ORIGINAL ARTICLE

Factors Related to Length of Stay of Critical Patients in Intensive Care Unit: A Single-center Cross-sectional Study

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ABSTRACT

Background. Intensive care units (ICUs) provide specialized care for critically ill patients, but prolonged length of stay (LOS) can strain limited ICU capacity, increase healthcare costs, and negatively affect patient outcomes. Predicting LOS at the time of ICU admission remains challenging because of the complex interplay of patients' clinical conditions and therapeutic needs.

Objective. This study aimed to identify clinical and admission-related factors associated with ICU LOS and determine predictors of prolonged stay among ICU patients.

Methods. This study employed a cross-sectional design, with data collected from patient medical records in 2024. The Charlson Comorbidity Index (CCI), Glasgow Coma Scale (GCS), Blood pressure (BP), and LOS were used as the dependent outcome variables. Data processing was conducted with the Pearson correlation coefficient, t-test, and Hierarchical multiple regression.

Results. A total of 146 ICU patients participated as respondents, with an average age of 63.36 ± 14.56 years, CCI (4.27 ± 2.33), GCS 12 ± 4, and the average LOS was 5.25 ± 4.99 days. The results showed that variables presenting a relationship with LOS were age (r = 0.17, p = 0.05), CCI (r = -0.46, p = 0.01), GCS (r = -0.54, p = 0.01), and use of a mechanical ventilator (MV) (t = 5.44, p = 0.01). Five variables identified as LOS predictors included age (B = 0.03), CCI (B = -0.37), GCS (B = -0.12), systolic blood pressure (SBP) (B = 0.01), and not using MV (B = -0.91), which were expected to cover 74% of the variance in LOS (adjusted R^2 = 0.725, F = 48.67).

Conclusion. Endeavors to minimize LOS can serve as a crucial strategy in reducing nosocomial infections, the financial burden of treatment, morbidity and mortality, and enhancing the quality of life of patients in the ICU. In addition, age, CCI, GCS, SBP, and MV were significant predictors of ICU patients' LOS, with CCI being the strongest predictor.

Keywords: length of stay, intensive care unit, critical patients

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INTRODUCTION

The Intensive Care Unit (ICU) is a specialized facility that cares for critically ill patients requiring intensive monitoring, including those with acute and chronic conditions or terminal illnesses in unstable states.[1] Care in an ICU room requires many professional staff and is equipped with good facilities to monitor the condition of patients.[2] However, the limited number of beds in the ICU, which is only 8% of the total bed capacity in the hospital, can cause serious problems and have a significant impact on other services, such as the Operating Room (OR), inpatient rooms, or the

emergency room (ER).[3] Expanding ICU capacity may not be possible due to physical constraints, insufficient resources, or government regulations.[4]

Patients receiving care in the ICU are a group with diverse medical conditions and various comorbidities. Consequently, highly skilled health resources and services are required to address the problem associated with Length of Stay (LOS).[5] Dependence on intensive interventions, such as ECG (electrocardiogram) monitoring, hemodynamic management, pain control, kidney function monitoring, mechanical ventilation support, or respiratory management, is one of the actions greatly needed during treatment in the ICU.[6] Additionally, early monitoring when critical patients are admitted to the ICU is an essential foundation in determining LOS.

The World Health Organization (WHO) reports that LOS is a crucial metric for tracking and assessing hospital performance.[7] LOS in the ICU is both a measure of the quality of care and a significant influence on hospital costs; Furthermore, the duration of stay serves as a standard for gauging resource usage and forecasting an increased likelihood of readmission.[8] However, due to the intricate interplay of patient features, physiological status, and therapeutic needs, LOS remains challenging to forecast at the time of patients' admission, despite its clinical significance. The majority of ICU patients spend only a few days in the hospital. Nonetheless, a small percentage of patients with severe, chronic, or persistent illnesses stay in the hospital for longer than a week. Several studies found that an LOS is characterized as more than 21 or 30 days in medical ICUs and 3 to 14 days in cardiology and surgical ICUs.[9] However, it is imperative to ascertain the patients' characteristics before admission, the rationale for their ICU admission, and any potential issues that may arise during their hospitalization.

