Original Article

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Epidemiology of Sepsis and Septic Shock in the Medical Intensive Care Unit after Implementing the National Early Warning Score for Sepsis Detection

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Abstract:

Objective: This study aimed to investigate the characteristics, microbiological profile, and mortality of patients with sepsis and septic shock in the medical intensive care unit (MICU).

Material and Methods: Demographic data, clinical characteristics, microbiological profiles, empirical antimicrobial regimen, and hospital mortality were collected retrospectively from patients with sepsis or septic shock that were admitted to the MICU in 2020. The National Early Warning Score (NEWS) of ≥5 was utilized for sepsis screening, and the Sepsis-3 definition was applied to categorize cases of sepsis and septic shock.

Results: Out of the 642 patients admitted to the MICU, 123 patients (19.2%) were included in this study. From these, 70.7% were diagnosed with sepsis and 29.3% with septic shock. The hospital mortality rates of overall patients, sepsis, and septic shock were 28.5%, 20.7%, and 47.2%, respectively. Comorbidities were identified in 89.4%. Septic shock and mortality were associated with higher Sequential Organ Failure Assessment scores, NEWS, and lactate levels (p-value<0.05). The majority of cases were hospital-acquired infections. The respiratory tract was the most affected site of infection. Gram-negative bacteria; particularly *Enterobacterales* and multidrug-resistant *Acinetobacter baumannii*,

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were identified as major pathogens in this study. Carbapenems and vancomycin were primarily prescribed in patients with septic shock, while carbapenems and β-lactam-β-lactamase inhibitors were commonly prescribed for sepsis patients. **Conclusion:** Sepsis and septic shock are commonly observed in the MICU, and they are associated with a high mortality rate. The NEWS is a practical tool for sepsis screening in the MICU.

Keywords: critical illness, intensive care unit, mortality, sepsis, septic shock

Introduction

Sepsis is a clinical syndrome characterized by the body's response to infection, leading to systemic inflammation and the failure of various organs throughout the body. Septic shock is a severe condition in which sepsis leads to the failure of the cardiovascular system, resulting in cellular oxygen deficiency. Sepsis and septic shock are substantial causes of morbidity, healthcare costs, and mortality, with septic shock being associated with mortality rates ranging from 40% to 80%[1,2].

In Thailand, the prevalence of patients with sepsis or septic shock among hospitalized patients suspected of having an infection was reported to be 34.9%. The mortality rate in patients with sepsis and septic shock was 30% and 55.6%, respectively[3]. Sepsis and septic shock are major reasons for Intensive Care Unit (ICU) admission and are the leading causes of death in critically ill patients. The incidence was reported to be 18.9 cases per 100 ICU admissions, and the overall hospital mortality rate was 49.7%[4].

Sepsis and septic shock are medical emergencies that require early diagnosis and immediate management to improve the chances of a positive outcome. There are multiple tools available for screening and diagnosing sepsis. These include: the Systemic Inflammatory Response Syndrome (SIRS) criteria, the Sequential Organ Failure Assessment (SOFA) score, the quick SOFA (qSOFA) score in addition to the National Early Warning Score (NEWS) and the Modified Early Warning Score (MEWS)[2,5,6].

Effective antimicrobial management is crucial for improving the treatment outcomes of sepsis and septic shock. A deeper understanding of sepsis epidemiology, its impact, and the microbiological profile can contribute to the development and implementation of more effective interventions, ultimately improving the prognosis of patients with sepsis and septic shock in the ICU. This study aimed to investigate the characteristics, microbiological profile, and hospital mortality of patients with sepsis and septic shock in the medical intensive care unit (MICU) of Songklanagarind Hospital; Thailand. It utilized the National Early Warning Score (NEWS) for sepsis screening.

Material and Methods

Study design, setting, and participants

This retrospective study was conducted at Songklanagarind Hospital, an 800-bed tertiary care university hospital situated in Songkhla, Thailand. There are four board-certified intensivists working full-time in this MICU, which has ten beds. The hospital's sepsis guidelines are aligned with the Surviving Sepsis Campaign: 2016, which guides sepsis management[7]. This study received approval from the human research ethics committee of the Faculty of Medicine, Prince of Songkla University (EC number: REC.63-556-19-2, date of approval: March 1, 2021).

Patients over 18 years of age and admitted to the MICU during the period from January to December 2020 were screened for the study. Patients suspected of having an infection, NEWS ≥5, underwent a septic workup, and received empirical antimicrobial treatment were eligible for inclusion in the study.

