

UDC 61

**EMERGENCY ROOM OVERCROWDING FACTORS AFFECTING TREATMENT
MANAGEMENT OF SEPSIS PATIENTS IN DR. SAIFUL ANWAR PUBLIC HOSPITAL**

Arifani Nisa

Medical Emergency Resident, Faculty of Medicine, University of Brawijaya, Indonesia

Dradjat Respati S., Prasetyadjati Ari, Freddy Antonius, Eko A. Suryanto

Emergency Medicine Staff, Faculty of Medicine, University of Brawijaya, Indonesia

Setijowati Nanik

Public Health Science Staff, Faculty of Medicine, University of Brawijaya, Indonesia

Sasmito Priyo

Institut Medika Drg. Suherman Jakarta, Indonesia

E-mail: humas@ub.ac.id

ABSTRACT

Emergency Room (ER) overcrowding is one of the world's health problems in the last ten years. Overcrowding has adverse effects on ER services. Overcrowding obstructs therapeutic procedures, such as sepsis treatment. This study aimed to determine the relationship between the ER overcrowding and sepsis patients' management based on the Hour-1 Sepsis Bundle. The study was an analytic observational study on 38 septic patients in critical emergency rooms. The observation recorded time until triage, occupancy rate, length of stay (LOS) in the emergency room, number of staff in the emergency room, boarding time, the percentage of boarders, and sepsis management's suitability based on Hour-1 Sepsis Bundle. There was no significant relationship between ER overcrowding and suitability of Hour-1 Sepsis Bundle as a whole. However, based on the analysis between independent variables and each bundle component, there was a significant relationship between time until triage and blood culture examinations ($p = 0.037$). Besides, the occupancy rate has a significant relationship with the measurement of serum lactate levels ($p = 0.023$). Furthermore, there is a significant relationship between total ER staff and ER junior staff on antibiotics administration ($p = 0.038$ and $p = 0.013$). The time until triage influenced blood culture examinations, ($p = 0.037$), occupancy rate influenced the measurement of serum lactate levels, and the total ER staff and ER junior team influenced antibiotic administration.

KEY WORDS

Overcrowding, time until triage, occupancy rate, hour-1 sepsis bundle, sepsis, septic shock, LOS, boarding time, boarders.

The Emergency Room (ER) is one of the unique elements of a hospital. The ER provides health services to the community twenty-four hours a day and seven days a week. Also, ER assures of service for patients with health and social problems. The consequence of the role is the uncontrollable level of ER overcrowding (Masserang, 2016). ER overcrowding is a significant problem in the world for the last ten years. ER overcrowding occurs due to an imbalance between the demand for health services and lack of space in the emergency room and hospital. Overcrowding in the emergency room and hospital coincides with internal and external factors (Di Somma et al., 2014).

ER overcrowding produces a low quality of emergency services, affecting patient safety (Hong, Shin, Song, Cha, & Cho, 2013). Many international studies noted the adverse effects on patients undergoing long wait times in the emergency room. The long wait time delays various time-sensitive procedures, one of which is the sepsis bundle (Diercks et al., 2007).

Preliminary research at the Emergency Room of dr. Saiful Anwar Hospital (RSSA), Indonesia, in February 2020 involving 30 sepsis patients (priority 1/P1) showed the following result: 33% of the sepsis patient did not undergo lactic acid testing, 80% of the sepsis patient did not undergo culture examination, and 80% of the sepsis patient received antibiotics administration after 1 hour. The purpose of this study was to determine the extent of the Emergency Room overcrowding factors (time until triage, length of stay, boarding time, occupancy rate, percentage of boarding patients, and the number of Emergency Room staff) affecting the management of sepsis patients in the Emergency Room.

