



ORIGINAL ARTICLE

***Staphylococcus aureus* bacteremia: A review on the detection of metastatic infections**

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KEYWORDS

Staphylococcus aureus;
Persistent
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Metastatic foci of
infection;
Mortality

Abstract *Staphylococcus aureus* is an important cause of both community-acquired and healthcare-associated bacteremia. The aim of this study was to identify foci of metastatic infection, risk factors for metastatic infection and their impact on mortality in patients with *S. aureus* bacteremia. A retrospective study was conducted between January 1, 2019 and January 1, 2022. A total of 104 adult patients with *S. aureus* isolated from blood cultures were evaluated by an infectious disease physician and included in the study. Patient data were analyzed using logistic regression to identify risk factors for metastatic infection and their impact on mortality. Metastatic infection occurred in 62% of the 104 patients: skin soft tissue infections (20%), spondylitis/spondylodiscitis (20%), endocarditis (18%), paravertebral/epidural abscesses (17%) and others. Metastatic infections were less common in patients with catheters and healthcare-associated bacteremia. Elevated levels of C-reactive protein and erythrocyte sedimentation rate were significantly associated with metastatic infections. Community-acquired and persistent bacteremia increased the likelihood of metastatic infection by 7.6-fold and 4.8-fold, respectively. The six-month mortality rate was 21% and was similar in the group with and without metastatic infections. Persistent bacteremia and advanced age increased mortality by 3.2-fold and one-fold, respectively. In conclusion, metastatic infections are common in *S. aureus* bacteremia. Infectious disease consultation is important for detecting metastatic foci and reducing mortality. Elevation of acute phase reactants, mode of acquisition and persistence of bacteremia are indicators of metastatic infection. It should be acknowledged that mortality increases with persistent bacteremia and advanced age and these patients should be followed closely.

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PALABRAS CLAVE

Staphylococcus aureus;
Bacteriemia
persistente;
Focos metastásicos
de infección;
Mortalidad

Bacteriemia por *Staphylococcus aureus*: una revisión sobre la detección de infecciones metastásicas

Resumen *Staphylococcus aureus* es una causa importante de bacteriemia adquirida en la comunidad y asociada a la asistencia sanitaria. El objetivo de este estudio fue identificar los focos de infección metastásica y sus factores de riesgo y su impacto en la mortalidad de los pacientes con bacteriemia por *S. aureus* en un hospital universitario de Estambul, Turquía. Se realizó un estudio retrospectivo (enero de 2019 -enero de 2022) que incluyó 104 pacientes adultos en cuyos hemocultivos se detectó *S. aureus* y que fueron evaluados por un médico infectólogo. Los datos de los pacientes se analizaron mediante regresión logística. El 62% tuvo infecciones metastásicas, con compromiso de los tejidos blandos de la piel (20%), espondilitis/espondilodiscitis (20%), endocarditis (18%), abscesos paravertebrales/epidurales (17%) y otras. Las infecciones metastásicas fueron menos frecuentes en pacientes con catéteres y bacteriemia asociada a la asistencia sanitaria. Los niveles elevados de proteína C reactiva y velocidad de sedimentación globular se asociaron significativamente con las infecciones metastásicas. La bacteriemia adquirida en la comunidad y la bacteriemia persistente aumentaron la probabilidad de infección metastásica en 7,6 y 4,8 veces, respectivamente. La tasa de mortalidad a los 6 meses fue del 21% y fue similar al comparar entre los grupos con infecciones metastásicas o sin estas. La bacteriemia persistente aumentó la mortalidad en 3,2 veces y la edad avanzada en 1 vez. Se concluye que las infecciones metastásicas son frecuentes en la bacteriemia por *S. aureus* y que los pacientes con bacteriemia persistente y edad avanzada deben ser objeto de seguimiento.

