MINH
MALAHAYATI INTERNATIONAL JOURNAL OF NURSING AND HEALTH SCIENCE
ISSN 2620-9152 (Print)
ISSN 2621-4083 (Online)
DOI: 10.33024
Nomor: 79/E/KPT/2023

ARTICLE INFORMATION
Received: April, 15, 2025
Revised: April, 28, 2025
Available online: April, 29, 2025
at : https://e-jurnal.iphorr.com/index.php/minh

Sepsis protocol adherence and emergency department overcrowding: An observational study

Nisa Arifani[1], Leli Mulyati[2]*, Priyo Sasmito[3], Treesia Sujana[4], Sri Wahyuni Gayatri[5], Novia Dwi Astuti[6], Nurfanida Librianty[7], Sukirman Lie[8], Elina Deviana[9], Farly Ihsan[10]

[1]Program Studi Emergensi Medisin, Fakultas Kedokteran, Universitas Brawijaya
[2]Politeknik Kesehatan Kemenkes Bengkulu
[3]Program Doktor Ilmu Kedokteran dan Kesehatan, Fakultas Kedokteran Universitas Padjadjaran
[4]Institut Kesehatan Immanuel
[5]Fakultas Kedokteran Universitas Muslim Indonesia
[6]STIKes Rajekwesi Bojonegoro
[7]Fakultas Kedokteran Militer Universitas Pertahanan Republik Indonesia
[8]Fakultas Kedokteran Universitas Methodist Indonesia
[9]Rumah Sakit Umum Pusat Surakarta
[10]RSUD dr. Drajat Prawiranegara
Corresponding author: *E-mail: mulyati1776@gmail.com

Abstract

Background: Emergency Department (ED) overcrowding is a persistent global challenge that affects the quality and timeliness of patient care, particularly for sepsis management. Despite established guidelines such as the hour-1 sepsis bundle and national sepsis guideline, adherence remains inconsistent.
Purpose: To analyze the relationship between sepsis protocol compliance and emergency unit crowding.
Method: A retrospective observational cohort study was conducted, analyzing adult sepsis and septic shock patients triaged as Priority 1. Data on patient demographics, sepsis severity scores, ED occupancy rates, and adherence to sepsis protocols using the Hour-1 sepsis bundle and the National Sepsis Guideline were collected. Statistical analysis was performed using Fisher's Exact Test to examine associations between ED overcrowding and compliance with sepsis protocols, with a significance threshold of $p<0.05$.
Results: This study included 38 cases with a mean age of 56.6 years and the majority (52.6%) of patients were female. Most cases were diagnosed with septic shock (55.3%) and the average occupancy rate of the emergency department was 80.8%. Serum lactate measurements were performed in 68.4% of cases, blood culture sampling in 21.1%, and broad-spectrum antibiotics were given in 94.7%. Full compliance with both sepsis protocols was only 5.3%. Compliance with fluid resuscitation was high at 97.4%, while compliance with blood culture sampling was low at 5.3% and 7.9%. No significant association was found between protocol compliance and ED crowding ($p > 0.05$).
Conclusion: There was no significant correlation between ED crowding and adherence to sepsis protocols. Strategic and clinical policy interventions are needed to improve adherence to sepsis management guidelines.
Suggestion: Future research should investigate additional barriers to sepsis care, such as financial constraints, physician decision-making processes, and variations in adherence across healthcare settings to develop more comprehensive strategies to improve sepsis outcomes worldwide.

Keywords: Adherence; Emergency Department (ED); Sepsis Protocol.

DOI: https://doi.org/10.33024/minh.v8i2.870

INTRODUCTION

Emergency Department (ED) overcrowding is a well-documented issue affecting patient care. Some studies show that dense ED causes delays in antibiotic administration and resuscitation (Biteker, Özlek, Çelik, Özlek, & Biteker, 2017; Gaieski, Agarwal, Mikkelsen, Drumheller, Sante, Shofer, & Pines, 2017). ED density is also reported to be related to the increase in mortality rates and service quality (Darraj, Hudays, Hazazi, Hobani, & Alghamdi, 2023; Sartini, Carbone, Demartini, Giribone, Oliva, Spagnolo, & Cristina, 2022). Sepsis is one of the time-sensitive conditions in ED that requires immediate intervention following standardized protocols (Singer et al., 2016). An overcrowded ED has the potential to affect the quality of services for sepsis patients in ED.

