ORIGINAL ARTICLE

Bloodstream Infections Leading to Sepsis: Clinical and Microbiological Profiling of Bacteremia among Hospitalized Patients in Surabaya, Indonesia

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ABSTRACT

Introduction: Bacteremia poses a significant health risk due to its frequently atypical presentation and potential progression to sepsis. Understanding its clinical profiles and causative pathogens is essential for timely diagnosis and effective management. This study examined the characteristics of bacteremia cases in 2022 at Universitas Airlangga Hospital, Surabaya, Indonesia.
Methods: A retrospective, descriptive observational study was conducted utilizing hospitalized bacteremia patients' medical records. A total of 107 patients met the inclusion criteria, which required positive blood cultures along with complete data on age (≥19 years), sex, comorbidities, clinical manifestations, bacterial infection diagnosis, outcomes, and pathogen characteristics. Medical records failing to meet these criteria were excluded. The data were categorized and analyzed by variables.
Results: Bacteremia predominantly affected patients aged >65 years (36.4%), males (50.5%), and those with diabetes (54.2%) and with pneumonia (79.4%). Key symptoms included tachycardia (55.1%), tachypnea (55.1%), anemia (65.4%), and leukocytosis (71.0%), despite normal vitals observed in numerous cases. Gram-positive bacteria were most prevalent (69.7%), mainly *Staphylococcus hominis* (18.7%). *Escherichia coli* (9.3%) was the leading Gram-negative isolate, while extended-spectrum beta-lactamase (ESBL) strains (4.2%) were the primary multidrug-resistant organisms (MDRO). Sepsis and septic shock were equally prevalent (35.5%). Mortality (64.5%) occurred primarily due to septic shock (49.3%).
Conclusion: Sepsis and septic shock frequently occur in older males with diabetes and pneumonia. Key symptoms include frequent tachycardia, tachypnea, anemia, and leukocytosis. Septic shock, the leading cause of death in bacteremia patients, frequently occurs alongside infections *by Staphylococcus hominis* and ESBL-producing *Escherichia coli*.

Keywords: Bacteremia; sepsis; mortality; comorbidities; infectious diseases

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Highlights:
1. This study offers fresh perspectives on the clinical profiles of hospitalized bacteremia patients and the characteristics of causative bacteria at Universitas Airlangga Hospital, a topic that has been minimally explored in the Indonesian medical community.
2. It highlights the prevalence of bacteremia, its clinical manifestations, and outcomes to determine the mortality rate of hospitalized bacteremia patients.
3. This study informs future bloodstream infection control strategies, enhancing healthcare outcomes by emphasizing the importance of improving clinical data collection and monitoring.

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INTRODUCTION

Indonesia is a developing country where infectious diseases continue to be a major problem. The most common type of infection is bloodstream infection, which includes bacteremia. Bacteremia is a condition in which the blood contains live bacteria. This disease can develop into a complication, such as sepsis, which may become one of the highest causes of morbidity and mortality worldwide if not treated immediately (Dini et al., 2016). Sepsis may develop when the infection is resistant to the host's defenses, although not all bacteremia cases progress to sepsis.

According to Lagu et al. (2012), the number of severe sepsis and septic shock cases diagnosed in the United States increased from 415,280 in 2003 to 711,736 in 2007, with a mortality rate of 29.1%. The cost of hospitalization for patients with severe sepsis and septic shock rose to USD 24.3 million in 2007. Severe sepsis and septic shock accounted for 29.5% of intensive care diagnoses in 198 intensive care units across 24 countries in continental Europe in 2002 (Vincent et al., 2006). The mortality rate of patients in intensive care reached 32.2% for severe sepsis and increased to 54.1% for septic shock (Ministry of Health of the Republic of Indonesia, 2017). A retrospective observational study on sepsis patients was conducted by Purba et al. (2020) in four major hospitals in Indonesia from 2013 to 2016. The study found that the national burden of sepsis was estimated to be USD 130 million per 100,000 patients. Sepsis patients with multifocal infections and single lower respiratory tract infections showed the highest cost, at approximately USD 33–48 million per 100,000 patients. The cost of sepsis with cardiovascular infections was the highest per patient, reaching USD 4,256.

Bacteremia can affect individuals of all age groups and sexes. However, elderly patients, especially those with several comorbidities, such as cancer, diabetes, cardiovascular disease, and chronic renal failure, are at a higher risk of acquiring bacteremia and sepsis (Arcens et al., 2018). The symptoms of infection are sometimes atypical in bacteremia patients and often result in hampered early detection, increasing the risk of developing sepsis that leads to death. Therefore, it is important to be aware of the clinical spectrum of bacteremia in order to reduce the risk of sepsis and determine the appropriate management.

One of the reasons for this study was the difficulty in determining the global incidence of sepsis, especially in developing countries such as Indonesia, due to a lack of data or reporting (Purba et al., 2020). Universitas Airlangga Hospital was chosen as the place to conduct this study because the clinical profile of hospitalized bacteremia patients in the facility is still lacking in data. Consequently, it was necessary for this study to investigate the clinical profile of these patients. The researchers aimed to generate valuable data that could be used to inform future infection control strategies for the management and prevention of bloodstream infections.