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Introduction

Staphylococcus aureus is a leading cause of both community-acquired and healthcare-associated bacteremia¹. In a study conducted in Finland between 2004 and 2018, the prevalence of *S. aureus* in community-acquired and healthcare-associated bacteremia was reported to be 11.8% and 15.3%, respectively¹³. *S. aureus* bacteremia is classified into two categories: complicated and uncomplicated. To classify a case as uncomplicated, several criteria must be met: endocarditis must be excluded, no vascular grafts or prosthetic devices should be present, blood cultures obtained 48–96 h after the initial set must show no growth, source control must be achieved within 72 h of initiating appropriate antibiotic therapy, and there must be no clinical or radiological evidence of metastatic infection¹⁹. For this reason, all patients with *S. aureus* bacteremia should undergo follow-up blood cultures, transthoracic echocardiography (TTE), and a thorough evaluation for both the entry site of infection and potential metastatic spread^{1,23}.

The reported incidence of metastatic foci in patients with *S. aureus* bacteremia varies widely, ranging from 5% to 75%. Inadequate management can lead both to poor prognosis and recurrence^{14,26}. Identified risk factors for metastatic infection include persistent fever and bacteremia, elevated C-reactive protein (CRP) levels, delayed initiation of treatment, and community-acquired infection^{10,12}.

The aim of this study was to identify metastatic infection foci and the risk factors for metastatic infection in patients with *S. aureus* bacteremia and to investigate the impact of these risk factors on mortality.

Materials and methods

This single-center, retrospective, descriptive study was conducted at the University of Health Sciences, Istanbul Ümraniye Training and Research Hospital, between January 1, 2019, and January 1, 2022.

The study was carried out in accordance with the principles of the Declaration of Helsinki. Ethical approval for the retrospective use of data was obtained from the local ethics committee of Ümraniye Training and Research Hospital, University of Health Sciences, Turkey (Ref. No: 195, Date: 26.05.2022). Patient information obtained from the hospital automation system was recorded on the case forms.

Inclusion criteria were as follows: patients aged 18 years and older, patients admitted to the infectious diseases service or evaluated by an infectious disease physician, patients with *S. aureus* positive blood culture (central venous catheter, hemodialysis catheter, and/or peripheral blood culture), patients evaluated by echocardiography, patients with at least one investigated metastatic infection focus related to symptoms and signs.

Exclusion criteria included: patients under the age of 18, patients directly admitted to the intensive care unit with no investigation of metastatic foci, patients not evaluated by an infectious disease physician, patients without echocardiographic evaluation, patients with no investigation of metastatic infection focus.

If the patients had multiple episodes of bacteremia, only the first episode was considered for the study. The Charlson comorbidity index was calculated for all patients. Conditions considered to determine immunosuppression

included chronic kidney disease, liver cirrhosis, human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS), malignancy, chemotherapy, solid organ transplantation, hematopoietic stem cell transplantation, corticosteroid use, and biological agents use.

The following laboratory parameters were evaluated: leukocyte count; components of the sequential organ failure assessment (SOFA) score such as bilirubin, platelet count, and international normalized ratio (INR), as well as acute phase reactants including CRP, procalcitonin, and erythrocyte sedimentation rate (ESR). Additionally, methicillin resistance of *S. aureus* strains was assessed.

Bacteremia was defined as community-acquired when there was no recent contact with the healthcare system. Cases occurring within 72 h of hospitalization, or in patients receiving chemotherapy or hemodialysis, residing in nursing homes, or hospitalized within the previous 90 days, were classified as healthcare-associated bacteremia. Persistent bacteremia was defined as the continued presence of bacterial growth in blood cultures taken after 96 h of appropriate antimicrobial treatment. Persistent fever was defined as the continuation of fever after 72 h of appropriate treatment.

Interventions for source control were evaluated, including catheter removal, valve surgery, non-valve-related surgeries, and vascular interventions.

Cases in which the source of bacteremia could not be identified at the initial evaluation were examined under the title of primary bacteremia. Patients who developed clinical signs and symptoms of infection during follow-up, in the absence of an initially identifiable source, were evaluated for metastatic infection foci. These included: endocarditis, septic intracranial emboli, septic pulmonary emboli, peripheral vascular complications, spondylitis and/or spondylodiscitis, paravertebral or epidural abscess, intra-abdominal abscess or infection, osteomyelitis and/or septic arthritis, prosthetic joint infection, sacroiliitis, skin soft tissue infection and/or abscess. Endocarditis was diagnosed using the modified Duke criteria. Septic intracranial emboli were identified using magnetic resonance imaging (MRI), and septic pulmonary emboli were diagnosed via computed tomography (CT). The presence of multiple nodular cavitory lesions consistent with hematogenous dissemination was considered septic emboli. In addition to blood cultures, synovial fluid cultures from needle aspiration or surgical drainage were used for the diagnosis of septic arthritis and prosthetic joint infection. The diagnosis of other metastatic infectious foci was based on physical examination and appropriate imaging findings.

