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RESEARCH ARTICLE

BLOODSTREAM INFECTIONS IN INTENSIVE CARE UNIT PATIENTS IN TERTIARY HOSPITALS IN SANA'A CITY, YEMEN

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Abstract

Background and Aims: One of the most common infection among critically ill patients is bloodstream infection (BSI). The present study was conducted to inspect the clinical manifestations, and septic organisms in the intensive care units of university hospitals in Sana'a city, Yemen. Also to compare clinical characteristics, mortality and risk factors for positive case versus negative case for bacterial growth among sepsis patients.

Subjects and methods: From January 1 to April 30, 2022, a cross-sectional study was undertaken on sepsis patients hospitalized in intensive care units at four hospitals in Sana'a, Yemen. A well-structured questionnaire was used to collect specific medical data for each subject. Patients suspected of having sepsis underwent tests such as blood culture, complete blood count, and C-reactive protein. Gram staining was used to identify organisms, and the VITEK II Bacterial Bioprinting System was used to study them. This study included 145 intensive care unit (ICU) patients who displayed one or more indications of sepsis.

Results: Of the 145 ICU patients with suspected sepsis, 87 (60%) had culture-confirmed sepsis. The bulk of the identified bacteria (57.5%) were Gram-negative. In the ICU, the most prevalent sepsis agents are *E. coli* (23%), *Klebsiella* species (12.6%), and *Burkholderia cepacia* (7%). The most common Gram-positive pathogens are *Staphylococcus epidermidis* (27.6%) and *S. aureus* (10.3%). Significant positive culture outcomes were found with rapid onset of sepsis (*OR*=3.3, *p*=0.002), decreased urination (*OR*=2.2, *p*=0.02), older patients (*OR*=4, *p*=0.001), and death (*OR*=7.8). The commonest symptoms among the cases were fever (66.9%), increased heart rate (67.6%), confusion (62.8%) and respiratory distress (52.4%); the mortality rate was 29%.

Conclusion: Gram-negative bacteria were the most common cause of sepsis, and substantial positive culture results were associated with early onset, decreased urination, older patients, and death. Sepsis's incidence, mortality, and morbidity rates in Yemen are likely underestimated because it is infrequently reported as a primary diagnosis (typically as a consequence of cancer or another illness). More research into the frequency and risk factors of sepsis in ICUs is recommended.

Keywords: Bacteria, blood culture, Bloodstream infections (BSIs), Gram-negative, Gram positive, ICUs, Sepsis.

INTRODUCTION

Bloodstream infections (BSIs) are among the most common acquired illnesses in intensive care unit (ICU) patients. BSIs might be the result of bacterial bloodstream diffusion from a localized illness (secondary BSI) or the only recognized infectious process (primary BSI)[1]. In a global assessment evaluating the occurrence and consequences of infections in intensive care units, BSIs were found in 15% of infected patients and were the 3rd most generally seen illness[1]. In view of the developing health-care-system organization, the established categorization of BSIs as community-acquired or hospital-acquired is being revisited. An increasing percentage of patients with advanced age and many co-morbidities are care for as outpatients, since health care services are shifting from hospitals to the community

via various out-of-hospital institutions[2,3]. The severity of the disease, the disruption of anatomical barriers (i.e., use of invasive equipment and surgery), and compromised immune response are just a few of the risk factors for developing BSI in patients in critical care units[4]. Additional risk factors for catheter-related BSIs in patients with central venous catheters (CVC) include insufficient sterile method adoption, operator inexperience, insertion site colonization, contamination of the catheter hub, and duration of catheter installation[5-7]. Risk factors for BSIs brought on by resistant bacteria have been identified in a number of observational studies[8]. The risk of BSI brought on by resistant microbes is generally enhanced by prior antibiotic exposure, hospitalization, stays in nursing homes and long-term care institutions, and other risk factors for healthcare-associated BSI[9,10]. Additionally, being extremely young or old, having a weaker immune system as a result of diseases like cancer or diabetes, serious trauma, and burns are risk factors for ICU sepses[11-14]. Numerous species, including bacteria, viruses, and fungi, can result in sepsis[11]. The lungs, brain, urinary tract, skin, and abdominal organs are typical sites for the main infection[12]. A recently published multinational observational research[13] of 1,156 ICU patients worldwide revealed data on hospital-acquired BSIs. Gram-positive microbes made up 33.4% of all BSI-causing pathogens, whereas Gram-negative ones made up 56.8%. Although sepsis guidelines advise getting blood cultures before beginning antibiotic treatment, infection in the blood is not necessary for the diagnosis. Finding the potential site of the infection can be aided by medical imaging. Similar signs and symptoms could also be caused by anaphylaxis, adrenal insufficiency, low blood volume, heart failure, and pulmonary embolism[12].

