final
Selected Organism	99% Probability	Acinetobacter baumannii		
	Bionumber:	0241010103500210		
ID Analysis Messages				

Biochemical Details

2	APPA	-	3	ADO	-	4	PyrA	-	5	lARL	-	7	dCEL	+	9	BGAL	-
10	H2S	-	11	BNAG	-	12	AGLTp	+	13	dGLU	+	14	GGT	-	15	OFF	-
17	BGLU	-	18	dMAL	-	19	dMAN	-	20	dMNE	+	21	BXYL	-	22	BAlap	-
23	ProA	-	26	LIP	-	27	PLE	-	29	TyrA	+	31	URE	-	32	dSOR	-
33	SAC	-	34	dTAG	-	35	dTRE	-	36	CIT	+	37	MNT	+	39	5KG	-
40	ILATk	+	41	AGLU	-	42	SUCT	+	43	NAGA	-	44	AGAL	-	45	PHOS	-
46	GlyA	-	47	ODC	-	48	LDC	-	53	lHISa	-	56	CMT	+	57	BGUR	-
58	O129R	+	59	GGAA	-	61	lMLTa	-	62	ELLM	-	64	lLATa	-			

Fig. 1. Biochemical tests for the diagnosis of *A.baumannii* Using Vitek2 Compact System.

at 94˚C for 3 minutes and 30 cycles of 94˚C for 30 seconds, annealing to each primer as mentioned in Table 1, extension at 72˚C for 1 minute, and final extension at 72˚C for 8 minutes. The resulted amplicons were detected using agarose gel electrophoresis (1.5% ethidium bromide-stained agarose gel at 50 volts for 1.5 hours) and visualized by Documentation System (Cleaver, UK's Gel).

Results and discussion

Only 5 specimens of a sputum taken from ICU patients were diagnosed as *A. baumannii.* The results of vitek 2 compact system for identification of *A.baumannii* showed that all isolates belonged to *A.baumannii* with 99% similarity Fig. 1. The antibiogram test revealed that all isolates showed highest percentage of resistance (100%) toward Ticarcillin, Ticarcillin /clavulanic acid, Piperacillin, piperacillin /tazobactam, ceftazidime, cefotaxime, cefpodoxime, cefixime, cefteram, cefradine, ceftriaxone, doripemen, Ertapenem, imipenem, meropenem, isepamicin, Netilmicin, Amikacin, Tobramycin, Gentamicin, ciprofloxacin, Levofloxacin, Gatifloxacin, and Trimethoprim-Sulphamethazole, while the lowest resistance observed to minocycline and doxycycline (20% to each one). No antibiotic resistance to colistin was observed. All 5 isolates were denoted as CRAB Table 2.

All CRAB isolates gave positive results for Metallo β-Lactamase, while the results of modified Hodge test revealed that all CRAB isolates have no ability to produce carbapenemase.

The prevalence of $bla_{OXA51\text{-}like}$, $bla_{OXA\text{-}24\text{-}like}$, bla_{GES}, bla_{NDM}, and bla_{KPC} among CRAB revealed that only 5(100%), 4 (80%), 1 (20%), and 2(40%) isolates were possessing these genes, respectively, except bla_{KPC}, which was not detected in all CRAB Table 3 and Figs. 2 to 6.

The pattern of distribution of antibiotic resistance genes was shown in Table 4 which revealed a variation in the possession of genes among CRAB isolates. A high percentage of gene patterns among CRAB isolates was observed for isolates that possess both $bla_{OXA51like}$ and $bla_{OXA24\text{-}like}$ (60%), followed by genes patterns that involved isolates that possess $bla_{OXA51\text{-}like}$, bla_{GES}, bla_{NDM}, and $bla_{OXA24\text{-}like}$ as well as isolates that possess genes patterns $bla_{OXA51like}$ and bla_{NDM} with a low percentage (20% to each pattern).

Globally, a great challenge for infection-control practitioners as well as clinicians over the world is infection due to *A. baumannii* because of their ability to prosper in the hard environments of intensive care units under a major selection pressure of disinfectants and antibiotics, that has been found to be related to high resistance to antibiotics and higher mortality among bacteremia patients in compression with other species.[16] Research on drug resistance mechanisms, including enzymes, membrane proteins, efflux pumps, and beneficial mutations, is crucial for effective antibiotic use and developing new treatment strategies.[17] The most significant carbapenem resistance mechanism in *A. baumannii* is degradation of

Table 2. Antibiotic Susceptibility Pattern of *Acinetobacter baumannii* Isolated from ICU (n = 5).