METHODS

This study was descriptive observational research utilizing secondary data from the medical records of bacteremia patients hospitalized in 2022 at Universitas Airlangga Hospital, Surabaya, Indonesia (Muslimin et al., 2023). The patients exhibited positive blood cultures, with the blood samples taken from either one side or both sides of the body but not restricted to a specific body part. A total of 107 medical records of hospitalized patients, starting from age 19, met the inclusion criteria for this study. These medical records must include data on blood culture results, age, sex, patient outcomes, comorbidities, clinical manifestations, diagnoses of bacterial infectious diseases, and characteristics of causative bacteria.

The chosen data collection technique was total sampling, which was employed to obtain secondary data from patient medical records that met the predetermined variables (Subhaktiyasa, 2024). This study used a retrospective design and was carried out in the medical records room and microbiological laboratory of Universitas Airlangga Hospital, Surabaya, Indonesia, between June 2023 and April 2024. The data were categorized according to the specified variables and processed using Microsoft Excel for Windows, version 16.0 (Microsoft Inc., Redmond, WA, USA, 2016). The data were presented in tables and graphs showing frequencies and percentages. The results were then interpreted by descriptive analysis. The ethical approval for this study was granted by the Health Research Ethics Committee of Universitas Airlangga Hospital, Surabaya, Indonesia, under certificate number 135/KEP/2023, issued on October 10, 2023.

RESULTS

Distribution of patients with bacteremia and sepsis

In this study, 107 datasets that fit the inclusion criteria were obtained. Table 1 presents the distribution of bacteremia patients who experienced further complications, specifically in the form of sepsis or septic shock, at Universitas Airlangga Hospital, Surabaya, Indonesia, in 2022. The analysis of the obtained data revealed that of the 107 patients confirmed with bacteremia, not all experienced further complications. Among the patients, 38 (35.5%) developed sepsis, and an equal number (38, 35.5%) progressed to septic shock. In contrast, 31 patients (29.0%) had neither sepsis nor septic shock

complications.

Bacteremia in this study was defined as the presence of bacteria in the bloodstream, determined by positive results in the patients' blood cultures. Sepsis was identified as a more severe condition that occurred as a result of bacteremia, characterized by a systemic response to infections that lead to organ failure. Septic shock was typically identified by low blood pressure resulting from organ failure during the sepsis phase. The classification in this study was derived from doctors' notes in the patients' medical records.

Table 1. Distribution of patients with bacteremia and sepsis

Complications	n (%)
Bacteremia	107 (100.0%)
Sepsis	38 (35.5%)
Septic shock	38 (35.5%)
No sepsis/septic shock	31 (29.0%)

Distribution of hospitalized patients with bacteremia

Table 2 presents data on the distribution of bacteremia patients hospitalized in 2022 at Universitas Airlangga Hospital, Surabaya, Indonesia. Five variables were analyzed for these patients who met the inclusion criteria of this study: sex, age, comorbidities, bacterial infectious diseases, and mortality.

The number of bacteremia cases were distributed across different age groups as follows: 2 (1.9%) in the 19–25 age group, 9 (8.4%) in the 26–35 age group, 4 (3.7%) in the 36–45 age group, 21 (19.6%) in the 46–55 age group, 32 (30.0%) in the 56–65 age group, and 39 (36.4%) in the >65 age group. The majority of bacteremia cases occurred in patients older than 56 years.

Among the 107 patients analyzed, the most prevalent comorbidity was diabetes mellitus, which accounted for 58 patients (54.2%). This was followed by heart disease in 57 patients (53.3%) and chronic kidney disease in 56 patients (52.3%). Other comorbidities observed were as follows: hypertension and vascular disease in 42 patients (39.3%), malignancy in 15 patients (14.0%), chronic obstructive pulmonary disease in 7 patients (6.5%), liver disease in 5 patients (4.7%), human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) in 4 patients (3.7%), and autoimmune disease in 1 patient (0.9%). The remaining five patients (4.7%) did not present any of the aforementioned comorbidities.

Infectious diseases identified in the hospitalized bacteremia patients were divided into six categories: bacterial pneumonia in 85 individuals (79.4%), skin and soft tissue infections in 25 individuals (23.4%), gastrointestinal infections in 14 individuals (13.1%), central nervous system infections in 5 individuals (4.7%), urinary tract infections in 5 individuals (4.7%), and other infections in 23 individuals (21.5%). The data revealed that the most prevalent bacterial infectious disease among the hospitalized patients was bacterial pneumonia.

The majority of patients, totaling 69 individuals (64.5%), were declared deceased. Meanwhile, the remaining 38 patients (35.5%) were discharged alive from the hospital. As shown in Figure 1, the most common cause of mortality among the hospitalized bacteremia patients was septic shock, affecting 34 individuals (49.3%). This was followed by sepsis, which affected 18 individuals (26.1%). The least frequent occurrence was mortality without complications, as observed in 17 individuals (24.6%).