The time when the blood cultures for *S. aureus* were obtained was defined as the time of diagnosis, and follow-up blood cultures of the patients were examined. If empiric treatments were effective against *S. aureus* strains, the initiation of the treatment was determined as day zero. For patients who did not receive appropriate treatment, the day on which useful treatment was initiated was recorded. Patients who had changes in their treatment during follow-up had their long-term treatment regimens recorded. Six months after treatment, patients were contacted through the e-Nabiz system or by phone to inquire about mortality.

Patients were grouped according to the presence or absence of metastatic infection. Patients were compared in terms of demographic characteristics, laboratory find-

ings, and clinical features. Risk factors associated with the development of metastatic infection and their impact on mortality were also examined.

Data were analyzed using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY). Frequency and percentage were used for categorical data, while median, minimum, and maximum were used as descriptive values for continuous data. The normality of the variables was evaluated using the Kolmogorov-Smirnov test. For intergroup comparisons, the Mann-Whitney *U*-test was used for comparing continuous variables between two groups. The Pearson Chi-square or Fisher's exact test was used for comparing categorical variables. Logistic regression analysis was used to examine the risk factors affecting the development of metastatic infection. The most suitable model in multivariate logistic regression analysis was created using the backward Wald method. A *p*-value of <0.05 was considered statistically significant.

Results

A total of 161 patients with *S. aureus* bacteremia was initially considered. Twenty-three patients were excluded because they were admitted to the intensive care unit or diagnosed with bacteremia on the day of admission, as appropriate physical examination and imaging could not be performed in the intensive care unit. Among the remaining 138 patients, 26 were excluded for not undergoing echocardiography (ECHO) and/or an investigation for metastatic foci, and 8 patients were not evaluated by an infectious disease specialist. Consequently, 104 patients were included in the study.

Metastatic infection was observed in 65 out of 104 patients (62%). Spondylodiscitis (20%) and skin-soft tissue infection (20%) were the most common types of metastatic infections, followed by endocarditis (18%) and paravertebral or epidural abscesses (17%) (Fig. 1). Multiple metastatic infections were present in 37 patients.

Table 1 shows the demographic characteristics of groups with and without metastatic infection. A statistically significant difference was found between the two groups in terms of catheter usage ($p < 0.05$), with catheter use being less prevalent among patients with metastatic complications.

Laboratory findings are shown in Table 2. CRP and ESR levels were significantly higher in patients with metastatic infections ($p < 0.05$). There was no statistically significant relationship between metastatic infection and methicillin resistance ($p > 0.05$).

Table 3 summarizes the clinical findings and their management. Fever, persistent bacteremia, and community-acquired bacteremia were more prevalent in patients with metastatic infections, whereas healthcare-associated bacteremia was more prevalent in the non-metastatic group. Patients with metastatic infections received longer intravenous and total treatment durations, and surgical interventions were performed more often. The six-month mortality rate in patients with *S. aureus* bacteremia was 21%, with no statistically significant difference in mortality between patients with and without metastatic complications.

