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Original Article

Evaluation of hospital acquired infections in intensive care unit

Yoğun bakımda gelişen hastane enfeksiyonlarının incelenmesi

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ABSTRACT

Aim: Hospital acquired infections are a serious problem in inpatients in terms of mortality and cost. The aim of this study is to present hospital acquired infections and risk factors, causative pathogens, antibiotic resistance status, and mortality relationship in a public hospital intensive care unit (ICU) over the scope of 5-years.
Methods: Hospital acquired infections developed between January 2016 and December 2020 in Bolu İzzet Baysal State Hospital Adult ICUs were investigated retrospectively. Samples taken from areas such as central venous catheter, deep tracheal aspirate, urinary catheter and wound area were studied. Hospital acquired infections was diagnosed based on Centers for Disease and Control (CDC) criteria.
Results: A total of 3587 patients were admitted to the ICUs between January 2016 and December 2020, and 309 (8.6%) patients were diagnosed with hospital acquired infections. When considered as comorbidity, neurological disorders were the most common, while sepsis was the most common hospitalization diagnosis in patients with hospital infection. The most common hospital acquired infections was ventilator associated pneumonia (VAP) with 38.8% (n=120) of the patients. Examining the culture isolate results, the most isolated agent as hospital acquired infections was Acinetobacter spp. (32.6%, n=101). Acinetobacter spp. and Klebsiella spp. It was resistant to all antibiotics with 4.9%.
Conclusion: Hospital acquired infections rates may vary in intensive care units due to reasons such as awareness, physical conditions, education of working personnel, etc. Knowing the risk factors well, early culture isolate monitoring in suspected cases and selecting the appropriate antibiotic are effective in patient treatment and may reduce mortality.

Keywords: Acinetobacter spp, hospital acquired infections, intensive care unit, multi drug resistance, ventilator-associated pneumonia

ÖZ

Amaç: Hastane enfeksiyonları yatan hastalarda mortalite ve maliyet açısından ciddi bir sorundur. Bu çalışmamızın amacı, bir devlet hastanesi yoğun bakım ünitesinde (YBÜ) 5 yıllık hastane enfeksiyonları ve risk faktörlerini, etken patojenleri, antibiyotik direnç durumlarını ve mortalite ilişkisini sunmaktır.
Yöntem: Bolu İzzet Baysal Devlet Hastanesi Yetişkin YBÜ'lerinde Ocak 2016 ile Aralık 2020 arasında gelişen Hastane enfeksiyonları retrospektif olarak araştırıldı. Santral venöz kateter, derin trakeal aspirat, üriner kateter ve yara yeri gibi alanlardan alınan örnekler çalışıldı. Centers for Disease and Control-CDC kriterleri esas alınarak hastane enfeksiyonu tanısı konuldu.
Bulgular: Ocak 2016 ile Aralık 2020 yılları arasında YBÜ'lerine toplam 3587 hasta yatmış olup, 309 (8,6 %) hastaya hastane enfeksiyonu tanısı konuldu. Komorbidite olarak bakıldığında en sık nörolojik bozukluklar görülürken, hastane enfeksiyonu gelişen hastalardaki en sık yatış tanısı sepsisti. Hastaların 38,8%'inde (n=120) Ventilator Associated Pneumonia(VAP) ile en sık hastane enfeksiyonu idi. Kültür izolat sonuçlarına bakıldığında, hastane enfeksiyonu olarak en sık izole edilen ajan Acinetobacter spp. (32,6%, n=101)'dı. Acinetobacter spp. ve Klebsiella spp. 4.9% ile tüm antibiyotiklere dirençliydi.
Sonuç: Yoğun bakımlarda farkındalık, fiziki şartlar, çalışan personelin eğitimi durumu vb. sebeplerden dolayı hastane enfeksiyonu oranları farklı çıkabilmektedir. Risk faktörlerinin iyi bilinmesi, şüphelenildiği durumlarda erken kültür izolat takibi ve uygun antibiyotik seçimi hastaların tedavisinde etkili olup, mortalitenin azalmasında etkili olabilir.