Table 2. Distribution of the hospitalized bacteremia patients

Characteristics	n (%)
Sex	
Male	54 (50.5%)
Female	53 (49.5%)
Age (years)	
>65	39 (36.4%)
56–65	32 (30.0%)
46–55	21 (19.6%)
36–45	4 (3.7%)
26–35	9 (8.4%)
19–25	2 (1.9%)
Comorbidities	
DM	58 (54.2%)
Heart diseases	57 (53.3%)
CKD	56 (52.3%)
Hypertension	42 (39.3%)
Vascular disease	42 (39.3%)
Malignancy	15 (14.0%)
COPD	7 (6.5%)
Liver disease	5 (4.7%)
HIV/AIDS	4 (3.7%)
Autoimmune disease	1 (0.9%)
None of the above	5 (4.7%)
Bacterial infectious diseases	
Bacterial pneumonia	85 (79.4%)
Skin and soft tissue infection	25 (23.4%)
Gastrointestinal infection	14 (13.1%)
CNS infection	5 (4.7%)
UTI	5 (4.7%)
Others	23 (21.5%)
Outcomes	
Deceased	69 (64.5%)
Alive	38 (35.5%)

Notes: DM=diabetes mellitus; CKD=chronic kidney disease; COPD=chronic obstructive pulmonary disease; HIV/AIDS=human immunodeficiency virus/acquired immunodeficiency syndrome; CNS=central nervous system; UTI=urinary tract infection.

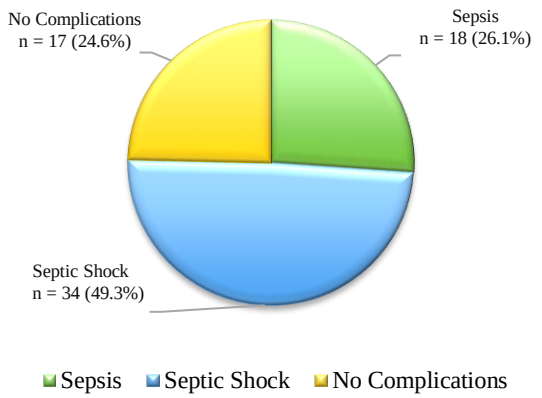

Figure 1. Diagram illustrating the distribution of deceased patients

Clinical manifestations in hospitalized patients with bacteremia

Table 3 presents data on the mean, standard deviation, and median of the clinical features present in 107 bacteremia patients who were hospitalized in 2022 at Universitas Airlangga Hospital, Surabaya, Indonesia. The recorded clinical features included six vital signs and three blood parameters. The components were selected based on the quick Sequential Organ Failure Assessment (qSOFA) and Sequential Organ Failure Assessment (SOFA) parameters, considered common instruments for diagnosing sepsis. The following clinical features of the patients were recorded as mean and standard deviation: temperatures (37.22 ± 1.14), heart rates (105.93 ± 22.24), respiratory rates (24.46 ± 8.09), systolic blood pressures (128.22 ± 33.64), diastolic blood pressures (74.43 ± 22.32), mean arterial pressures (91.74 ± 25.21), hemoglobin levels (11.11 ± 2.58), leukocyte counts (15.74 ± 8.70), and platelet counts (265.12 ± 148.96). The recorded medians of clinical features in the patients included temperatures (37.00), heart rates (102.00), respiratory rates (22.00), systolic blood pressures (122.00), diastolic blood pressures (70.00), mean arterial pressures (87.00), hemoglobin levels (10.90), leukocyte counts (13.12), and platelet counts (243.00).

It was found that the mean and median values for vital signs and blood parameters were identical, indicating that the temperatures, diastolic blood pressures, mean arterial pressures, and platelet counts were within normal ranges. Meanwhile, the heart rates, respiratory rates, systolic blood pressures, and leukocyte counts showed an increase beyond normal limits. The hemoglobin levels in the blood examination were the only parameter that fell below the normal limit. The smallest standard deviation was recorded for the temperature parameter at 1.14, while the largest standard deviation was noted for platelet counts at 148.96.

Table 3. Statistical data of the patients' clinical manifestations

Parameters	Mean±SD	Median
Vital signs		
Temperatures (°C)	37.22 ± 1.14	37.00
HR (/minute)	105.93 ± 22.24	102.00
RR (/minute)	24.46 ± 8.09	22.00
SBP (mmHg)	128.22 ± 33.64	122.00
DBP (mmHg)	74.43 ± 22.32	70.00
MAP (mmHg)	91.74 ± 25.21	87.00
Blood counts		
Hb (g/dL)	11.11 ± 2.58	10.90
Leukocytes (10^3/µL)	15.74 ± 8.70	13.12
Platelets (10^3/µL)	265.12 ± 148.96	243.00

Notes: SD=standard deviation; HR=heart rate; RR=respiratory rate; SBP=systolic blood pressure; DBP=diastolic blood pressure; MAP=mean arterial pressure; Hb=hemoglobin.

