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Original Research

Do Seasonal Changes and Climate Effect the Prevalence of Antibiotic Resistance of *Acinetobacter calcoaceticus-baumannii* Complex?

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Abstract

The high rate of carbapenem resistant *Acinetobacter calcoaceticus-baumannii* Complex (ABC) is indicated as a threat to public health. We aimed to determine the ABC isolated from Near East University hospital from 2016 to 2019 based on seasonality and climate changes. A total of 218 patients were examined between 2016 and 2019. All isolates were healthcare-acquired isolates, which are defined as those obtained after 48 hours of admission. All isolates were identified by a Phoenix 100 System. Antibiotic susceptibility analysis was reported based on EUCAST guidelines. Isolates were grouped according to seasons as follows: December through February as Quarter 1 (Q1); March through May as Quarter 2 (Q2); June through August as Quarter 3 (Q3); and September through November as Quarter 4 (Q4). Statistical analysis was performed with SPSS Ver 13.0 (SPSS Inc., Chicago, IL, ABD) program. There were significant differences between the number of patients with ABC infections according to years (p=0.000). The rate of carbapenem resistance of ABC was 86.2 % (n = 188). The resistance rates of the ABC isolates as well as carbapenem resistance peaked in October. The infection increased in the summer and decreased gradually in the autumn, winter and spring (p = 0.009). No significant difference was found between the carbapenem resistance of ABC infection and seasonality (p = 0.202). We have found that ABC infections and the carbapenem resistance of ABC increases in the summer months. However, more studies should focus on the epidemiological aspect of ABC infections.

Keywords: *Acinetobacter baumanii complex*, multi-drug resistance, sesaonality

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Introduction

Acinetobacter baumannii-calcoaceticus complex (ABC) is a major global health threat because of its ability to survive in different environments and also the increase level of antibiotic resistance [1, 2]. The Centers of Disease Control and Prevention (CDC) and the World Health Organization (WHO) has categorized multidrug resistant (MDR) *Acinetobacter* as dangerous pathogens [3, 4]. The details of the resistance patterns provide important insights into emerging pathogens besides being important for public health, infection control and antimicrobial stewardship approaches [5].

Seasonal and climate variations in the incidence of human infection can affect diagnosis and also give direction for infection prevention interventions [6, 7]. Gram negative bacteria in particular are identified as exhibiting seasonal trends in human infection. However, a limited number of studies have reported the effects of seasonality on hospital associated infections [8, 9, 10]. It has been reported that the prevalence of gram negative pathogens such as ABC might be increased during the warmer, summer months [11]. Additionally, some studies have indicated that the incidence peaks during winter but a lack of seasonality has also been indicated [12, 13]. As Hippocrates stated in Book II of the *Aphorisms*, 'Every disease occurs at any season of the year, but some of them occur more frequently and have greater severity at certain times'' [14, 15].

The objective of this study was to examine ABC isolated from Near East University hospital from 2016 to 2019 based on seasonality and climate changes.

Material and Methods

In this retrospective study, a total of 218 patients were received and examined between 2016 and 2019. When multiple isolates were detected in the same patient, only the first isolate obtained within a >2 days period was included in the study. All isolates were healthcare-acquired isolates, which are defined as those obtained after 48 hours of admission. Isolates were grouped according to specimen source (respiratory, skin, soft tissue, sputum, blood etc.). All isolates were identified by a Phoenix 100 System (Becton Dickinson, USA). Antibiotic susceptibility analysis was reported based on EUCAST guidelines. The antibiotics were grouped into classes: meropenem and imipenem (MEM/IPM) and gentamicin (GEN) as carbapenems; ciprofloxacin as fluoroquinolones; piperacillin-tazobactam (TZP) as antipseudomonal penicillins and trimethoprim/sulfamethoxazole (TMP-SXT).

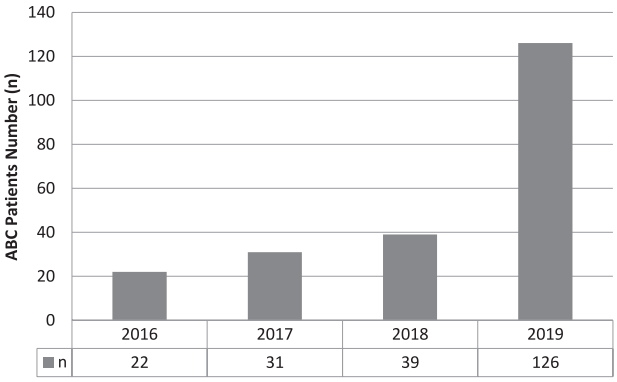

Fig. 1. Distrubition of the Abc infection according to years (p = 0.000).