The question under consideration is whether LOS can be predicted at the time of ICU admission. Several innovations have been developed to reduce the problem of LOS in the ICU.[10,11] Numerous studies were previously conducted to identify factors associated with LOS.[12,13] However, the uncertainty of patients' LOS in the ICU is still among the problems and phenomena that need to be investigated. Extending LOS can cause several complications, such as financial constraints, or increase the risk of health problems (Nosocomial Infections).[14]

Various conditions, such as blood pressure (BP) problems, decreased consciousness, comorbidity status, cases experienced by patients (Acute, Chronic/terminal), and use of mechanical ventilators (MV), are an essential part of the initial screening performed during admission to the ICU to determine LOS.[15-17] BP is frequently employed as an initial physiological parameter. Numerous studies have demonstrated a correlation between BP and disease severity, particularly in patients with cardiovascular instability. Moreover, the GCS is a reliable indicator of both neurological and general clinical health. It is a scale used to assess an individual's level of consciousness. On the other hand, the LOS and recovery pathways are influenced by the comorbidity burden, which is frequently measured using the CCI, and the necessity for MV upon admission or in the early stages of hospitalization is indicative of severe respiratory distress. It is imperative to identify risk factors that may influence the LOS in the ICU. A comprehensive examination of the effects of BP, GCS, comorbidity status, case experience, and MV utilization on the LOS of patients admitted to the ICU is therefore necessary. The objective of this study is twofold: firstly, to ascertain the variables associated with the LOS of patient care in the ICU; and secondly, to examine the predictor factors.

METHODS

Study Design and Respondents

A cross-sectional design using consecutive sampling was conducted in the intensive care unit (ICU) of a private hospital in Bandung, Indonesia. This study involved 146 ICU patients, consisting of 81 males and 65 females. Data collected from patient medical records in January to December 2024 included comorbidities, Glasgow Coma Scale (GCS), patient arrival status (ER or ward/other), use of MV, and BP when the patient was first admitted to the ICU. Furthermore, the initial evaluation by the attending physician is used to determine the diagnosis at the time of admission to the ICU, which is then categorized as acute or chronic/terminal. The terms 'chronic' or 'terminal' are used to indicate a chronic disease that is decompensating or end-stage. Conversely, the term 'acute' indicates the onset of a serious illness or an acute attack. The data set included patients who were transferred to the ward and patients who were declared dead after receiving treatment for less than three weeks. Exclusion criteria were patients transferred to another hospital and patients aged less than 18 years. This study was approved by the Hospital Institutional Review Board (HIRB) (010/KEPK/RSAB/III/2024).

Study Instrument

This study used demographic characteristics (age and gender) and disease-related factors measured upon ICU admission. These factors included comorbidities, GCS, patient arrival status (ER or ward/other), use of MV, and BP. The CCI was employed to assess comorbidity, where a higher score indicates greater mortality risk. The CCI showed moderate to good discriminant ability (range: 0.661 to 0.881) across different populations, with higher scores indicating greater comorbidity.[18] Consciousness was evaluated using the GCS, which rates eye opening, verbal, and motor responses from 3 to 15; higher scores indicate better consciousness.[19] Systolic and diastolic blood pressure (SBP and DBP) were then examined. The length of stay (LOS) was assessed from the start of treatment until ICU discharge.

Statistical Analysis

Before analysis, all data were examined to determine errors, missing values, distribution, normality for primary variables, homogeneity of variables, homoscedasticity, and linearity for each statistical procedure. The relationship between demographic characteristics, illness-related factors, and LOS was explored with an independent t-test and Pearson correlation. Moreover, multiple hierarchical regressions were used to explain the predictor variables in LOS. However, based on a cut-off point value of p <0.20 for LOS, variables that were significant with LOS were included in the regression model. Dummy variables were performed on gender, VM, admission, and diagnosis of patients, and all variables were included in this analysis using two models. In Model 1, demographic characteristics (age and gender) were entered as baseline demographic variables. In Model 2, illness-related factors, including BP, GCS, CCI, MV status, and diagnostic (acute or terminal), were entered simultaneously to assess their additional explanatory value beyond demographic characteristics (age and gender). The block-wise entry facilitated the evaluation of patients' unique contributions to ICU LOS.

RESULTS

Demographic Characteristics, Illness-related Factors, and Patients' LOS in ICU

Based on demographic characteristics of 146 ICU patients included in this study, the average age was 63.36 (14.56) years, and the largest percentage of respondents were males (55.5%). Among illness-related factors, the average CCI, GCS, SBP, and DBP were 4.27 ± 2.33, 12 ± 4, 123.44 ± 37.24 mmHg, and 71.16 ± 20.99 mmHg, respectively. The majority of respondents (58.2%) used MV, had an acute diagnosis (69.2%), and came from the ER (71.2%). In addition, the average length of stay (LOS) in the ICU was 5.25 ± 4.99 days. Of these patients, 74.7% were transferred to the ward, and 25.3% died (Table 1).