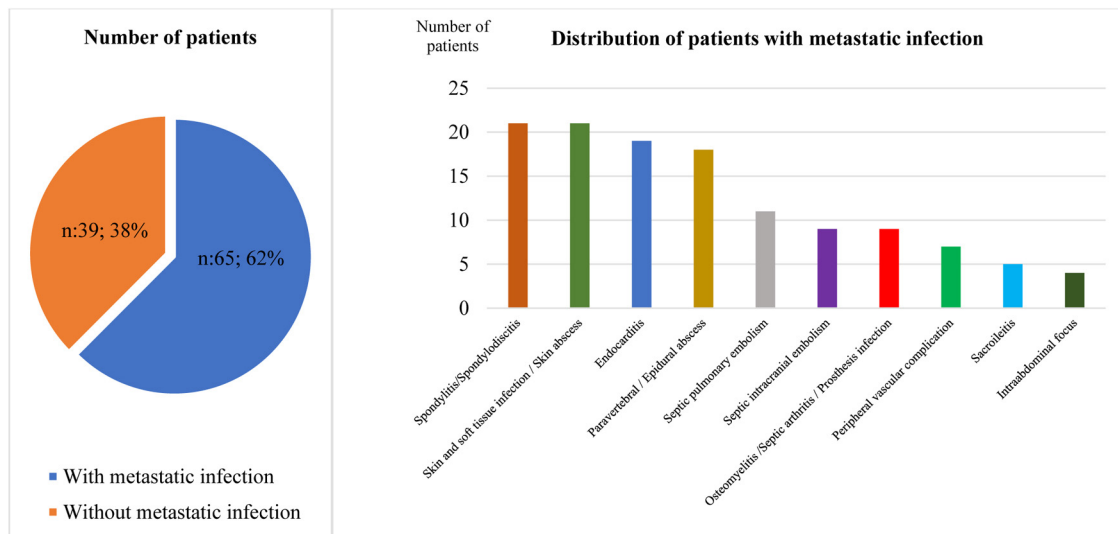


Figure 1 Frequency and distribution of metastatic infection in patients.

Table 1 Distribution of demographic characteristics among patients.

Number of patients (n = 104)	Without metastatic infections (n = 39)	With metastatic infection (n = 65)	p-Value
	n (%) or median (min-max)	n (%) or median (min-max)	
Age	64 (22-88)	64 (19-88)	0.727
Gender			1.000
Male	23 (59)	37 (56.9)	
Female	16 (41)	28 (43.1)	
IV drug dependence	0 (0)	1 (1.5)	1.000
Native heart valvular disease	27 (69.2)	47 (72.3)	0.911
Immunosuppression	27 (69.2)	35 (53.8)	0.180
Diabetes	13 (33.3)	34 (52.3)	0.093
Hemodialysis	14 (35.9)	14 (21.5)	0.171
Charlson comorbidity index	5 (1-10)	5 (0-11)	0.774
Catheter	16 (41)	7 (10.7)	0.002
Permanent HD catheter	14 (35.9)	6 (9.2)	0.002
CVC or temporary HD catheter	2 (5.1)	1 (1.5)	0.555
Presence of foreign material outside catheter	10 (25.6)	19 (29.2)	0.101

p-values in bold: statistically significant.

Table 4 shows the logistic regression analysis of risk factors affecting the metastatic infection. Except for age and gender, all variables in the univariate model were found to be statistically significant ($p < 0.05$). Catheter use and healthcare-associated bacteremia were related to reduced metastatic infections, while elevated CRP, ESR, community-acquired, and persistent bacteremia increased the risk. The most significant factors were community-acquired bacteremia and persistent bacteremia (7.6 and 4.8 times, respectively). In the multivariate analysis using the backward Wald method, CRP and community-acquired bacteremia were identified as the most appropriate model. It was found that for each increase in community-acquired bacteremia and CRP, the development

of metastatic infection increased by 12.7 times and 1 time, respectively.

Table 5 analyzes the effect of risk factors affecting the development of metastatic infection on mortality. Age, persistent bacteremia and treatment duration were found to be significant variables. Persistent bacteremia and age increased mortality by 3.2 times and 1 time, respectively, and mortality rate decreased as the duration of treatment increased. Variables found to be significant in the univariate model were re-evaluated in the multivariate model using the backward Wald method. It was found that the increase in post-treatment persistent bacteremia increased mortality by 8.2 times, while an increase in age augmented mortality by 1 time.

Table 2 Distribution of laboratory parameters of the patients.