Definition

Any patient showing clinical signs of infection, such as fever or localized symptoms such as a cough, abdominal pain, or dysuria, were considered as a suspected infection case. The NEWS (range 0–20) of ≥5 was utilized as an indicator of acute organ dysfunction for sepsis screening in this study[8]. The definition used to classify sepsis and septic shock cases in this study was the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis–3)[2]. Sepsis is defined as a life–threatening condition characterized by organ dysfunction, resulting from a dysregulated host response to infection. Septic shock was clinically identified by the need for vasopressors to maintain a mean arterial pressure of 65 mm Hg or higher, and a serum lactate level greater than 2 mmol/L. The SOFA score in the range of 0 to 24, which is a recommended tool for assessing organ dysfunction according to the Sepsis–3 criteria, was also computed for each patient included in the study[2]. The previous Sepsis–2 definition was also used to classify patients as having severe sepsis and septic shock, and it was employed to evaluate hospital mortality within these categories[9].

Community–acquired infection was defined as the manifestation of infection, either before or within 48 hours after admission, whereas hospital–acquired infections were defined as infections acquired after hospitalization manifesting 48 hours after admission to the hospital[10]. Mixed organisms were defined as culture results revealing more than one type of organism from a single specimen. Multiple organisms from multiple sites were considered to have affected more than one type of organism, with specimens collected from various organs per patient. Multidrug–resistant (MDR) was defined as resistance to three or more antimicrobial classes [11]. Inadequate coverage of antimicrobial treatment was defined as microbiological documentation of an infection that is not being effectively treated[12].

Data collection and data analysis

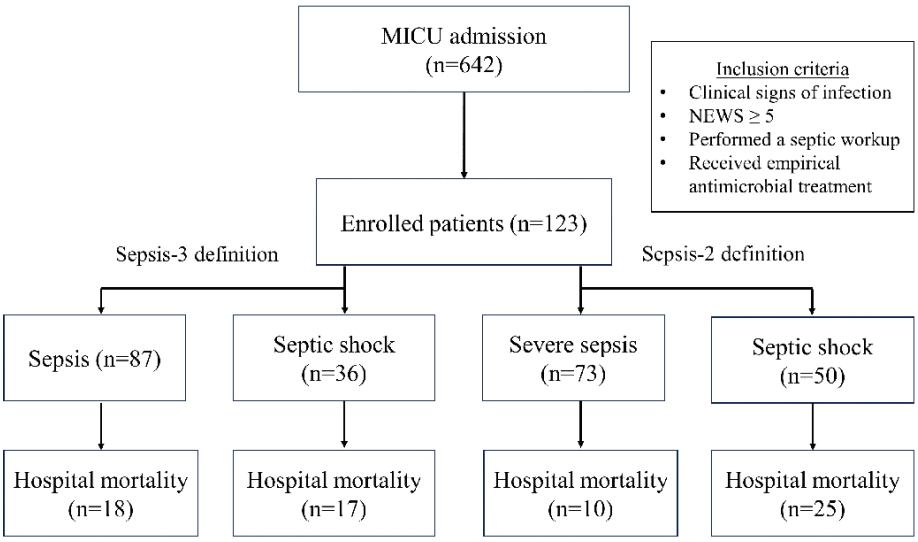
Demographic information, chronic medical conditions, the type of infection (community–acquired vs. hospital–acquired), site of infection, and all components of the variables of NEWS and SOFA scores were retrospectively recorded. This captured the highest and lowest values during the first 24 hr of MICU admission at the time of sepsis or septic shock diagnosis. Lactate levels, details of the empirical antimicrobial regimen, results of septic workup, antimicrobial susceptibility and hospital discharge status (survival or death) were all collected as part of the study's data.

Descriptive statistics were employed to summarize the findings of the study. Normally distributed data were presented as mean±standard deviation (S.D.), while non–normally distributed data were reported as median with interquartile range (IQR). Categorical variables were compared using Pearson's Chi–square test or Fisher's exact test. Fisher's exact test was used when more than 20% of cells have expected frequencies less than five. Continuous variables were analyzed using either the t–test or the Wilcoxon rank sum test. All statistical analyses were performed using the STATA program, version 17.0 BE–basic edition, Stata Corporation, Texas; USA.

