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ORIGINAL RESEARCH

Prevalence of Infectious Diseases and the Assessment of Antibiotic Use in the Anesthesia Intensive Care Unit*

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ABSTRACT

Infections remain a major cause of morbidity and mortality in intensive care units. In this retrospective study, conducted to determine the prevalence of infections and resistance patterns in intensive care patients and to highlight the prognostic value of biomarkers and disease severity scores, 195 patients with suspected or confirmed infections admitted to the Anesthesia ICU of XXXXX Hospital between March 2020 and March 2021 were evaluated. Demographic data, infection foci, microbiological findings, biomarkers (WBC, CRP, PCT), and disease severity scores (APACHE II, SAPS II, SOFA) were analyzed. The infection prevalence was 60.6%, and ICU mortality was 49.7%. The median age was 67 years (IQR: 56–77), and 61% were male. Age, sex, and BMI were not associated with mortality. Non-survivors had significantly higher severity scores (APACHE II: 28.6 vs. 18.1; SAPS II: 63.2 vs. 41.2; SOFA: 10.8 vs. 6.4; all p<0.001). Common comorbidities included cardiovascular disease (69.2%), diabetes (21.0%), and chronic respiratory disease (19.5%). Respiratory (36.0%), intra-abdominal (18.0%), and bloodstream infections (17.4%) were most common. Tracheal aspirates were the most frequent culture-positive samples (35.3%). *K. pneumoniae*, *A. baumannii*, and *E. coli* were the predominant pathogens. Antimicrobial resistance was found in 56.0% of culture-positive cases, without a significant mortality association (p=0.118). Empirical antimicrobial therapy was initiated in 87.7% of patients. By the 72nd hour of treatment, significant reductions were observed in PCT (1.4→0.9 ng/mL, p<0.001) and WBC (15.3→12.4×10³/µL, p<0.001) levels, while the change in CRP was not statistically significant (p=0.181). In the mortality group, initial CRP (111.0 vs. 78.5 mg/L, p=0.032) and PCT (2.4 vs. 1.0 ng/mL, p=0.034) levels were higher, whereas WBC did not differ significantly (p=0.787). Our findings suggest that severity scores and biomarker changes have prognostic value in infected critically ill patients, and integrating host response with microbiological data may aid clinical management.

Keywords: Intensive care infections. Antimicrobial resistance. Biomarkers. Empirical antibiotics. Mortality.

Anestezi Yoğun Bakım Ünitesinde Enfeksiyöz Hastalıkların Prevalansı ve Antibiyotik Kullanımının Değerlendirilmesi