Anahtar kelimeler: Hastane enfeksiyonu, Yoğun bakım ünitesi, çoklu ilaç direnci, Acinetobacter spp, ventilatör ilişkili pnömoni

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INTRODUCTION

Hospital acquired infections (HAIs), which are "health-related infections" according to the World Health Organization, are one of the most common issues faced by hospitalized patients (1). HAI, which is one of the major cause of increased mortality, treatment difficulties, and high costs, are most commonly observed in intensive care units (ICUs) (2). A long hospital stay, severe clinical picture, presence of comorbid diseases, invasive tools, such as intubation tubes, venous catheters, urinary catheters in ICU patients, and failure to comply with adequate asepsis–antisepsis rules increase the susceptibility to infection (3). Resistant pathogens develop due to the inappropriate use of antibiotics in the ICU. Surveillance studies can assist in appropriate empirical treatment by recognizing sensitive and resistant pathogens (4).

In this study, we aimed to present the relationship among HAI and risk factors, causative pathogens, antibiotic resistance status, and mortality in a public hospital ICU over a period of 5 years.

METHODS

Bolu Abant İzzet Baysal University Clinical Research Ethics Committee approval (No: 2021/253, 09.11.2021) was obtained, and HAIs developed between January 2016 and December 2020 in Bolu İzzet Baysal State Hospital Adult ICUs were investigated retrospectively.

Infectious disease doctors, infection control nurses, and clinical microbiology doctors performed the surveillance studies. Culture isolation was regularly performed on patients with a fever of 38.2°C and above with samples of blood, central venous catheter, deep tracheal aspirate, and urinary catheter and from areas, such as the wound area and nose, if suspected. Additionally, culture samples from these areas were collected during fever-free periods in cases such as the patient's hemodinamia, antibiotic response status, and increase in inflammatory biomarkers. Nosocomial infections were diagnosed based on the Centers for Disease Control and Prevention criteria (5).

The number of patients, number of sick days, number of hospital infections, hospital infection rates, catheter-related urinary system infection rates, ventilator-related pneumonia rates, catheter-related blood circulation rates, microorganisms isolated from cultures, antibiotic resistance status, and clinically related inflammatory biomarkers were recorded by the infection control nurse.

All data were analyzed using SPSS 22.0. Frequency, percentage, and binary variables were calculated using the chi-square formula via this program.

RESULTS

A total of 3,587 patients were admitted to the ICU between January 2016 and December 2020; 48.8% (n=1,751) of these patients were female, and the mean age was 71.6±16.1 years. Based on the blood and culture samples obtained in this study, 309 patients were diagnosed with HAI based on the Centers for Disease Control (CDC) criteria, and the prevalence of HAI was found to be 8.6%. The mean age of the 309 patients diagnosed with HAI was 72.7±19.3 years. The mortality rate of patients with HAI was 64.4%, while that of patients not diagnosed with HAI was 41.9%. Of the 309 patients diagnosed with HAI, 48.5% (n=150) were female, and of the 3,278 patients not diagnosed with HAI (Table 1).

Table1. Demographic and clinical characteristics of the study.

	Overall n %	HAI (+) n %	HAI (-) n %	P value
Mortality	1575 (43.9)	199 (64.4)	1376(41.9)	<0.05
Sex				
Female	1751	150 (48.5%	1601 (48.8)	>0.05
Male	1836	159 (51.5)	1677 (51.2)	

HAI: Hospital acquired infection

On examining the patients diagnosed with HAI, it was found that the most common comorbidities were previous cerebrovascular events; neurological disorders, including Alzheimer's disease and parkinsonism (35.2%, n=109); hypertension (32.6%, n=101); chronic obstructive pulmonary disease (COPD) (20.7%, n=64); and diabetes mellitus (19.7%, n=61). Considering the diagnoses of ICU admission, sepsis (31.7%, n=98), stroke (39.4, n=91) and COPD exacerbation (12.6%, n=39) were the most common admission diagnoses (Table 2).