Results

During the 1–year study period, a total of 123 patients were diagnosed with sepsis or septic shock: out of 642 patients admitted to the MICU; which represents approximately 19.2% (Figure 1). According to the Sepsis–3 definition, sepsis was diagnosed in 70.7% of the cases, and septic shock was identified in 29.3% of the cases. However, when using the Sepsis–2 definition, severe sepsis was diagnosed in 59.3% of the cases, and septic shock was identified in 40.6% of the cases.

Demographic, clinical characteristics, microbiological profile, and empirical therapy regimen of enrolled patients



MICU=medical intensive care unit, NEWS=the National Early Warning Score

Figure 1 The flow diagram demonstrates inclusion criteria, the prevalence of sepsis and septic shock as well as hospital mortality

are presented in Table 1. Comorbidities were present in 89.4% of patients, with hypertension being the most frequently reported chronic medical condition. The majority of patients developed infections during their hospitalization. Among the 91 patients with hospital-acquired infections, 72 patients (79.1%) developed sepsis or septic shock during their admission to the MICU. The three most commonly affected sites of infection were the respiratory tract, urinary tract, and abdominal region.

Septic shock patients had greater NEWS, SOFA scores, and lactate levels than sepsis patients (p-value<0.05). Lactate levels were measured in all septic shock patients; however, in 25.3% of sepsis patients lactate levels were unavailable. Fourteen of the 87 patients diagnosed with sepsis, using Sepsis-3 criteria, were given vasopressors. Ten of the 14 patients had lactate levels less than 2.0 mmol/L, while four did not have their lactate levels tested or reported. However, if the Sepsis-2 definition were applied, these 14 patients would have been diagnosed with septic shock.

Approximately 50% of patients had positive cultures gram-negative bacteria were the most frequently isolated pathogens. A monotherapy antimicrobial regimen was selected for empirical therapy in both the sepsis and septic shock groups. The most common combination regimens included: carbapenems with colistin, carbapenems with vancomycin, third-generation cephalosporins with either fluoroquinolones or macrolides, and third-generation cephalosporins with clindamycin or metronidazole.

Carbapenems and vancomycin were the primary choices in septic shock cases, while β-lactam-β-lactamase inhibitor combinations (BLBLIs) and carbapenems were frequently prescribed in sepsis patients. The most common BLBLI in this study was piperacillin/tazobactam. Among patients with positive cultures, the adequacy of the empirical therapy regimen was evaluated, revealing that 44.4% of

Table 1 Demographic, clinical characteristics, microbiological profile, and empirical therapy regimen of 123 participants along with a comparison between sepsis and septic shock; as defined by the Third International Consensus (Sepsis-3)

Characteristics	Total (n=123)		Sepsis (n=87)		Septic shock (n=36)		p-value
Male, n (%)	73	(59.3)	49	(56.3)	24	(66.7)	0.288
Age, year, median (IQR)	67	(53, 78)	69	(53, 80)	67	(54, 73)	0.580
Chronic medical condition, n (%)							
Hypertension	37	(30.1)	27	(31.0)	10	(27.8)	0.720
Dyslipidemia	27	(22.0)	18	(20.7)	9	(25.0)	0.599
Diabetes mellitus	24	(19.5)	16	(18.4)	8	(22.2)	0.626
Malignancy	17	(13.8)	10	(11.5)	7	(19.4)	0.245
COPD/Asthma	10	(8.1)	8	(9.2)	2	(5.6)	0.502
Congestive heart failure	8	(6.5)	6	(6.9)	2	(5.6)	0.784
Cerebrovascular disease	8	(6.5)	6	(6.9)	2	(5.6)	0.784
Chronic kidney disease	7	(5.7)	5	(5.7)	2	(5.6)	1.000[a]
Coronary heart disease	6	(4.9)	5	(5.7)	1	(2.8)	0.670[a]
Liver cirrhosis	6	(4.9)	5	(5.7)	1	(2.8)	0.670[a]
HIV	3	(2.4)	2	(2.3)	1	(2.8)	1.000[a]
Type of infection, n (%)							
Community-acquired	32	(26.0)	21	(24.1)	11	(30.6)	0.460
Hospital-acquired	91	(73.0)	66	(75.9)	25	(69.4)	
Site of infection, n (%)							
Respiratory tract	75	(61.0)	53	(60.9)	22	(61.1)	0.984
Urinary tract	10	(8.1)	10	(11.5)	0	(0.0)	0.034
Abdominal	8	(6.5)	6	(6.9)	2	(5.6)	0.784
Bloodstream	6	(4.9)	2	(2.3)	4	(11.1)	0.060
Skin/soft tissue	4	(3.3)	1	(1.1)	3	(8.3)	0.075[a]
Myocardial/pericardial	2	(1.6)	2	(2.3)	0	(0.0)	1.000[a]
Multiple sites	18	(14.6)	13	(14.9)	5	(13.9)	0.880
NEWS							
Median (IQR)	7	(6, 9)	6	(5.5, 9)	8	(6, 9)	0.025
SOFA score							
Median (IQR)	9	(6, 12)	7	(5, 11)	12	(11, 14)	<0.001
Lactate, n (%)							
Lactate measurement	101	(82.1)	65	(74.7)	36	(100.0)	0.001
Lactate level (mmol/L)							
Median (IQR)	2.1	(1.3, 3.3)	1.4	(1.1, 2.3)	3.4	(2.5, 5.2)	<0.001
Culture positive, n (%)	63	(51.2)	44	(50.6)	19	(52.8)	0.824
Microorganisms, n (%)							0.985[a]
Mixed organisms	9	(14.3)	6	(13.6)	3	(15.8)	
Multiple organisms from multiple sites	6	(9.5)	4	(9.1)	2	(10.5)	
Gram negative	35	(55.6)	25	(56.8)	10	(52.6)	
Gram positive	10	(15.9)	7	(15.9)	3	(15.8)	
Fungi	2	(3.2)	1	(2.3)	1	(5.3)	
Empirical antimicrobial regimen, n (%)							
Monotherapy	85	(69.1)	61	(70.1)	24	(66.7)	0.500
Combination[b]	38	(30.8)	26	(29.9)	12	(33.3)	