ÖZET

Enfeksiyonlar, yoğun bakım ünitelerinde morbidite ve mortalitenin başlıca nedenlerindendir. Yoğun bakım hastalarında enfeksiyonların yaygınlığını ve direnç paternlerini ortaya çıkararak, biyobelirteçler ile hastalık şiddeti skorlarının prognozdaki önemini vurgulamayı amaçladığımız bu retrospektif çalışmada; Mart 2020–Mart 2021 tarihleri arasında XXXXX Hastanesi Anestezi YBÜ'nde şüpheli veya doğrulanmış enfeksiyon tanısı ile izlenen 195 hasta değerlendirildi. Demografik veriler, enfeksiyon odakları, mikrobiyolojik bulgular, biyobelirteçler (WBC, CRP, PCT) ve hastalık şiddeti skorları (APACHE II, SAPS II, SOFA) analiz edildi. Enfeksiyon prevalansı %60,6; mortalite oranı %49,7 olarak bulundu. Medyan yaş 67,0 yıl (IQR: 56,0-77,0) olup hastaların %61,0'ı erkekti. Yaş, cinsiyet ve vücut kitle indeksi mortalite ile ilişkili bulunmadı. Mortalite grubunda APACHE II (28,6 vs. 18,1), SAPS II (63,2 vs. 41,2) ve SOFA (10,8 vs. 6,4) skorları anlamlı olarak daha yüksekti (tüm skorlar için p <0,001). Kardiyovasküler hastalıklar (%69,2), diyabet (%21,0) ve kronik solunum yolu hastalıkları (%19,5) en yaygın komorbiditelerdi. En yaygın enfeksiyon odakları solunum sistemi (%36,0), intraabdominal (%18,0) ve kan dolaşım sistemi (%17,4) olarak belirlendi. Toplam 133 kültür pozitif örnek arasında en sık üreme, (n=47, %35,3) trakeal aspirat kültürlerinde saptandı. İzole edilen patojenler arasında en sık *K. pneumoniae*, *A. baumannii* ve *E. coli* görüldü. Kültür pozitif vakaların %56,0'sında antimikrobiyal direnç mevcut olup, mortaliteyle istatistiksel olarak ilişkilendirilmedi (p=0,118). Hastaların %87,7'sine ampirik antimikrobiyal tedavi başlandı. Antimikrobiyal tedavinin 72. saatinde PCT (1,4→0.9 ng/mL, p<0,001) ve WBC (15,3→12,4 ×10³/µL, p<0,001) düzeylerinde anlamlı düşüş izlenirken, CRP değişimi anlamlı değildi (p=0,181). Mortalite grubunda başlangıç CRP (111,0 vs. 78,5 mg/L, p=0,032) ve PCT (2,4 vs. 1,0 ng/mL p=0,034) düzeyleri daha yüksekken, WBC de anlamlı fark saptanmadı (p=0,787). Bulgularımız, enfeksiyonu olan kritik hastalarda hastalık şiddeti skorları ve biyobelirteç değişimlerinin prognostik değerini ortaya koymakta; konak yanıtı ile mikrobiyolojik verilerin birlikte değerlendirilmesi, hasta yönetimini kolaylaştırabilir.

Anahtar Kelimeler: Yoğun bakım enfeksiyonları. Antimikrobiyal direnç. Biyobelirteçler. Ampirik antibiyotikler. Mortalite.

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Intensive care units (ICUs) are among the hospital settings where infectious diseases are most prevalent and associated with high mortality. ICU patients are at increased risk for infections due to comorbidities, prolonged hospitalization, and invasive procedures. The EPIC III study demonstrated that 54% of ICU patients had suspected or confirmed infections, with a mortality rate of 30%[1].

Understanding ICU infection epidemiology, risk factors, and resistance patterns is critical for reducing mortality and improving infection control. Depending on patient populations and local practices, infection rates and resistance profiles vary widely between centers. The increasing prevalence of multidrug-resistant (MDR), extensively drug-resistant (XDR), and pandrug-resistant (PDR) organisms further complicates management and highlights the need for ongoing surveillance and robust local data[2].

Early diagnosis and timely, appropriate empirical antimicrobial therapy are essential for improving outcomes in critically ill patients, as delays or inappropriate regimens can significantly increase morbidity, mortality, and healthcare costs[3]. Biomarkers such as C-reactive protein (CRP), procalcitonin (PCT), and white blood cell (WBC) count are increasingly used to support diagnosis, prognostication, and guidance of therapy[4]. In addition, the severity of illness is routinely assessed in ICU practice using scoring systems such as Acute Physiology and Chronic Health Evaluation II (APACHE II), Simplified Acute Physiology Score II (SAPS II), and Sequential (or Sepsis-related) Organ Failure Assessment (SOFA), which play an important role in predicting patient prognosis[1]. Although microbiological cultures are considered the gold standard, they frequently fail to confirm infection; therefore, empirical treatment remains the cornerstone of initial ICU management. However, inappropriate empirical therapy is common due to underlying bacterial resistance, leading to suboptimal outcomes and increased healthcare costs[5,6].

In this study, we aimed to describe the prevalence of infections among critically ill patients, identify the microbiological characteristics and resistance patterns observed, and examine how infection-related biomarkers and severity scores relate to infection status. The results are intended to contribute to the growing body of data on ICU infections by providing observations from a single center.