Isolates were grouped according to seasons into four quarters as follows: December through February as Quarter 1 (Q1); March through May as Quarter 2 (Q2); June through August as Quarter 3 (Q3); and September through November as Quarter 4 (Q4). One sample T-test was performed to evaluate the significance of ABC incidence between seasons (Q1,Q2 ,Q3,Q4). The Independent-sample T test was used to compare the average of age and gender, while the Pearson Chi-square test was used to find the difference between age and gender.

Results and Discussion

We retrospectively analysed ABC isolates from 218 patients at Near East University Hospital, located in Nicosia, North Cyprus from 2016-2019. From the two hundred and eighteen (218) patients, 82 (37.6%) were female and 136 (62.4%) were male, and their ages varied between 17-96 (with a median of 66.6 years). When we compared the average age of the male and female patients, a statistically significant difference was observed (p = 0.002). Accordingly, it is seen that older women patients are more likely to contract the ABC infection than men. In Table 1, the age groups and the sexes of ABC reproduced patients are compared, and it can be observed ABC infections in women over 65 years of age were found to be significantly higher (p = 0.000).

Table 1. Evaluation of ABC patients in terms of age groups and gender.

	≤65 age	>65 age	Total	p
Male	72 (%52.9)	64 (%47.1)	136 (%100)	0.000
Female	23 (%28)	59 (%72)	82 (%100)	
Total	95 (%43.6)	123 (%56.4)	218 (%100)	

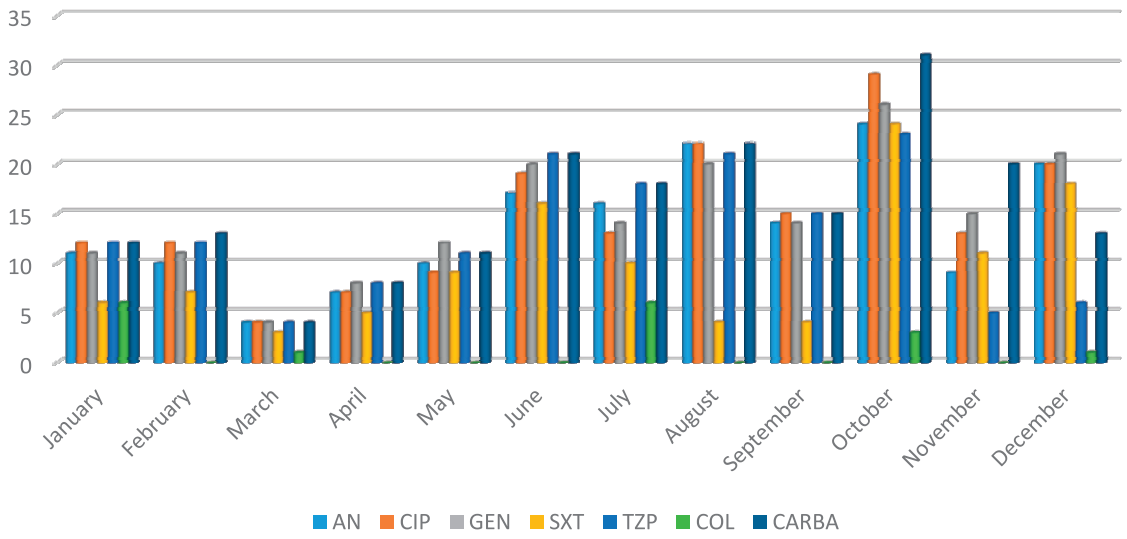

Fig. 2. The distrubition of the antibiotics of the Abc isolates according to months.

According to years, the ABC infection percentages were 10.1% in 2016, 14.2% in 2017, 17.9% in 2018 and 57.8% in 2019 (Fig. 1). There were significant differences between the number of patients with ABC infections according to years (p = 0.000). The sample types of the study yielded the following results: 41.3% (n = 90) in suction fluid, 25.7% (n = 56) in sputum, 15.1% (n = 33) in urine, 10.1% (n = 22) in blood, 0.9% (n = 2) in catheter tip and 6.9% (n = 15) in abscess-wound.

Among the ABC strains, the amikacin resistance was 78.8%, the ciprofloxacin resistance was 85%, the gentamicin resistance was 81.9%, the imipenem resistance was 85.1%, the meropenem resistance was 86.6%, the piperacillin-tazobactam resistance was 86.6% and the trimethoprim/sulfamethoxazole resistance was 61.3%. The rate of carbapenem resistance of ABC was 86.2 % (n = 188). Fig. 2 shows the distribution of antibiotic resistance of ABC isolates according to the months. The resistance rates of the ABC isolates as well as carbapenem resistance peaked in October.

