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The Relationship Between mSOFA and the Ratio of Treatment Costs to BPJS Coverage in Medical Cases in the ICU at Dr. Cipto Mangunkusumo National General Hospital: A Cost Analysis Study

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Abstract

In the prospective payment system based on INA-CBGs, understanding the relationship between patient clinical complexity and the proportion of intensive care unit (ICU) costs relative to the INA-CBGs tariff is essential for evaluating service efficiency and equity in health financing allocation. However, few empirical studies in Indonesia have examined how factors such as the mSOFA score, mechanical ventilation use, hemodialysis, and length of ICU stay relate to ICU cost proportions. This prospective cohort study was conducted at Dr. Cipto Mangunkusumo National General Hospital from 1 January to 31 March 2026, involving 46 adult patients admitted to the medical ICU with complete INA-CBGs claims. Data were extracted from electronic medical records and the hospital's financial information system, including daily mSOFA scores, mechanical ventilation status, hemodialysis administration, ICU length of stay, actual ICU costs, and corresponding INA-CBGs tariffs. The analysis showed that no increase in ICU cost proportion was observed with higher mSOFA scores or longer ICU stays. In contrast, variability in cost proportion decreased among patients with mSOFA ≥6 and ICU stays longer than four days, suggesting that in critically ill patients with high disease severity, ICU costs become relatively more predictable compared with INA-CBGs tariffs. ICU cost proportion is not determined linearly by a single intervention but instead results from a complex interplay among disease severity, accuracy of diagnosis and procedure coding, and daily clinical dynamics during ICU admission.

INTRODUCTION

Intensive Care Unit (ICU) services are among the most resource-intensive components of healthcare, as patient management in the ICU requires advanced medical equipment, skilled healthcare personnel, and continuous intensive monitoring. In this context, it is important to consider the economic impact of ICU services on patients, hospitals, and society. In addition, the high cost of ICU treatment is a critical issue, particularly within the national health insurance system such as BPJS Kesehatan (Halim & Manggala, 2024; Rahayuningrum et al., 2016; Yassir et al., 2025). Under this system, payments are made through a case-based payment mechanism, namely the Indonesian Case-Based Groups (INA-CBGs) (Happy, 2018). However, previous studies have shown a gap between the actual cost of care and reimbursements received through the INA-CBGs system, which are often insufficient to fully cover the costs of managing critical ICU cases (Sugiarto & Roziq, n.d.).

To address this issue, data are needed as feedback for BPJS Kesehatan regarding the financing gap in the treatment of critically ill patients. Therefore, an initial assessment is required to estimate treatment costs for ICU medical cases. Disease severity scores can be used as predictive tools in this context. One widely used scoring system is the Sequential Organ

Failure Assessment (SOFA) score and its modification, the modified SOFA (mSOFA). The mSOFA is an adaptation that excludes certain laboratory parameters that are not routinely performed, making it more cost-efficient. Studies have shown that mSOFA has varying sensitivity and specificity in identifying patients at high risk, particularly outside the ICU (Song et al., 2018). However, in ICU settings, SOFA and its modifications (mSOFA) can serve as comprehensive tools for assessing disease severity and estimating medical resource utilization and treatment costs (Aggrawal et al., 2024; Bulger et al., 2015; Ranzani et al., 2017; Sayed, 2022).

The BPJS Kesehatan payment system through the INA-CBGs mechanism calculates reimbursement based on average case costs derived from historical data and standardized care assumptions. The gap between actual costs and INA-CBGs tariffs has been reported in various studies, where factors such as comorbidities, surgical procedures, and intensive care utilization contribute to these differences (Taofik et al., 2015). Meanwhile, disease severity measured by the mSOFA score may explain variability in treatment costs, as higher mSOFA scores indicate greater organ dysfunction and increased need for medical intervention (Deng et al., 2025; Hong et al., 2025; Ohbe et al., 2023; Zhou et al., 2025).