Parameter	Without metastatic infection (median [min-max])	With metastatic infection (median [min-max])	p-Value
WBC (μ l)	11250 (940–30700)	12450 (250–31480)	0.418
PLT (μ l)	191000 (44000–461000)	210000 (26000–581000)	0.119
CRP (mg/dl)	131 (4.2–420)	219 (17–480)	<0.001
ProCT (ng/dl)	21.5 (6–98)	28 (1–50)	0.637
ESR(mm/h)	56 (2–101)	70 (4–120)	0.009
INR	1.2 (1–3.1)	1.2 (0.9–3.3)	0.713
Total bilirubin (mg/dl)	0.8 (0.1–18.4)	0.7 (0.1–10.7)	0.380
Direct bilirubin (mg/dl)	0.3 (0.1–13.2)	0.3 (0.1–9.5)	0.828
Signaling time of blood culture (h)	17 (1–59)	16 (1–57)	0.554
MSSA	30 (76.9)	48 (73.8)	0.907
MRSA	9 (23.1)	17 (26.2)	0.907

p-values in bold: statistically significant.

Table 3 Distribution of clinical characteristics and patient management.

Number of patients (n = 104)	Without metastatic infections (n = 39) n (%) or median (min-max)	With metastatic infection (n = 65) n (%) or median (min-max)	p-Value
<i>Community-acquired bacteremia</i>	8 (20.5)	43 (66.2)	<0.001
<i>Healthcare-associated bacteremia</i>	31 (79.5)	22 (33.8)	<0.001
<i>Polymicrobial infection</i>	14 (35.9)	15 (23.1)	0.236
<i>Primary bacteremia</i>	17 (44.7)	34 (52.3)	0.591
<i>Duration of symptoms</i>			0.253
Less than 6 weeks	38 (97.4)	58 (89.2)	
6–12 weeks	1 (2.6)	7 (10.8)	
<i>Persistent bacteremia</i>	4 (10.3)	23 (35.4)	0.009
<i>Persistent fever</i>	0 (0)	10 (15.4)	0.012
<i>Time to start treatment (days)</i>	0 (0–6)	0 (0–21)	0.098
<i>Duration of IV treatment (days)</i>	15 (6–42)	30 (5–131)	<0.001
<i>Total duration of treatment (days)</i>	17 (6–42)	42 (8–198)	<0.001
<i>Catheter removal</i>	13 (81.3)	7 (100)	0.526
<i>Valve surgery</i>	0 (0)	5 (7.7)	0.154
<i>Surgical interventions other than valve surgery</i>	0 (0)	21 (32.3)	<0.001
<i>Vascular surgical interventions</i>	0 (0)	4 (6.2)	0.294
<i>Mortality (6 months)</i>			1.000
Living patients	31 (79.5)	51 (78.5)	
Dead patients	8 (20.5)	14 (21.5)	

p-values in bold: statistically significant.

Discussion

Despite appropriate treatment, the mortality rate in *S. aureus* bacteremia continues to carry a mortality rate ranging from 20% to 50%, and survivors often experience significant morbidity¹⁵. Determining the source of bacteremia is crucial for early focus control and treatment management. In cases of nosocomial *S. aureus* bacteremia, the central venous catheter is usually the source, but in community-acquired bacteremia, the primary focus remains undetermined in 45–85% of cases, presenting as primary

bacteremia²². Key principles in treatment management include identifying the primary focus, ensuring appropriate focus control, and documenting the sterilization of blood alongside treatment⁹.

In our study, metastatic infection was found in 62.5% of patients. The frequency of metastatic foci of infection ranged from 5.7% to 75.3%^{14,26}. These findings were associated with the methods used to identify the foci, and the highest rate of metastatic infection was detected through PET/CT scans²⁶. In the study by Lahey et al., although complications were observed more frequently in patients

Table 4 Examination of risk factors affecting the development of metastatic infection.

Variables	Single variable OR (95% CI)	p-Value	Multivariable OR (95% CI)	p-Value
Age	1.01 (0.98–1.04)	0.526		
Gender				
Female	Reference	–		
Male	0.92 (0.41–2.06)	0.838		
Presence of catheter	0.18 (0.06–0.53)	0.002		
CRP	1.01 (1.00–1.02)	<0.001	1.01 (1.00–1.02)	0.038
ESR	1.02 (1.00–1.04)	0.014		
Community-acquired bacteremia	7.57 (2.98–19.23)	<0.001	12.70 (2.08–77.62)	0.010
Healthcare-associated bacteremia	0.13 (0.05–0.34)	<0.001		
Persistent bacteremia	4.79 (1.51–15.17)	0.008		

Table 5 The effect of risk factors affecting the development of metastatic infection on mortality.