Table 4. Categorization of clinical manifestations in the hospitalized bacteremia patients

Parameters	n (%)
Vital signs	
Temperatures	
Normal	46 (43.0%)
Hypothermia	24 (22.4%)
Hyperthermia	2 (1.9%)
Febrility	35 (32.7%)
Heart rates	
Normal	47 (43.9%)
Bradycardia	1 (0.9%)
Tachycardia	59 (55.1%)
Respiratory rates	
Normal	46 (43.0%)
Bradypnea	2 (1.9%)
Tachypnea	59 (55.1%)
Blood pressures	
Normal	38 (35.5%)
Hypotension	21 (19.6%)
ISH	13 (12.1%)
Pre-hypertension	7 (6.5%)
Stage 1 hypertension	8 (7.5%)
Stage 2 hypertension	13 (12.1%)
Stage 3 hypertension	7 (6.5%)
Blood parameters	
Hb	
Normal	37 (34.6%)
Anemia	70 (65.4%)
Leukocytes	
Normal	28 (26.2%)
Leukopenia	3 (2.8%)
Leukocytosis	76 (71.0%)
Platelets	
Normal	66 (61.7%)
Thrombocytopenia	21 (19.6%)
Thrombocytosis	20 (18.7%)

Notes: ISH=isolated systolic hypertension; Hb=hemoglobin.

Table 4 shows the categorization of clinical manifestations, including vital signs and blood counts, in the hospitalized patients with bacteremia. Forty-six individuals (43.0%) exhibited normal temperatures, 24 individuals (22.4%) presented with hypothermia, 2 individuals (1.9%) experienced hyperthermia, and 35 individuals (32.7%) were categorized as febrile. Heart rates were classified as normal for 47 individuals (43.9%), bradycardia for 1 individual (0.9%), and tachycardia for 59 individuals (55.1%). Respiratory rates were categorized as normal for 46 individuals (43.0%), bradypnea for 2 individuals (1.9%), and tachypnea for 59 individuals (55.1%). Blood pressure classification included normal for 38 individuals (35.5%), hypotension for 21 individuals (19.6%), isolated systolic hypertension for 13 individuals (12.1%), pre-hypertension for 7 individuals (6.5%), stage 1 hypertension for 8 individuals (7.5%), stage 2 hypertension for 13 individuals (12.1%), and stage 3 hypertension for 7 individuals (6.5%).

Hemoglobin levels indicated normal ranges in 37 patients (34.6%) and anemia for 70 patients (65.4%). Leukocyte counts showed normal levels in 28 individuals (26.2%), leukopenia in 3 individuals (2.8%), and leukocytosis in 76 individuals (71.0%). Platelet counts were classified as normal for 66 individuals (61.7%), thrombocytopenia for 21 individuals (19.6%), and thrombocytosis for 20 individuals (18.7%).

Characteristics of the causative bacteria

Table 5 presents data on the distribution and characteristics of bacteria that caused bacteremia in patients hospitalized in 2022 at Universitas Airlangga Hospital, Surabaya, Indonesia. The characteristics of the causative bacteria included their Gram classification, encompassing Gram-negative and Gram-positive, as well as their genus or species identification. It was observed that Gram-positive bacteria were the most common type in the patients' blood cultures, accounting for 83 cases (69.7%). Meanwhile, Gram-negative bacteria were recorded in 36 cases (30.3%). All Gram-positive bacteria were found to be cocci (round), while all Gram-negative bacteria were classified as bacilli (rod) shaped.

A total of around 31 types of bacteria were found across all samples. The most prevalent bacteria identified in patient blood cultures were *Staphylococcus hominis* in 20 cases (18.7%), followed by *Staphylococcus epidermidis* in 13 cases (12.1%), *Staphylococcus aureus* in 11 cases (10.3%), *Escherichia coli* in 10 cases (9.3%), *Acinetobacter baumannii* and *Klebsiella pneumoniae* in 8 cases each (7.5%), *Staphylococcus haemolyticus* in 7 cases (6.5%), *Enterococcus faecalis* and *Pseudomonas aeruginosa* in 5 cases each (4.7%), and *Staphylococcus cohnii* and coagulase-negative staphylococci (CoNS) in 3 cases each (2.8%). Simultaneously, *Enterobacter cloacae*, *Staphylococcus saprophyticus*, *Staphylococcus sciuri*, *Staphylococcus warneri*, and *Streptococcus pyogenes* were detected in two cases each (1.9%).