The difference between actual costs and INA-CBGs reimbursements highlights the need for a more responsive tariff adjustment approach. Studies analyzing this gap suggest that variability in care needs, particularly among critically ill patients, is one of the main contributing factors. Thus, the use of mSOFA scores as a severity indicator is expected to improve understanding of how incremental score changes correlate with increased treatment costs, thereby supporting more accurate reimbursement policy adjustments that better reflect patients' clinical conditions (Sugiarto & Roziq, n.d.).

Overall, this issue presents a dual challenge: ensuring high-quality intensive care for critically ill patients while addressing limitations in the BPJS Kesehatan reimbursement system, which may not fully accommodate variations in disease severity. Therefore, research exploring the relationship between mSOFA scores and the proportion of ICU costs covered by BPJS through INA-CBGs simulation is highly relevant for improving severity-based healthcare financing systems (Zajic et al., 2024).

This study aimed to determine the proportion of actual ICU costs compared with INA-CBGs reimbursement rates as a basis for more efficient and financially sustainable ICU service planning. It examined the relationship between disease severity based on mSOFA scores and the proportion of actual ICU costs relative to BPJS Kesehatan reimbursements under the INA-CBGs system, as well as the effects of ICU length of stay, hemodialysis procedures, and mechanical ventilation on treatment costs. The hypothesis stated that there is a relationship between mSOFA scores, ICU length of stay, and the use of extracorporeal therapies (hemodialysis and mechanical ventilation) with the proportion of actual ICU costs relative to INA-CBGs reimbursements. The objective of this study was to analyze the relationship between mSOFA scores and the proportion of ICU treatment costs borne by BPJS Kesehatan under INA-CBGs simulation in medical ICU patients, including the effects of disease severity, extracorporeal therapy, and length of ICU stay on cost proportions. This study is expected to contribute academically by enriching health economics literature, support decision-making in healthcare financing systems, and assist clinical management in improving ICU service efficiency, relevance, and cost-effectiveness.

METHOD

Research Design

This study was a cost analysis using a prospective cohort design that aimed to determine the proportion between actual hospital costs and BPJS reimbursement for medical ICU cases at Dr. Cipto Mangunkusumo Hospital, based on mSOFA scores and the use of extracorporeal therapies, including mechanical ventilation and hemodialysis.

Place and Time of Research

The research was conducted in the ICU of Dr. Cipto Mangunkusumo Hospital in 2026 after receiving approval from the FKUI-RSCM Ethics Committee and written approval from the patient's family who had received an explanation about this research.

Population and Research Sample

The study population is a medical case in patients who were treated in the ICU of Dr. Cipto Mangunkusumo Hospital in the period of January 1 – March 31, 2026. The research sample is a research subject that meets the inclusion criteria and is not included in the exclusion criteria.

Inclusion, Exclusion, and Drop-Out Criteria

1. Kriteria Inklusi
    a. Critically ill patient with a medical case who is treated in the ICU of Dr. Cipto Mangunkusumo Hospital
    b. Age ≥18 years old
    c. The patient or the patient's family is willing and agrees to be the subject of the research
2. Exclusion Criteria
    a. Critically ill patient with surgery case who is treated in the ICU of Dr. Cipto Mangunkusumo Hospital
    b. Patients with a history of ICU remission treatment
    c. Patients with financing for ICU treatment other than BPJS
3. Kriteria Drop-Out
    a. Patient dies in ICU care
    b. Patients and families decide to come out as research subjects

How It Works

1. The research will begin after obtaining ethical approval from the FKUI – RSCM research ethics committee.
2. The identification of research subjects was carried out by anesthesiology residents on duty in the Adult ICU and ICU Emergency Room. If it meets the criteria, informed consent will be given to the subject's family/guardian.
3. Explain the research procedure to the subject's family/guardian who has met the criteria, then ask the subject's family/guardian to sign a research approval letter. After the family/guardian agrees and signs the informed consent, the subjects are included in this study. Patients who fell within the rejection criteria were excluded in the study.
4. The subject's identity, medical record number, date of start of treatment and initial diagnosis were recorded at the time of admission to the ICU.
5. Basic data of subjects were recorded when they arrived at the ICU, such as weight, consciousness, date of ICU admission and diagnosis of ICU admission.

