

Research Paper

The Predominant Microorganism During the COVID-19 Pandemic in the Toxicological Intensive Care Unit



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ABSTRACT

Background: Although many studies have investigated the prevalence of hospital infections during the COVID-19 pandemic, the results are still challenging.

Methods: In this routine data-based study, the medical records of 2213 poisoned patients admitted to the Toxicological Intensive Care Unit (TICU) of the Loghman Hakim Hospital from 2018 to 2022 were retrospectively reviewed. After the implementation of exclusion criteria, 220 patients were separated into the control and case groups. The information of the patients was extracted based on a preplanned form and analyzed with SPSS software, version 26.

Results: Unlike the pre-pandemic period, when *Staphylococcus aureus* was the predominant pathogen, during the pandemic period, the predominant pathogen in tracheal culture was *Acinetobacter* spp., which increased from 11.3% in the pre-pandemic period to 14.9% during the COVID-19 pandemic. Moreover, coagulase-negative staphylococci in blood culture and *Enterobacter* spp. in tracheal culture both significantly decreased during the COVID-19 pandemic ($P=0.035$ and $P=0.05$, respectively), while *Streptococcus viridans* in the tracheal culture and *Enterococcus* in the urine culture both significantly increased ($P=0.013$).

Conclusion: Although in the pre-pandemic period, *S. aureus* was usually the most common pathogen among poisoned patients in TICU, the predominant pathogen changed to *Acinetobacter* spp. during the COVID-19 pandemic period. Some hospital-acquired infections decreased and others increased in a different way between the two groups.

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1. Introduction

During any given outbreak of respiratory viruses, secondary bacterial and fungal infections were common causes of morbidity and overall mortality, but the impact of these secondary infections during the COVID-19 pandemic remains under study [1]. The change in lifestyle during the COVID-19 pandemic period, for example, arbitrary and excessive prescription of antibiotics, may increase the incidence of hospital-acquired infections (HAIs) during this period [2]. HAIs are one of the health care problems worldwide that brings a lot of expenses every year. Currently, at least 700,000 people die per year due to multidrug-resistant bacteria (MDR) infections, and the number could rise to 10 million by 2050 [3]. In recent years, many studies have been conducted on bacterial infections during the COVID-19 pandemic and the occurrence of MDR in hospital environments, but the results are still challenging [2, 4].

Previous studies have indicated that the predominant pathogen causing HAIs during the COVID-19 pandemic changed compared to the prepandemic period [5]. Besides, some studies have revealed that HAIs increased during the COVID-19 pandemic [4, 6]. This may be caused by various factors, such as the collapse of health systems, the recruitment of inexperienced healthcare providers who are not adequately trained in the control and prevention of hospital-acquired infections, self-medication and the indiscriminate prescription of antibiotics in hospitals, and the improper use of personal protective equipment (PPE) [4, 6]. On the other hand, some studies have indicated a decrease in multidrug-resistant organisms during the COVID-19 pandemic, which is probably due to the adoption and application of infection prevention and control (IPC) measures to control the spread of SARS-CoV-2 during the COVID-19 pandemic [7].

This study evaluated the possible change in the profile of pathogens causing HAIs and the predominant pathogen during the COVID-19 pandemic among patients admitted to the Toxicological Intensive Care Unit (TICU) at [Loghman Hakim Hospital](#). To the best of our knowledge, the reports and evidence about the incidence and changes of nosocomial infections and the dominant pathogen in the ICU of the poisoning department of [Loghman Hakim Hospital](#) during the COVID-19 pandemic are very limited.

2. Materials and Methods

Study design

This routine data-based study was conducted retrospectively by reviewing electronic medical records of all poisoned patients admitted to the TICU at [Loghman Hakim Hospital](#) in Tehran from March 21, 2018, to July 21, 2022. After the implementation of exclusion criteria, 1993 patients were excluded from the study. Of the 220 included patients, 119 patients who were admitted to the hospital before the COVID-19 pandemic declaration were assigned to the control group, and 101 patients who were admitted to the hospital after the COVID-19 pandemic declaration were assigned to the case group. In addition to demographic data, data on the results of the tracheal, urine, and blood cultures of patients were collected. All poisoned TICU patients whose duration of hospitalization was greater than or equal to five days were included in the study. Exclusion criteria included an incomplete medical record, infection symptoms on admission, and a hospitalization duration of fewer than five days.

Data analyses

Statistical analysis of the collected data was done using SPSS software, version 26. and appropriate statistical tests. The student's t-test and Chi-square test were used to compare quantitative and qualitative variables between the two groups, respectively. Quantitative variables were reported as Mean±SD and qualitative variables as percentages. The $P < 0.05$ were considered statistically significant.