Table 5. Characteristics of the causative bacteria

Causative bacteria	n (%)
Type of Gram	
Gram-positive	83 (69.7%)
Gram-negative	36 (30.3%)
Genus/species of Gram-positive bacteria	
Staphylococcus hominis	20 (18.7%)
Staphylococcus epidermidis	13 (12.1 %)
Staphylococcus aureus	11 (10.3 %)
Staphylococcus haemolyticus	7 (6.5%)
Enterococcus faecalis	5 (4.7%)
CoNS	3 (2.8%)
Staphylococcus cohnii	3 (2.8%)
Staphylococcus saprophyticus	2 (1.9%)
Staphylococcus sciuri	2 (1.9%)
Staphylococcus warneri	2 (1.9%)
Streptococcus pyogenes	2 (1.9%)
Aerococcus viridans	1 (0.9%)
Kocuria rhizophila	1 (0.9%)
Kocuria rosea	1 (0.9%)
Leuconostoc mesenteroides	1 (0.9%)
Staphylococcus arlettae	1 (0.9%)
Staphylococcus equorum	1 (0.9%)
Staphylococcus lentus	1 (0.9%)
Staphylococcus xylosus	1 (0.9%)
Streptococcus anginosus	1 (0.9%)
Streptococcus thoraltensis	1 (0.9%)
Streptococcus uberis	1 (0.9%)
α-hemolytic streptococci	1 (0.9%)
Not identified	1 (0.9%)
Genus/species of Gram-negative bacteria	
Escherichia coli	10 (9.3%)
Acinetobacter baumannii	8 (7.5%)
Klebsiella pneumoniae	8 (7.5%)
Pseudomonas aeruginosa	5 (4.7%)
Enterobacter cloacae	2 (1.9%)
Burkholderia cepacia	1 (0.9%)
Citrobacter koseri	1 (0.9%)
Pantoea spp.	1 (0.9%)

Notes: CoNS=coagulase-negative staphylococci.

The bacteria with the least prevalence in the patients' blood cultures consisted *of Aerococcus viridans*, *Burkholderia cepacia*, *Citrobacter koseri*, *Kocuria rhizophila*, *Kocuria rosea*, *Leuconostoc mesenteroides*, *Pantoea* spp., *Staphylococcus arlettae*, *Staphylococcus equorum*, *Staphylococcus lentus*, *Staphylococcus xylosus*, *Streptococcus anginosus*, *Streptococcus thoraltensis*, *Streptococcus uberis*, and α-hemolytic streptococci, each amounting to a single case (0.9%). In one particular case (0.9%), the blood culture procedure was halted after Gram staining because the patient had died prior to further bacterial culturing, hence preventing the identification of the bacterial species responsible

for the infection. Of the 119 bacteria found in the cultures, 11 were categorized as multiple drug-resistant organisms (MDRO). As illustrated in Figure 2, these multidrug-resistant bacteria included extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* with 5 cases (4.2%), ESBL-producing *Klebsiella pneumoniae* with 4 cases (3.4%), and methicillin-resistant *Staphylococcus aureus* (MRSA) with 2 cases (1.7%).

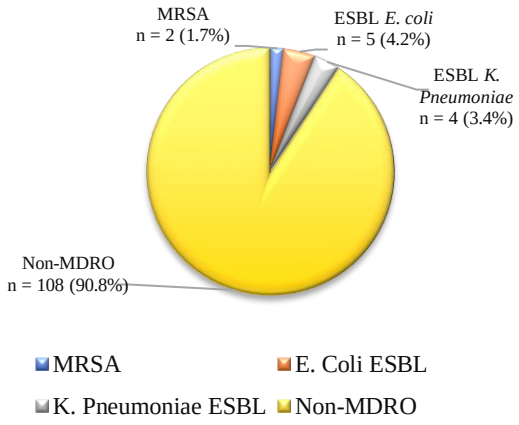

Figure 2. Diagram showing the multidrug-resistant organism (MDRO) distribution

DISCUSSION

Bacteremia, sepsis, and septic shock

Bacteremia refers to the presence of viable bacteria in the bloodstream, which can vary from asymptomatic cases to severe infections and potentially fatal septic shock (Hess, 2023). The prevalence of bacteremia among hospitalized patients in Indonesia is quite high. In a study conducted in 11 hospitals across Jakarta Province, Indonesia, 9.8% of hospitalized patients acquired nosocomial infections (Suarmayasa, 2023). Another study conducted at Koja Regional General Hospital, Jakarta, Indonesia, revealed that the prevalence of positive blood cultures among all intensive care unit patients was 15.6% (Mansyoer & Widjaja, 2017). Meanwhile, this study revealed that the rate of bacteremia reached around 23% among all patients hospitalized in 2022 at Universitas Airlangga Hospital, Surabaya, Indonesia, according to the blood culture results. The data indicated a slightly higher rate compared to previous studies.

Bacteremia plays an important role in the development of sepsis, especially in critically ill patients. Bacterial sepsis is a life-threatening condition that arises when the body's response to an infection injures its tissues and organs. Sepsis has recently been redefined as a life-threatening organ dysfunction caused by a dysregulated host response to infection (Bullock & Benham, 2023). Of the 107 patients with confirmed bacteremia in this study, 38 individuals (35.5%) exhibited sepsis.

Septic shock is the most severe form of sepsis, characterized by a drop in blood pressure, decreasing tissue perfusion pressure, and resultant hypoxia (Srzić, 2022). A study conducted by Ahmed et al. (2021) concluded that 38.75% of patients experienced septic shock. This is in line with this study, wherein 38 (35.5%) patients fell into a state of septic shock.