Material and Method

Ethics

This study was approved by the Izmir Kâtip Çelebi University Non-Interventional Clinical Studies Institutional Review Board (Decision No: 0351, August 26, 2021). All procedures adhered to ethical guidelines and complied with the principles of the Declaration of Helsinki. We anonymized patient data and handled it in compliance with confidentiality principles to ensure patient privacy.

Study Population and Inclusion Criteria

We conducted this retrospective study between March 1, 2020, and March 1, 2021, in the 23-bed ICU of İzmir, Turkey. Adult patients (≥18 years) hospitalized for at least 72 hours were screened for inclusion.

The prevalence of infectious diseases was determined by calculating the proportion of patients diagnosed with a suspected or confirmed infection among all screened patients, regardless of microbiological culture positivity. Only patients with a suspected or confirmed infectious disease were included in the final analysis.

Patient data were obtained from the hospital information management system, archived medical records, and electronic patient files. For patients with multiple ICU admissions, only the first episode was analyzed. Exclusion criteria were incomplete medical records, ICU stay of less than 72 hours, confirmed COVID-19 diagnosis, or pregnancy.

Data Collection and Analysis

We reviewed a total of 700 patient records. The study flow chart is presented in Figure 1. The final analysis included 195 patients diagnosed with a suspected or confirmed infectious disease.

We collected demographic data, including age, sex, and body mass index (BMI), clinical characteristics, major comorbidities (e.g., cardiovascular disease, diabetes, malignancy), and infection-predisposing factors present at ICU admission (such as indwelling devices, recent surgery, prolonged hospitalization, or immunosuppression), as well as data on suspected or confirmed infection sites, microbiological cultures, antibiograms, and biomarker levels (WBC, CRP, and PCT). Biomarker measurements were obtained at ICU admission and approximately 72 hours after initiation of antimicrobial therapy, per the standard clinical protocol. In the retrospective analysis, when laboratory results were not available exactly at 72 hours, the value closest to this time point was used for statistical analysis. BMI categories were defined according to the World Health Organization (WHO) criteria as follows: underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), pre-obesity (25.0–29.9 kg/m²), obesity class I (30.0–34.9 kg/m²), obesity class II (35.0–39.9 kg/m²) and obesity class III (≥40 kg/m²) [7]. APACHE II, SAPS II, and SOFA scores at ICU admission were also documented.

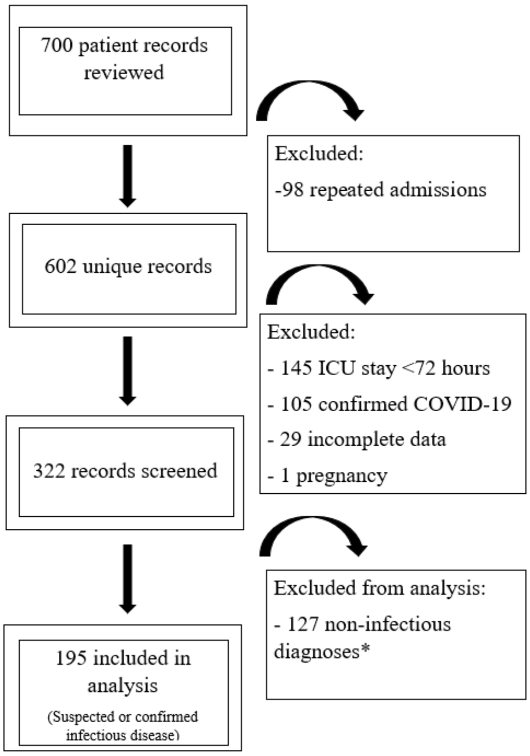

Figure 1.
*Flow Diagram of the Patient Selection Process (*Included in the denominator for prevalence calculation)*

Infection foci were determined based on clinical judgment supported by physical examination and laboratory parameters. In certain infection types, such as intra-abdominal infections and deep-seated soft tissue infections, microbiological confirmation was frequently not feasible due to clinical context or sampling limitations. Diagnoses were made based on clinical and perioperative findings in these cases.

