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RESEARCH ARTICLE

# Factors affecting mortality in patients with *Klebsiella pneumoniae* bloodstream infection in the intensive care unit

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## ABSTRACT

**Aim:** In recent years, *Klebsiella pneumoniae* bloodstream infections (KP-BSIs) have emerged as a major public health concern due to their increasing prevalence and their strong association with high morbidity and mortality rates. Despite this growing threat, there is a lack of epidemiological data specific to Bolu province, Turkey. This study aims to characterize the epidemiological, microbiological, and clinical features of KP-BSIs in this region, with a particular focus on identifying risk factors associated with carbapenem resistance and patient mortality.

**Methods:** A total of 142 patients with KP-BSIs that developed in the intensive care unit (ICU) over approximately four years were included in the study. The association between demographic and clinical data of the patients and carbapenem resistance and mortality was analyzed.

**Results:** Among the patients monitored in the intensive care unit, 64.8% died. No independent predictors were identified for the development of carbapenem-resistant *K. pneumoniae* infections in the multivariate analysis. However, the following factors were found to be associated with an increased risk of mortality: age over 65 years, the presence of pneumonia or a urinary tract infection a bloodstream infection linked to an intravenous catheter, prior use of a central venous catheter, hospitalisation within the last three months, recent or prolonged exposure to broad-spectrum antibiotics, and infections at other anatomical sites. Notably, having a tracheostomy was associated with a reduced risk of death, while a one-unit increase in albumin was associated with a 13.8% lower risk of death, a one-unit increase in C-reactive protein (CRP) was associated with a 1.9% higher risk.

**Conclusions:** This study provides important data on the rate of KP-BSI isolated from secondary care facilities and the risk factors for mortality. Existing literature has typically focused on identifying risk factors for death in tertiary care public hospitals. However, this study examined the intensive care units of secondary care public hospitals and found high mortality rates among patients. The high mortality rate of patients with KP-BSI highlights the urgency of implementing appropriate infection control strategies.

**Keywords:** *Klebsiella pneumoniae*, bloodstream infection, mortality

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## INTRODUCTION

The marked increase in antibiotic resistance in *K. pneumoniae* isolates has been linked to fatal outcomes. Firstly, it has been demonstrated that bloodstream infections (BSIs) caused by extended-spectrum β-lactamase (ESBL) *Enterobacterales* are associated with treatment failure (1-3). More recently, BSIs caused by carbapenem-resistant *K. pneumoniae* (CRKP) were reported to result in mortality in approximately 49%-57% of cases (4-6).

The most common risk factors for mortality in patients with BSI caused by *K. pneumoniae* are the severity of the underlying disease, length of time in the intensive care unit (ICU) at the onset of infection, presence of ESBL or CRKP strains, and delay in initiating appropriate therapy. Conversely, controlling the source of infection and administration of early and appropriate antimicrobial therapy have been associated with improved survival (7). Therefore, it is useful to assess the risk of CRKP in patients with suspected *Klebsiella pneumoniae* bloodstream infections (KP-BSI) and to examine risk factors for mortality.

## MATERIALS AND METHODS

### Ethical approval

The study received ethics committee approval from the Bolu Abant İzzet Baysal University Clinical Research Ethics Committee (decision no: 201 /date: September 10, 2024). All procedures were performed in accordance with the ethical standards set by the Declaration of Helsinki.

### Bacterial isolates, identification, susceptibility testing, and study design

A total of 142 non-duplicate clinical *K. pneumoniae* isolates (one isolate per patient) were included in the study. These isolates were obtained from blood cultures in the ICU of Bolu State Hospital between January 2021 and August 2024, and they were accepted as causative agents. All strains isolated during the study period were selected for inclusion in the study.

A retrospective, patient- and laboratory-based surveillance approach was used to analyze the data obtained from relevant sources. Adult patients (18 years of age or older) who had started antibacterial treatment for the infectious agent in question and whose blood samples collected 48 hours after admission to the ICU showed growth of *K. pneumoniae* were included in the study. Blood samples were taken into blood culture bottles and incubated in an automated system. After the preliminary identification of the samples that showed growth within five days, they were transferred to 5% sheep blood agar and EMB agar media and incubated at 35.5-37°C for 18-24 hours. Antimicrobial identification and antibiotic susceptibility testing of the isolates were performed using standard conventional methods with a fully automated device (VITEK2, bioMerieux, France). EUCAST methods and interpretation criteria were used for all antimicrobial agents (8).