Relationship between Demographic Characteristics, Illness-related Factors, and LOS in ICU

This study found that patients' LOS in ICU had a significant positive relationship with age (r = 0.17, p <0.05) and the use of MV (t = 5.44, p <0.01), as well as a negative relationship with comorbidities (r = -0.46, p <0.01) and GCS (r = -0.54, p <0.01). Meanwhile, LOS did not show a

Table 1. Demographic Characteristics of Respondents (n = 146)

Variable	Mean	SD	Minimum	Maximum	Frequency	Percent
Age (years)	63.36	14.56	21	93		
CCI number	4.27	2.33	1	11		
Gender						
Male					81	55.5
Female					65	44.5
GCS	12	4	3	15		
Systolic (mmHg)	123.44	37.24	46	214		
Diastolic (mmHg)	71.16	20.99	21	123		
MV						
Yes					85	58.2
No					61	41.8
Admission						
ER					104	71.2
Ward/others					42	28.8
Diagnostic						
Acute					101	69.2
Chronic/Terminal					45	30.8
LOS (day)	5.25	4.99	1	17		
Discharged to ward					109	74.7
Died					37	25.3

CCI – Charlson Comorbidity Index, GCS – Glasgow Coma Scale, MV – Mechanical Ventilation, ER – Emergency Room, LOS – Length of Stay

Table 2. Relationship between Demographic Characteristics and LOS of Patients in ICU (n = 146)

No	Variable	1	2	3	4	5
1	Age					
2	CCI	0.36**				
3	GCS	-0.15	-0.10			
4	Systolic	0.03	-0.06	0.06		
5	Diastolic	-0.15	**-0.20***	0.13	**0.77****	
6	LOS	**0.17***	**-0.46****	**-0.54****	0.04	-0.04

*Bold (significant); *level of the significant is 0.05; **level of the significant is 0.01*

Table 3. Association between Demographic Characteristics and LOS of Patients in ICU (n = 146)

Variable	n	Mean	SD	*t*	*p* Value
Gender					
Male	81	4.19	1.23	-0.20	0.85
Female	65	4.23	1.28		
MV					
Yes	85	4.64	1.40	**5.44**	**0.01**
No	61	3.60	0.61		
Arrival status					
Emergency Room	104	4.15	1.21	-0.89	0.37
Ward/others	42	4.35	1.35		
Diagnostic					
Acute	101	4.14	1.26	-0.93	0.35
Chronic/Terminal	45	4.35	1.23		

Bold is a significant variable with p <0.05

significant relationship to gender, SBP, DBP, arrival status, and diagnosis (Tables 2 and 3).

Predictors of LOS in ICU

Five (5) variables significantly correlated with LOS: age, CCI, GCS, SBP, and lack of MV use (Table 4). However, three variables not correlated with LOS (gender, DBP, and diagnosis) were included in the multiple linear regression model. The variable included in Model I was age, which showed a significant relationship (B = 0.01, p <0.05), and accounted for 2.9% of the variance in patients' LOS. Model II (final model) consisted of age, gender, comorbidities, GCS, BP, MV (dummy variable), and diagnosis (chronic or terminal) dummy variable. The results showed that R^2 increased from 0.029 to 0.740, and the significant variables in model II were age (B = -0.03, p <0.001), comorbidities (B = -0.37, p <0.001), GCS (B = -0.12, p <0.001), SBP (B = 0.01, p <0.05), and not using MV (B = -0.91, p <0.001)".

DISCUSSION

The average age of the study respondents was elderly, and the results showed that increasing age was associated with longer LOS in the ICU. This finding is supported by existing research, which shows that the risk of longer LOS in patients increases with age; Decline in the function of several organs and the immune system is a contributing factor.[20,21] In addition, the majority of respondents in this study were male; however, the current study found no significant relationship between gender and LOS of critically ill patients in the ICU.[22]

Based on illness-related factors in Table 2, comorbidity status had a significant relationship with LOS. This finding aligned with previous studies indicating that recovery and healing can be hindered when organ dysfunction occurs due to comorbidities.[23,24] Once patients reached a more stable state, however, follow-up care was possible in a standard treatment room despite ongoing comorbidities.[25] On the other hand, the current study demonstrated that as the number of comorbidities increased, patients experienced shorter LOS in the ICU. This finding indicates that the presence of comorbidities substantially increases the risk of high mortality.[26] Besides that, the current results suggest that greater comorbidity complexity may reduce ICU LOS, likely due to increased patient fatalities. The observed mortality rate was 25.3% (Table 1).

GCS of patients during admission had a significant relationship with LOS in the ICU, where a reduction in GCS score was a sign of decreased consciousness. This describes the critical condition status of patients requiring intensive care, where decreased GCS is associated with an increased risk of using MV, leading to an increase in LOS.[15,27,28] Conversely, the risk of complications from MV, specifically ventilator-associated pneumonia (VAP), a lung infection that frequently occurs in patients on ventilators, has the potential to prolong the duration of ICU stay. Consequently, the weaning process for patients on MV must be initiated promptly. However, it is essential to consider the patient's individual condition during the weaning process.[29]

Predictors of LOS

As we age, there is a tendency for the function of several organs to decline. Similarly, advanced ageing is associated with a decline in the patient's immune system, which affects the healing process and causes an increase in LOS in the ICU.[30] In addition, comorbidity is an important predictor and indicator of patient LOS in the ICU. In the present study, a higher CCI was associated with a reduced LOS.