Although the negative effects of ED overcrowding have been extensively studied, the direct association between overcrowding and sepsis protocol adherence is not well-established (Pires, Neves, & Pazin-Filho, 2019). Most research has focused on broad systemic delays rather than analyzing specific components of sepsis management (Sartini et al., 2022). Additionally, existing studies primarily examine high-resource hospitals, leaving uncertainty regarding the factors influencing sepsis care in developing nations where ED congestion is often more severe (Evans, Rhodes, Alhazzani, Antonelli, Coopersmith, French, & Levy, 2021). This lack of data presents a challenge for designing targeted interventions that can improve adherence to sepsis protocols in overcrowded emergency settings.

This study examines the relationship between ED occupancy and sepsis treatment adherence in a tertiary teaching hospital in Indonesia. By assessing adherence to the 1-hour sepsis bundle and national sepsis guidelines, this study provides a new perspective on how ED crowding affects protocol adherence, not just clinical outcomes. These findings are expected to contribute to evidence-based strategies to optimize sepsis care in crowded EDs, offering insights that can inform hospital administrators and policymakers in both resource-rich and resource-limited healthcare settings.

RESEARCH METHOD

This study used an observational cohort design, conducted in the Emergency Department of Dr. Saiful Anwar Hospital, a third-level teaching hospital in Malang. This study focused on adult patients diagnosed with sepsis or septic shock who were selected as Priority 1 cases. Inclusion criteria included patients aged ≥18 years and diagnosed with sepsis or septic shock based on the Sequential Organ Failure Assessment (SOFA) criteria, while exclusion criteria were patients whose medical records were incomplete or did not meet the clinical criteria for sepsis or septic shock.

Data collection included patient demographics, sepsis severity scores (qSOFA and SOFA), emergency department occupancy, and adherence to sepsis care protocols. This study examined two established sepsis care protocols: Hour-1 bundle, which requires lactate measurement, blood culture sampling, broad-spectrum antibiotic administration, fluid resuscitation, and vasopressor use within one hour; and the National Sepsis Guidelines, which follow similar principles with an extended intervention timeframe of three and six hours (modified 3-hour and 6-hour sepsis bundle) (Ministry of Health of the Republic of Indonesia, 2017; Levy, Evans, & Rhodes, 2018).

Hour-1 bundle consists of several stages, namely, measuring serum lactate, re-measure if initial > 2 mmol/L, obtain blood cultures before antibiotics, give broad-spectrum antibiotics, start crystalloids quickly 30 ml/kg BW Give vasopressors for hypotension that remains after fluid resuscitation to maintain MAP > 65 mmHg. The National Sepsis Guideline consists of the first 2 times of the 3-hour bundle including; measuring serum lactate, obtaining blood cultures before

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[1]Politeknik Kesehatan Kemenkes Bengkulu
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[3]Program Doktor Ilmu Kedokteran dan Kesehatan, Fakultas Kedokteran Universitas Padjadjaran
[4]Institut Kesehatan Immanuel
[5]Fakultas Kedokteran Universitas Muslim Indonesia
[6]STIKes Rajekwesi Bojonegoro
[7]Fakultas Kedokteran Militer Universitas Pertahanan Republik Indonesia
[8]Fakultas Kedokteran Universitas Methodist Indonesia
[9]Rumah Sakit Umum Pusat Surakarta
[10]RSUD dr. Drajat Prawiranegara
Corresponding author: *E-mail: mulyati1776@gmail.com

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antibiotic administration, administering broad-spectrum antibiotics, and administering 30 ml/kg BW for patients with hypotension or serum lactate > 4 mmol/L. The second 6-hour bundle is vasopressors for hypotension that is unresponsive to fluid therapy to maintain MAP > 65 mmHg.