Age, sex, clinical data, prognosis (mortality or survival), and laboratory parameters—including albumin, glucose, creatinine, procalcitonin, C-reactive protein (CRP), hemoglobin, white blood cell count (WBC), and lymphocyte count (LYM)—were recorded following retrieval from the institutional database and patient files.

Clinical data included hospitalization within the past three months, broad-spectrum antibiotic use, antibiotic use for ≥5 days within the past three months, comorbidities, possible sources and risk factors for bacteremia, and 28-day mortality.

### Statistical analysis

The research data were analzed using the IBM SPSS 26.0 program. Descriptive statistics were presented for categorical variables as numbers and percentages, and for interval variables as mean and standard deviation. A Chi-square test was employed to compare categorical variables in independent groups. A Student's t-test was used to compare interval variables with a normal distribution between two independent groups. In the multivariate analysis, variables with $p<0.05$ in univariate analysis were added to the logistic

regression model, and the enter method was used. The statistical significance level was set at p<0.05.

## RESULTS

The study included 142 patients with BSIs associated with *K. pneumoniae* in the anaesthesia ICU of a public hospital. The majority of patients were male (54.9%) and 65 years of age or older (80.3%). The most common infections were sepsis (95.8%), pneumonia (74.6%), and urinary tract infections (61.3%). The most common comorbidities were hypertension (47.2%), diabetes (29.6%), and heart disease (23.9%). The most common invasive devices were urinary catheters (95.1%) and central venous catheters (71.8%). A total of 62.7% of patients had a history of hospitalisation within the previous three months, 62% had used broad-spectrum antibiotics for more than five days or within the last three months, and 79.6% had concomitant infection growth in another site.

Carbapenem-susceptible and carbapenem-resistant organisms represented 14.1% and 85.9% of patients, respectively. There was no statistically significant difference between age, sex, focus of infection, concomitant diseases, use of invasive devices, hospitalisation wtihin the last three months, history of antibiotic use, growth in another focus and laboratory parameters of carbapenem-sensitive and resistant patients (p>0.05) (Table 1).

### Risk factors for mortality

While 35.2 percent of the patients survived, 64.8 percent died within 28 days. The univariate analysis identified the following risk factors for death: age 65 years or older [OR: 3.793 (1.606-8.961)], pneumonia [OR: 1.894 (0.516-6.949)], urinary tract infection [OR: 2.067 (1.021-4.184)] and BSI associated with an intravenous catheter [(OR: 4.634 (1.308-16)]. The following factors were identified as risk factors for death in univariate analysis: age over 65 years [OR: 3.793 (1.606-8.961)], pneumonia [OR: 1.894 (0.516-6.949)], urinary tract infection [OR: 2.067 (1.021-4.184)], BSI associated with an intravenous catheter [OR: 4.634 (1.308-16.577)], history of central venous catheter [OR: 3.511 (1.050-11.738)], history of hospitalisation in the last three months [OR: 1.270 (0.148-10.934)], history of broad-spectrum antibiotic use for more than five days or within the last three months [OR: 1.067 (0.134-8.486)], and the presence of an accompanying growth in another focus [OR: 4.142 (1.762-9.734)]. It was established that the presence of a tracheostomy was associated with a reduced risk (OR: 0.128, 95% CI: 0.032-0.519). When examining the correlation between a one-unit increase in laboratory parameters and the risk of death, the following results were observed: WBC (OR: 1.082, 1.017-1.151), glucose [OR: 1.008 (1.001–1.016)], creatinine (OR: 3.110, 1.593-6.071), and procalcitonin (OR: 1.039, 1.003-1). Elevated levels of CRP [OR: 1.031 (1.019-1.044)] and other parameters, including WBC [OR: 1.082 (1.017-1.151)], glucose [OR: 1.008 (1.001-1.016)], creatinine [OR: 3.110 (1.593-6.071)], procalcitonin [OR: 1.039 (1.003-1.077)], and CRP [OR: 1.031 (1.019-1.044)] were found to increase the risk of death. Conversely, elevated levels of HGB [OR: 0.758 (0.633-0.908)] and albumin [OR: 0.786 (0.719-0.860)] were associated with a reduced risk of death (Table 2).