Antibiotic name	Rang of MIC* (μg/ml)	NO. (%) of Resistant isolates	Rang of MIC** (μg/ml)	No. (%) of Sensitive isolates
Ticarcillin	64	5(100%)	≤ 4	0
Piperacillin	64	5(100%)	≤ 4	0
Ticarcillin-clavulanic acid	≥128	5(100%)	≤ 4	0
Piperacillin-tazobactam	≥128	5(100%)	16	0
Ceftazidime	≥ 64	5(100%)	4	0
Cefotaxime	≥ 64	5(100%)	4	0
Cefpodoxime	≥ 64	5(100%)	4	0
Cefixime	≥ 64	5(100%)	4	0
Cefteram	≥ 64	5(100%)	4	0
Cefradine	≥ 64	5(100%)	4	0
Ceftriaxone	≥ 64	5(100%)	4	0
Imipenem	≥ 16	5(100%)	≤0.5	0
Meropenem	≥ 16	5(100%)	≤0.5	0
Doripemen	≥ 16	5(100%)	≤0.5	0
Ertapenem	≥ 16	5(100%)	≤0.5	0
Tobramycin	≥ 16	5(100%)	≤ 1	0
Gentamicin	≥ 16	5(100%)	≤ 1	0
Amikacin	≥ 16	5(100%)	≤ 1	0
Netilmicin	≥ 16	5(100%)	≤ 1	0
Isepamicin	≥ 16	5(100%)	≤ 1	0
Ciprofloxacin	≥ 4	5(100%)	≤ 0.5	0
Levofloxacin	≥ 4	5(100%)	≤0.12	0
Gatifloxacin	≥ 4	5(100%)	≤ 0.5	0
Trimethoprim_Sulfamethoxazole	160	5(100%)	≤ 20	0
Minocycline	≥ 16	1(20%)	≤ 1–2	4(80%)
Doxycycline	≥ 16	1(20%)	≤ 1–2	4(80%)
Colistin	8	0	≤ 0.5	5(100%)

*Rang of minimal inhibitory concentration of resistance isolates, **Rang of minimal inhibitory concentration of Sensitive isolates.

Table 3. The percentage of genes encoding carbapenemase resistance among carbapenem resistance *Acinetobacter baumannii.*

Bacterial isolates(n = 5)	NO.(%) of isolates that possess:				
	bla_{KPC}	bla_{GES}	bla_{NDM}	$bla_{OXA\text{-}51like}$	$bla_{OXA\text{-}24\ like}$
CRAB	0	1(20)	2(40)	5(100)	4(80)

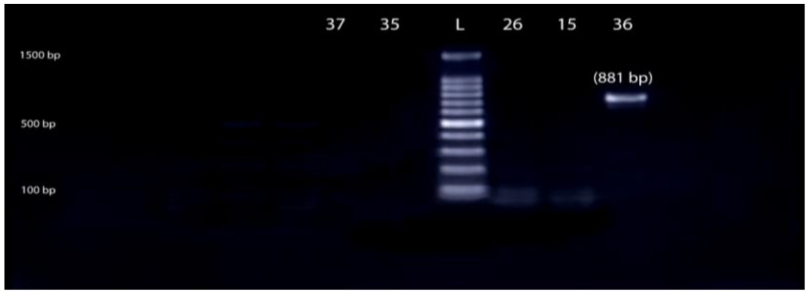


Fig. 2. Agarose gel electrophoresis of bla_{KPC} gene(881bp) in *A. baumannii* isolates.

Table 4. The percentage of gene patterns among Carbapenem resistance *Acinetobacter baumannii.*

Pattern of antibiotic resistance genes	Pattern of MBL Production	No (%) of isolates
$bla_{OXA51\text{-}like}$, bla_{GES}, bla_{NDM}, $bla_{OXA24\text{-}like}$	Positive	1(20%)
$bla_{OXA51like}$, bla_{NDM}	Positive	1(20%)
$bla_{OXA51like}$, $bla_{OXA24\text{-}like}$	Positive	3(60%)

MBL: Metallo-β- lactamase.