METHODS OF RESEARCH

This study was a cross-sectional, observational analytic study using secondary data in a state-owned regional referral hospital and teaching hospital, dr. Saiful Anwar Hospital (RSSA), Indonesia. The study observed 38 non-traumatic sepsis patients over 18 years of age (Table 1) who received triage and screening using a quick Sequential Organ Failure Assessment (qSOFA). The sepsis patient obtained more than 2 points score and triaged to P1. Furthermore, the sepsis patient received a diagnosis of sepsis and septic shock using SOFA scores with more than 2 points increase. Researchers recorded the ER overcrowding factors, namely time until triage, length of stay, boarding time, occupancy rate, percentage of boarders, and total ER staff upon the patient's arrival. The observation on sepsis management was based on the Hour-1 Sepsis Bundle (Levy, 2018).

Time until triage is the time required for a patient to get an initial triage examination calculated from the patient's arrival until the initial triage examination. ER overcrowding occurs due to a five-minute delay between the initial triage examination and the patient's arrival (Boyle, Abel, Raut, & Austin, 2016). The ER occupancy rate is the ratio of the total number of patients in the ER to the number of patients receiving treatment per hour (McCarthy et al., 2008). ER overcrowding occurs when the occupancy rate is > 100% (Boyle, Abel, Raut, & Austin, 2016)

Length of Stay (LOS) is the total time required for a patient to receive services in the ER. LOS is calculated from the patient's arrival (the time the patient registers) until the patient leaves the ER. ER overcrowding occurs when 90% of the patient's LOS is more than four hours (Boyle, Abel, Raut, & Austin, 2016).

Table 1 – General Characteristic of Research Subject

Variable	n (%)	$\bar{x} \pm SD$	Median (min-max)
Gender			
Male	18 (47.4)		
Female	20 (52.6)		
Age (Years)		56.6 ± 16.6	60 (19-84)
19-60 years	6 (15.8)		
45-60 years	15 (39.5)		
>60 years	17 (44.7)		
Arrival Process			
Reference	17 (44.7)		
Non-reference	21 (55.3)		
Diagnosis			
Sepsis	17 (4.7)		
Sepsis shock	21(55.3)		
Shift on Time of Arrival			
Morning Shift (07.00 AM - 14.00 PM)	10 (26.3)		
Afternoon Shift (14.00 PM - 21.00 PM)	17 (44.7)		
Evening Shift (21.00 PM - 07.00 AM)	11 (28.9)		

Senior ER staff are nurses who have worked for more than five years or doctors who have at least five semesters of specialist education. Junior ER staff are nurses who have

worked less than five years or doctors undergoing specialist education with less than five semesters of experience.

Boarding time is the length of time required of an inpatient to reach the inpatient room. Prolonged boarding time occurs when inpatients wait for more than 2 hours to enter the inpatient room. ER overcrowding occurs when more than 10% of inpatients are in the ER (Boyle, Abel, Raut, & Austin, 2016). Boarders are inpatients waiting to be admitted to an inpatient ward. ER overcrowding occurs when the percentage of boarders is > 10%.

Hour-1 Bundle is the sepsis treatment adhering to the revised sepsis bundle based on the old SSC recommendation. The three-hour and six-hour bundles were combined into the Hour-1 Bundle to initiate resuscitation and sepsis management. Overall resuscitation may take more than an hour and be completed in more than an hour. However, resuscitation, such as blood collection and lactate and culture measurement, administration of resuscitation fluids and antibiotics, and administration of vasopressor drugs for life-threatening hypotension, may be done earlier (Levy, 2018).

Table 2 – Management Characteristics based on ER Overcrowding Factor in Research Subject

Variable	n (%)	$\bar{x} \pm SD$	Median (min-max)
Input measurement			
1. Time until triage (minute)		2.03±0.6	2 (1-3)
≤ 5 minute	38 (100)		
>5 minute	0 (0)		
ER measurement			
2. Occupancy rate (%)		80.8±36.8	78.6 (12-128.6)
≤ 100%	24 (63.2)		
>100%	14 (36.8)		
3. LOS in ER (minute)		912.9±520.0	738 (340-2435)
<240 minute	0 (0)		
>240 minute	38 (100)		
4. Total ER staff (staff)		14.2 ± 1.1	14 (13-17)
Senior Staff		5.8 ± 0.5	6 (5-7)
Junior Staff		8.5 ± 1.0	8 (8-11)
Output Measurement			
5. ER Boarding time (minute)		742.7 ± 529.4	538.5 (39-2330)
≤ 120 minute	1 (2.6)		
>120 minute	37 (97.4)		
6. Boarders percentage (%)		52.0 ± 18.4	50.0 (9.1-84.2)
≤ 10%	1 (2.6)		
>10%	37 (97.4)		