Table 2. Demographic and clinical characteristics of the study.

Comorbidity	**n**	**%**
Diabetes mellitus	61	19.7
Hypertension	101	32.6
Cardiac Disorder	36	11.6
Neurologic Disorder	109	35.2
Cancer	19	6.1
Chronic renal failure	29	9.3
COPD	64	20.7
Diagnosis	**n**	**%**
Sepsis	98	31.7
Stroke	91	29.4
Pulmonary thrombo-embolism	10	3.2
Acute kidney injury	9	2.9
COPD exacerbation	39	12.6
Trauma	23	7.4
Other	39	12.6

COPD: chronic obstructive pulmonary disease.

A total of 38.8% (n=120) patients developed ventilator-associated pneumonia (VAP), 22% (n=68) developed central line-associated bloodstream infection (CLABSI), 20.7% (n=64) developed catheter-associated urinary tract infection (CAUTI), 11.9% (n=37) developed bloodstream infection (BSI), and 6.4% (n=20) developed surgical site infection and pressure wounds. Examination of the culture isolate results revealed the growth of *Acinetobacter spp.* (32.6%, n=101); *Pseudomonas spp.* (22.3%, n=69); *Escherichia coli* (14.8%, n=46); *Klebsiella spp.* (14.5%, n=45); *Enterococcus spp.* (8.4%, n=26); coagulase-negative staphylococci (CoNS) (1.6%, n=5); and *Haemophilus Influenzae, Staphylococcus aureus,* and *Proteus spp.* (5.5%, n=17) (Table 3).

Upon examination of the antibiotic resistance profile of patients with HAI, it was found that 4.9%, 5.9%, and 95% of the *Acinetobacter spp.* strains were resistant to all antibiotics, colistin, and

Table 3. The infection sites and pathogens isolated in HAI.

Bacteria	**BSI (n)**	**CLABSI (n)**	**CAUTI (n)**	**VAP (n)**	**Other (n)**	**Overall (n, %)**
Acinetobacter spp.	10	16	9	63	3	101 (32,6)
Pseudomonas spp.	6	15	11	34	3	69 (22,3)
Klebsiella spp.	9	12	12	9	3	45 (14,5)
E. Coli	1	8	20	8	9	46 (14,8)
Enterococcus spp.	6	10	10	-	-	26 (8,4)
CoNS	4	1	-	-	-	5 (1,6)
Other	1	6	2	6	2	17 (5,5)
Overall (n, %)	37 (11,9)	68 (22)	64 (20,7)	120 (38,8)	20 (6,4)	309 (100)

CoNS: Coagulase-negative staphylococci, BSI: Blood Stream Infection, CLABSI: Central Line-Associated Blood Stream Infection, CAUTI: Catheter-Associated Urinary tract Infection, VAP: Ventilator Associated Pneumonia.

Table 4. Resistance profile of frequently isolated bacteria.

	Acinetobacter spp. **(%)**	***Pseudomonas spp.*** **(%)**	***Klebsiella spp.*** **(%)**	***E. Coli*** **(%)**	***Enterococcus spp.*** **(%)**
Ampicilin-sulbaktam	100	100	95.8	89.7	71.8
Ceftriaxone	100	89.8	82	76	80
Piperacillin-Tazobactam	100	33.8	75.5	44	77.7
Meropenem	95	40.6	32	7.3	28
Colistin	5.9	1.4	16.2	-	-
Vancomycin/Linezolid	-	-	-	-	0/0
Pan-resistant	4,9	1.4	4.9	-	-

meropenem, respectively. Of the *Pseudomonas spp*. Strains, 1.4%, 33.8%, 40.6%, and 1.4% were resistant to all antibiotics, piperacillin-tazobactam, meropenem, and colistin, respectively. Of the *Klebsiella spp.* strains, 4.9%, 75.5%, 32%, and 16.2% were resistant to all antibiotics, piperacillin-tazobactam, meropenem, and colistin. Of the *E. Coli* strains, 44% and 7.3% were resistant to piperacillin-tazobactam and meropenem. Of the *Enterococcus ssp.* strains, 77.7% and 28% were found to be resistant to piperacillin-tazobactam and meropenem, respectively (Table 4).