This study was conducted to investigate the clinical manifestations, and septic organisms in intensive care units of university hospitals, Sana'a, Yemen. Also to compare clinical characteristics, mortality and risk factors for positive case versus negative case for bacterial growth among sepsis patients.

SUBJECTS AND METHODS

Study design and subjects: In this cross-sectional study, ICU patients admitted to ICUs at Al Kuwait, Al Gumhory, Al Sabeen, and ALThawra hospitals in Sana'a city between initial admission and first January 1 through April 30 in 2022 (time allowed for PhD field work in clinical microbiology). During the study period, patients who had suspected sepsis and were admitted for at least 72 hours were included.

Diagnosis of sepsis: According to international criteria, sepsis was suspected based on the presence of clinical indications or risk factors and was confirmed as sepsis if a blood culture was positive[15].

Questionnaire: Face-to-face interviews with the patients' family were used to gather vital and socio-demographic information using self designed questionnaire. Clinicians used standardized instruments to capture the clinical characteristics of individuals with sepsis. All patients' guardians provided written consent after being informed of the study's objectives.

Ethic approval: The Research and Ethics Committee of the Faculty of Medicine and Health Sciences at Sana'a University, Sana'a, Yemen, approved all the methods used in this study (Approval No. UGR/SU-223).

Laboratory investigations

Standard microbiological procedures were followed when conducting laboratory examinations[16]. Trained nurses took blood samples under aseptic conditions that were used for laboratory tests on complete blood counts, C-reactive proteins, and blood cultures. Blood was inoculated into a BacT/Alert PF plus culture bottle (BIOMERIEUX, France, LOT 4053532) with at least 1 ml (usually 5 ml in adult patients) and allowed to incubate until the BacT/Alert instrument (BACTEC 9050, Becton Dickinson) flagged it as positive or negative for culture. All positive samples were sub-cultured on blood agar, MacConkey agar, and choclate agar, and they were all incubated at 37 °C for 24-48 hours. To distinguish between gram-positive and gram-negative bacteria, gram-staining was used. To suspend the bacterium in 3.0 ml of sterile saline in a test tube, enough pure culture colonies were employed. According to the instructions in the product information manuals (BIOMERIEUX), pure bacterial suspension was added to the bacterial specific identification and sensitivity testing kit device and analyzed by the VITEK II system for bacterial bio-typing and antibiotic susceptibility (results of patterns will be published in a separate article). Gram negative bacteria were identified using a VITEK ® GN ID identification card (lot 2410933203), while gram positive bacteria were identified using a VITEK ® GP ID identification card (lot 2420938203). All treatments were carried out for standard therapeutic and diagnostic purposes.

Statistical analysis: EPI-Info version 6.0 was used to analyze the data (CDC, USA). The frequencies of categorical variables were displayed. Using Pearson's chi-square, associations between independent and dependent variables were examined, and odds ratios (OR) and 95% confidence intervals (CI) were given. When necessary, Fisher's exact test was applied. A *p* value of 0.05 or less was regarded as significant.

RESULTS

The study is set out in 3 tables, and Table 1 shows the gender and ages of the sepsis patients, who were tested for bacterial septicemia. Male patients were 59.3% and female patients 40.7%, and 38.8% were children under 15 years of age, with a mean ± SD of total age equal to 34.3 ± 28.5 years, and ages ranged from 1 month to 90 years (Table 1). Of the 145 ICU patients with suspected sepsis, 87 (60%) had culture-confirmed sepsis. The bulk of the identified bacteria (57.5%) were Gram-negative. In the ICU, the most prevalent sepsis agents are *E. coli* (23%), *Klebsiella* species (12.6%), and *Burkholderia cepacia* (7%). The most common Gram-positive pathogens are *Staphylococcus epidermidis* (27.6%) and *S. aureus* (10.3%) (Table 2).