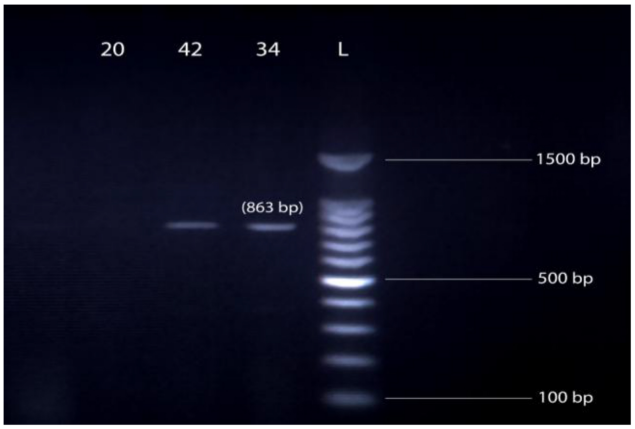


Fig. 3. Agarose gel electrophoresis of *bla*$_{GES}$ gene (863bp) in *A. baumannii* isolates.

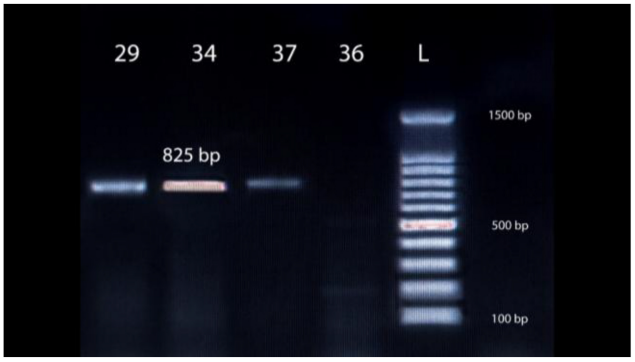


Fig. 4. Agarose gel electrophoresis of *bla*$_{NDM}$ gene(825bp) in *A. baumannii* isolates.

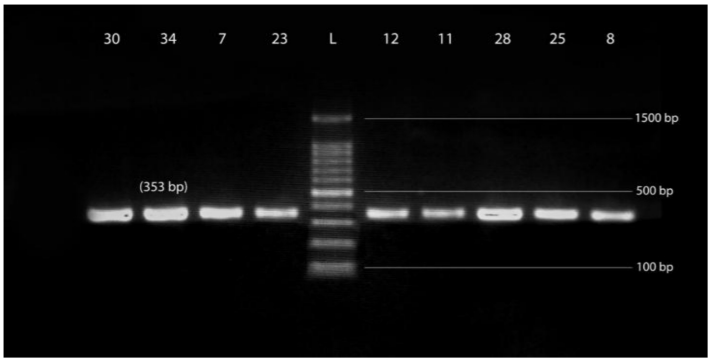


Fig. 5. Agarose gel electrophoresis of OXA$_{51\text{-}like}$ gene(353bp) in *A. baumannii* isolates.

carbapenems by enzymes, which is usually carried out by carbapenemase enzymes, where the encoding genes are usually located on plasmids and are highly transmissible.[18]

This study and many previous reports conducted in this regard indicate a higher prevalence of isolates acquired from inpatients compared to outpatients, which indicates an increased risk of acquiring *A.baumannii* in a hospital or healthcare facility setting.[19–21] which indicates infection is transmitted among patients using ventilators in ICUs.[22] The antibiotic susceptibility testing was carried out for all the sputum isolates, and it was found that resistance to most antibiotics is very high (100%). Several previous local studies also reported a high distribution of antibiotic resistance isolates,[23,24] as mentioned in many international studies.[25,26] A susceptibility of isolates to colistin made treatment with colistin alone may be sufficient, in accordance with recent studies.[27,28] The development of antimicrobial