Descriptive statistics were used to summarize patient characteristics, and Fisher's Exact Test was applied to demonstrate the association between ED housing level and adherence to sepsis protocols with a significance threshold set at $p<0.05$.

RESEARCH RESULTS

Table 1. Distribution of Respondent Characteristics (N=38)

Variables	Results	95% CI
Age (Mean±SD)(Range)(Years)	(56.7±16.6)(19-84)	51.4-61.9
Gender (n/%)		
Male	18/47.4	
Female	20/52.6	
Diagnosis (n/%)		
Sepsis	17/44.7	
Septic shock	21/55.3	
Sepsis Scoring (Mean±SD)(Range)		
Initial qSOFA	(2.1±0.7)(1-3)	1.8-2.3
SOFA	(6.5±3.2)(0-15)	5.4-7.5
ED Overcrowding Parameter (Mean±SD)(Range)		
ED LOS (hour)	(15.2±8.7)(5.7-40.6)	12.5-18.0
Occupancy rate (%)	(80.8±36.8)(12.0-128.6)	69.1-92.5
Shift when the Patient Arrived (n/%)		
Morning	10/26.3	
Afternoon	17/44.7	
Night	11/30.0	

Based on Table 1. the average age of participants was 56.6 years (SD±16.6). The majority were female, 20 participants (52.6%), diagnosed with septic shock, 21 participants (55.3%). The average Sequential Organ Failure Assessment (SOFA) score was 6.5 (SD±3.2), with a 95% confidence interval ranging from 5.4 to 7.5. The average length of stay (LOS) in the ED was 15.2 hours (SD±8.7), ranging from 5.7 to 40.6 hours. The average ED occupancy rate was 80.8% (SD±36.8), with 69.1% to 92.5% in the 95% confidence interval. Most patients came on the afternoon shift (44.7%).

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Corresponding author: *E-mail: mulyati1776@gmail.com

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Table 2. Sepsis Protocol Implementation in Emergency Department

Variables	n/%	Minutes After the Patient Arrives (Mean±SD)(Range)	95% CI
Lactate serum measurement	26/68.4	(57.4± 80.1)(0.0-257.0)	(26.6-88.2)
Blood culture examination	8/21.1	(412.4± 359.7)(52.0-1064.0)	(163.1-661.6)
Broad-spectrum antibiotics administration	36/94.7	(209.0± 175.7)(0.0-914.0)	(151.6-266.4)
Fluid resuscitation	38/100.0	(9.4± 49.5)(0.0-300.0)	(0.0-25.1)
Vasopressor administration	21/100.0	(117.4± 123.4)(0.0-510.0)	(64.6-170.2)

Serum lactate measurements were performed in 68.4% of cases, while blood culture sampling was performed in only 21.1% of patients. Broad-spectrum antibiotics were administered in 94.7% of cases, with a mean delay of 209.0 minutes (SD±175.7) from arrival. Fluid resuscitation was the most adhered to intervention, performed in 100% of cases, with a mean administration time of 9.4 minutes (SD±49.5). Vasopressor administration, required for patients in septic shock, was administered to all indicated patients with a mean of 117.4 minutes (SD±123.4). The longest intervention time was observed in blood culture sampling, with a mean waiting time of 412.4 minutes (SD±359.7), indicating a significant decrease in adherence to early diagnostic interventions.