As part of the routine ICU diagnostic protocol, microbiological samples, including blood, urine, and respiratory tract specimens, were obtained from all patients at ICU admission, wherever clinically and technically feasible. Based on clinical judgment, additional cultures were collected from suspected infection sites, such as surgical fields, wounds, or indwelling catheters. Some patients provided multiple samples, and a subset of cultures yielded more than one pathogen.

Antimicrobial treatments were classified as empirical or targeted based on microbiological evidence. Since individual patients could receive multiple antibiotics during their ICU stay, antimicrobial usage patterns were analyzed according to the number of antibiotic initiations, not the number of patients.

ICU mortality was defined as death during ICU stay. Patients discharged or transferred were considered survivors at ICU disposition.

Statistical Analysis

We performed statistical analyses using IBM SPSS version 21.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range, IQR), and categorical variables as frequencies and percentages. For comparisons, the independent samples t-test or Mann–Whitney U test was used for continuous variables, depending on distribution. Categorical variables were compared using the Pearson's chi-square (χ^2) test. Changes in biomarker levels were assessed using the paired samples t-test or the Wilcoxon signed-rank test. The association between AMR and ICU mortality was evaluated using the chi-square test. A p-value of <0.05 was considered statistically significant. All tests were two-tailed.

Results

Patient Characteristics and Association with Mortality

After applying the exclusion criteria, the prevalence of suspected or confirmed infectious diseases among eligible ICU patients was 60.6% (195/322). The median age was 67.0 years (IQR: 56.0–77.0). Among the study population, 60% were older than 65 years. Of the cohort, 61.0% were male. The most prevalent BMI category was pre-obesity, with 40.5% of patients, followed by obesity class I at 28.2%.

The ICU mortality rate in this cohort was 49.7% (97/195). When examining the association between demographic characteristics and ICU mortality, there was no statistically significant relationship between mortality and age (median age, 72.0 (61.0–81.0) vs. 64.5 (54.3–80.0) years; p = 0.085), sex (p = 0.847), or BMI category (p = 0.703). These are summarized in Table I.

Table I. Association of Demographic and Clinical Characteristics with ICU Mortality

Variable	Non-Survivors (n=97)	Survivors (n=98)	Total (n=195)	p-value
Age (year), median (IQR)	72.0 (61.0–81.0)	64.5 (54.3–80.0)	67.0 (56–77)	0.085
Sex, n (%)				0.847
Female	39 (40.2)	37 (37.8)	76 (39.0)	
Male	58 (59.8)	61 (62.2)	119 (61.0)	
BMI category, n (%)				0.703
Normal (18.5–24.9)	22 (22.7)	18 (18.4)	40 (20.5)	
Pre-obesity (25–29.9)	41 (42.3)	38 (38.8)	79 (40.5)	
Obesity I (30–34.9)	26 (26.8)	29 (29.6)	55 (28.2)	
Obesity II (35–39.9)	8 (8.2)	11 (11.2)	19 (9.7)	
Obesity III (≥40)	0 (0.0)	2 (2.0)	2 (1.0)	
Severity Scores, mean ± SD				
APACHE II	28.6 ± 8.6	18.1 ± 7.4	23.3 ± 9.6	<0.001
SAPS II	63.2 ± 16.3	41.2 ± 16.3	52.2 ± 19.1	<0.001
SOFA	10.8 ± 3.7	6.4 ± 2.5	8.6 ± 3.9	<0.001

Abbreviations: *BMI = Body Mass Index; IQR = Interquartile Range; SD = Standard Deviation; APACHE II = Acute Physiology and Chronic Health Evaluation II; SAPS II = Simplified Acute Physiology Score II; SOFA = Sequential Organ Failure Assessment*

The mean APACHE II, SAPS II, and SOFA scores for the entire cohort were 23.3 ± 9.6, 52.2 ± 19.1, and 8.6 ± 3.9, respectively. All three scores were significantly higher in non-survivors compared to survivors. Details are provided in Table I.