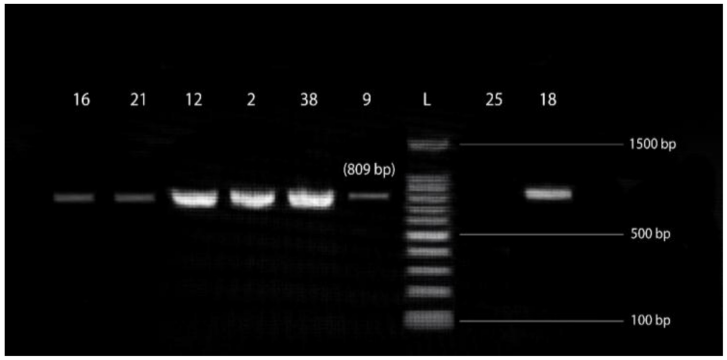


Fig. 6. Agarose gel electrophoresis of $OXA_{24\text{-}like}$ gene(809bp) in *A. baumannii* isolates.

resistance in *A. baumannii* leads to significant challenges to the treatment of infected individuals, particularly immunocompromised patients. The potential therapeutic options become very limited when effective drugs such as carbapenem antibiotics are excluded. The alarming levels of antibiotic resistance in Iraq can be linked to the widespread and uncontrolled use of antibiotics especially carbapenems, for the treatment of various diseases.

According to various studies, the worldwide distribution of carbapenemase in *A.baumanniii* was very diverse. In this study, all five CRAB isolates gave negative results to the production of carbapenemase using the Hodge test compared with numerous studies in Iraq that showed positive results (94% in Duhok and 13.4% in Baghdad),[29,30] as well as in Egypt (73.3%) and India (18.8%).[31,32]

The present study reported that 100% of CRAB isolates were positive for MBL comparison with other studies in Egypt (44.4%)[31] and Nepal (66.6%).[33] The ability of CRAB to produce MBL may be due to several factors that mediated its production. One of the most important factors is the acquisition of genes encoding MBL production by horizontal gene transfer. Treatment of a bacterial cell with EDTA led to an increase in its permeability and made it more sensitive to acquisition genes encoding antibiotic resistance.

The PCR results indicated a variation in the distribution of carbapenemase genes, and it has been found that $bla_{OXA\ 51\text{-}like}$ and $bla_{OXA\ 24\text{-}like}$ were the most common. In contrast, many previous studies reported uncommon presence of these genes among *A. baumannii*.[34,35] On the other hand, the present study noticed that there is no relationship between the presence of carbapenemase encoding genes and antibiotic resistance patterns among carbapenem resistant or carbapenem-sensitive isolates. This may be due to the presence of insertion sequences (ISAbaI) upstream of $bla_{OXA51\text{-}like}$. These factors lead to the overexpression of carbapenemase, which in turn causes carbapenem resistance, particularly to imipenem. The problematic of MBLs producer isolates is the presence of a large number of plasmids that are transferable and the ability to wide rearrangement, suggesting widespread horizontal transition and adaptability among bacterial populations.[36,37] bla_{KPC} and bla_{GES} genes are highly transmissible due to their links to mobile genetic elements on integrons and conjugative plasmids, respectively.[38,39]

Conclusion

This study reveals a high prevalence of carbapenemase-encoding genes among CRAB isolated from ICU patients, with high resistance toward most antibiotics except minocycline, colistin, and doxycycline. The presence of multiple resistance genes, particularly $bla_{OXA51\text{-}like}$ and $bla_{OXA24\text{-}like}$, highlights the critical need for stringent infection control measures and the development of novel treatment strategies to combat the spread of multi-drug resistant *A. baumannii* in ICU settings. These findings underscore the importance of continuous surveillance and tailored antimicrobial stewardship programs to manage and mitigate the impact of CRAB infections in healthcare facilities.

Ethical approval

Ethical approval was sought from the University of Kufa, specifically the College of Medicine, and the Health Department in Al-Najaf prior to the start of this study. In addition, the relevant Al-Sadder hospital research ethics committees gave their approval.

Authors' declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images, that are not ours, have been

included with the necessary permission for republication, which is attached to the manuscript.
- No animal studies are present in the manuscript.
- Authors sign on ethical consideration's approval
- Ethical Clearance: The project was approved by the local ethical committee at University of Kufa.

Authors' contribution statement

A. K. N.: study design, supervision, data interpretation, writing – original draft, writing – review and editing, final approval of the manuscript. G. R. T.: laboratory work, data collection, data curation, writing – review and editing.