The logistic regression analysis, which included variables exhibiting significant differences in the univariate analysis (procalcitonin with a high proportion of missing data was not incorporated into the regression model), revealed that the presence of a central venous catheter was associated with an elevated risk of mortality [OR: 3.511 (1.050-11.738)], whereas the use of a tracheostomy was associated with a reduced risk of mortality [OR: 0.128 (0.032-0.519)]. A one-unit increase in albumin value was associated with a decreased risk of death (OR: 0.862, 95% CI: 0.750–0.991). Conversely, a one-unit increase in CRP value was linked to an increased risk of death (OR: 1.019, 95% CI: 1.001–1.036). The remaining risk factors identified in the univariate analysis did not demonstrate a statistically significant differences in the multivariate analysis (p> 0.05) (Table 3).

**Table 1.** Comparison of clinical characteristics between carbapenem-resistant *K. pneumoniae* - bloodstream infections (CRKP-BSI) and carbapenem- susceptibility *K. pneumoniae* - bloodstream infection (CSKP-BSI) patients

| **Demographics** | | **Total** | **Carbapenem-resistant** | | **OR (%95 CI)** | **p value** |
|---|---|---|---|---|---|---|
| | | | **CSKP n=20 (%14.1)** | **CRKP n=122 (%85.9)** | | |
| | | **n (%)** | **n (%)** | **n (%)** | | |
| **Gender** | Male | 78 (54.9) | 7 (35) | 71 (58.2) | ref | 0.054 |
| | Female | 64 (45.1) | 13 (65) | 51 (41.8) | 0.387 (0.144-1.038) | |
| **Age(y)** | < 65 (y) | 28 (19.7) | 3 (15) | 25 (20.5) | ref | 0.569 |
| | ≥ 65 (y) | 114 (80.3) | 17 (85) | 97 (79.5) | 0.685 (0.186-2.522) | |
| **Type of BSI Number of patients** | | | | | | |
| Sepsis | | 136 (95.8) | 18 (90) | 118 (96.7) | 3.278 (0.559-19.212) | 0.168 |
| Pneumonia | | 106 (74.6) | 11 (55) | 95 (77.9) | 2.879 (1.081-7.664) | 0.030 |
| Urinary system infections | | 87 (61.3) | 13 (65) | 74 (60.7) | 0.830 (0.309-2.230) | 0.713 |
| Bloodstream infections associated with an intravenous catheter | | 24 (16.9) | 1 (5) | 23 (18.9) | 4.414 (0.562-34.683) | 0.127 |
| Surgical site infections | | 5 (3.5) | 0 (0) | 5 (4.1) | - | 1.000 |
| Complicated skin and soft tissue infections | | 28 (19.7) | 4 (20) | 24 (19.7) | 0.980 (0.300-3.198) | 0.973 |
| Central nervous system infections | | 2 (1.4) | 0 (0) | 2 (1.6) | - | 1.000 |
| **Comorbidities/Underlying disease** | | | | | | |