Cardiovascular diseases (69.2%) and diabetes mellitus (21.0%) were the leading comorbidities (Table II). Frequently observed infection-related risk factors included prolonged hospitalization (14.4%), urinary catheterization (9.4%), mechanical ventilation (8.3%), recent surgery (7.6%), and malignancy (8.6%) (Table III).

Table II. Distribution of Comorbidities in the Study Population

Comorbidity	n	(%)
Cardiovascular disease	135	69.2
Chronic respiratory disease	38	19.5
Chronic kidney disease	33	16.9
Diabetes mellitus	41	21.0
Malignancy	26	13.3
Chronic liver disease	11	5.6
Neurological disease	22	11.3
Immunosuppression	14	7.2

Some patients had more than one comorbidity; thus, totals exceed the number of patients. Comorbidities with a prevalence below 5% are not shown.

Table III. Infection-Predisposing Factors Present at ICU Admission

Category	n	%
Indwelling devices		
Mechanical ventilation (intubation, tracheostomy, NIV)	55	8.3
Central venous catheter	36	5.5
Urinary catheter	62	9.4
Nasogastric tube	46	7.0
Other foreign bodies (drains, nephrostomy, etc.)	46	7.0
Nutrition/Treatment		
Total parenteral nutrition	10	1.5
Dialysis	12	1.8
Surgery/Procedures		
Recent surgery (<30 days)	50	7.6
Prolonged Hospitalization	95	14.4
Immunosuppression		
Immunosuppressive drug use	11	1.7
Neutropenia	6	0.9
Hematological disease	7	1.1
Malnutrition	20	3.0
Malignancy	57	8.6
Chemotherapy/radiotherapy	22	3.3
Transplantation (bone marrow/organ)	2	0.3
Autoimmune/rheumatologic disease	6	0.9
Comorbidities		
Diabetes mellitus	54	8.4
Dementia/head trauma	20	3.0
Loss of skin integrity (burn, pressure ulcer, open wound)	32	4.8
Other	22	3.3

Abbreviations: *NIV, noninvasive mechanical ventilation.*

Multiple factors may coexist in a single patient. "Other" includes IV drug abuse, obesity, chronic alcoholism, and a history of aspiration. Data refer to risk factors identified on ICU admission.

Infection Distribution and Culture Results

To evaluate the overall infection burden at ICU admission, we analyzed clinically diagnosed infection foci, regardless of culture positivity. A total of 328 infection sites were identified in 195 patients, as multiple foci could be present in a single individual. The most common site of infection was the respiratory tract (n = 118, 36.0%), followed by intra-abdominal infections (n = 59, 18.0%) and bloodstream infections (n = 57, 17.4%) **(**Table IV**).**

Table IV. Distribution of Top Five Most Common Clinically Diagnosed Infection Foci at ICU Admission (n=328)

Infection Focus	n	%
Respiratory tract infections	118	36.0
Intra-abdominal infections	59	18.0
Bloodstream infections	57	17.4
Urinary tract infections	40	12.2
Skin and soft tissue	33	10.1

Less common infections, including endocarditis, mediastinitis, and CNS infections, were observed in individual cases and are not shown here.

Distribution of Culture-Positive Samples, Resistance Patterns, and Mortality

A total of 133 culture-positive samples were obtained from 100 patients admitted to the ICU. The most frequently sampled sites with positive results were tracheal aspirate (n = 47, 35.3%), urine (n = 37, 27.8%), and bloodstream or catheter tip specimens (n = 33, 24.8%) (Table V).