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انتشار بعض جينات المقاومة للمضادات الحيوية في بكتيريا *Acinetobacter baumannii* المقاومة للكاربابينيم المعزولة من المرضى الراقدين في وحدة العناية المركزة في النجف / العراق

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الملخص

تعتبر بكتيريا *Acinetobacter baumannii* من مسببات الأمراض الخطيرة التي تنتقل إلى المستشفيات، وتصيب المرضى الذين يعانون من نقص المناعة والحالات الحرجة في وحدات العناية المركزة. ويشكل ظهور بكتيريا *A. baumannii* المقاومة للكاربابينيم (CRAB) تهديدًا خطيرًا بسبب مقاومتها للعديد من المضادات الحيوية. هدفت هذه الدراسة الى التحري عن انتشار الجينات المشفرة لانتاج انزيم الكاربابنميز بين عزلات CRAB من المرضى الراقدين في وحدة العناية المركزة في مستشفى الصدر / النجف. تم جمع ثماني عينات من القشع من المرضى الراقدين في وحدة العناية المركزة المشتبه إصابتهم ببكتيريا *A. baumannii*. تمت زراعة هذه العينات لعزل وتشخيص بكتيريا *A. baumannii* اعتمادا على الاختبارات المظهرية والزرعية ونظام Vitek 2 Compact (GN- ID). تم تحديد حساسية العزلات البكتيرية للمضادات الحيوية باستخدام نظام Vitek 2 Compact (AST). أجري اختبار هودج المعدل واختبار تخليق ميتالو-بيتا لاكتاماز (MBL) للكشف المظهري عن العزلات المنتجة لانزيم الكاربابينيميز. تم استخدام تفاعل انزيم البلمرة المتسلسل (PCR) للتحري عن جينات bla*OXA51-like* و bla*OXA24-like* و bla*GES* و bla*NDM* و bla*KPC* . بينت النتائج عدم اصابة جميع المرضى بـبكتيريا *A. baumannii* ، أذ تم تشخيص 5 عزلات فقط تعود لبكتيريا *A. baumannii*. بينت نتائج اختبار الحساسية للمضادات الحيوية أن جميع العزلات (100٪) كانت مقاومة لمعظم المضادات الحيوية وان جميع هذه العزلات كانت مقاومة للكاربابنيم CRAB، حيث لوحظ ان أقل مقاومة ابدتها العزلات كانت للمضادين مينوسايكلين والدوكسيسايكلين بينما لم تظهر أي مقاومة للكوليستين. مظهريـاً كانت جميع العزلات منتجة لانزيمات البيتالاكتاميز المعدنيــة MBL بينما لم تمتلك أي من العزلات القابلية على إنتاج انزيم الكاربابينيميز. أظهرت نتائج تفاعل أنزيم البلمرة المتسلسل انتشار جين bla*OXA51-like* وبنسبة 100% ، ثم جين bla*OXA24-like* بنسبة 80% وجين bla*NDM* بنسبة 40% بينما كانت نسبة انتشار الجين bla*GES* هي 20% . بينت النتائج عدم وجود جين الـ bla*KPC* في جميع عزلات CRAB. بينت النتائج ان 60% من العزلات المنتجة لانزيمات البيتالاكتاميز المعدية كانت حاملة لكلا الجينين bla*OXA51like* و bla*OXA24-like* بينما 20% من العزلات المتبقية كانت حاملة للجينات bla*OXA51-like*, bla*GES*, bla*NDM*, bla*OXA24-like* و 20% كانت حاملة للجينين bla*OXA51like* و bla*NDM* . سلطت الدراسة الحاليــة الضوء على الانتشار العالي لجينات المقاومة للمضادات الحيوية بين عزلات CRAB المعزولة من المرضى الراقدين في وحدة العناية المركزة، وتؤكد هذه النتائج على الحاجة إلى تدابير فعالة لمكافحة العدوى واستراتيجيات علاجية جديدة لمكافحة البكتيريا المقاومة للمضادات الحيوية *A. baumannii* في وحدات العناية المركزة.

الكلمات المفتاحية: *Acinetobacter baumannii*، الجينات المشفرة للكاربابنميز، المقاومة للكاربابنيم، أنزيمات البيتالاكتاميز المعدنية، PCR .