According to seasonality, the ABC infection percentages were 22.9% (n = 50) in Q1, 14.2% (n = 31) in Q2, 32.1% (n = 70) in Q3 and 30.7% (n = 67) in Q4 (Table 2). Accordingly, it was noted that the infection increased in the summer and decreased gradually in the autumn, winter and spring (p = 0.009). Fig. 3 shows the distribution of carbapenem resistance of ABC according to seasonality. The monthly incidence of carbapenem resistance of ABC isolates peaked in the summer (32.4%). Also, no significant difference was found between the carbapenem resistance of ABC infection and seasonality (p = 0.202).

Acinetobacter species is a multidrug resistant microorganism that can be found in hospitals worldwide that causes nosocomial infections [16-18]. Therefore, the clinical significance of *A. baumannii* is mostly due to its ability to easily acquire resistance to different groups of antimicrobials [19]. The Infectious Diseases Society of America has included *A. baumannii* in its list of six highly resistant pathogens that are frequently resistant to licensed antimicrobials [20]. *A. baumannii* is intrinsically resistant to many antimicrobial agents due to its selective ability to prevent various molecules from penetrating the bacterial outer membrane [21]. The combined resistance to fluoroquinolones, aminoglycosides and carbapenems was the most frequently reported resistance phenotype for *Acinetobacter* spp. in 2015 [22]. In this study, the resistance of the ABC strains to amikacin, ciprofloxacin, gentamisin, imipenem and meropenem were 78.8%, 85%, 81.9%, 85.1% and 86.6%, retrospectively. In our study, the rates of resistance to the indicated antibiotics were consistent with the literature [23-25].

Seasonal variation was first described in *Acinetobacte*r spp in the 1970s [11]. However, two of the main studies on the seasonality of ABC (health care association infection) have been reported. Retaillau et al., who performed the first study in 1974-1977, indicated that health care association

Table 2. The distribution of the Abc infection according to seasonality.

Season	Spring (S2)			Summer (S3)			Autmn (S4)			Winter (S1)		
Month	March	April	May	June	July	August	Semptember	October	November	December	January	February
Abc (n)	6	11	14	22	23	25	18	34	15	24	12	14
Total	31 (%14.2)			70 (%32.1)			67 (%30.7)			50 (%22.9)		

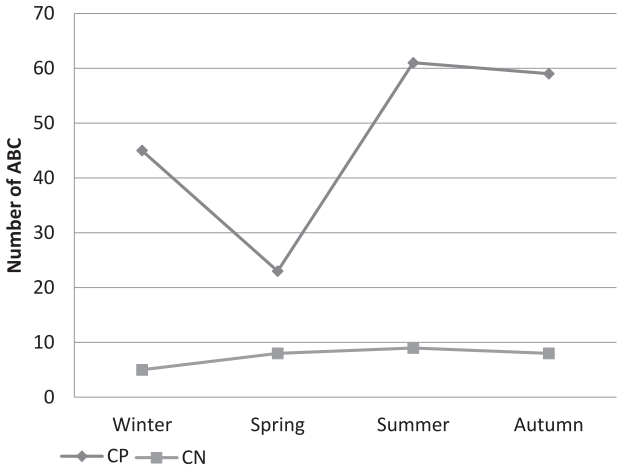

Fig. 3. Distrubition of the carbapenem resistance of the ABC strains according to seasonality.

infection increased during the summer months [26]. Also, Gales et al. reported that the highest number of *Acinetobacter* spp infections occurred during the summer [27]. In our study, the highest number of ABC infections were also observed during the summer. There have been many suggestions regarding why ABC infections were highest in the summer [7, 9, 28, 29].

Two studies have focused on the seasonal variation and antimicrobial resistance of ABC isolates. One of them indicated that non-MDR ABC isolates were identified in warm months [13]. The other study reported that they found a greater association with temperature for imipenem-resistant isolates than imipenem susceptible isolates of ABC [30]. In our study, we found that the carbapenem resistance of ABC isolates peaked in summer, which is consistent with the findings of Fukuta et al. [13]. Also, we found that the rate of antimicrobial resistance was the highest in November according to the months.

Conclusion

In conclusion, we have found that ABC infections and the carbapenem resistance of ABC increases in the summer months. In summer season, when temperatures rises, sweating increases in healthcare staff parallelly. Hence, colonization of bacteria in the skin is facilitated and thus it may cause an increase of ABC-related infections. In addition, we think that the increasing use of air conditions and ventilators in the summer months is one of the factors causing the increase of ABC-related pneumonia especially in intensive care units. However, more studies should focus on the epidemiological aspect of ABC infections.

Conflict of Interest

The authors declare no conflict of interest.

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