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Original article

Acinetobacter infections in intensive care unit patients at Al-Azhar University Hospitals in Assiut

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ABSTRACT

Background: The increasing occurrence of *Acinetobacter* infections in intensive care units and among patients with weakened or compromised immune systems is a major concern for clinicians around the world. This is primarily due to the bacteria's remarkable capacity to develop resistance to various antibiotic classes, which significantly restricts the range of available treatment options. ***Objectives*:** Examine the patterns of healthcare-related infections and the resistance profiles of *Acinetobacter* species in the Intensive Care Units at Al-Azhar University Hospitals in Assiut. ***Material and Methods*:** samples collected from 200 ICU patients with infections underwent direct microscopic examination and cultured on blood and MacConkey agar plates. The VITEK 2 automated microbiology system was utilized to perform species-level identification of Gram-negative bacilli that are oxidase-negative. The susceptibility profiles were evaluated using the Modified Kirby-Bauer disc diffusion technique. ***Results*:** Among 200 patients with infections, 9% (n=18) were identified as being infected with *Acinetobacter* species. This bacterium accounted for 13.8% of lower respiratory tract infections (LRTIs), 8.3% of wound infections, and 2.6% of urinary tract infections (UTIs). The most common species detected was *Acinetobacter baumannii*, making up 61.1% of the cases. Significant factors associated with *Acinetobacter* infections included extended ICU stays (p=0.03) and chronic obstructive pulmonary disease (COPD) (p=0.005). The most effective antibiotics were imipenem (83.3%), followed by ofloxacin (16.7%) and amikacin (5.6%). Notably, 55.5% (10 out of 18 isolates) were categorized as multidrug-resistant (MDR) *Acinetobacter* isolates. ***Conclusion and recommendations*:** The rise in infections caused by *Acinetobacter* has posed a substantial challenge to healthcare systems. Patients who undergo invasive procedures, have extended ICU stays, or suffer from various underlying conditions are more susceptible to these infections. Successfully eliminating *Acinetobacter* spp. necessitates strict adherence to effective infection control measures and judicious use of antibiotics.

Introduction

Acinetobacter, a coccobacillus that is Gram-negative, has evolved from a microorganism with uncertain pathogenicity into a significant infectious agent in hospitals globally [1]**.** The organism is capable of developing various resistance mechanisms, resulting in the development of bacterial strains resistant to every antibiotic currently available [2].

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Acinetobacter baumannii belongs to the ESKAPE group that consists of clinically significant organisms, primarily associated with healthcare settings, known for their high potential to develop considerable resistance to antimicrobials [3].

Various ESKAPE pathogens comprise *Staphylococcus aureus, Enterococcus faecium, Acinetobacter baumannii, Klebsiella pneumoniae, Enterobacter species* and *Pseudomonas aeruginosa* [4].

Moreover, the World Health

Organization has identified the *Acinetobacter baumannii* resistant to carbapenems microbe as a high-priority pathogen on its list of antibiotic-resistant organisms highlighting the urgent need for effective drug development [5]. In addition, *A. baumanni*i resistant to carbapenem is one of the critical-precedence pathogens on the global Health Organization precedence listing of antibiotic-resistant microorganism for powerful drug development [6].

The difficulty of managing *Acinetobacter* isolates that are resistant to multiple drugs has increased, resulting in increased fatality rates. Nearly all antimicrobial medications involving aminoglycosides, quinolones, carbapenems and broad-spectrum β -lactams, have been shown to cause resistance in *A. baumannii*. The utility of carbapenems is threatened by the emergence of multidrug-resistant organisms like *A. baumannii*, despite the fact that these drugs are successful in treating the majority of gram-negative nosocomial infections. Studies have revealed a rise in carbapenem resistance worldwide [7].

Aim of the study

The aim of this work was isolation, identification and antimicrobial susceptibility of *Acinetobacter* species in Patients at Intensive Care Units at Al Azhar University Hospitals in Assiut.

MATERIALS AND METHODS

The research was carried out from January to December 2023. The study was approved by Al Azhar Faculty of Medicine ethical committee. Clinical samples were obtained from patients in Intensive Care Units at Al Azhar University Hospitals in Assiut. The collected samples were processed at the Department of Medical Microbiology and Immunology, Faculty of Medicine Al Azhar University for isolation of organisms.

Species-level identification was performed utilizing the Air Force Specialized Hospital's VITEK 2 automated microbiology equipment at the microbiology department.

Consent was taken from patient's family to be enrolled in the study.. This research included 200 participants (139 men and 61 women) who exhibited clinical signs of infection. For each participant, demographic details such as ward, name, age, and gender were gathered. Clinical aspects were documented, encompassing hospitalization duration, presence of pre-existing conditions, risk factors (such as the use of invasive devices), prior investigations, and antibiotic therapy.