Significant positive culture outcomes were found with rapid onset of sepsis (*OR*=3.3, *p*=0.002), decreased urination (*OR*=2.2, *p*=0.02), older patients (*OR*=4, *p*=0.001), and death (*OR*=7.8). The commonest symptoms among the cases were fever (66.9%), increased heart rate (67.6%), confusion (62.8%) and respiratory distress (52.4%); the mortality rate was 29% (Table 3).

DISCUSSION

Sixty percent of the current patient sample had sepsis with a culture that was positive, which is comparable to the 40–70% range reported in the majority of other investigations[17-21]. Additionally, the scope of the current investigation is greater than that of study of Sigakis *et al.*,[22] where only 11% of samples were positive for cultures. This may be due to Sigakis *et al.*, study[22] involving patients from all hospital units rather than only the ICU, as was the case in the current analysis. Additionally, earlier studies used culture results from samples taken before presentations or prospectively over the course of more than 24 hours, and results may be influenced by infection from an earlier or later hospital stay. A feature of the current study that helps to better isolate the impact of a sepsis episode is the restriction of cultures to samples collected during the first 24 hours after fulfilling sepsis criteria.

Table 1: Sex and ages of sepsis patients, tested for bacterial sepcitemia (n=145).

Characteristics	N (%)
Gender	
Male	86 (59.3)
Female	59 (40.7)
Age groups in Years	
<15	49 (33.8)
15 -24	8 (5.5)
25 -34	15 (10.3)
35-44	14 (9.7)
45 -54	11 (7.6)
≥55	48 (33.1)
Total	145 (100)
Mean	34.3 years
SD	28.5 years
Mode	0.01 years
Median	35 years
Min –Max	0.01-90 years
SD err	2.36
T test	14.5
p	< 0.000

SD= standard division, SD err= standard error

When compared to the findings for neonatal sepsis, our study's culture-confirmed sepsis rate was high (60%). Studies from underdeveloped nations found varying percentages of culture-confirmed neonatal sepsis, including 62.8% in Pakistan[23], 57% in Yemen[24], 45.9% in Egypt[25], 44.7% in Ethiopia[26], 24% in Tanzania[27], and 12.6% in Nepal[28]. The proportion of newborn with sepsis varies between nations for a number of reasons, including sample size and the various methods employed. A recent international observational research that included 1,156 ICU patients worldwide provided data on hospital-acquired BSIs[13]. In the current investigation, 34.5% of the total number of BSI-causing bacteria were Gram-negative and 28.3% were Gram-positive. In the current study, 24 (16.6%) of all septicemia-related ICU patients had Coagulase-negative *staphylococci* (CoNS) (Table 2). In newborns, coagulase-negative *staphylococci* (CoNS) are the most frequent bacteria responsible for late-onset sepsis. They frequently exhibit multiple forms of antibiotic resistance, and their capacity to produce biofilm is thought to be the primary factor determining their pathogenicity. A lower host inflammatory response was linked to CoNS sepsis with biofilm-forming strains, which may have limited the immune system's ability to fight the infection[29].

S. aureus was implicated in septicemia in the present investigation in 9 (6.2%) of all septicemia ICU patients (Table 2). *S. aureus* is a Gram-positive, facultative anaerobic pathogen that can be acquired in both hospitals and the community. It is a component of the skin's microbiota and is typically isolated from moist regions like the axillae and anterior nares[30]. Many *S. aureus* strains, which were once opportunistic, are now aggressively pathogenic and responsible for a wide spectrum of disorders, from skin and wound infections to serious conditions like BSIs and soft-tissue and bone infections[30,31]. *S. pneumoniae* was implicated in 5 (3.4%) of the total septicemia patients in the ICU in the current investigation (Table 2). *Streptococcus pneumoniae* can enter the bloodstream through a number of different routes, including lymphatic vessels, endothelium and epithelial cell injury, and direct invasion of endothelial cells. All three mechanisms most likely help infected patients' bloodstream invasion[15]. Twenty (13.8%) of the total number of septicemia ICU patients in the current study had E. coli septicemia (Table 2). Most frequently commensal, *E. coli* are Gram-negative, facultative anaerobes that can produce potentially lethal toxins, including enterohemorrhagic verotoxins, such *E. coli O157:H7*, which can lead to hemolytic uremic syndrome and renal failure[32]. In the current study, 11 (7.6%) of all the ICU patients with septicemia were caused by *Klebsiella pneumoniae* (Table 2). Despite being a rare sepsis-causing bacteria, *Klebsiella pneumoniae* is widely known for its severe consequences and high mortality. Due to a probable immune system decline, *K. pneumonia* caused bacteremia is more common and has a worse prognosis in patients with underlying illnesses. Therefore, it is crucial to control underlying illnesses to reduce the death rate from sepsis caused by *K. pneumoniae*[33].