Table V. Distribution of Culture-Positive Samples by Sample Type (n = 133)

Culture Type	n	%
Tracheal Aspirate	47	35.3
Urine	37	27.8
Bloodstream (Blood + Catheter Tip)	33	24.8
Other (Wound, Surgical, Sputum, etc.)	16	12.0

The distribution of pathogen groups varied by culture site. In tracheal aspirate cultures (n=47), Gram-negative bacteria were the most frequently isolated group (n=31), followed by Gram-positive bacteria (n=8), fungal pathogens (n=7), and one atypical isolate. Among urine isolates (n=40), Gram-negative organisms predominated (n=24), while fungal (n=11) and Gram-positive pathogens (n=5) were less common. In blood and catheter tip cultures (n=36), Gram-positive bacteria were the leading group (n=21), followed by Gram-negative bacteria (n=9) and fungal isolates (n=6) (Figure 2). In some samples, more than one pathogen was identified, resulting in a higher total number of isolates than the number of culture samples.

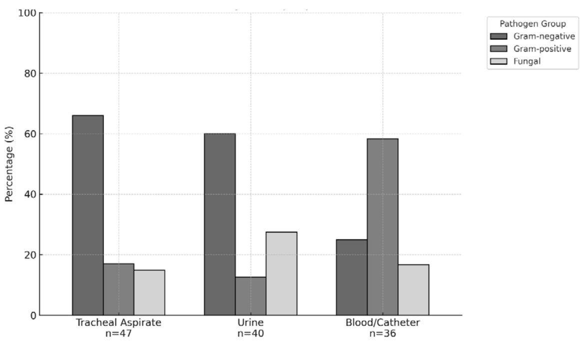

Figure 2.
Distribution of Pathogen Groups by Culture Site

Of the 100 patients with culture-positive results, antimicrobial resistance was found in 56 patients (56.0%). Of these, 39 (69.6%) died during their ICU stay. Among patients with susceptible pathogens (n = 44), 21 (47.7%) died. Although mortality was higher in the resistant group, the difference was not statistically significant (p = 0.118).

Our study revealed that 55.0% (11/20) of *Klebsiella pneumoniae* isolates produced Extended-Spectrum Beta-Lactamase (ESBL), while 41.2% (7/17) of *Escherichia coli* isolates did the same. Carbapenem resistance was noted in 20.0% (4/20) of *K. pneumoniae* and 11.8% (2/17) of *E. coli* isolates. Remarkably, 81.3% (13/16) of *A. baumannii* isolates exhibited carbapenem resistance (CRAB). Additionally, ampicillin resistance was found in 77.8% (7/9) of *Enterococcus faecium* isolates, and MRSA (Methicillin-Resistant *Staphylococcus aureus*) was detected in 25.0% (2/8) of *Staphylococcus aureus* isolates.

Antibiotic Utilization Patterns

In 87.7% (n=171) of patients, empirical therapy was administered, while only 12.3% (n=24) received culture-guided treatment. A total of 329 antibiotic initiations were recorded, as some patients received more than one agent during their ICU stay. The most commonly used agent was meropenem (n = 100, 30.4%), followed by piperacillin-tazobactam (n = 60, 18.2%), teicoplanin (n = 32, 9.7%), tigecycline (n = 29, 8.8%), and ceftriaxone (n = 27, 8.2%).

Biomarker Trends and Association with Mortality

At 72 hours, PCT and WBC levels showed a significant decrease from baseline (p<0.001 for both), while CRP levels declined without reaching statistical significance (p = 0.181) (Table VI).

Table VI. Comparison of Biomarker Levels at ICU Admission and at 72 Hours After Initiation of Antimicrobial Therapy

Biomarker	Admission Values (n = 195) *Median (IQR)*	72nd Hour Values (n = 195) *Median (IQR)*	p-value
WBC (×10³/µL)	15.3 (10.1–20.6)	12.4 (8.5–16.4)	**<0.001**
CRP (mg/L)	100.2 (42.7–180.4)	80.0 (34.0–171.5)	0.181
PCT (ng/mL)	1.4 (0.4–9.3)	0.9 (0.3–4.8)	**<0.001**

In the non-survivor group, 72-hour PCT and CRP values remained significantly higher than in survivors (p = 0.032 and p = 0.034), with no significant difference observed in WBC counts (p = 0.787) (Table VII).