6. An assessment of the subject's mSOFA score was also carried out based on physical and laboratory examinations.
7. Total financing is recorded while patients are admitted to the ICU based on hospital rates and INACBGs simulation rates.
8. If conditions have improved, subjects are prepared to move out of ICU care. A record of the length of treatment in the ICU was carried out

Data Analysis

Data analysis using the SPSS version 25 application officially licensed by the University of Indonesia. Bivariate analysis is used for statistical tests. Patient characteristics are displayed in the form of a table to assess the distribution of data. The results of the analysis are statistically significant if the significance value is less than 0.05 and the 95% confidence interval (IK 95) does not include a value of 1.

RESULTS AND DISCUSSION

Research Subject Flow

Data collection was carried out from January 1 to March 31, 2026 by observing critical patients who were treated in the ICU of Dr. Cipto Mangunkusumo Hospital in accordance with the inclusion and exclusion criteria of the study. A total of 59 research subjects who met the research criteria were successfully identified, of which 13 subjects were expelled because they died, so that 46 subjects were analyzed. The number and flow of patients who followed the monitoring to the end are presented in figure 4.1.

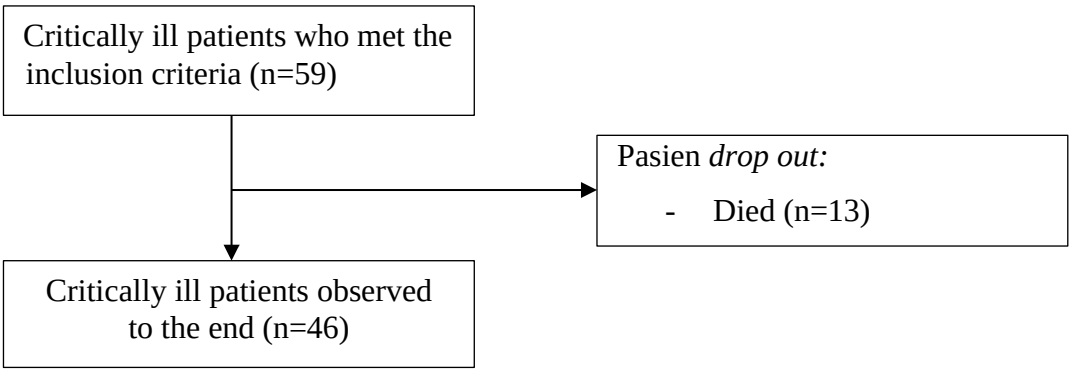

Figure 4.1 Research Subject Observation Flow

Characteristics of Research Subjects

The frequency distribution of the study subjects as critically ill patients who are treated in the ICU is presented in Table 4.1. Demographically, the proportion of patients with high costs in the age group ≥50 years (20.0%) compared to the <50 age group (19.2%), showed a difference that was not insignificant. Patients with high costs were balanced between males (19.0%) and females (20.0%). In terms of nutritional status, the incidence of high costs increased as the body mass index (BMI) increased: highest in the obese group (BMI ≥25.0; 30.8%), while lowest in the lean group (BMI <18.5; 14.3%). Interestingly, patients without comorbidities actually had a greater proportion of high costs (37.5%) than those with one or more comorbidities (14.3%). In contrast, patients with severe organ dysfunction, characterized

by a score (mSOFA) of ≥6. all (100%) were included in the low-cost group, in stark contrast to the mSOFA group <6 (75.7% low-cost). Duration of hospitalization also showed that patients with a duration of treatment ≤4 days had a higher proportion of high costs (21.7%) than those with a long stay (>4 days; 12.5%). Finally, hemodialysis (12.5%) and mechanical ventilation (14.7%) interventions were not associated with an increased risk of high cost.