B. cepacia was the etiology of septicemia in the current investigation in 6 (4.1%) of all septicemia ICU patients (Table 2). *B. cepacia* (Bcc) is an aerobic, catalase-producing, Gram-negative bacillus that is normally of moderate virulence and is not thought to be a normal component of the human flora. It can have a serious impact on children who are immunocompromised, such as those who have cancer, congenital heart disease, or a history of prematurity. In children with cystic fibrosis (CF) and chronic granulomatous disease (CGD),

significant bacteremia is seen in some cases. Immunocompetent people are rarely impacted, however nosocomial infections have been reported as a result of tainted drugs. Examples include ultrasound gel, contaminated sodium chloride, pure water, and 5% dextrose.

Table 2: Frequency and percentage of isolated bacterial species from sepsis cases (145 ICU sepsis patients).

Micro-organisms	N (%)	% positive culture
Gram positive Bacteria	41 (28.3)	47.1
Coagulase negative *Staphylococcus*	24 (16.6)	27.6
S. aureus	9 (6.2)	10.3
S. pneumoniae	5 (3.4)	5.7
Enterococci species	2 (1.4)	2.3
Streptococcus pyogens	1 (0.7)	1.1
Gram negative bacteria	50 (34.5)	57.5
E. coli	20 (13.8)	23
Klebsiella species	11 (7.6)	12.6
B. cepacia	6 (4.1)	7
Haemophilus influenzae	5 (3.4)	5.7
Acinetobacter baumannii	4 (2.8)	4.6
P. aeruginosa	3 (2.1)	3.4
Chryseobacterium indologenes	1 (0.7)	1.1
C. albicans	3 (2.1)	3.4
P. falciparum	1 (0.7)	1.1
Negative blood culture	58 (40)	66.7
Mixed bacterial (2 different isolates)	7 (4.8)	8
Total positive culture	87 (60)	100

The methods of transmission are nebulization, flushing orogastric tubes, and humidifying oxygen delivery equipment[34]. In the current study, *Haemophilus influenzae* caused septicemia in 5 (3.4%) of the total septicemia ICU patients (Table 2). Infections like bacteremia, meningitis, epiglottitis, and septic arthritis are brought on by Hi's profusion of virulence factors, which offer resistance to complement. Patients with neoplasm, asplenia, alcohol use disorder, HIV infection, chronic pulmonary disease, long-term steroid usage, or an underlying viral lung infection are more likely to contract the infection[35].

Two (1.4%) of the total number of ICU patients with septicemia were affected by *Enterobacter* (Table 2). *Enterobacter* is a genus of Gram-negative, facultatively anaerobic, opportunistic infections that express a wide range of ESBLs and carbapenemases, including KPC, OXA, and MBLs[36]. This pathogen also has endotoxins[36]. In the current study, *Acinetobacter baumannii* was discriminated for septicemia in 4 (2.8%) of the total septicemia ICU patients (Table 2). *Acinetobacter baumannii*, a gram-negative, facultatively anaerobic, opportunistic pathogen, is the most prevalent resistant *Acinetobacter* species. It can survive for up to 5 months on inanimate things because of its thick cell wall, which helps it withstand dry circumstances, high temperatures, and changes in pH and nutrients[37]. As a result of both limited membrane penetration and active efflux pumps, *A. baumannii* naturally resists a wide range of antibiotics. Widespread resistance to cephalosporins, fluoroquinolones, aminoglycosides, and tigecycline is brought on by over-expression of the AdeABC and AbeM efflux pumps, which also confers resistance to ammonia-based disinfectants[38]. Additionally, *A. baumannii* isolates produce an exo-polysaccharide that causes the formation of biofilms and express a potent cytotoxin that specifically targets epithelial cells to aid in colonization[39].