Table 3 – Characteristics of Clinical Management Based on Sepsis Treatment According to the Hour-1 Sepsis Bundle

No	Hour-1 Sepsis Bundle	TD n (%)	≤ 1 hour n (%)	>1-6 hour n (%)	>6 hour n (%)	Mean Time (Minute)
1.	Lactate level assessment	12 (31.6)	18 (47.4)	8 (21.1)	0 (0)	57.4
2.	Culture sampling	30 (78.9)	2 (5.3)	2 (5.3)	4 (10.5)	412.4
3.	Administration of antibiotics	2 (5.3)	5 (13.2)	26 (68.4)	5 (13.2)	209.0
4.	Administration of resuscitation fluid	0 (0)	37 (97.4)	1(2.6)	0 (0)	10.5
5.	Administration of vasopressor according to indication	17 (44.7)	7 (18.4)	13 (34.2)	1 (2.6)	117.4

Note: TD = Not carried out, this sample was not included in the average calculation of the time.

The analysis involved 38 research samples providing numerical data. The Saphiro Wilk normality test revealed that the data were not normally distributed. Furthermore, the relationship between overcrowding factors and treatment suitability based on the Hour-1 Sepsis Bundle was tested using the Mann-Whitney test. The Mann-Whitney test found no significant relationship between the overcrowding variable and the suitability of treatment based on the Hour-1 Sepsis Bundle ($p > 0.05$). The data were converted into categorical data and tested using the chi-square test. The chi-square test found no significant relationship

between overcrowding factors and the suitability of Hour-1 Sepsis Bundle implementation. The complete data are presented in Table 4 below:

Table 4 – Relationship between Independent Variables and Suitability of Hour-1 Sepsis Bundle

No.	Variable	Hour-1 Sepsis Bundle		P-value
		Suitable	Unsuitable	
1.	Time until triage			0.938
	< 5 minute	0	0	
	>5 minute	36	2	
2.	Occupancy rate			1.000
	< 100%	23	1	
	>100%	13	1	
3.	LOS in ER			1.000
	<240 minute	0	0	
	>240 minute	36	2	
4.	Total ER Staff (total)			0.239
	Senior Staff			
	Junior Staff			
5.	Boarding time in ER			0.794
	< 120 minute	1	0	
	>120 minute	35	2	
6.	Boarders Percentage			0.394
	< 10%	1	0	
	>10%	35	2	

In-depth data analysis separated the variables contained in the Hour-1 Bundle and analyzed the relationship of each variable and overcrowding factors using the Kruskal-Wallis non-parametric test. The following Table 5 describes the test result.

Table 5 – Relationship between Independent Variables and Components of the Hour-1 Sepsis Bundle

No	Variable	P-value				
		Lactate	Culture	Antibiotic	Fluid	Vasopressor
1	Time until triage	0.719	0.037*	0.412	0.957	0.863
2	Occupancy rate	0.023*	0.595	0.511	0.463	0.910
3	LOS in ER	0.649	0.428	0.991	0.820	0.794
4	Total ER Staff (total)	0.603	0.084	0.038*	1.000	0.265
	Senior Staff	0.627	0.396	0.745	0.603	0.131
	Junior Staff	0.526	0.531	0.013*	0.636	0.743
5	Boarding time in ER	0.425	0.606	0.924	0.157	0.881
6	Boarders Percentage	0.172	0.289	0.129	0.360	0.230

*Description ($P < 0.05$).

RESULTS OF STUDY

Based on the preliminary data analysis (table 5), there was no relationship between overcrowding variables and bundle series. The categorical data were assessed using the chi-square test. The in-depth analysis assessed independent variables and each component of the Hour-1 sepsis bundle. The analysis revealed a significant relationship between occupancy rate and measurement of lactate levels, time until triage and culture sampling, as well as total ER staff and ER junior staff on antibiotics administration (table 5).