Endotracheal tubes, sputum, pressure sores, urine, and infected wounds were among the several sorts of specimens that were collected. All samples were subjected to: Direct microscopic examination of a Gram–stained smear, culture on MacConkey and blood agar media and biochemical tests [8]. Further identification to species level was done by VITEK 2 automated system [9].

The identification of *Acinetobacter* was carried out by:

1- Colony appearance: smooth, convex, glistening, sometimes mucoid, pale yellow colonies on MacConkey medium.

2- Motility: Non-motile.

3- Gram stain: *Acinetobacter* appears as short, Gram-negative rods, but often more coccoid and arranged in pairs or clusters.

4- Biochemical tests: negative oxidase and positive catalase test.

5- VITEK 2 automated microbiology system.

Antimicrobial susceptibility test for Acinetobacter isolates was done using a disc diffusion method (Modified Kirby Bauer technique) on Muller Hinton agar according to Clinical and Laboratory Standards Institute (CLSI 2021) guidelines [10].

The following antimicrobial discs were used:

• Combination of β lactam β lactamase inhibitor

Ampicilin/ sulbactam (20 µg)

Amoxacillin /Clavulante (30 µg)

Piperacillin/ Tazobactam (110 µg)

• Aminoglycosides:

Gentamicin (3 µg)

Amikacin (10 µg)

• Fluoroquinolones:

Ciprofloxacin (5µg)

Ofloxacin (5 µg)

• Cephalosporins:

1 st generation: Cefazolin (30 µg)

2nd generation: Cefuroxime (30µg)

3rd generation: Ceftriaxone (30µg)

4th generation: Cefepime (30µg)

• Carbapenems:

Imipinem (10µg)

• Cefoperazone/Sulbactam (75µg)

RESULTS:

It was found that out of 178 patients whose samples showed growth with Acinetobacter spp were 18 patients (9%). while 160 (80%) samples showed non-Acinetobacter growth Figure (1).

As regard sex, Males were more than females [139 (69.5) versus 61(30.5%) respectively] as shown in Figure (2)

Among the Acinetobacter group, A.baumannii was the main isolated spp. (61.1%) while A.lwoffii (27.8%)and A. Junii were (11.1%) (Figure 3).

Antibiotic susceptibility test:

The most effective antibiotics were imipinem (83.3%), Ofloxacin (16.7 %) and amikacin (5.6%). On the other hand strains were 100% resistant to Ampicilin/Sulbactam, Amoxacillin/Clavulinate, Gentamicin ,cefazolin, Ciprofloxacin, Cefuroxime, Ceftriaxone, cefepime and cefuroxime.

Totally 83.3% (15/18 isolates) were found to be MDR *Acinetobacter* isolates.

Table 1. Gender distribution among *Acinetobacter* and non-*Acinetobacter* groups.

Gender	Acinetobacter group (no=18)	*Non*- Acinetobacter group (no=160)	Total (no=178)	P value
	no. (%)	no. (%)	no. (%)	0.54
Male	13 (10.3)	113 (89.7)	126 (100)	
Female	5 (9.6)	47 (90.4)	52(100)	

This table showed no statistically significant difference between infection in both sex (p=0.54).

Table 2. Distribution of *Acinetobacter* group and non–*Acinetobacter* group in relation to age

Age (years)	*Acinetobacter* group (no=18) (%)	Non- *Acinetobacter* group (no=160)%	Total (no=178) (%)	P value
20-30	**2 (14.3)**	**12 (85.7)**	**14 (100)**	**0.88**
31-40	**3 (9.4)**	**29 (90.6)**	**32 (100)**	
41-60	**8 (10.1)**	**71 (89.9)**	**79 (100)**	
Above 61	**5 (9.5)**	**48 (90.5)**	**53 (100)**	

It was found that there was no specific age group for Acinetobacter infected patients(p=0.88).

Table 3. Types of clinical specimens among *Acinetobacter* and non -*Acinetobacter* groups.

Clinical specimens	***Acinetobacter* group(no=18)**	**Non-*Acinetobacter* group (no=160)**	**Total =178**	**P value**
	no. (%)	**no . (%)**	**no. (%)**	
Respiratory (Sputum and ETT aspirate.)	**13 (13.8)**	**78 (86.2)**	**91(100)**	**0.44**
Wound exudates and bed sore	**4 (8.3)**	**44(91.7)**	**48 (100)**	**0.30**
Urine	**1 (2.6)**	**38 (97.4)**	**39(100)**	**0.16**

There was no statistically significant difference between *Acinetobacter* and non-*Acinetobacter* groups as regard type of infections.