P. aeruginosa was discriminated to septicemia in 3 (2.1%) of the total septicemia ICU patients (Table 2). *P. aeruginosa* is a facultative anaerobic, Gram-negative, rod-shaped, opportunistic bacteria surviving in microaerobic states, for instance, the thick mucus of lungs of cystic fibrosis patients. The ubiquity and survival capacity of antimicrobial solutions of acetate-buffered benzalkonium chloride in extreme environments are major determinants of outbreaks of nosocomial infections. It has a high propensity to form biofilms. Its outer-membrane porins make it impermeable and resistant to many antibiotics[40,41]. *Chryseobacterium indologenes* was discriminated for septicemia in 1 (0.7%) of the total septicemia ICU patients (Table 2). A Gram-negative, oxidase-positive, non-glucose-fermenting bacillus, *C. indologenes* is present in the environment. Human infections are typically related with devices, occur in patients who have undergone medical procedures, or in patients who have underlying medical disorders and are hospitalized[42]. In the current study, patients in ICUs have different risk factors for BSI development, the most common risk factors were diabetic mellitus (35.9%), younger age (33.8%), old age (33.1%) and kidney disorders (31.7%), followed by major trauma (26.9%), asthma (18.6%) and burns (15.9%). However less frequently with myeloma, cancer, autoimmune disorder, immunocompromized and chronic obstructive pulmonary disease (Table 3). These results are similar to those reported by the CDC for risk factors of contracting septicemia among ICUs patients[43].

In another study conducted by Timsit and Laupland[4]; found that patients in ICUs have different risk factors

for BSI development, including greater severity of illness, disruption of anatomical barriers (ie, use of invasive devices, or surgery), and impaired immunological response[4]. Also several studies reported that patients with a central vein catheter (CVC) have additional risk factors for catheter-related BSIs (inadequate adoption of a sterile technique, inexperience of the operator[5-7]. When comparing a positive culture with a negative culture, considering clinical features, there was a high rate of positive culture with a rapid onset of sepsis symptoms (77.6%) with an associated *odds ratio* of 3.3, *confidence interval*=1.5–7.2 *p*=0.002, while there was no significant association with other clinical manifestations (Table 3). While there was a high rate of positive cultures with decreased urination (68.3%), there was no association between positive blood cultures and other clinical manifestations such as high or low blood pressures, increased heart rate, or increased breathing rate (*OR*=2.2, *CI*=1.1-4.3, *p*=0.02, Table 3).

Table 3: Associated clinical manifestations of sepsis patients and associated disorders, with positive culture for bacteria among sepsis ICUs patients in Sana'a tertiary hospials.

Clinical manifestations	Total N=145	*Postive culture N=87	*OR*	*95% CI*	X^2	*p*
	N (%)	N (%)				
Onset						
Rapid (less than 3 hours)	49 (33.8)	38(77.6)	3.3	1.5-7.2	9.4	0.002
Prolonged (several days)	96 (66.2)	49 (51.04)	0.3	0.013-0.3	9.4	0.002
Fever	97 (66.9)	61 (62.9)	1.4	0.7-2.9	1.01	0.31
Low body temperature	25(17.2)	11(44)	0.4	0.1-1.06	3.2	0.07
Chills	32 (22.1)	23 (71.9)				
Faint	20 (13.8)	14(70)	0.5	0.22-1.1	2.8	0.09
Skin rash	14 (9.7)	8 (57.1)	0.87	0.28-2.6	0.05	0.81
Blood pressure						
Increased heart rate	98 (67.6)	57 (58.2)	0.78	0.38-1.6	0.42	0.5
Normal blood pressure	97 (66.9)	44 (45.4)	0.09	0.03-0.26	26	<0.001
High blood pressure	19 (13.1)	12 (63.2)	1.2	0.4-3.2	0.09	0.7
Low blood pressure	29 (20)	13 (44.8)	0.46	0.2-1.05	3.3	0.06
Increased breathing rate	76 (52.4)	48 (63.2)	1.3	0.7-2.5	0.66	0.41
Decreased urination	82 (56.6)	56 (68.3)	2.2	1.1-4.3	5.4	0.02
Absent or almost no urine output	39 (26.9)	21 (53.8)	0.7	0.3-1.4	0.81	0.35
Sharp pain	59 (40.7)	29 (49.2)	0.46	0.2-0.9	4.8	0.02
Confusion	91 (62.8)	53(58.2)	0.8	0.41-1.6	0.31	0.57
Odema	46 (31.7)	22 (47.8)	0.47	0.23-0.97	4.1	0.04
Risk factors						
Younger Age	49 (33.8)	29(59.2)	0.9	0.47-1.9	0.02	0.88
Old age	48 (33.1)	31(64.6)	4.0	1.1-9.9	9.9	0.001
Major trauma	39 (26.9)	18(46.2)	0.4	0.2-0.92	4.3	0.03
Asthma	27 (18.6)	12 (44.4)	0.4	0.19-1.6	3.3	0.06
Chronic obstructive pulmonary disease	9 (6.2)	7 (77.8)	2.4	0.49-12.2	1.2	0.26
Myeloma	3 (2.1)	1(33.3)	0.32	0.28-3.6	0.97	0.34
Burns	23 (15.9)	15 (65.2)	1.3	0.51-3.3	0.31	0.57
Diabetic Miletus	52 (35.9)	28 (53.8)	0.44	0.2-0.8	5.5	0.01
Cancer	3 (2.1)	1 (33.3)	0.2	0.02-2.1	2.1	0.14
Kidney disorders	46 (31.7)	25 (54.3)	0.81	0.4-1.7	0.2	10.6
Immunocompromised	7 (4.8)	4 (57.1)	0.88	0.19-4.1	0.02	0.87
Autoimmune disorder	5 (3.4)	4 (80)	2.7	0.2-25	0.86	0.36
Prognosis						
Cure	103 (71)	50 (48.5)	0.1	0.04-0.3	19	<0.001
Death	42 (29)	37 (88.1)	7.8	2.8-21.5	19	<0.001