Table 1 (continued)

Characteristics	Total (n=123)		Sepsis (n=87)		Septic shock (n=36)		p-value
Antimicrobial class							
Carbapenems	60	(48.8)	37	(42.5)	23	(63.9)	0.031
BLBLIs	24	(19.5)	22	(25.3)	2	(5.6)	0.012
3rd-generation Cephalosporins	24	(19.5)	17	(19.5)	7	(19.4)	0.990
Vancomycin	11	(8.9)	3	(3.4)	8	(22.2)	0.001
Colistin	18	(14.6)	13	(14.9)	5	(13.9)	0.880
Co-trimoxazole	4	(3.3)	4	(4.6)	0	(0.0)	0.320[a]
Aminoglycosides	2	(1.6)	2	(2.3)	0	(0.0)	1.000[a]
Fluoroquinolones	3	(2.4)	3	(3.4)	0	(0.0)	0.555[a]
Empirical therapy regimen with inadequate coverage, n (%)[b]	28/63	(44.4)	19/44	(43.2)	9/19	(47.4)	0.759

[a]Fisher's exact test, [b]The adequacy of the antimicrobial spectrum was determined in culture-positive patients (n=63), BLBLIs=β-Lactam-β-Lactamase Inhibitors, COPD=chronic obstructive pulmonary disease; HIV=human immunodeficiency virus, IQR=interquartile range, max=maximum, MDR=multidrug-resistant, min=minimum, NEWS=the National Early Warning Score, S.D.=standard deviation, SOFA=the sequential organ failure assessment

the total patients received antimicrobial regimens with inadequate coverage.

The microorganisms isolated from infection sites, categorized by the type of infection (community-acquired vs. hospital-acquired), are shown in Table 2. The top five common pathogens identified were *Acinetobacter baumannii*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Staphylococcus aureus*. The antimicrobial susceptibility of these top five pathogens is presented in Supplementary Table 1. Among respiratory tract infections, which were the most common site of infection, MDR *A. baumannii* was the predominant cause in hospital-acquired infections, whereas *K. pneumoniae* was the common pathogen in community-acquired infections.

Table 3 shows a comparison of clinical characteristics between patients that survived and those whom died during their hospitalization. The overall hospital mortality was 28.5% among the 123 patients. The hospital mortality rates for severe sepsis, as per Sepsis-2 and sepsis as per Sepsis-3, were 13.7% and 20.7%, respectively. In the case of septic shock, the hospital mortality rates, based on Sepsis-2 and Sepsis-3 definitions, were 50.0% and 47.2%, respectively. The mortality rate was higher in septic shock patients compared to those with severe sepsis and sepsis; regardless of whether Sepsis-2 or Sepsis-3 definitions were used. Malignancy was the only chronic medical condition that impacted mortality. The hospital mortalities stratified by the SOFA score, the NEWS, and lactate level are presented in Figure 2. The NEWS, SOFA score, and the lactate levels were found to be higher in patients that did not survive compared to those whom survived.