Table 4. Duration of hospital stay for *Acinetobacter* and non -*Acinetobacter* groups.

Duration of hospital stay (days)	*Acinetobacter* group (no=18)	Non- *Acinetobacter* group (no=160)	**Total (no=178)**	**P value**
	no. (%)	no. (%)	no. (%)	
Less than 7	4 (7.3)	51 (92.7)	55 (100)	0.03
More than 7	14 (11.4)	109 (88.6)	123 (100)	
Mean of Days ± SD	8.67± (2.612)	7.90± (2.285)		

Prolonged stay in hospital was significantly associated with *Acinetobacter* infection (p=0.03).

Table 5. Mechanical ventilation and Ventilator-associated Pneumonia (VAP) among *Acinetobacter* and non-Acinetobacter groups.

	***Acinetobacter* group (no=18)**	**Non-*Acinetobacter* group (no= 160)**	**Total (178)**	**P value**
	no. (%)	**no. (%)**	**no. (%)**	
Mechanical ventilation	**9 (14.5)**	**53 (85.5)**	**62 (100)**	**0.89**
VAP	**9 (21)**	**34 (79)**	**43 (100)**	**0.00**

Mechanical ventilation and VAP among *Acinetobacter*, there was statistically significant (p=0.00).

Table 6. urinary catheterization and UTIs among *Acinetobacter* and non *Acinetobacter* groups.

	***Acinetobacter* group (no=18)**	**Non-*Acinetobacter* group(no= 160)**	**Total 178**	**P value**
	no. (%)	**no. (%)**	**no. (%)**	
Urinary catheterization	**17 (11.2)**	**135(88.8)**	**152 (100)**	**0.166**
UTIs	**1 (3.8)**	**25 (96.2)**	**26 (100)**	**0.8**

There was no statistically significant between urinary catheterization and UTIs among *Acinetobacter* and non-Acinetobacter groups.

Figure 1. Distribution of Acinetobacter infected patients among studied patients.

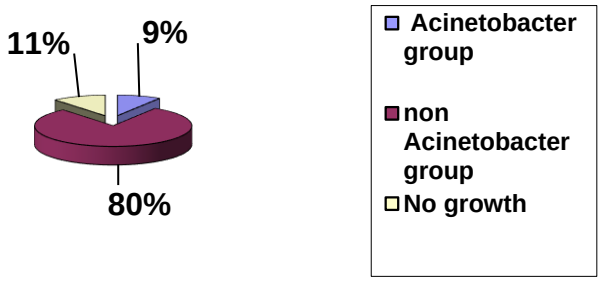


Figure 2. *Acinetobacter* infection according to gender.

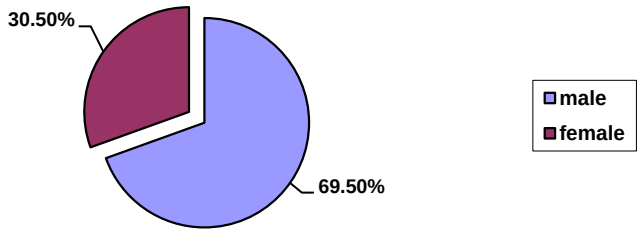
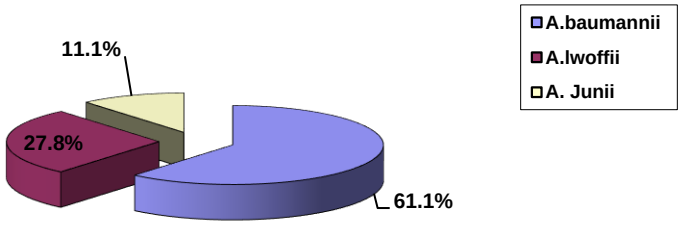


Figure 3. Distribution of different species of *Acinetobacter*.



Discussion

In this investigation, we discovered that patients got infected by *Acinetobacter* spp. across an age range of 20‑85 years [mean age ± (SD), 57.72 ± (12.1) years]. There was no specific age group associated with *Acinetobacter* infections. However, a higher prevalence of infection was noted among males (13/18) compared to females (5/18).

In spite of this, no statistically significant differences were observed in age or sex between the *Acinetobacter* group and the non-*Acinetobacter* group (p=0.45 and p=0.56, respectively).

Our study results are reliable to those of *Nwadike et al* , who identified *Acinetobacter* species from sick patients admitted to university teaching hospital in Nigeria. There are no statistically significant distinctions in age or gender between the *Acinetobacter* and non-*Acinetobacter* group.[11]

The findings of this study revealed that 72.2% (13/18) of the *Acinetobacter* isolates were linked to lower respiratory tract infections (LRTIs), while 22.2% (4/18) were associated with wound infections, and 5.6% (1/18) with urinary tract infections (UTIs).