DISCUSSION

The main purpose of our study was to obtain detailed information on the epidemiology of HAI in ICUs. We aimed to explain the predisposition status of patients affected by HAIs and to identify the causes of mortality. Although the discovery of antibiotics and their increased use in the following period play an important role in the treatment of patients with low immunity and increased comorbidities, HAI remains one of the most important determinants of mortality in ICUs (4). This was consistent with the findings of our study in which the mortality of patients with HAI was found to be high.

Suetens et al.[6] found that the prevalence of HAIs in ICUs was 19.2%. Investigating the antibiotic resistance profile of ICU patients in our country, Cetin et al.[3] found that the prevalence of ICU hospital infection was 13.67%. In our study, the prevalence of hospital infection was found to be 8.6% in the two general ICUs and anesthesia ICUs.

Cetin et al.[3] diagnosed 19.6% of intensive care patients with HAIs as having ventilator-associated pneumonia, 43.2% with urinary catheter-associated urinary system infection, 29.1% with bloodstream infection, 6.9% with central venous catheter-associated bloodstream infection, and 1.2% with nosocomial pneumonia. Choudhuri et al.[7] monitored hospital infections, diagnosed pneumonia (33%), urinary system infections (31%), and blood circulation infections (11%) in their retrospective study. Ganesan et al.[8] detected ventilator-related infections with 10.5 in 1000 device days, urinary catheter-related infection with 0.97, and central venous catheter-related catheter infection with 0.43 in their study investigating device-related hospital infections. In a surveillance study conducted in the ICU and palliative care center, Taş et al.[9] diagnosed 54.35% of patients with urinary system infection, 38.04% with blood circulation infection, and 2.18% with ventilator-associated pneumonia. In our study, 38.8%, 22%, 20.7%, 11.9%, and 6.4% of patients developed VAP, CLABSI, CAUTI, BSI, and infections, respectively.

Wang et al.[10] investigated respiratory ICU hospital infections and detected *Staphylococcus aureus* in 20.9% of patients with reproduction, *Klebsiella pneumonia* in 16.4%, and *Candida albicans* in 8.5%. In their study on epidemiological and clinical risk factors related to infections and drug resistance in ICU, 31% of the bacteria were identified to be *Acinetobacter baumannii*, 30% were *Enterobactericeae species*, 24% were Staphylococci, and 10% were *Pseudomonas aeruginosa* (11). Balın et al.[12] evaluated hospital infections in the ICU and found *Acinetobacter spp.* as the causative agent in 29.9%, *Pseudomonas aeruginosa* in 19.69%, CoNS in 13.38%, and *Candida spp.* in 5.51% cases. Duszynska et al.[13] investigated device-related ICU infections and isolated *Acinetobacter baumannii* in VAP and CA-UTIs, and methicillin-resistant *Staphylococcus epidermidis* in CLA-BSI as the most common agents. Scamardo et al.[14], in their study on neonatal ICU, found that 28% of the patients who developed VAP had *Pseudomonas aeruginosa* and 20% had *Stenotrophomonas maltophilia* and CoNS agents, 22% of the patients who developed CLA-BSI had CoNS, and 19% had *Candida Parapsilosis* agents; they could not isolate the agent in 18% of the patients. On examining the culture isolate results of our study, it was found that the most common strain was *Acinetobacter spp.* (32.6%), followed by *Pseudomonas spp.*

(22.3%), *Escherichia coli* (14.8%), *Klebsiella spp.* (14.5%), *Enterococcus spp.* (8.4%), CoNS (1.6%), and *Haemophilus Influenzae, Staphylococcus aureus, and Proteus spp.* (5.5%).