Bacteremia in female and male patients

This study showed that the prevalence of male patients was observed more (50.5%) than female patients (49.5%). However, the findings revealed a minor difference of merely one point. The data from this study also indicated variations in the type of bacteremia between the two sexes. The five cases of urinary tract infections recorded consisted of 80% female patients and 20% male patients. Prior research has similarly found that bacteremia in female patients is often associated with urinary tract infections, mainly caused by Gram-negative bacteria, such as *Escherichia coli* (Lee et al., 2018). On the other hand, bacteremia in male patients tends to be associated with intra-abdominal infections or infections originating from other sources.

Previous studies have highlighted differences in the immune response between male and female patients that may influence the risk and prognosis of bacteremia. Females are considered to have a stronger immune response to bacterial infections, which may influence the likelihood of bacteremia progressing to sepsis and overall prognosis (Dias et al., 2022). Meanwhile, factors such as smoking habits, alcohol consumption, and environmental exposure can affect the risk of bacteremia in males. Sex hormones play a role, as the relationship between bacteremia and sexes is still not fully understood and requires further research.

Bacteremia across age groups

The prevalence of bacteremia tends to increase with age. Several prior studies, including research by Martin-Loeches et al. (2019), have demonstrated that bacteremia is more common in the elderly population. Factors such as decreased immune function, physical weakness, comorbidities, and repeated exposure to health care can increase the risk of bacteremia. The earlier findings are in line with this study, which presents data on the age categorization of bacteremia patients in the inpatient room of Universitas Airlangga Hospital, Surabaya, Indonesia, in 2022. This study found that around 86% of the patients were middle-aged and elderly.

The data provided in this study indicated that

more than half of the bacteremia cases occurred in the 56–65 and >65 age groups. This is consistent with a previous study conducted by Lee et al. (2017) in patients with bacteremia, where the most common age category was the elderly aged 65–85 years. Epidemiological research in the United States also showed that the incidence of sepsis increases with age. They reported that senior citizens (over 65 years) have a higher risk of experiencing sepsis compared to younger age groups.

Comorbidities in hospitalized bacteremia patients

This study revealed that the three most common comorbidities in bacteremia patients hospitalized in 2022 at Universitas Airlangga Hospital, Surabaya, Indonesia, were diabetes mellitus (54.2%), heart disease (53.3%), and chronic kidney disease (52.3%). Diabetes mellitus is often associated with decreased immune function, impaired circulation, and tissue damage. Diabetes mellitus-associated disorders can increase the risk of bacterial infections and complications, such as bacteremia (Berbudi et al., 2020).

A previous study conducted by Sipilä et al. (2023) highlighted that patients with heart disease have a higher risk of acquiring bacterial infections, including bacteremia, compared to the general population. Factors such as blood stagnation, impaired circulation, and endothelial damage that frequently occur in heart disease create an environment conducive to the growth and spread of pathogenic bacteria in the body. Endothelial damage associated with heart disease can facilitate bacterial invasion into the bloodstream and elevate the likelihood of bacteremia (Vilcant & Hai, 2023).

Other than patients with diabetes mellitus and heart disease, individuals suffering from chronic renal failure also have an elevated risk of bacteremia (Ponce et al., 2023). This is especially notable in infections related to catheter use. Chronic renal failure is associated with immune system dysfunction, metabolic disorders, and decreased kidney function, which can increase the risk of bacterial infections and bacteremia.

Bacterial infectious diseases in bacteremia patients

The diagnosis of bacterial infectious diseases in this study was obtained from the doctors' statement noted in the patients' medical records, along with the results of supporting examinations such as radiologic examination. The most common infectious disease diagnosed in bacteremia patients hospitalized in 2022 at Universitas Airlangga Hospital, Surabaya, Indonesia, was bacterial pneumonia. A study conducted by Tambajong et al. (2016) at Prof. Dr. R. D. Kandou Central General Hospital, Manado, Indonesia, similarly identified pneumonia as the most prevalent underlying disease (71.4%) causing sepsis in patients within the internal care unit. Another study conducted by Nainggolan et al. (2017) at the same hospital concluded that sepsis and septic shock infections were mainly caused by pneumonia, with a prevalence of 75%. Both studies are in line with this study, wherein bacterial pneumonia exhibited a notable distribution in respiratory tract infections related to the incidence of bacteremia and sepsis, with cases amounting to 79.4%.

Other prevalent infectious diseases identified in this study included skin and soft tissue infections, accounting for 23.4% of the total cases. Although not as many as bacterial pneumonia, the disease exhibited a high number of cases compared to other categories. In this study, 11 (44.0%) of the 25 skin and soft tissue infection cases originated from ulcerative wounds, while 8 (32.0%) were classified as cellulitis cases. Skin and soft tissue infections have become more common, contributing to a substantial number of hospital admissions. Gram-positive bacteria, particularly *Staphylococcus aureus*, remain the most frequently isolated pathogens in skin and soft tissue infections (Bassetti et al., 2018). This aligns with the data from this study, which indicated that up to 80% of patients with skin and soft tissue infections exhibited Gram-positive bacteria in their blood cultures.