Variables	Single variable OR (95% CI)	p-Value	Multivariable OR (95% CI)	p-Value
Age	1.05 (1.01–1.10)	0.012	1.06 (1.01–1.10)	0.018
Gender				
Female	(Reference)			
Male	1.76 (0.65–4.78)	0.266		
Presence of catheter	1.82 (0.61–5.48)	0.286		
CRP	1.01 (1.00–1.02)	0.187		
ESR	1.00 (0.98–1.01)	0.615		
Community acquired bacteremia	0.83 (0.32–2.14)	0.705		
Health care associated bacteremia	1.20 (0.47–3.09)	0.705		
Persistent bacteremia	3.19 (1.18–8.62)	0.022	8.20 (2.07–32.48)	0.003
Duration of IV therapy	0.96 (0.93–1.00)	0.056		
Total duration of treatment	0.96 (0.92–0.99)	0.015	0.93 (0.88–0.98)	0.011

evaluated by an infectious disease physician, mortality was lower. This was associated with an increased detection of metastatic foci by infectious diseases consultation and appropriate management of the disease¹⁶. Similarly, the high rate of metastatic infections in our study was attributed to the fact that all patients were evaluated by infectious disease physicians, which facilitated the detection of these infections.

Bacteria form a biofilm to protect themselves from the host's immune response and the effects of antibiotics. This process plays a significant role in the development of many diseases such as osteomyelitis, prosthetic device infections, and endocarditis³. Spondylodiscitis and soft tissue skin infection were the most common metastatic foci in these patients, followed by endocarditis and paravertebral/epidural abscesses. Van der Vaart et al. reported a similar endocarditis rate (18%) in their cohort of 491 patients with *S. aureus* bacteremia, with 39% of endocarditis cases involving intracardiac foreign bodies – a feature not observed in our cohort²⁴. Instead, native valvular heart disease was prevalent among our patients. A pediatric study examined 111 patients with metastatic infections. Pulmonary system involvement was the most frequent manifestation of metastatic infection, followed

by osteoarticular and soft tissue involvement⁸. The difference between metastatic infections in adult and pediatric patients was attributed to the impact of comorbidities in adults on secondary involvement²⁵.

In cases of catheter-associated bacteremia, the earlier detection and treatment of patients reduce the development of metastatic infections. In a study by Kovacs and colleagues on nosocomial *S. aureus* bacteremia, 64% of the cases were central line-associated bloodstream infections. While extravascular complications such as vertebral osteomyelitis and endocarditis were more common in non-catheter-related bacteremia cases, mortality was found to be similar in both groups¹⁴. In our study, the low incidence of metastatic infections in catheter-related bacteremia was likely due to early recognition and treatment of patients, as well as early catheter removal for bacteremia control.

CRP levels increase as the duration of symptoms lengthens, making it a risk factor for the development of metastatic infection²⁶. In a study of 73 patients with MSSA bacteremia, 19.2% of the patients experienced metastatic infection. Community-acquired bacteremia and a CRP level higher than 10 mg/dl were identified as predictive factors for the development of metastatic foci¹². In our study CRP and ESR levels were higher in patients with metastatic infec-

tion. Elevated ESR was linked to osteoarticular involvement in 35 patients, with an increase in this value observed in bone joint infections⁶.