*Culture-confirmed sepsis, N, number of suspected sepsis; n, number of culture-confirmed septic cases; OR, odds ratio; CI, confidence interval, X^2, chi square

With regard to septicemia risk factors, there was a high proportion of positive cultures in older patients (64.6%), with an associated *OR* of 4, *CI*=1.1-9.9, and *p*=0.001 (Table 3). Approximately 40% of the current patients with clinically diagnosed septicemia had a negative culture. The negative culture could also be a result of sampling error or testing error (false-negative), but this is rare[22]. Negative culture results may also reflect issues unique to the microorganism, such as viral or fungal origin, a non-infectious source of symptoms, or genetic differences. Studies have shown that only about 1% of environmental bacteria are currently culturable[44,45]; only half of the bacterial species inhabiting the human mouth have been characterized, and the colonic flora is suspected to be mostly unidentified[22]. Infection by any of these non-culturable organisms would result in culture negative sepsis. Similar to other studies, as prior antibiotic use

was associated with culture negative sepsis, antibiotics may have sterilized the cultures[46,47]. Very low grade toxemia or intermittent bacteremia are other possibilities. Considering the prognosis, there was a high rate of positive culture with death (88.1%) with an *OR* equal to 7.8, *CI*=2.8–21.5, $p<0.001$ (Table 3). The present findings on the difference in case-by-case mortality for all sepsis patients differ from several other studies in which there is a similar mortality rate in both diagnostic groups (positive culture vs negative culture). On the other hand, Sigakis *et al*., found a higher mortality rate in culture-negative patients[22]

Limitations of the study

The limitations of the study were as follows. First, because the data came from one geographical location (Sana'a city), we were not able to accurately determine the types of isolates for Yemen. Secondly, no research was done to identify the sources of infection in this study as Al-Amad *et al*., have done before[48]. In determining bacterial contamination of intensive care units. Molecular research should also be conducted on these isolates to confirm the bacterial diagnosis.

CONCLUSIONS

BSIs are among the leading causes of infections in ICU patients. Gram-negative bacteria were the most common cause of sepsis, and substantial positive culture results were associated with early onset, decreased urination, older patients, and death. Sepsis's incidence, mortality, and morbidity rates in Yemen are likely underestimated because it is infrequently reported as a primary diagnosis (typically as a consequence of cancer or another illness). More research into the frequency and risk factors of sepsis in ICUs is recommended. The epidemiology of severe sepsis in developing countries may differ significantly from developed countries, warranting greater interest in future studies in developing countries to understand this problem.

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AUTHOR'S CONTRIBUTIONS

Al-Yousafi EA: fieldwork for this study as part of a PhD. **Al-Shamahy HA:** formal analysis, data curation, supervision. **Othman AM:** writing, review, and editing, methodology, data curation. **AlShawkany AARM:** resources, review. All authors read and approved the final manuscript for publication.

DATA AVAILABILITY

Data will be made available on request.

CONFLICT OF INTEREST

There are no competing interests involved in this work.

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