El Mekes et al.[11], in their study investigating multidrug resistant (MDR) bacteria, found that the MDR bacteria detection status was 42%, and the most common resistance rate was 70% in imipenem-resistant *A. baumannii*. In the same study, extended spectrum β-lactamase (ESBL)-producing *Enterobacteriaceae*, ceftazidime resistant *P. aeruginosa*, and MRSA were other resistant bacterial strains. In their studies conducted in the pediatric ICU, Wang et al.[15] isolated carbapenem-resistant *A. Baumannii*, MRSA, pandrug-resistant *P. Aeruginosa*, VRE, and carbapenem-resistant *Enterobactericeae* strains as MDR bacteria. Mekonnen et al.[16] investigated the resistance profiles of *Acinetobacter* and *P. aeruginosa* and found MDR rates of *Acinetobacter* spp. and *P. aeruginosa* as 81% and 83% respectively. Poletajew et al.[17] investigated MDR cases in a tertiary hospital and identified ESBL-producing *Klebsiella spp. E. Coli*, and *Enterobacter spp.*, followed by MRSA, VRE, and Metallo-beta-lactamase-producing *Klebsiella spp.* Lin et al.[18] investigated MDR bacterial infections in patients who underwent abdominal surgery and isolated *E. Coli* as the most common gram-negative bacteria (45.1%). Colot et al.[19] conducted research on MDR control and isolated VRE and CRE as the most common agents. Ceylan et al.[20] investigated the antibiotic resistance status of *A. Baumanni* strains and found 100%, 100%, 100%, and 1.4% resistance to meropenem, piperacillin-tazobactam, ceftriaxone, and colistin, respectively. Uğur et al.[21] investigated the resistance profile of *Acinetobacter baumannii* and *Pseudomonas aeruginosa* strains, and *Acinetobacter baumannii* was 96%, 99%, 79%, and 0.5% resistant to imipenem and meropenem, piperacillin-tazobactam, amikacin resistance, and colistin, respectively. Further, *Pseudomonas aeruginosa* was 40%, 53%, and 5% resistant to meropenem, piperacillin-tazobactam, and colistin, respectively. Koçak et al.[22] investigated carbapenem-resistant *Klebsiella pneumoniae* isolates and found that the colistin resistance of these strains was 39.5%.

In our study, we found the colistin resistance of *Acinetobacter spp., Pseudomonas spp.,* and *Klebsiella spp.* to be 5.9%, 1.4%, and 16.2%, respectively, and a significant proportion of these strains were also resistant to all antibiotics whose antibiograms were studied. While all *Acinetobacter spp.* were resistant to piperacillin-tazobactam and 95% were resistant to meropenem, we found that the piperacillin-tazobactam resistance of *Pseudomonas spp.* was 33.8%, meropenem resistance was 40.6%, while the piperacillin-tazobactam resistance of *Klebsiella* was 75.5%. In our study, looking at the resistance of *Enterococcus spp.* to vancomycin and linezolid, it can be concluded that all strains were sensitive to these two antibiotics.

As a result, device-related HAI rates, device-related and other HAI agents, and antibiotic resistance profiles are different as reported in the literature. This situation can be influenced by many factors, such as the physical characteristics of the ICU, the type of patient followed, personnel education, and HAI awareness. In addition to the importance of understanding this situation globally, we believe that knowing the causative agents and resistance profiles of each hospital can be useful for empirical antibiotic selection. We believe that we were successful in presenting our hospital's 5-year HAI profile and that our study has the potential to significantly contribute to literature.

Ethics Committee Approval: The study protocol was approved by the Bolu Abant İzzet Baysal University Clinical Research Ethics Committee (09.11.2021 / 2021/253).

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