This study found that 76% of the skin and soft tissue infection cases developed in patients who had diabetes mellitus, which was identified as the most common comorbidity (54.2%) among the patients. Diabetes mellitus is a disease that can increase the risk of skin and soft tissue infections, potentially leading to bacteremia or sepsis. Prior research conducted by Hu et al. (2022) additionally suggests that obesity can be a predisposing factor for severe infections, such as skin and soft tissue infections.

Mortality outcome in hospitalized bacteremia patients

This study found that the mortality rate among bacteremia patients who were admitted to the inpatient room of Universitas Airlangga Hospital, Surabaya, Indonesia, in 2022, reached 64.5% of the total population. This group included patients with complications such as sepsis or septic shock, as well as those without such problems. Factors such as disease severity, the presence of septic shock, and antimicrobial resistance can affect the mortality rate in patients with bacteremia. A previous study revealed that sepsis was associated with a mortality rate of 25–30%, with 50–85% attributable to septic shock (Minasyan, 2019).

Prior research suggests that elevated mortality rates may be observed in patients with septic shock or other complications (La Via et al., 2024). This

study revealed similar findings, indicating that septic shock was the leading cause of mortality among hospitalized patients with bacteremia. Septic shock accounted for 49.3% of all mortality cases. On the other hand, sepsis was the second highest cause of mortality, accounting for 26.1%, following septic shock.

Clinical manifestations of bacteremia in hospitalized patients

The most common abnormal symptoms observed as clinical manifestations of infection in this study were tachycardia (55.1%), tachypnea (55.1%), anemia (65.4%), and leukocytosis (71.0%). Bacteremia can cause tachycardia and tachypnea, which are considered cardinal signs of sepsis (Yamashiro & Nomoto, 2017). Anemia and leukocytosis have demonstrated a notable prevalence in bacteremia cases. Leukocytosis, an increase in white blood cells, is a typical response to infection and frequently serves as a marker for diagnosing bacteremia (Uhlenhopp et al., 2020). Anemia, albeit less frequently highlighted, can occur due to the body's response to prolonged infection and inflammation (Clark et al., 2018). Although hypotension was not the most common manifestation in this study, it managed to be in second place, with a total of 21 cases (19.6%). In addition, it was shown that of all patients who experienced hypotension, 15 (71.4%) fell into a state of septic shock, while 5 (23.8%) had sepsis.

Temperature, as another manifestation, also supports the notion that fever (febrile) is a common symptom resulting from infection. The mechanism of fever occurs due to the presence of pyrogens, which may originate from outside the body (exogenous pyrogens) or from within the body (endogenous pyrogens). Pyrogens cause tissue damage and stimulate the production of prostaglandin E2, which is carried to the hypothalamus and causes an increase in body temperature (El-Radhi, 2018). In this study, fever ranked second after the normal temperature category. Normal manifestations, especially related to temperature and blood pressure, may occur considering the relatively changing values while the patient is in the intensive care unit.

The platelet counts of the patients in this study were mainly within the normal range. This is in line with prior research conducted by Pairunan et al. (2016), which reported an average platelet count of 320 x 10^3/µL in sepsis patients and 319 x 10^3/µL in septic shock patients. The study further revealed that there was no association between peripheral blood images and the incidence of sepsis. Another study by Rosita & Husodo (2015) also found that out of 38 sepsis patients who met the inclusion criteria, 27 had normal to increased platelet values.

In this study, thrombocytopenia was found among the hospitalized bacteremia patients, with a prevalence rate of 19.6%. This finding is in accordance with a prior study that identified an association between thrombocytopenia and the incidence of sepsis or septic shock, which might be caused by antibodies to platelets or related to the incidence of disseminated intravascular coagulation (Pairunan et al., 2016). Zhou et al. (2022) conducted research on sepsis patients in the intensive care unit, revealing that thrombocytopenia, expressed by diminished platelet counts, was present in 18% of the patients.

Characteristics of causative bacteria

This study identified Gram-positive bacteria as the most common type found in the blood cultures of bacteremia patients in the inpatient room of Universitas Airlangga Hospital, Surabaya, Indonesia, in 2022, with an incidence rate of 69.7%. The most widely distributed bacteria included *Staphylococcus hominis* (18.7%), *Staphylococcus epidermidis* (12.1%), and *Staphylococcus aureus* (10.3%) from the Gram-positive coagulase-negative staphylococci group, alongside *Escherichia coli* (9.3%), *Acinetobacter baumannii* (7.5%), and *Klebsiella pneumoniae* (7.5%) from the Gram-negative group. Earlier research conducted by Toyyibah et al. (2022) is in line with this study, suggesting that the three predominant bacteria responsible for sepsis were Gram-positive, primarily *Staphylococcus hominis*. Similar to the findings of this study, the most prevalent Gram-negative bacteria identified in the earlier research included *Escherichia coli*, *Acinetobacter* spp., and *Klebsiella pneumoniae*.