| Hypertension | | 67 (47.2) | 8 (40) | 59 (48.4) | 1.405 (0.537-3.678) | 0.489 |
| Coronary artery disease | | 34 (23.9) | 6 (30) | 28 (23) | 0.695 (0.244-1.977) | 0.495 |
| Chronic kidney failure | | 12 (8.5) | 3 (15) | 9 (7.4) | 0.451 (0.111-1.835) | 0.258 |
| Diabetes | | 42 (29.6) | 5 (25) | 37 (30.3) | 1.306 (0.442-3.858) | 0.630 |
| COPD | | 28 (19.7) | 4 (20) | 24 (19.7) | 0.980 (0.300-3.198) | 0.973 |
| Metastatic solid tumor (n=141) | | 20 (14.2) | 1 (5) | 19 (15.7) | 3.539 (0.447-28.038) | 0.205 |
| Neurological | | 68 (47.9) | 11 (55) | 57 (46.7) | 0.717 (0.277-1.855) | 0.494 |
| Surgery | | 9 (6.3) | 2 (10) | 7 (5.7) | 0.548 (0.105-2.847) | 0.470 |
| **Risk Factors** | | | | | | |
| Dialysis | | 17 (12) | 1 (5) | 16 (13.1) | 2.868 (0.359-22.921) | 0.302 |
| Urinary catheter | | 135 (95.1) | 20 (100) | 115 (94.3) | - | 0.593 |
| Central venous catheter | | 102 (71.8) | 11 (55) | 91 (74.6) | 2.402 (0.910-6.340) | 0.072 |
| Gastrostomy and jejunostomy tube | | 35 (24.6) | 5 (25) | 30 (24.6) | 0.978 (0.328-2.918) | 0.969 |
| Tracheostomy | | 33 (23.2) | 6 (30) | 27 (22.1) | 0.663 (0.233-1.890) | 0.442 |
| **Clinical information** | | | | | | |
| Hospitalization within 3 months | | 89 (62.7) | 15 (75) | 74 (60.7) | 0.514 (0.175-1.506) | 0.221 |
| History of broad-spectrum antibiotic use within 3 months or longer than 5 days | | 88 (62) | 14 (70) | 74 (60.7) | 0.661 (0.238-1.838) | 0.427 |
| Concurrent infectious focus | | 113 (79.6) | 14 (70) | 99 (81.1) | 1.845 (0.640-5.317) | 0.253 |
| **Laboratory parameters** | | | | | | |
| Hemoglobin(g/dL) | | 9.3±2.1 | 8.8±2.1 | 9.4±2.1 | 1.172 (0.899-1.527) | 0.240 |
| White blood cell ($10^9$/L) | | 12.8±6.7 | 12.1±6.7 | 13.0±6.7 | 1.020 (0.947-1.100) | 0.599 |
| Lymphocyte ($10^9$/L) | | 1.2±0.9 | 0.9±0.8 | 1.2±1.0 | 1.591 (0.793-3.193) | 0.191 |
| Albümin (g/L) | | 22.3±5.6 | 22.7±5.1 | 22.2±5.7 | 0.986 (0.904-1.075) | 0.749 |
| Glucose (mg/dL) | | 157.6±64.5 | 154.1±69.6 | 158.2±63.9 | 1.001 (0.993-1.009) | 0.791 |
| Creatinine (mg/dL) | | 1.4±0.9 | 1.5±1.2 | 1.4±0.9 | 0.830 (0.524-1.314) | 0.426 |
| **Procalcitonin (ug/L)** (n=105) | | 14.3±24.6 | 21.0±32.6 | 13.5±23.6 | 0.990 (0.969-1.011) | 0.342 |
| C-reactive protein (mg/L) | | 107.7±36.9 | 108.0±39.7 | 107.7±36.6 | 1.000 (0.987-1.013) | 0.965 |

COPD: Chronic obstructive pulmonary disease.