There was a significant relationship between the occupancy rate and the measurement of lactate levels ($p = 0.023$) < 0.05 . The Mann-Whitney test was conducted to determine different groups using ≤ 1 hour as a reference. The Mann-Whitney test confirmed a significant relationship ($p = 0.004$) between the occupancy rate and the measurement of lactate levels in ≤ 1 hour and between 1-6 hours.

There were significant relationship between time until triage and culture sampling ($p = 0.037$) < 0.05 . It indicates a relationship between time until triage and culture sampling. The Mann-Whitney test was conducted to determine different groups using ≤ 1 hour as a

reference. The Mann-Whitney test confirmed no significant relationship between time until triage and groups forgoing culture sampling, under 1-hour sampling group, and 1-6 hour sampling group. Due to the lack of significant difference in the ≤ 1 -hour reference, the researcher compared group forgoing culture sampling and 1-6 hour sampling group. There was a significant relationship ($p = 0.016$) between time until triage, 1-6 hour culture sampling group, and groups forgoing culture sampling.

There was a significant relationship between total ER staff and ER junior staff on antibiotics administration ($p = 0.013$ and 0.038) < 0.05 . It indicates a relationship between total ER staff and ER junior staff on antibiotic administration. The Mann-Whitney test was conducted to determine different groups using ≤ 1 hour as a reference. The Mann-Whitney test confirmed a significant relationship ($p = 0.016$) between total ER staff and ER junior staff on antibiotics administration ≤ 1 -hour group and the group forgoing antibiotics administration. Also, there was a significant relationship ($p = 0.042$) between total ER staff, antibiotics administration ≤ 1 -hour group, and group forgoing antibiotics administration.

DISCUSSION OF RESULTS

Emergency Room overcrowding is a significant health problem in the world for the last ten years. In general, ER overcrowding occurs due to the increasing demand for health services and lack of space in the ER and hospital. Internal and external factors influence ER overcrowding. The most influential factor to date is inadequate access to treatment rooms in addition to the lack of doctors and nurses in the ER (Di Somma et al., 2014).

ER measurements were represented through the occupancy rate. The average P1 occupancy rate was 80.8%. The dominance of the occupancy rate was $< 100\%$ (63.2%). The findings indicate P1 occupancy rate is adequate to manage patients. However, the occupancy rate is not in line with the LOS data of P1 septic patients. There was a mean LOS of 912.9 minutes, represented through 38 samples. The 38 samples remained in the ER for more than 4 hours. The number of ER staff ranging from 13-17 staff per shift per case. However, this study did not measure the ER staff's average productivity to determine the average human resources ability to manage patients.

The ER output measurement is represented through the boarding time and the percentage of boarders. The mean boarding time for sepsis patients treated at P1 was 742.7 minutes with a predominance of boarding time > 120 minutes in 37 samples (97.4%). The findings suggest that most patients had to wait more than 2 hours before being transferred to an inpatient ward. The percentage of boarders was 52.0% on average. The dominance of the percentage of boarders $> 10\%$ occurred in 37 samples (97.4%). The findings indicate that 52.0% of patients in the ER were waiting to transfer to the inpatient room. Therefore, boarding time and percentage of boarders are alleged to be the main factor of the ER overcrowding issue.

Factors causing long boarding time are patients in critical condition, incapable of receiving outpatient treatment, and triaged into P1. The patient was immediately registered for hospitalization forgoing complete examination results. Besides, P1 patients generally require a longer stabilization process before transferred to the inpatient room. dr. Saiful Anwar Hospital is a type A hospital acting as a regional referral hospital. There is a low referral rate to higher referral hospitals. Therefore, sepsis patients treated at P1 ER of dr. Saiful Anwar Hospital has a low rate of referral to another hospital despite full inpatient rooms.