Discussion

The purpose of this study was to describe the characteristics, microbiological profile, and hospital mortality of sepsis and septic shock in the MICU, with a specific focus on the utilization of the NEWS for sepsis screening. Various screening tools have been proposed for sepsis detection, each with different levels of sensitivity and specificity. While qSOFA was previously recommended for sepsis screening in Sepsis-3, it has since been advised against use as the sole screening tool due to its limited sensitivity; as

Table 2 Microorganisms isolated from infection sites in sepsis and septic shock patients, categorized by type of infection (n=86 organisms)

	Community-acquired (24 organisms)	Hospital-acquired (62 organisms)
Respiratory tract		
Gram negative	9	33
Acinetobacter baumannii	0	2
Acinetobacter baumannii (MDR)	0	12
Alcaligenes xyloxidans	0	1
Elizabethkingia meningoseptica	0	2
Enterobacter aerogenes	0	1
Escherichia coli	0	1
Haemophilus influenzae	1	0
Haemophilus parainfluenzae	1	0
Klebsiella pneumoniae	5	2
Klebsiella pneumoniae (MDR)	1	3
Pseudomonas aeruginosa	1	6
Stenotrophomonas maltophilia	0	3
Gram positive	5	6
Enterococcus faecalis	0	2
Enterococcus faecium	1	0
Staphylococcus aureus	3	3
Streptococcus angiosus	0	1
Streptococcus pneumoniae	1	0
Mycobacterium tuberculosis	1	0
Urinary tract		
Gram negative	3	6
Acinetobacter baumannii (MDR)	0	2
Enterobacter cloacae	0	1
Escherichia coli	2	0
Escherichia coli (ceftriaxone non-susceptible)	1	3
Gram positive	3	2
Enterococcus faecalis	0	1
Enterococcus faecium	1	1
Klebsiella pneumoniae	1	0
Staphylococcus aureus	1	0
Abdominal		
Gram negative	0	4
Acinetobacter baumannii (MDR)	0	1
Klebsiella pneumoniae (MDR)	0	1
Pseudomonas aeruginosa	0	2
Gram positive	0	4
Enterococcus faecium	0	1
Coagulase negative staphylococci	0	2
Staphylococcus saprophyticus	0	1
Torulopsis glabrata	0	1
Bloodstream		
Gram negative	1	2
Escherichia coli (ceftriaxone non-susceptible)	1	0
Pseudomonas aeruginosa	0	1
Stenotrophomonas maltophilia	0	1

Table 2 (continued)

	Community-acquired (24 organisms)	Hospital-acquired (62 organisms)
Gram positive	2	2
Enterococcus faecium	0	1
Staphylococcus aureus	1	0
Coagulase negative staphylococci	0	1
Streptococcus mutans	1	0
Candida spp.	0	2

MDR=multidrug-resistant

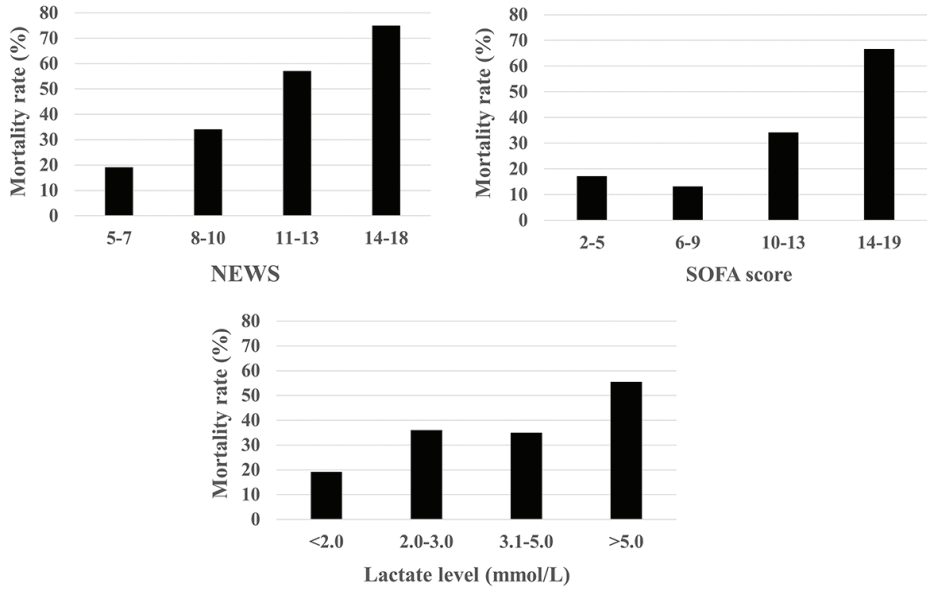


Figure 2 Hospital mortality stratified by the Sequential Organ Failure Assessment (SOFA) score and the National Early Warning Score (NEWS)