The virulence factors of coagulase-negative staphylococci, such as biofilms, extracellular proteins, hemagglutinins, lantibiotics, bacteriocins, and toxins, play a role in causing sepsis (Goulart, 2023). *Staphylococcus aureus* has quite distinctive virulence factors, including coagulase, an enzyme-like protein that can clot plasma. In addition, this bacterium possesses Panton-Valentine leukocidin (PVL), which functions to destroy leukocytes, thereby assisting in the process of tissue infection (Larasati et al., 2020).

Gram-negative bacteria, such as *Escherichia coli*, *Acinetobacter baumannii*, and *Klebsiella pneumoniae*, have virulence factors that include capsules, lipopolysaccharides, adhesins, and fimbriae. Capsules are present on the surface of bacteria, serving to mediate the attachment of bacteria to host cells and enhance their resistance to phagocytosis. Lipopolysaccharide, a component of the cell wall of Gram-negative bacteria, stimulates the release of pro-inflammatory mediators and causes systemic or tissue inflammation (Riwu et al., 2022). Adhesins and fimbriae are proteins that help bacteria adhere to host cells and inhibit the host's

immune system. In addition, fimbriae also play a role in the absorption of iron, which is important for bacterial growth (Jin & Marshall, 2020).

Mansyoer & Widjaja (2017) conducted an investigation that is in accordance with this study. In the research, the most commonly identified microorganisms from the Gram-positive group were *Staphylococcus hominis*, *Staphylococcus epidermidis*, *Staphylococcus haemolyticus*, and *Staphylococcus aureus*. Meanwhile, the common microorganisms from the Gram-negative group were *Salmonella typhi* and *Acinetobacter baumannii*.

The bacteria identified as prevalent contaminants from the blood cultures in this study were coagulase-negative staphylococci (i.e., *Staphylococcus epidermidis*, *Staphylococcus hominis*, *Staphylococcus haemolyticus*, *Staphylococcus cohnii*, and *Staphylococcus warneri*), *Staphylococcus aureus*, *Streptococcus anginosus*, *Kocuria rhizophila*, and *Kocuria rosea*. Approximately 28.1% of the aforementioned bacterial species/genus have the potential to become contaminants. Meanwhile, bacteria such as *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii* are usually considered true pathogens, rather than contaminants, unless there are specific indications of contamination (Aiesh et al., 2023).

The clinical and microbiological profiles of bacteremia in hospitalized patients, which remain minimally studied in Indonesia, can be better understood through this study. By focusing on the clinical profiles of patients and the characteristics of the causative bacteria, this study offers an important contribution to the identification and comprehension of the distribution, causes, and impact of infections that cause bacteremia, especially in the hospital environment. This study is one of the few to explore microbiological data concerning bloodstream infections caused by bacteria while also extending the discussion to sepsis and septic shock as complications, thus enriching the existing literature and paving the way for further research.

However, several limitations need to be considered. Firstly, this study did not limit the anatomical sites from which blood samples were collected for the culturing. The study samples included patients who had their blood drawn from either one side of the body or both sides for culturing. Therefore, positive results could not be ascertained as either due to contamination or indicative of a real systemic infection. Secondly, the timing of blood laboratory testing was not consistent across patients, potentially leading to certain trends in the data. Lastly, vital sign variables were unevenly recorded on the first day of admission due to the lack of files uploaded to the medical record database of Universitas Airlangga Hospital, Surabaya, Indonesia. These limitations might affect the generalizability of the study results and pose challenges in comprehensive data interpretation.

CONCLUSION

Bacteremia is linked to notable morbidity and mortality, particularly among elderly patients with comorbidities such as diabetes. Although some clinical manifestations remain within normal limits, others exhibit a predominance of abnormal results. This evidence indicates the possibility of variation in hospitalized patients with infection. Moreover, this study suggests that bacteremia is a strong risk factor for the occurrence of sepsis at Universitas Airlangga Hospital, Surabaya, Indonesia.

Further research is warranted to investigate the role of medical devices, such as central venous catheters and urinary catheters, as risk factors for bacteremia in hospitalized patients. Additional research is recommended to assess the incidence of infections, patient demographics, and adherence to infection control protocols. The findings may inform policy recommendations for stricter infection prevention measures. To validate these results, prospective cohort studies should monitor patients utilizing these devices, assess the incidence of bacteremia, and evaluate the effectiveness of interventions such as improved sterilization practices and alternative device applications. This approach would help refine infection control strategies and reduce the risk of device-related bacteremia.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ETHICS CONSIDERATION

This study followed all relevant ethical guidelines and received clearance from the Health Research Ethics Committee of Universitas Airlangga Hospital, Surabaya, Indonesia, under certificate number 135/KEP/2023, granted on October 10, 2023.

FUNDING DISCLOSURE

None to declare.

AUTHOR CONTRIBUTION

NM contributed to the study conceptualization and design, analysis and interpretation of the data, drafting of the article, and collection and assembly of data. Furthermore, TPA, FS, and PDE participated in the critical revision of the article for important intellectual content and provided final approval of the article.

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