This aligns with the observations made by Custovic et al, which noted that the most common sites for *Acinetobacter* infections was the respiratory tract, accounting for 74.1% of cases.[12] Surgical sites of infections were documented at 11.1%, and urinary tract infections were at 3.7%. Similarly, *Ye et al* found that, in 57.9% of the cases, the respiratory tract served as the major location for *Acinetobacter* growth.[13]

As Regard to duration of hospital stay, the present study reported that prolonged stay in hospital was significantly associated with *Acinetobacter* infection (p=0.03). These results come in agreement with studies done by Yu et al in China, Agodi et al in Italy, Joshi et al in India, Falagas and Kopterides in Greece , Baran et al in

Turkey and Nwadike V. et al in Nigeria , who reported that longer duration of hospital ICU stay was a significant risk factor for *Acinetobacter* infections ($p \leq 0.05$).[14] [15] [16][17][18] [11]

Also in Malaysia Zakuan et a**.**[19] reported that *Acinetobacter* patients were most located in ICUs and had a longer stay and Lone et al in India found that a longer stay in hospital (beyond the first week) was significantly associated with a remarkably higher rate of infection ($p<0.05$). [20]

Moreover, Ye et al reported that prolonged ICU stay was significant risk factor ($p<0.001$). [13]

However, these results differed from Prashanth and Badrinath in India who found no correlations between *Acinetobacter* infections and prolonged hospital stay.[21]

As Regard to invasive device The present study found that out of 178 infected patients, 62 patients (34.8%) were found to be mechanically ventilated. 43/62(69.4%) of all mechanically ventilated patients: developed VAP. *Acinetobacter spp.* represented (21%) 9/43 of all patients developed VAP and represented (14.5) 9/62 of all mechanically ventilated patients. This was statistically insignificant ($p=0.00$). These results agreed with Mahgoub et al, Ayan et al **,** Lone et al Zakuan et al , Hernández and Nwadike V. et al who recorded that mechanical ventilation was significant risk factor for Acinetobacter infections.[22] [23][20][24][19][11]

Regarding urinary catheterization, among 178 patients with infections, 152

(85.3%) were using urinary catheters. Of these, 26 patients (14.6%) developed urinary

tract infections (UTIs), with *Acinetobacter* UTIs accounting for just 1 patient (3.8%)

out of the 26 with UTIs, and 1 patient (0.6%) out of the 178 catheterized patients. This differentiation was statistically insignificant ($p=0.8$). Urinary catheter use was

determined to be a non-significant risk factor for *Acinetobacter* infections by *Nwadike et al* [9], which is consistent with our findings. (0.47). On the other hand, urinary catheters were found to be a substantial risk factor designed for *Acinetobacter* infections ($p \leq 0.05$) by Ayan et al , Baran et al, Hernández et al, Lone et al, Mahgoub et al , and Zakuan et al [23][18] [24][20][22][19]

During the current investigation, imipenem (83.3%), ofloxacin (16.7%), and amikacin (5.6%) were determined to be the most effective antibiotics against *Acinetobacter* spp. On the other hand, the strains showed total resistance (100%) to cefuroxime, ceftriaxone, gentamicin, ampicillin/sulbactam, amoxicillin/clavulanate, and cefuroxime.

The majority of the *Acinetobacter* isolates in our study demonstrated multidrug resistance (MDR), or resistance to three or more antibiotic classes, consistent with the

results of *Enas et al* [25]

Furthermore, 41% of *Acinetobacter* spp. were MDR, according to Eser et al **,** who also found that these bacteria were resistant to 80.4% amikacin, 98% piperacillin/tazobactam, 92.2% cefepime, 100% ceftriaxone, 100% tetracycline, and 86.3% trimethoprim/sulfamethoxazole.[26]

Similarly, *Cetin et al* initiates that although the majority of separates were multidrug resistant (MDR),they were sensitive to gentamicin (53%) and imipenem (56%) and, and highly resilient to ampicillin-sulbactam (62.1%), piperacillin/tazobactam (94.8%), and ciprofloxacin (95.5%).[27]

Conclusion

Acinetobacter infection in ICU should be prevented by early recognition of *Acinetobacter* isolates,preventing transmission of this organism by Infection control procedures, Using of invasive devices should be minimized and strict aseptic techniques should be followed and effective antibiotic treatment of *Acinetobacter* infections.

Funding statement

None

Conflict of interests

The authors declare no conflict of interest.

Data availability

All data generated or analyzed during this study are included in this puplished article.

Authors' contribution

All authors made significant contributions to the work presented, including study design, data collection, analysis, and interpretation. They also contributed to the article's writing, revising, or critical evaluation, gave final approval for the version to be published.

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