Table 3. Sepsis Protocol Adherence based on Hour-1 Bundle Sepsis and National Sepsis Guideline

Sepsis protocol	Hour-1 Sepsis Bundle		National Sepsis Guideline		p-value
	In accordance (n/%)	Not accordance (n/%)	In accordance (n/%)	Not accordance (n/%)	
Lactate serum measurement	18/47.4	20/50.6	23/60.5	15/39.5	0.36
Blood culture examination	2/5.3	36/94.7	3/7.9	35/92.1	1.00
Broad-spectrum antibiotics administration	6/15.8	32/84.2	21/55.3	17/44.7	< 0.001
Fluid resuscitation	37/97.4	1/ 2.6	37/97.4	1/ 2.6	1.00
Vasopressor administration	24/63.2	14/36.8	37/97.4	1/ 2.6	< 0.001
Complete bundle	2/5.3	36/94.7	2/5.3	36/94.7	1.00

Adherence to the Hour-1 Sepsis Bundle and National Sepsis Guideline showed significant variation. For the Hour-1 bundle, 47.4% of cases adhered to lactate measurement recommendations, while only 5.3% complied with blood culture sampling requirements. Antibiotic administration was completed within the recommended timeframe in 15.8% of cases, whereas 97.4% of patients received timely fluid resuscitation. Vasopressor administration adhered to the guideline in 63.2% of cases. Compliance with the National Sepsis Guideline, which follows a longer time frame, showed slightly higher adherence rates, with 60.5% of cases completing lactate measurements and 7.9% completing blood culture sampling. Antibiotic administration adherence was significantly higher at 55.3%, and vasopressor administration compliance reached 97.4%. However, the complete adherence rate to all sepsis protocol components remained low at 5.3% for both guidelines.

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Table 4. Data analysis

Sepsis Protocol	Occupancy Rate	Adherence		p-value
		In accordance (n/%)	Not accordance (n/%)	
Hour-1 Sepsis Bundle				
Lactate serum measurement	>100%	7/50.0	7/50.0	1.00
	≤100%	11/45.8	13/54.2	
Blood culture examination	>100%	1/7.1	13/92.9	1.00
	<100%	1 /4.2	23/95.8	
Broad-spectrum antibiotics administration	>100%	4/28.6	10/71.4	0.17
	<100%	2/8.3	22/91.7	
Fluid resuscitation	>100%	14/100.0	0/0.0	1.00
	<100%	23/95.8	1/ 4.2	
Vasopressor administration	>100%	10/71.4	4/28.6	0.50
	<100%	14/58.3	10/41.7	
Complete bundle	>100%	1/ 7.1	13/92.9	1.00
	<100%	1/ 4.2	23/95.8	
National Sepsis Guideline				
Lactate serum measurement	>100%	7/50.0	7/50.0	0.49
	<100%	16/66.7	8/33.3	
Blood culture examination	>100%	1/ 7.1	13/92.9	1.00
	<100%	2/8.3	22/91.7	
Broad-spectrum antibiotics administration	>100%	9/64.3	5/35.7	0.51
	<100%	12/50.0	12/50.0	
Fluid resuscitation	>100%	14/100	0/0.0	1.00
	<100%	23/95.8	1/ 4.2	
Vasopressor administration	>100%	14/100.0	0/0.0	1.00
	<100%	23/95.8	1/ 4.2	
Complete bundle	>100%	1/ 7.1	13/92.9	1.00
	<100%	1/ 4.2	23/95.8	

The statistical analysis investigating the relationship between ED overcrowding and sepsis protocol adherence showed no significant correlation across all variables. The occupancy rate did not significantly influence compliance with lactate measurement (p = 1.00), blood culture sampling (p = 1.00), antibiotic administration (p = 0.17), fluid resuscitation (p = 1.00), or vasopressor administration (p = 0.50). The complete adherence to the sepsis bundle also did not differ significantly between cases with occupancy rates above or below 100% (p = 1.00). Similarly, the National Sepsis Guideline adherence showed no statistically significant association with ED congestion, suggesting that factors other than overcrowding may play a more critical role in determining adherence to sepsis protocols.