Community-acquired bacteremia, implanted prosthesis, persistent fever and persistent bacteremia are among the risk factors for the development of metastatic complications^{7,10,17}. A study of 104 patients revealed that CRP level (>100 mg/dl) and metastatic infection were found more frequently in persistent bacteremia. Although community-acquired bacteremia was also common in these patients, it was not statistically significant¹⁸. In another study of 2008 patients, endocarditis was found to be the most common focus of infection. IV drug use, underlying heart disease, community-acquired bacteremia, bacteremia lasting more than 48 h, and high CRP levels were associated with endocarditis¹⁷. Our study found that community-acquired bacteremia increased the risk of metastatic infection by 7.6 times, and persistent bacteremia after treatment increased the risk by 4.8 times. These results highlight the importance of the mode of bacteremia acquisition and the surveillance of blood cultures in predicting the risk of complications in patients. In community-acquired bacteremia, delayed diagnosis and prolonged duration of bacteremia can increase the risk of metastatic complications. In line with the guidelines on the management of bacteremia, the group developing metastatic complications received longer treatment and interventions aimed at controlling the focus of infection^{9,19}. Therefore, the six-month mortality rates were similar between the groups with or without metastatic complications in our study.

Similar rates of metastatic infection have been found both in MSSA and MRSA bacteremia^{2,18}. However, some studies show the opposite. A study conducted in a pediatric population showed that MRSA strains increased the development of metastatic complications by approximately three times⁸. In our study, the frequency of metastatic complications was similar in MSSA and MRSA bacteremia. However, the lack of examination of the virulence factors of the microorganism through genomic analysis was considered a limitation of the study.

Currently, *S. aureus* bacteremia has a mortal course between 20-30% despite appropriate treatment²². A study analyzing 839 episodes of bacteremia found that the 28-day mortality rate was 14.5%. In this study, the evaluation by an infectious disease physician within 48 h and early source control were found to be associated with increased survival²¹. The higher mortality rate in our study (21%) may be attributed to a longer follow-up period (6 months vs. 28 days). Furthermore, the unknown time to source control and the timing of the patient's evaluation by infectious disease specialists may also be related to our observed mortality rate.

Although studies examining the risk factors affecting mortality in *S. aureus* bacteremia report conflicting results, age was found to be a risk factor for mortality in most of them^{4,5}. Yilmaz et al. found an age-related increase in mortality²⁷, while Minejima et al. stated that mortality rates were higher when bacteremia persisted for three days or more²⁰. Some studies suggest that nosocomial bacteremia

may be a risk factor for mortality, possibly linked to the high prevalence of comorbidities in this patient group⁴. However, other studies show that the mode of acquiring bacteremia is not a risk factor for mortality¹¹. In our study, in addition to age and gender, persistent bacteremia was associated with an 8.2-fold increase in mortality, while each additional year of age increased the risk by approximately one-fold. Conversely, longer durations of antimicrobial therapy were associated with decreased mortality. While persistent bacteremia was linked to both metastatic complications and increased mortality, our inability to evaluate mortality in relation to the specific type of metastatic complication represents a limitation of this study.

In our study, the risk factors leading to the development of metastatic infection were persistent bacteremia, community-acquired bacteremia, elevated CRP and ESR levels. Metastatic complications occurred with similar frequency in MRSA and MSSA strains. However, since the virulence factors of *S. aureus* strains were not analyzed by genomic analysis in our study, no definite conclusion could be reached on this issue. Although PET/CT was not routinely used, metastatic complications were detected in 62% of patients, and six-month mortality was similar in both groups. This was attributed to the detection of metastatic infections, effective source control, and appropriate treatment duration. The limitations of our study include the lack of data on the time to source control, the absence of a detailed investigation into causes of mortality, and the failure to conduct an evaluation on the relationship between mortality and the type of metastatic infection.

In conclusion, when *S. aureus* bacteremia is detected, the portal of entry of infection and metastatic complications should be investigated in all patients. Infectious disease consultation is crucial for the detection and appropriate management of metastatic foci, potentially reducing recurrence. Spondylodiscitis, skin soft tissue infection, and endocarditis are the most common metastatic complications. Persistent bacteremia, community-acquired bacteremia, elevated ESR and CRP levels are risk factors for the development of metastatic infection. Close monitoring is particularly warranted for elderly patients and those with persistent bacteremia, given their elevated mortality risk.

Ethical approval

The study was carried out in accordance with the principles of the Declaration of Helsinki. Ethical approval for the retrospective use of data was obtained from the local ethics committee of Umraniye Training and Research Hospital, University of Health Sciences, Turkey (Ref. No: 195, Date: 26.05.2022).

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Conflict of interest

There is no conflict of interest in our study.

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