**Table 2.** Comparison of patient mortality according to demographic and clinical characteristics

| | | Survived n=50 (%35.2) | 28-day mortality n=92 (%64.8) | Univariate analysis | |
|---|---|---|---|---|---|
| | | n (%) | n (%) | OR (%95 CI) | p value |
| **Gender** | Male | 27 (54) | 51 (55.4) | ref | 0.870 |
| | Female | 23 (46) | 41 (44.6) | 0.944 (0.473-1.885) | |
| **Age (y)** | < 65 (y) | 17 (34) | 11 (12) | ref | **0.002** |
| | ≥ 65 (y) | 33 (66) | 81 (88) | 3.793 (1.606-8.961) | |
| **Type of BSI number of patients** | | | | | |
| Sepsis | | 44 (88) | 92 (100) | - | **0.002** |
| Pneumonia | | 32 (64) | 74 (80.4) | 2.313 (1.067-5.014) | **0.032** |
| Urinary system infections | | 25 (50) | 62 (67.4) | 2.067 (1.021-4.184) | **0.043** |
| Bloodstream infections associated with an intravenous catheter | | 3 (6) | 21 (22.8) | 4.634 (1.308-16.412) | **0.011** |
| Surgical site infections | | 1 (2) | 4 (4.3) | 2.227 (0.242-20.486) | 0.470 |
| Complicated skin and soft tissue infections | | 8 (16) | 20 (21.7) | 1.458 (0.591-3.601) | 0.413 |
| Central nervous system infections | | 1 (2) | 1 (1.1) | 0.538 (0.033-8.797) | 0.660 |
| **Comorbidities/Underlying disease** | | | | | |
| Hypertension | | 18 (36) | 49 (53.3) | 2.026 (0.998-4.112) | 0.050 |
| Coronary artery disease | | 8 (16) | 26 (28.3) | 2.068 (0.856-4.995) | 0.103 |
| Chronic kidney failure | | 2 (4) | 10 (10.9) | 2.927 (0.615-13.920) | 0.161 |
| Diabetes | | 12 (24) | 30 (32.6) | 1.532 (0.701-3.349) | 0.285 |
| COPD | | 10 (20) | 18 (19.6) | 0.973 (0.410-2.307) | 0.951 |
| Metastatic solid tumor (n=141) | | 6 (12.2) | 14 (15.2) | 1.286 (0.461-3.590) | 0.631 |
| Neurological | | 25 (50) | 43 (46.7) | 0.878 (0.440-1.748) | 0.711 |
| Surgery | | 3 (6) | 6 (6.5) | 1.093 (0.261-4.571) | 0.903 |
| **Risk factors** | | | | | |
| Dialysis | | 3 (6) | 14 (15.2) | 2.812 (0.768-10.302) | 0.107 |
| Urinary catheter | | 45 (90) | 90 (97.8) | 5.000 (0.933-26.785) | 0.060 |
| Central venous catheter | | 23 (46) | 79 (85.9) | 7.134 (3.179-16.010) | **<0.001** |
| Gastrostomy and jejunostomy | | 13 (26) | 22 (23.9) | 0.895 (0.405-1.977) | 0.784 |
| Tracheostomy | | 18 (36) | 15 (16.3) | 0.346 (0.156-0.770) | **0.008** |
| **Clinical information** | | | | | |
| Hospitalization within 3 months | | 24 (48) | 65 (70.7) | 2.608 (1.278-5.324) | **0.008** |
| History of broad-spectrum antibiotic use within 3 months or longer than 5 days | | 22 (44) | 66 (71.7) | 3.231 (1.573-6.634) | **0.001** |
| Concurrent infectious focus | | 32 (64) | 81 (88) | 4.142 (1.762-9.734) | **0.001** |
| CRKP | | 45 (90) | 77 (83.7) | 0.570 (0.194-1.674) | **0.304** |
| **Laboratory parametres** | | | | | |
| Hemoglobin(g/dL) | | 10.1±2.0 | 8.9±2.0 | 0.758 (0.633-0.908) | **0.003** |
| White blood cell ($10^9$/L) | | 10.9±5.4 | 13.9±7.1 | 1.082 (1.017-1.151) | **0.013** |
| Lymphocyte ($10^9$/L) | | 1.2±0.7 | 1.2±1.0 | 0.930 (0.650-1.331) | **0.692** |
| Albumin (g/L) | | 26.0±4.4 | 20.2±5.2 | 0.786 (0.719-0.860) | **<0.001** |
| Glucose (mg/dL) | | 140.3±38.1 | 167.0±73.5 | 1.008 (1.001-1.016) | **0.020** |
| Creatinine (mg/dL) | | 1.0±0.5 | 1.6±1.0 | 3.110 (1.593-6.071) | **0.001** |
| Procalcitonin (ug/L) (n=105) | | 6.2±16.0 | 18.9±27.3 | 1.039 (1.003-1.077) | **0.036** |
| C-reactive protein (mg/L) | | 84.1±37.0 | 120.5±30.1 | 1.031 (1.019-1.044) | **<0.001** |

*COPD: Chronic obstructive pulmonary disease.