3. Results

Demographic characteristics

In this study, the medical records of 220 patients were reviewed; 119 patients were in the control group, and 101 were in the case group. There was no significant difference in demographic information between the two groups ([Table 1](#)).

There was a marginally significant difference in favor of the control group in terms of positive tracheal culture ($P=0.055$) and positive blood cultures ($P=0.081$). On the other hand, there was a slight and statistically non-significant increase in positive urine cultures among poisoned patients hospitalized during the COVID-19 pandemic (26.1% versus 19%; $P=0.271$). Mechanical ventilation and duration of hospitalization were significantly higher in patients hospitalized during the COVID-19 pandemic ($P=0.008$ and $P=0.023$, respectively) ([Table 1](#)).

Table 1. Demographic characteristics of the case and control group

Variables	Mean±SD/No. (%)		P	
	Control (n=119)	Case (n=101)		
Age (y)	37.08±15.64	37.9±16.4	0.7	
Gender	Male	72(60.5)	55(54.5)	0.36
	Female	47(39.5)	46(45.5)	
Underlying disease	Yes	27(24.1)	25(24.8)	0.152
	No	58(51.8)	62(61.4)	
	Unknown	27(24.1)	14(13.9)	
Overall infection	Yes	63(76.8)	63(71.6)	0.44
	No	19(23.2)	25(28.4)	
T/C infection	Yes	57(85.1)	59(72.0)	0.055
	No	10(14.9)	23(28.0)	
B/C infection	Yes	16(20.0)	9(10.3)	0.081
	No	64(80.0)	78(89.7)	
U/C infection	Yes	15(19.0)	23(26.1)	0.271
	No	64(81.0)	65(73.9)	
Duration of hospitalization	8.9±8.57	12.3±12.54	0.023*	
Ventilation	Yes	98(82.4)	95(94.1)	0.008**
	No	21(17.6)	6(5.9)	
Outcome	Discharge	97(81.5)	73(72.3)	0.1
	Death	22(18.5)	28(27.7)	

Abbreviations: T/C: Tracheal culture; B/C: Blood culture; U/C: Urine culture.

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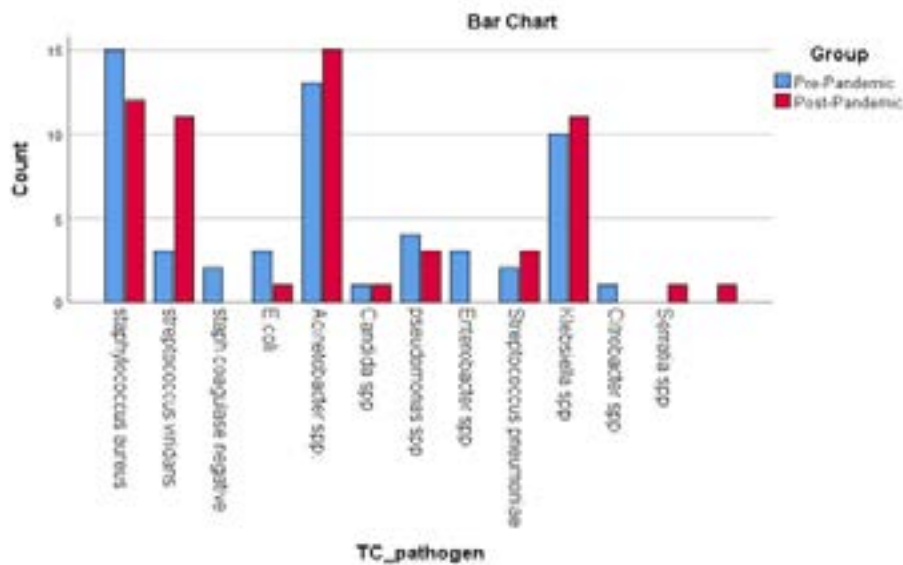
*P<0.05, **P<0.01.

Types of hospital-acquired infection and the predominant pathogen before and during the COVID-19 pandemic

The results showed that *S. aureus* in the pre COVID-19 pandemic (13%), and *Acinetobacter* spp. during the COVID-19 pandemic (14.9%) were the most common HAIs. Despite the overall decrease in HAIs, especially in tracheal and blood cultures, some pathogens increased during the COVID-19 pandemic and some pathogens plummeted during the COVID-19 pandemic (Table 2). Figures 1-3 depict the frequency of different pathogen-causing HAIs during the pre and in pandemic.