Table VII. Mortality Impact of Initial WBC, CRP, and PCT Values

Biomarker	Non-Survivors (n = 97) *Median (IQR)*	Survivors (n = 98) *Median (IQR)*	p-value
WBC (×10³/µL)	16.0 (9.5–21.9)	14.8 (10.4–19.2)	0.787
CRP (mg/L)	111.0 (50.0–198.2)	78.5 (24.2–147.5)	**0.032**
PCT (ng/mL)	2.4 (0.5–11.1)	1.0 (0.4–7.0)	**0.034**

Discussion and Conclusion

The primary objective of this study was to investigate the epidemiological features, infection profiles, antimicrobial resistance patterns, and prognostic markers among critically ill patients with suspected or confirmed infections in the ICU. Our findings demonstrate that respiratory tract infections constituted the predominant infection focus. Multidrug-resistant pathogens were frequently isolated, and biomarker trends and severity scores provided valuable prognostic insights.

Patient Demographics and Infection Risk

The mean age of our ICU cohort was 67 years, with 60% of patients aged 65 or older. While advanced age has consistently been identified as a risk factor for ICU-acquired infections and worse outcomes in the literature[8,9], our study did not observe a statistically significant association between age and ICU mortality. However, a non-significant trend toward increased mortality in older patients was evident, suggesting that age remains a clinically important consideration, particularly in larger populations[8].

Neither sex nor BMI category demonstrated a significant association with ICU mortality, consistent with prior studies that have reported variable or weak relationships between these demographic factors and ICU outcomes in heterogeneous populations[10-12]. Some meta-analyses even highlight an "obesity paradox" in critical illness, where higher BMI does not necessarily predict poorer outcomes[12]. Significant comorbidities and infection-predisposing factors at ICU admission were summarized to provide a comprehensive view of our population, as these are well-established contributors to infection risk and ICU morbidity[1,13].

Severity scores in our cohort reflected a high burden of critical illness, with mean APACHE II, SOFA, and SAPS II values indicating moderate to severe disease. Among eligible ICU patients, the prevalence of suspected or confirmed infection was 60.6%, and the ICU mortality rate was 49.7%. Both infection prevalence and mortality were slightly higher than in large multicenter studies such as EPIC III, EPIC II, and the SOAP study[1,14,15], likely reflecting a more severely ill patient population in our cohort.

Overall, while our cohort's outcomes reflect a substantial disease burden, the observed mortality rate is within the range expected for populations with comparable severity of illness. Interpretation of these results should consider the heterogeneity of the patient population and local ICU practices.

Infection Distribution and Microbiological Findings

Respiratory tract infections (RTIs) were our cohort's most common infection focus, accounting for 36% of all clinically diagnosed infection sites. This finding is consistent with previous research highlighting the significant burden of respiratory infections, including ventilator-associated pneumonia, among ICU patients[13].

Tracheal aspirate samples were the most frequently positive among patients with positive cultures, representing 35.3% of all culture-positive specimens. Our cohort's most frequently isolated pathogens were *Klebsiella pneumoniae, Acinetobacter baumannii, and Escherichia coli,* particularly in respiratory tract samples. These Gram-negative organisms predominated in clinical and microbiological findings and were followed by Gram-positive bacteria and fungal pathogens in lower proportions.

This distribution reflects the local epidemiology of our ICU and aligns with the literature reporting the frequent isolation of MDR Gram-negative bacteria in intensive care settings[13]. However, given our study's single-center and retrospective nature, our results should be interpreted within the context of our institution's patient population.

Respiratory tract cultures, especially tracheal aspirates, yielded the highest rates of pathogen isolation, further emphasizing the importance of ongoing surveillance and infection control measures to reduce the burden of respiratory infections in the ICU.