indicated in the Surviving Sepsis Campaign 2021[6]. In this study, NEWS with a threshold of ≥5 was used for sepsis screening. This approach has been previously recognized as an effective predictor of sepsis-related outcomes in addition to being considered the most accurate sepsis detection scoring system, based on previous studies[13–15].

In this study, the lowest SOFA score observed among our participants was 2 for sepsis patients and 4 for septic shock patients, which aligns with the recommended SOFA ≥2 score to define organ dysfunction in sepsis by the Sepsis-3 definition. The overall prevalence of sepsis and septic shock in this study was 19.2% of MICU admissions; the prevalence of sepsis was 13.6%, while septic shock was 5.6%. The majority of patients had at least one comorbidity, with hypertension and diabetes mellitus being the most common comorbidities. Epidemiological studies of sepsis in

Table 3 Comparison of clinical characteristics between patients that survived and those whom died during their hospitalization

Characteristics	Death (n=35)		Survived (n=88)		p-value
Sepsis definition					
Sepsis-2 definition, n/total (%)					
Severe sepsis	10/73	(13.7)	63/73	(86.3)	<0.001[a]
Septic shock	25/50	(50.0)	25/50	(50.0)	
Sepsis-3 definition, n/total (%)					
Sepsis	18/87	(20.7)	69/87	(79.3)	0.003[a]
Septic shock	17/36	(47.2)	19/36	(52.8)	
Age, year, median (IQR)	70	(62, 81)	66	(52, 77)	0.109
Type of infection, n (%)					
Community-acquired	7	(20.0)	25	(28.4)	0.337
Hospital-acquired	28	(80.0)	63	(71.6)	
Site of infection, n (%)					
Multiple sites	7	(20.0)	11	(12.5)	0.288
Respiratory tract	22	(62.9)	53	(60.2)	0.787
Urinary tract	1	(2.9)	9	(10.2)	0.177
Abdominal	7	(20.0)	7	(8.0)	0.301
Bloodstream	1	(2.9)	5	(5.7)	0.673[b]
Skin/soft tissue	3	(8.6)	1	(1.1)	0.069[b]
Myocardial/pericardial	0	(0.0)	2	(2.3)	1.000[b]
Chronic medical condition, n (%)					
Hypertension	10	(28.6)	27	(30.7)	0.818
Dyslipidemia	9	(25.7)	18	(20.5)	0.525
Diabetes mellitus	9	(25.7)	15	(17.0)	0.274
Malignancy	9	(25.7)	8	(9.1)	0.016
COPD/Asthma	4	(11.4)	6	(6.8)	0.399
Congestive heart failure	2	(5.7)	6	(6.8)	0.823
Cerebrovascular disease	1	(2.9)	7	(8.0)	0.301
Chronic kidney disease	4	(11.4)	3	(3.4)	0.100
Coronary heart disease	0	(0.0)	6	(6.8)	0.182[b]
Liver cirrhosis	2	(5.7)	4	(4.5)	1.000[b]
HIV	0	(0.0)	3	(3.4)	0.557[b]
NEWS score					
Median (IQR)	8	(6.0, 10.0)	6	(5.0, 8.0)	0.003
SOFA score					
Median (IQR)	13	(8.0, 14.0)	8	(5.0, 11.0)	<0.001
Lactate level (mmol/L)					
Median (IQR)	2.65	(1.7, 4.2)	1.8	(5.0, 11.0)	0.019
Empirical antimicrobial regimen, n (%)					
Monotherapy	22	(62.9)	62	(70.4)	0.414
Combination	13	(37.1)	26	(29.5)	
Culture positive	14	(40.0)	49	(55.7)	0.116
Empirical therapy regimen with inadequate coverage, n/total (%)[c]	7/14	(50.0)	21/49	(42.9)	0.635

[a]Comparison of mortality between sepsis/severe sepsis versus septic shock, [b]Fisher's exact test, [c] The adequacy of the antimicrobial spectrum was determined in culture-positive patients (n=63), COPD=chronic obstructive pulmonary disease, HIV=human immunodeficiency virus, IQR=interquartile range, NEWS=the national early warning score, S.D.=standard deviation; SOFA=the sequential organ failure assessment

ICUs have been conducted in various countries at different times and using different definitions of sepsis.