4. Discussion

Consistent with this study, previous studies have shown that in the pre-pandemic period, *S. aureus* was the most frequently isolated organism among patients admitted to the TICU at Lughman Hakim Hospital. Moreover, it was reported that *S. aureus* was predominant among drug and opioid abusers for their skin colonization [8]. However, some other studies have reported temporary episodes of *Acinetobacter baumannii* outbreaks (class 2 integron) in this hospital before the COVID-19 pandemic, which can be due to confounding factors, such

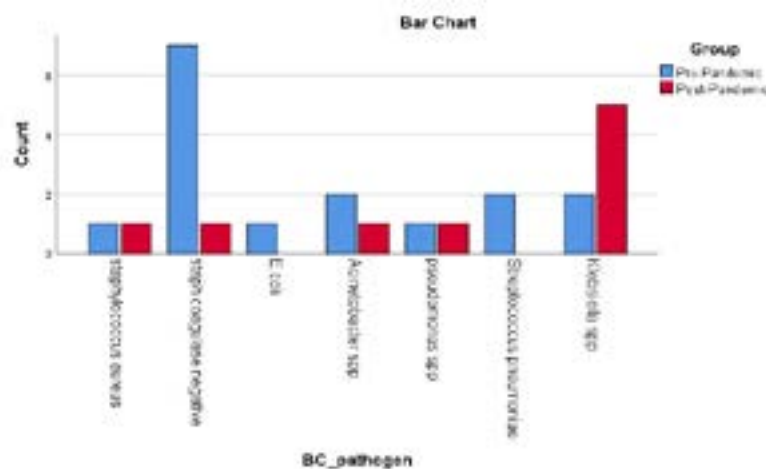


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Figure 1. Frequency of pathogens causing HAIs during the pre and postpandemic in tracheal culture

as environmental exposure or other resistance determinants, such as autolytic enzymes in the cell wall, plasmid, or chromosomal supervision control [9, 10]. During the COVID-19 pandemic period, the predominant pathogen was *Acinetobacter* spp., which was in line with the previous studies [11]. In one study, *A. baumannii* was found to be the most common Gram-negative bacteria isolated during the COVID-19 pandemic compared to the preCOVID-19 period [5]. In a review study, many instances of HAIs due to *A. baumannii* during the COVID-19 pandemic have been documented from different parts of the world, including Wuhan (China), France, Spain, Iran, Egypt, New York (United States of Amer-

ica), Italy, and Brazil [12]. The longer hospitalization periods of patients may have contributed to the shift of the predominant pathogen to *Acinetobacter* spp. during the COVID-19 pandemic. The duration of hospitalization is a risk factor related to outbreaks of *A. baumannii*. *A. baumannii* with high resistance rates was the primary cause of secondary bacterial infections in 102 of 1495 COVID-19 patients hospitalized in Wuhan. Nearly half of these patients passed away while receiving treatment [13]. *Acinetobacter* spp. is an opportunistic pathogen mainly associated with nosocomial infections. Opportunistic pathogens, especially in combination with viral respiratory tract infections, can cause secondary infections



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Figure 2. Frequency of pathogens causing HAIs during the pre and postpandemic in blood culture

Table 2. Frequency of HAIs during the pre and postpandemic

Pathogens	Positive Culture	No. (%)		P
		Control	Case	
<i>S. aureus</i>	T/C	15(13.0)	12(11.9)	0.8
	B/C	1(0.9)	1(1.0)	
	U/C	0(0.0)	1(1.0)	
<i>S. viridans</i>	T/C	3(2.6)	11(10.9)	0.013*
	B/C	-	-	
	U/C	-	-	
Coagulase-negative staphylococci	T/C	2(1.7)	0(0.0)	0.035*
	B/C	7(6.1)	1(1.0)	
	U/C	1(0.9)	0(0.0)	
<i>Escherichia coli</i>	T/C	3(2.6)	1(1.0)	0.42
	B/C	1(0.9)	0(0.0)	
	U/C	6(5.2)	8(7.9)	
<i>Acinetobacter spp.</i>	T/C	13(11.3)	15(14.9)	0.422
	B/C	2(1.7)	1(1.0)	
	U/C	3(2.6)	1(1.0)	
<i>Candida spp.</i>	T/C	1(0.9)	1(1.0)	0.379
	B/C	-	-	
	U/C	1(0.9)	1(1.0)	
<i>Pseudomonas spp.</i>	T/C	4(3.5)	3(3.0)	0.05*
	B/C	1(0.9)	1(1.0)	
	U/C	0(0.0)	2(2.0)	
<i>Enterobacter spp.</i>	T/C	3(2.6)	0(0.0)	0.54
	B/C	-	-	
	U/C	-	-	
<i>Streptococcus pneumoniae</i>	T/C	2(1.7)	3(3.0)	0.57
	B/C	2(1.7)	0(0.0)	
	U/C	-	-	
<i>Klebsiella spp.</i>	T/C	10(8.7)	11(10.9)	0.18
	B/C	2(1.7)	5(5.0)	
	U/C	4(3.5)	6(5.9)	

Pathogens	Positive Culture	No. (%)		P
		Control	Case	
<i>Citrobacter</i> spp.	T/C	1(0.9)	0(0.0)	0.013*
	B/C	-	-	
	U/C	-	-	
<i>Serratia</i> spp.	T/C	0(0.0)	1(1.0)	
	B/C	-	-	
	U/C	-	-	
<i>Enterococcus</i>	T/C	-	-	
	B/C	-	-	
	U/C	0(0.0)	4(4.0)	

Abbreviations: T/C: Tracheal culture; B/C: Blood culture; U/C: Urine culture.