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[5]Fakultas Kedokteran Universitas Muslim Indonesia
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[10]RSUD dr. Drajat Prawiranegara
Corresponding author: *E-mail: mulyati1776@gmail.com

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DISCUSSION

Sepsis protocols play a crucial role in improving patient outcomes by ensuring timely diagnosis and intervention (Singer, Deutschman, Seymour, Shankar-Hari, Annane, Bauer, & Angus, 2016). The Hour-1 Bundle and National Sepsis Guideline have been established as evidence-based frameworks designed to reduce mortality and complications associated with sepsis. In the ED setting, adherence to these protocols is essential due to the time-sensitive nature of sepsis management (Evans et al., 2021). Despite their importance, the findings of this study indicate that adherence to sepsis protocols remains suboptimal. The complete adherence rate was as low as 5.3% for both guidelines, with significant delays observed in lactate measurement and blood culture sampling. Research in Australia shows that the implementation of hour-1 and 3-hour bundle sepsis can improve adherence to sepsis protocols and reduce ICU admission rates (Venkatesh, Schlapbach, Mason, Wilks, Seaton, Lister, & Rice, 2022). However, other studies showed the opposite result, adherence to the protocol did not improve the outcome of sepsis patients (Evans et al., 2021; Uffen, Oosterheert, Schweitzer, Thursky, Kaasjager, & Ekkelenkamp, 2021).

Several factors also have been reported as barriers to sepsis protocol implementation. Previous studies reported poor compliance with sepsis protocols, often attributing these shortcomings to systemic inefficiencies, inadequate staff training, and resource constraints. Insufficient knowledge and awareness of protocol components among healthcare providers have been identified as key barriers to effective implementation (Rogan, Lockett, Peckler, Robinson, & Raymond, 2022; Sasmito, Pranata, Pamungkas, Emaliyawati, & Arifani, 2024). Limited availability of laboratory resources often results in delays in obtaining lactate measurements and blood culture results (Sasmito et al., 2024). Clinicians may also perceive blood cultures as less useful in guiding immediate treatment decisions, especially in cases where prior antibiotic administration may have already influenced microbial growth (Nisa, Dradjat Respati, Ari, Antonius, Suryanto, Nanik, & Priyo, 2021).

ED overcrowding has been widely recognized as a major issue that affects the quality and efficiency of patient care (Kenny, Chang, & Hemmert, 2020). High occupancy rates have been linked to longer wait times, increased clinician workload, and delayed treatment initiation. Given the time-sensitive nature of sepsis management, it is commonly assumed that ED congestion negatively impacts protocol adherence (Biteker et al., 2018; Darraj et al., 2023; Pires et al., 2019). However, the findings of this study indicate that ED overcrowding did not have a statistically significant effect on compliance with sepsis protocols. This study is in line with previous research which reported that ED overcrowding has no direct relationship with the occurrence of delayed antibiotic administration in sepsis patients (Chau, Bakar, Zamhot, Zaini, Binti Adanan, & Sabardin, 2024). The most important thing to improve outcomes in sepsis patients in the future is to focus on improving early recognition strategies, using a standardized treatment protocol, and evaluating the protocol implementation (Gilbert, 2018).

Addressing the challenges associated with sepsis management in the ED requires a multifaceted approach. Several strategies could be implemented to improve adherence to sepsis protocols despite ED congestion. First, optimizing triage systems to facilitate the early identification of sepsis patients could help streamline workflow and ensure timely intervention (Venkatesh et al., 2022). The use of the Early Warning System in hospitals as one of the sepsis screening tools is also reported to have the potential to improve the outcomes of sepsis patients (Lam, Hung, Lui, Kwok, Lam, Lau, & Rainer, 2024). Second, expanding ED staffing capacity, particularly during peak hours, may help mitigate delays

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Corresponding author: *E-mail: mulyati1776@gmail.com

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associated with high patient volumes. Investing in sepsis-specific training programs for healthcare providers can also enhance awareness and adherence to established protocols (McVeigh, 2020). Third, laboratory response times should be improved through point-of-care lactate testing, which can expedite clinical decision-making (Sasmito et al., 2024). Hospitals could also explore the feasibility of implementing pre-approved antibiotic protocols that allow nurses and junior doctors to initiate treatment without delays caused by physician unavailability (Sonis, Benzer, Black, Filbin, Hayes, Hibbert, & Aaronson, 2020). Finally, hospital administrators and policymakers should consider establishing dedicated sepsis inpatient units to facilitate early transfer and reduce ED congestion (Gavelli, Castello, & Avanzi, 2021).However, the developed protocol must consider the financial capabilities of hospitals and patients (Uffen et al., 2021).