According to the Sepsis-3 definition, which utilizes SOFA scores ≥2, the reported prevalence of sepsis in Asian countries is 22.4%[16]. Meanwhile, an epidemiological study of patients with severe sepsis and septic shock being admitted to ICUs in Thailand was conducted between 2004 and 2006[4]. The Sepsis-1 definition was used to diagnose sepsis and septic shock, while organ involvement in severe sepsis was determined using SOFA scores greater than 2. The overall incidence of severe sepsis and septic shock in this study was 18.9%, which aligns closely with our findings. However, the incidence of severe sepsis was 4.2%, and septic shock in that study was 14.7%[4], which differs from our results. The discrepancy in findings may arise from the use of the Sepsis-3 definition, which includes a lactate level of ≥2 mmol/L along with sepsis-induced hypotension requiring vasopressors to diagnose septic shock. Under Sepsis-1 criteria, some patients diagnosed with septic shock would be reclassified as having sepsis by the Sepsis-3 definition, if they required vasopressors but had a lactate level below 2 mmol/L. Furthermore, in addition to the incidence, the variation in sepsis definitions is likely to affect mortality rates as well.

The most commonly identified pathogens were gram-negative bacteria, particularly *Enterobacterales;* such as *K. pneumoniae* and *E. coli*. This aligns with findings from previous studies conducted in Thailand and other Asian countries[4,16-18]. For septic shock, the primary choice for empirical treatment was carbapenems, while sepsis patients were typically treated with piperacillin/tazobactam. The utilization of piperacillin/tazobactam in sepsis patients has sparked controversy due to its failure to show non-inferiority in 30-day mortality for patients with *E. coli* or *K. pneumoniae* bloodstream infections and ceftriaxone resistance[19]. However, it is traditionally recommended as a carbapenem-sparing option, particularly for patients with low-risk, non-severe infections caused by third-generation cephalosporin-resistant *Enterobacterales*[20,21]. The rationale for the use of piperacillin/tazobactam in sepsis patients needs to be substantiated through clinical studies.

Respiratory tract infections were the most prevalent source of infection in this study, with MDR *A. baumannii* as the predominant causative agent in hospital-acquired cases. This observation is consistent with the findings of previous studies[22]. It's important to highlight that a significant portion of these pathogens exhibited resistance to carbapenems, which are commonly used in empirical therapy, potentially negatively affecting treatment outcomes. Vancomycin was primarily selected for septic shock patients; however, our study did not detect methicillin-resistant *Staphylococcus aureus* (MRSA) from the results of the septic workup.

The overall hospital mortality was 28.5%, falling within the range reported in previous studies, where mortality rates of sepsis and septic shock in ICUs ranged from 23.4% to 49.7%[4,16,18,23]. The hospital mortality rate for severe sepsis according to Sepsis-2 was 13.7%, while it increased to 20.7% for sepsis patients when classified by the Sepsis-3 definition. The higher mortality rate in Sepsis-3 might be due to the fact that it categorizes patients with hypotension requiring vasopressors and a lactate level of less than 2.0 mmol/L as having sepsis; whereas, Sepsis-2 would classify them as having septic shock. This specific population could have a higher mortality rate than sepsis patients without hypotension. For similar reasons, the hospital mortality rate for septic shock decreased from 50% when defined by Sepsis-2 to 47.2% when classified under the Sepsis-3 definition.

Septic shock patients exhibited a higher mortality rate compared to sepsis, and this trend was correlated with elevated SOFA scores, NEWS, and lactate levels, which have been previously identified as predictors for mortality[13,15,24]. Malignancy was the only comorbidity found to be correlated with the mortality rate. Despite nearly 50% of the population receiving an empirical therapy regimen with inadequate coverage, this factor did not appear to

significantly impact mortality; potentially due to limited statistical power.