Table 4. Predictors of LOS of Patients in ICU (n = 146)

Predictor	Model I			Model II		
	B	95% CI	*B*	*B*	95% CI	β
Age	0.01*	0.00 to 0.03	0.17	**-0.03****	0.02 to 0.04	0.32
Gender	0.03	-0.38 to 0.44	0.01	-0.08	-0.30 to 0.13	0.03
CCI				**-0.37****	-0.42 to -0.32	-0.70
GCS				**-0.12****	-0.15 to -0.09	-0.38
Systolic				**0.01***	0.00 to 0.01	0.21
Diastolic				0.01	-0.02 to 0.00	-0.13
Not using MV				**-0.91****	-1.18 to -0.64	-0.36
Diagnostic (chronic/terminal)				0.05	-0.19 to 0.28	0.01
R^2		0.029			0.740	
Adjusted R^2		0.015			0.725	
ΔR^2		-			0.711	
F		2.10			48.67	

**p <0.05 level; **P <0.001 level of significance (2-tailed); Bold values: Predictors of LOS (Model I: Age), and (Model II/Final model: Age, CCI, GCS, Systolic, MV)*

This inverse relationship may appear paradoxical at first. This result should therefore be viewed in light of the research population's relatively high in-hospital death rate (25.3%). A reduced observed length of stay (LOS) may be attributable to patients with a high comorbidity burden experiencing rapid clinical deterioration and early mortality. Therefore, the shorter LOS among patients with higher CCI scores should be seen as a reflection of early death or treatment limitation in critically sick patients rather than as a sign of quicker recovery or more effective care. This phenomenon, where mortality acts as a competing outcome that shortens inpatient length, has been reported in earlier research, including critically sick and high-risk groups.[23,24] On the other hand, this study found that GCS had a negative correlation with LOS of patients in the ICU. On the other hand, the present study found that GCS has a negative correlation with LOS in the ICU, where a decrease in GCS score may increase patient LOS or vice versa. It is essential to acknowledge the importance of patient awareness in determining the status of patients undergoing intensive care in the ICU. The stability or instability of a patient's condition can be determined by their GCS, which in turn affects the length of their LOS.[31]

The use of MV is associated with increased LOS in the ICU, leading to the immediate initiation of the weaning process when the patient's respiratory condition becomes stable, thereby addressing nosocomial illnesses and reducing LOS.[32] Controlled reductions or increases in SBP have been demonstrated to have a favorable impact on the reduction of oxidative stress and systemic inflammation, which are prevalent in critically ill patients. It has been demonstrated that this promotes a more adaptive cardiovascular response and faster metabolic recovery after critical stress, which impacts LOS.[33,34]

Study Limitations

The limitations of this study included 1) Some variables were not evaluated, such as Acute Physiology and Chronic Health Evaluation (APACHE) or Sequential Organ Failure Assessment (SOFA) score, which could affect LOS in the ICU, and the interpretation of results across several acute disease categories may be hampered, as patients were not classified by specific primary diseases at ICU admission; However, the current data may provide important information in addressing the issue of length of stay. 2) The current study used secondary data; as a result, some specific information was not available, including the type of MV and the duration of patients' stay in the emergency room or ward before their admission to the ICU. 3) This study was conducted in a single hospital in Indonesia, which may limit the generalizability of the results. However, employing rigorous research methods will facilitate the acquisition of significant data concerning the issue of LOS in ICU patients. 4) Lack of diagnosis-based stratification and subgroup or sensitivity analyses may limit assessment of effect heterogeneity and robustness. 5) The absence of discharge-outcome (discharge/transfer versus death) stratification in the predictors may compromise the interpretation of LOS, particularly in relation to CCI and GCS, as a shorter LOS may indicate early mortality rather than recovery. Therefore, it is essential to exercise caution when interpreting the inverse relationships between CCI, GCS, and LOS; It is recommended that future research analyses be stratified by discharge type or that models based on competing risks or survival be used.

CONCLUSION

In conclusion, the LOS was found to be significantly predicted by admission screening characteristics. These characteristics included age, GCS, the CCI, SBP, and MV status. A shorter LOS has been linked to older age, greater comorbidity burden, and lower level of consciousness. This is probably indicative of early mortality among high-risk patients. It is noteworthy that the bivariate outcomes and the direction of the regression coefficients in the final model indicated that mechanical ventilation use was associated with prolonged hospitalization. In contrast, its non-use was associated with reduced LOS. The findings of this study underscore the pivotal role of early clinical evaluation in predicting patient outcomes and optimizing hospital resource utilization.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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