Some limitations of this study include the relatively small sample size that may limit the generalizability of the findings to larger hospital settings. Additionally, the retrospective nature of this study introduces the potential for documentation bias, as adherence was assessed based on medical records rather than direct observation of clinical practice. Another limitation is the reliance on occupancy rates as the primary indicator of ED congestion, which may not fully capture other operational inefficiencies that contribute to delays in care. Future studies should incorporate multicenter data collection to validate these findings and explore additional factors that may influence sepsis protocol adherence. Prospective studies with real-time data tracking may provide a more accurate assessment of ED workflow dynamics and patient management practices. Further investigation should also explore the role of financial constraints, physician decision-making, and institutional policies in shaping adherence to sepsis management guidelines.

CONCLUSION

There was no statistically significant correlation between occupancy and adherence to the 1-Hour Sepsis Bundle or National Sepsis Guidelines. However, overall adherence to sepsis protocols remained suboptimal, particularly in lactate measurement and blood culture sampling, suggesting the need for systemic improvements in workflow efficiency, staff training, and resource allocation.

SUGGESTION

These findings contribute to the broader understanding of sepsis management by demonstrating that while ED congestion is a known challenge, institutional and clinical factors play a more significant role in adherence to sepsis guidelines. Addressing these challenges requires targeted interventions, including optimization of triage systems, expanded staff support, and enhancement of laboratory capabilities to ensure timely diagnosis and treatment. Future research should investigate additional barriers to sepsis care, such as financial constraints, physician decision-making processes, and variations in adherence across healthcare settings to develop more comprehensive strategies to improve sepsis outcomes worldwide.

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Corresponding author: *E-mail: mulyati1776@gmail.com

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Nisa Arifani[1], Leli Mulyati[2]*, Priyo Sasmito[3], Treesia Sujana[4], Sri Wahyuni Gayatri[5], Novia Dwi Astuti[6], Nurfanida Librianty[7], Sukirman Lie[8], Elina Deviana[9], Farly Ihsan[10]

[1]Politeknik Kesehatan Kemenkes Bengkulu
[2]Program Studi Emergensi Medisin, Fakultas Kedokteran, Universitas Brawijaya
[3]Program Doktor Ilmu Kedokteran dan Kesehatan, Fakultas Kedokteran Universitas Padjadjaran
[4]Institut Kesehatan Immanuel
[5]Fakultas Kedokteran Universitas Muslim Indonesia
[6]STIKes Rajekwesi Bojonegoro
[7]Fakultas Kedokteran Militer Universitas Pertahanan Republik Indonesia
[8]Fakultas Kedokteran Universitas Methodist Indonesia
[9]Rumah Sakit Umum Pusat Surakarta
[10]RSUD dr. Drajat Prawiranegara
Corresponding author: *E-mail: mulyati1776@gmail.com

DOI: https://doi.org/10.33024/minh.v8i2.870

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[1]Politeknik Kesehatan Kemenkes Bengkulu
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[3]Program Doktor Ilmu Kedokteran dan Kesehatan, Fakultas Kedokteran Universitas Padjadjaran
[4]Institut Kesehatan Immanuel
[5]Fakultas Kedokteran Universitas Muslim Indonesia
[6]STIKes Rajekwesi Bojonegoro
[7]Fakultas Kedokteran Militer Universitas Pertahanan Republik Indonesia
[8]Fakultas Kedokteran Universitas Methodist Indonesia
[9]Rumah Sakit Umum Pusat Surakarta
[10]RSUD dr. Drajat Prawiranegara
Corresponding author: *E-mail: mulyati1776@gmail.com

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