This study has several limitations. Firstly, this study had limitations inherent to its retrospective observational design. Additionally, the absence of lactate level information in four sepsis patients may introduce misclassification bias. A prospective study might have been more suitable to answer the objectives of this study, as it allows for better control of these potential sources of bias. Secondly, the study measured crude hospital mortality, which might not directly reflect the outcome of sepsis and septic shock. It would be beneficial to consider other outcome measures that capture various aspects of patient outcomes, such as long-term survival, quality of life, or clinical improvements. Thirdly, we did not evaluate the specific risk factors for mortality rates in sepsis and septic shock patients, as it was not the primary objective of this study. Fourthly, the data collection period was limited to one year, resulting in a relatively small sample size for reporting microbiological profiles. This limitation affects our ability to provide comprehensive information for empirical regimen selection; particularly for hospital-acquired or ICU-acquired infections. Fifth, this study did not include information regarding the duration of antibiotic use, the specific types and volumes of fluids administered, or vasopressor usage; all of which could potentially impact sepsis-related mortality. Finally, it's important to note that this study was conducted in a single ICU at a tertiary care university hospital. Variations in patient disease severity and management at other facilities may impact the generalizability of our findings.

Conclusion

Sepsis and septic shock were diagnosed in 19.2% of MICU patients when a NEWS score ≥ 5 was employed for sepsis screening. Most cases were associated with hospital-acquired infections, with respiratory tract infections being the most common. Gram-negative bacteria were the predominant pathogens. Notably, the hospital mortality rate was higher for septic shock compared to sepsis. This correlated with elevated SOFA scores, NEWS scores, and lactate levels.

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Conflict of interest

All authors declare no conflicts of interest.

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Supplementary Table 1 Antimicrobial susceptibility of the top five common microorganisms

	Amikacin	Gentamicin	Netilmicin	Ampicillin	Cefotaxime	Cefoxitin	Ceftazidime	Cefuroxime	Ceftriaxone	Piperacillin/tazobactam	Cefoperazone/sulbactam	Imipenem/cilastatin	Meropenem	Ertapenem	Ciprofloxacin	Norfloxacin	Cotrimoxazole	Fosfomycin	Tigecycline	Colistin
Gram negative bacteria																				
Acinetobacter baumannii																				
Total isolates	2	2			2	1	2	2		2	2	1	2	1	2		2		1	2
Susceptible	2	2			0	0	2	0		2	2	0	2	1	2		2		1	2
% Susceptible	100	100			0	0	100	0		100	100	0	100	100	100		100		100	100
Acinetobacter baumannii (multidrug-resistant)																				
Total isolates	15	15	8	15	15	15	13	15	15	9	4	15	12	13	14		15		14	14
Susceptible	5	3	2	0	0	0	1	0	0	0	0	0	0	0	1		2		8	14
% Susceptible	33	20	25	0	0	0	8	0	0	0	0	0	0	0	7		13		57	100
Klebsiella pneumoniae																				
Total isolates	8	8		8	8	8	8	8	8	7	1	8	8	8	8		8			8
Susceptible	8	8		0	8	8	8	5	8	7	1	8	8	8	6		7			8
% Susceptible	100	100		0	100	100	100	63	100	100	100	100	100	100	75		87.5			100
Klebsiella pneumoniae (multidrug-resistant)																				
Total isolates	5	5		5	5	5	5	5	5	4	2	5	5	5	4		5		1	5
Susceptible	4	2		0	0	1	0	0	0	1	0	1	1	1	1		0		1	5
% Susceptible	80	40		0	0	20	0	0	0	25	0	20	20	20	25		0		100	100
Pseudomonas aeruginosa																				
Total isolates	10	10					10			9	5	9	9		10					
Susceptible	10	10					7			7	2	4	4		7					
% Susceptible	100	100					70			78	40	44	44		70					
Escherichia coli																				
Total isolates	3	3		3	3	3	3	3	3	3	2	3	3	3	3	3	3	3		2
Susceptible	3	3		1	3	3	3	2	3	3	2	3	3	2	3	3	3	3		2
% Susceptible	100	100		33	100	100	100	67	100	100	100	100	100	67	100	100	100	100		100
Escherichia coli (ceftriaxone non-susceptible)																				
Total isolates	5	5		5	5	5	5	5	5	4		5	5	5	5	4	4	4		5
Susceptible	5	4		0	0	5	0	0	0	4		5	5	5	1	1	0	4		5
% Susceptible	100	80		0	0	100	0	0	0	100		100	100	100	20	25	0	100		100

Supplementary Table 1 (continued)

	Clindamycin	Erythromycin	Fosfomycin	Fusidic acid	Oxacillin	Vancomycin
Gram positive bacteria						
Staphylococcus aureus						
Total isolates	8	8	8	7	8	8
Susceptible	7	6	8	7	8	8
% Susceptible	88	75	100	100	100	100