Crane stated that the hospital would place boarders in the emergency room due to a shortage of beds or nurses in the inpatient room, to conduct inpatient process. Due to inadequate inpatient capacity, the emergency room became a shelter for excess patients. ER overcrowding increases because of the number of inpatients entering the hospital through ER. As a result, ER receives unplanned boarding patients and provides low services. The practice is becoming more and more widespread. Boarding times increase due to the increasing number of transfers of patients between staffs (Crane, Dempsey, Jensen, Weintraub, & Strauss, 2014)

Increased boarding time is one of the factors that explain extended LOS despite a reasonable ER occupancy rate. Crane stated that the consequences of boarding are longer LOS and higher health costs. Several studies showed that boarders tend to stay longer in the hospital. In addition, boarders reduce the number of outpatients. ER overcrowding and boarding reduce patient satisfaction and potentially increase medical errors (Crane, Dempsey, Jensen, Weintraub, & Strauss, 2014).

The United States and many other developed countries agreed that ER overcrowding was the leading cause of boarders or hospitalized patients held in the ER. This study found that the occupancy rate, time until triage, and the number of staff influence ER procedures—in this case, the Hour-1 Sepsis Bundle (Noon, Crane, Harris, & Kauffman, 2014).

ER Occupancy rates and total ER staff are a reflection of the resources available in the ER. Emergency experts who joined the American College of Emergency Physicians (ACEP) in 2006 defined ER overcrowding as a consequence of an imbalance between the demand and supply of ER emergency services and the hospital's limited capacity (Schoenenberger et al., 2016). Occupancy rate affects the measurement of lactate levels < 1 hour and between 1-6 hours (Shin & et.al, 2013). The research result is in line with (Shin et al., 2013) which stated that occupancy rates > 100% were associated with low adherence to sepsis resuscitation bundles and reduced the likelihood of bundle component implementation on time. Every 10% increase in ER occupancy rate was associated with 4 minutes of antibiotic administration delay and decreased chance of antibiotics administration within 3 hours (Peltan et al., 2019).

Time until triage reflects the ER input factor. Triage means to sort patients based on their clinical conditions and a useful management tool to organize, monitor, and evaluate patients and resources available in the ER. (Ahsan, Karim, Fitzgerald, Morel, & Burke, 2019). The high input into the ER affects the implementation of the Hour-1 sepsis bundle procedure. In this case, high input into ER affects culture sampling.

Furthermore, ER RSSA data showed a stable number of emergency visits in the 2011 to 2015 period. However, there was a drastic change in the acute composition of the P1 category, as many as 1,167 P1 patients in 2011. The number increased to 3,672 P1 patients in 2015. RSSA is a regional referral hospital under the National Health Insurance with many primary and secondary referral patients from various regions and health facilities (32.9% of referral patients in 2015) (RSSA, 2016). This amount created a gap between the demand and supply of ER RSSA resources. Therefore, the gap leads to difficulty to control ER overcrowding.

Based on the point of view of the ER workforce, internal factors causing ER overcrowding is the lack of nurses and doctors in the ER (Di Somma et al., 2014). The finding is in line with the research result. The number of ER staff influenced the administration of antibiotics adhering to the procedure. P1 possessing seven beds capacity with a total dependent patient with a 1:1 requires seven nurses per shift. However, during the research period, there were 3-4 nurses available per shift.

CONCLUSION

There was no significant relationship between ER overcrowding factors (time until triage, occupancy rate, LOS, number of staff, boarding time, and percentage of boarders) and the overall implementation of the Hour-1 Sepsis Bundle. However, there was a relationship between time until triage and blood culture sampling, occupancy rate and measurement of lactate levels, and total ER staff and ER junior staff on antibiotics administration.

The sepsis management did not adhere to the 2016 SSC recommendations in the form of an Hour-1 Bundle. Besides, there was no official hospital guide. Therefore, it is necessary to create a guide for good sepsis management in the hospital. Coordination between policyholders is crucial to establish a joint policy in reducing the negative effects of ER overcrowding. Thus, increasing effective ER occupancy rate, optimizing the role of triage, and recalculating the adequate number of staff in the ER are crucial steps to take.

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