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*P<0.05, **P<0.01.

in hospitalized patients [14]. Moreover, the *Acinetobacter* species, which belongs to the ESKAPE group, with its ability to effectively escape antibiotic treatment, affects most of the patients hospitalized in the ICU who also have immune system defects [15]. *A baumannii* has been linked to bloodstream- and ventilator-associated infections in critically ill patients [16].

Among different pathogens, *Enterobacter* spp. in the tracheal culture and coagulase-negative staphylococci in the blood culture decreased significantly in the postCOVID-19 pandemic. Previous studies have also reported

the decline of these pathogens during the COVID-19 pandemic [17]. In a multicenter ecological analysis, during the period of quarantine and social distancing, *Enterobacteriales* spp. significantly reduced in blood samples [18]. A significant reduction in coagulase-negative staphylococci infections was also reported in another study, which reported a reduction in the number of infections caused by this pathogen from 93 cases in the pre-COVID-19 pandemic to 60 cases during the COVID-19 pandemic [17].

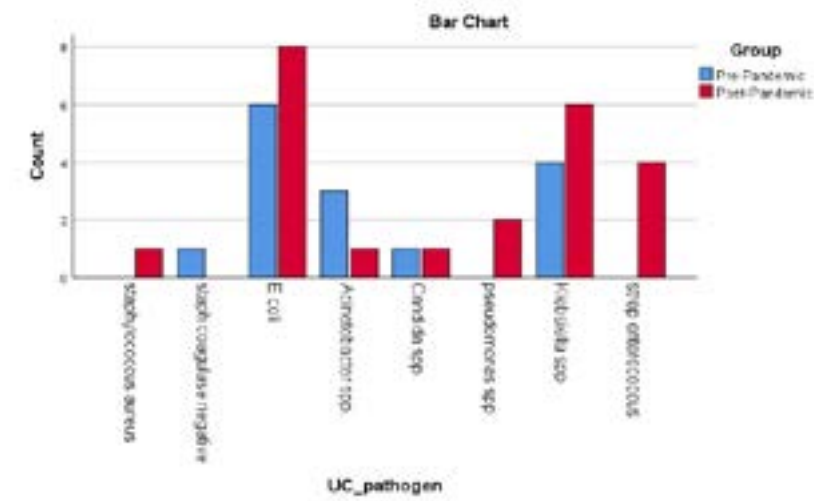


Figure 3. Frequency of pathogens causing HAIs during the pre and postpandemic in urine culture

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Conversely, the number of some pathogens increased significantly during the COVID-19 pandemic, including *S. viridans* and *Enterococcus*. *S. viridans* can cause infections, especially in immunocompromised patients [19]. The high prevalence of HAIs caused by *S. viridans* during the COVID-19 pandemic was also reported in other studies [20]. Furthermore, *S. viridans* is a causative agent of community-acquired respiratory tract infection [21]. Considering the high prevalence of respiratory tract disease during the COVID-19 pandemic [22], the observed increase in *S. viridans* incidence may be due to the high rate of community-acquired respiratory tract infection during this period. Previous studies have shown that the rate of co-infection with *Enterococcal* spp. among patients with COVID-19 is significantly high in the bloodstream [23]. However, the increase in urinary tract infections caused by *Enterococci* has also been described in other works [24]. It seems that over-prescription of broad-spectrum antibiotics, such as B-lactams, especially ceftriaxone, may alter the microbiota by selecting less common microorganisms, such as *Enterococcus* [25]. The present study had several limitations. Because this study was retrospective, it was impossible to obtain several important data. But since the COVID-19 pandemic is over, it is possible to reach a decisive conclusion in this regard by conducting systematic review and meta-analysis studies.

5. Conclusion

In this study, it was observed that during the COVID-19 pandemic, the profile of pathogens causing hospital-acquired infection changed. Despite the fact that in the preCOVID-19 pandemic period, *S. aureus* was usually the most common pathogen among poisoned patients in TICU, the predominant pathogen changed to *Acinetobacter* spp. during the COVID-19 pandemic period. In addition, some hospital-acquired infections decreased and others increased in a different way between the two groups. More research is required to ascertain whether these changes were caused by improved adherence to health guidelines, a change in the pattern of antibiotic prescriptions, or a change in the length of hospitalization.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the Shahid Beheshti University of Medical Sciences (Code: IR.SBMU.RETECH.REC.1401.258).

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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