**Table 3.** Binary logistic regression analysis for predictors of mortality in patients with *K. pneumoniae* - bloodstream infections

| Variables | Multivariate analysis* | |
|---|---|---|
| | OR (%95 CI) | p value |
| Central venous catheter | 3.511 (1.050-11.738) | **0.041** |
| Tracheostomy | 0.128 (0.032-0.519) | **0.004** |
| Albumin (g/L) | 0.862 (0.750-0.991) | **0.038** |
| C-reactive protein (mg/L) | 1.019 (1.001-1.036) | **0.035** |

*Logistic reggression model-Enter model. Hosmer-Lemeshow test.0.133 Nagerkerke $R^2$:0.677 Omnibus test:<0.001

## DISCUSSION

The results of this retrospective study showed that *K. pneumoniae* infections in the intensive care unit (ICU) are associated with mortality. The following factors were identified as risk factors for mortality: age 65 years or over, pneumonia, urinary tract infection, BSI associated with an intravenous catheter, central venous catheter, history of hospitalisation in the previous three months, history of broad-spectrum antibiotic use for more than five days in the previous three months, and concomitant growth in another focus. Having a tracheostomy was considered a protective factor. Laboratory findings revealed that a one-unit increase in blood albumin decreased the risk of death, whereas a one-unit increase in blood CRP significantly increased the risk of death.

The aim of our study was to determine the relationship between mortality and various risk factors contributing to the development of CRKP during *K. pneumoniae infection episodes* in patients hospitalized in our anesthesia intensive care unit. CRKP infections are a significant public health problem because they can spread rapidly across the globe, have limited treatment options, and negatively impact prognosis. Therefore, early detection of CRKP infections and, thus, reducing the incidence of CRKP are of public health importance (9). While the literature examines risk factors that play important roles in the development of CRKP infection, the reported findings vary widely. Studies have reported that patients with a history of hospitalization, and the use of invasive devices, such as central venous catheters, as well as the use of antibiotics, such as cephalosporins, carbapenems, and quinolones, are risk factors for CRKP. Furthermore, existing literature review also identified steroid use, stem cell transplantation, and an intensive care unit stay as potential risk factors (10,11). In our study, we aimed to identify potential risk factors for the development of CRKP infections. However, despite examining many different variables, we found no independent association between these variables and CRKP infection. One limitation of our study is the small number of patients with CRKP infections in our cohort (14.1%), which may have led to the failure to identify a significant association. However, the presence of multiple patients in the intensive care unit has been suggested as a contributing factor to the spread of CRKP infection. It is also noteworthy that there are studies in the literature consistent with our findings (12).

In our study, the mortality rate was found to be 64.8%, demonstrating the severity of *K. pneumoniae* infections in the intensive care units in Bolu. Therefore, identifying risk factors associated with this mortality rate is crucial for developing effective treatment and improving patient outcomes. In a study by Büyüktuna et al. (13), the mortality rate associated with *K. pneumoniae* infection in a Turkish intensive care unit was reported as 50%. However, in another study by Durdu et al. (14), KP-BSIs were investigated and the mortality rate in intensive care units was determined to be 63.2%. These rates reported in the literature are quite consistent with the findings in our study. Furthermore, Viale et al. (7) conducted a meta-analysis examining publications in MEDLINE between 1977 and 2012, reporting that the mortality rate of KP-BSI ranged from 14% to 46%. Another study conducted in Italy by Delle Rose et al., reported a 67.6% mortality rate for KP-BSI in intensive care units (15).

Thus, although studies on KP-BSI exist in the literature, published findings appear to vary by center. A review by Cekin et al. (16) listed risk factors for mortality, including a diagnosis of sepsis, use of a urinary catheter, a history of surgery, use of broad-spectrum antibiotics, antibiotic-resistant bacteraemia, coronary artery disease, inappropriate empirical treatment, healthcare-associated infections, urinary catheterization, and an ICU stay. In a study conducted in an intensive care unit

in Turkey, Büyüktuna et al. examined *K. pneumoniae* infections and reported that factors such as concurrent chronic obstructive pulmonary disease (COPD), treatment with cephalosporin and colistin antibiotics within the previous three months, and CRKP disease were associated with 20-day mortality (13).