Microbiology and Antimicrobial Resistance: Clinical Implications

The empirical antimicrobial therapy initiation rate in our study was notably high (87.7%). This finding can be attributed to several factors, including delays in infection diagnosis, frequent negative culture results, and the necessity for rapid treatment initiation in critically ill patients[1,5]. The literature similarly reports the widespread use of empirical therapy in intensive care settings and emphasizes that this approach contributes to the increasing risk of antimicrobial resistance[5,6]. Therefore, improving the proportion of culture-guided therapy in the ICU requires implementing rapid diagnostic methods and robust antimicrobial stewardship strategies.

Regarding microbiological findings, high ESBL and carbapenem resistance rates were observed among *Klebsiella pneumoniae* and *Escherichia coli* isolates, while *Acinetobacter baumannii* demonstrated a particularly high prevalence of carbapenem resistance. Similarly, significant rates of ampicillin resistance were noted in *Enterococcus faecium*, and MRSA was detected among *Staphylococcus aureus* isolates. These results are consistent with recent European and global surveillance reports, underscoring the ongoing challenge of multidrug resistance in intensive care settings[16,17]. However, given the limited number of isolates in our cohort, these findings should be interpreted in the context of our institution's patient population.

Interestingly, antimicrobial resistance was not statistically associated with increased mortality in our cohort. This observation aligns with previous reports suggesting that, although resistant organisms complicate clinical management and may prolong hospitalization, patient outcomes are often more closely related to underlying disease severity, comorbidities, and organ dysfunction rather than resistance status alone[18,19]. Nevertheless, our study found higher mortality rates among patients with resistant infections than those with susceptible pathogens. However, this difference did not reach statistical significance, likely due to the limited sample size. The high ESBL and carbapenem resistance rates among Gram-negative isolates in our cohort highlight the ongoing clinical and economic burden of multidrug-resistant organisms in the ICU, as these pathogens can increase broad-spectrum antibiotic use and escalate healthcare costs[20]. Taken together, these findings emphasize the need for continuous surveillance, robust infection control measures, and regular updates of antimicrobial treatment strategies to prevent the emergence and spread of resistant organisms in critical care settings[20]. Further studies with larger cohorts are warranted to validate these results.

Prognostic Value of Biomarkers

Biomarkers such as PCT and CRP are important in evaluating infection severity, guiding antimicrobial therapy, and predicting outcomes[4,22]. In our study, higher PCT and CRP baseline levels were significantly associated with mortality, and persistent elevation of PCT at 72 hours was predictive of worse outcomes. These findings support serial biomarker measurements, particularly PCT, as a valuable tool in the prognostication and management of critically ill patients. However, the utility of CRP kinetics was less robust, likely reflecting its sensitivity to non-infectious inflammatory conditions. WBC count did not provide substantial prognostic information, which aligns with previous studies[23]. Integrating biomarker trends with comprehensive clinical evaluation may enhance risk stratification and inform treatment decisions in the ICU[24,25].

Limitations

This study has several limitations that must be considered. The retrospective, single-center design restricts the generalizability of the results to other ICUs with differing patient profiles and antimicrobial resistance patterns. The absence of long-term follow-up precludes assessment of sustained clinical impact. A lack of multivariable adjustment for potential confounders, such as comorbidities and other critical illness factors, also limits causal inference. The lack of radiological data may also affect diagnostic accuracy, particularly in ventilated patients, where imaging can be nonspecific or misleading. The unavailability of advanced molecular diagnostics may have led to missed pathogen identification, especially in culture-negative cases. While biomarkers and severity scores provide valuable prognostic data, their specificity in distinguishing infectious from non-infectious inflammation is uncertain, particularly among septic patients with multiple comorbidities. Collectively, these limitations may influence both clinical decision-making and the broader applicability of our findings.

Future Directions

Further prospective, multicenter studies with larger sample sizes and multivariable analyses are needed to clarify the complex relationships among infection, host factors, antimicrobial resistance, and ICU outcomes.

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