A more detailed investigation of *K. pneumoniae* infections occurring in intensive care units using univariate analysis identified several risk factors. These factors included admission to the intensive care unit, shock, respiratory failure, multiple organ failure, acute renal failure, acidosis, infection due to extensively drug-resistant/pandrug-resistant (XDR/PDR) pathogens and treatment failure (12). A meta-analysis of mortality due to KP-BSIs in the MEDLINE database revealed the highest risk of death was exhibited by elderly patients and those with hematological disease, cirrhosis, solid organ transplantation (SOT), dialysis, heart failure, and critical illness (7). Univariate analysis in our study identified the following as risk factors for mortality: age over 65 years, presence of pneumonia, urinary tract infection, intravenous catheter-related BSI, history of central venous catheter, hospitalisation within the past three months, use of broad-spectrum antibiotics for more than five days within the past three months and presence of concomitant infection growth at another site. The discrepancies in the prevalence of comorbid conditions may be due to the heterogeneous patient profiles observed across different hospitals, as well as varying regional, developmental and socioeconomic factors within countries.

A tracheostomy is a critical procedure frequently performed on patients requiring long-term mechanical ventilation, particularly in emergency situations. The present study demonstrated that tracheostomy was associated with a reduced 28-day mortality risk ([OR: 0.128 (0.032-0.519)]. This finding can be attributed to the benefits of tracheostomy, which facilitate improved airway management and reduce complications associated with long-term intubation, irrespective of the presence of infection. Despite its invasive nature, numerous studies have shown that the timely application of tracheostomy reduces the risk of mortality in critically ill patients (17,18).

In our study, we found that a one-unit increase in CRP increased the risk of death by 1.9% (0.1-3.6) in logistic regression analysis. Studies in the literature have shown that higher CRP concentrations are positively associated with the risk of all-cause mortality in various populations (19). Monitoring CRP levels can provide valuable information about an individual's health status and potential risks. As expected for an acute-phase marker, particularly high CRP levels were more predictive of short-term than long-term mortality (19,20). These results are consistent with our study.

Several studies have consistently shown that low serum albumin levels are associated with an increased risk of mortality. For example, a study published in 2022 found that serum albumin levels (SAL) below 30 g/L were independently associated with a higher risk of both ICU and hospital mortality, even after multivariable adjustment (21). Similarly, a study in 2023 showed that patients with albumin levels below 26 g/L had a significantly increased risk of 90-day and 1-year all-cause mortality (22). The evidence strongly supports the notion that serum albumin levels are a critical factor in predicting mortality risk. Higher albumin levels are associated with reduced mortality, while lower levels increase the risk, particularly in critically ill patients and those with certain medical conditions.

The results of the present study are consistent with previous research, as all identified predictors align with those reported in earlier studies. However, no study was able to correctly associate all predictors. These inconsistencies may be due to the existence of different hospital settings, geographical regions, development levels, and socioeconomic status.

The present study is limited by its single-center design. However, we are confident that the results of our study will provide valuable information for future research. Furthermore, this study provides important data on the rate of KP-BSI isolated from secondary care facilities and the associated risk factors for mortality. Existing literature has typically focused on identifying risk factors for death in tertiary care public hospitals. However, this study examined the intensive

care units of secondary care public hospitals and found high mortality rates among patients. These findings highlight the urgent need for the implementation of appropriate infection control measures for patients with KP-BSI.

## CONCLUSIONS

We believe that the identification of risk factors for mortality will contribute to both our hospital database and to the existing literature on KP-BSI. However, it is important to note that our results need to be confirmed by further studies with longer follow-up periods and larger patient populations.

### Ethical approval

This study has been approved by the Bolu Abant İzzet Baysal University Clinical Research Ethics Committee (approval date 10/09/2024, number 201).

### Author contribution

Concept: ZKC, MD; Design: ZKC; Data Collection or Processing: ZKC, MD; Analysis or Interpretation: ZKC; Literature Search: ZKC, MD; Writing: ZKC. All authors reviewed the results and approved the final version of the article.

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### Conflict of interest

The authors declare that there is no conflict of interest.

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