Table 4.1 Frequency Distribution of Research Subjects

Variabel		**(n=46)**
Age	<50 Years	26 (56,6)
	>50 Years	20 (43,5)
Gender	Male	21 (45,7)
	Women	25 (54,3)
BMI score	18.5 ≤ BMI < 24.9	19 (41,3)
	BMI < 18.5	14 (30,4)
	25.0 ≤ BMI	13 (28,3)
Comorbidity Score	None	8 (17,4)
	Ada	38 (82,6)
mSOFA Score	<6	37 (80.4)
	≥6	9 (19,6)
Length of treatment	≤4	23 (50,0)
(Score)	>4	23 (50,0)
	No	38 (82,6)
Hemodialisa	Ya	8 (17,4)
	No	12 (26,1)
Ventilator	Ya	34 (73,9)
	≤1	37 (80,4)
Cost proportion score	> 1	9 (19,6)

The variable frequency distribution of age, sex, BMI, and length of treatment has a balanced distribution in proportion between the category groups. Meanwhile, the variable frequency distribution of comorbid scores, mSOFA, hemodialysis and cost proportion scores has an unbalanced distribution.

The relationship between the mSOFA Score and the Proportion of Cost of Care in the ICU

The relationship between mSOFA score and the proportion of care costs in the ICU is presented in Table 4.2 Based on the analysis of patients with an mSOFA score of <6 with a cost proportion score of ≤1 of 28 patients (75.7%) and a cost proportion score of >1 of 9 patients (24.3%). Meanwhile, patients with mSOFA scores of ≥6 as many as 9 patients (100%) all had a cost proportion score ≤1.

Table 4.2 Relationship between mSOFA Score and Proportion of Costs in ICU

mSOFA score	Cost Proportion Score		P value	RR(95%CI)
	≤1	>1		
	(n=37)	(n=9)		
<6	28(75,7)	9(24,3)	0,171	N/A
≥6	9(100)	0(0)		

A p-value of 0.171 from the chi-square test showed that there was no statistically significant difference between the mSOFA score groups <6 and ≥6 in terms of the distribution of cost

proportions in the ICU. The Risk Ratio (RR) could not be calculated (N/A) because there were *zero cells*; there were no cases with mSOFA ≥6 and cost ratio >1.

The Relationship between Length of Stay in the ICU and the Proportion of Cost of Treatment in the ICU

The relationship between length of ICU stay and the proportion of ICU care costs is presented in Table 4.3. Based on the results of the analysis, patients with a duration of treatment ≤4 days with a low proportion score of 18 patients (78.3%) and a high cost proportion score of 5 patients (21.7%). Meanwhile, patients with a duration of treatment >4 days with a proportion of low costs were 19 patients (82.6%) and a high cost proportion score of 4 patients (17.4%).

Table 4.3 Relationship between Length of Stay in the ICU and the Proportion of Costs in the ICU

Long treatment (day)	Cost Proportion Score		P value	RR(95%CI)
	≤1 (n=37)	>1 (n=9)		
≤4	18(78,3)	5(21,7)	1,000	0,947 (0,712-1,261)
>4	19(82,6)	4(17,4)		

A p-value of 1,000 indicates that there was no statistically significant difference in the proportion distribution of costs (>1 vs. ≤1) between the ≤4-day and >4-day treatment groups. Critical patients in the ICU with a stay of ≤4 days had a risk of 0.95 times the occurrence of a low-cost proportion score (≤1) compared to patients with a stay of more than 4 days (RR 0.947, 95% CI (0.712-1.261)).

The Relationship between Hemodialysis Procedures and the Proportion of Treatment Costs in the ICU

The relationship between hemodialysis procedures and the proportion of ICU care costs is presented in Table 4.4. Based on the analysis, patients who did not undergo hemodialysis had a high cost proportion score of 8 patients (21.1%) and a low cost proportion score of 30 patients (78.9%). Meanwhile, patients undergoing hemodialysis with a high cost proportion score of 1 patient (12.5%) and a low cost proportion score of 7 patients (87.5%).

Table 4.4 Relationship between Hemodialysis Procedure and Proportion of Costs in the ICU

Hemodialisa	Cost Proportion Score		P value	RR(95%CI)
	≤1 (n=37)	>1 (n=9)		
No	30(78,9)	8(21,1)	1,000	0,902 (0,662—1,229)
Ya	7(87,5)	1(12,5)		

Based on the results of the analysis, p=1,000 showed that there was no statistical evidence that the distribution of cost proportions (>1 vs. ≤1) differed between groups with and without hemodialysis.

Relationship between Mechanical Ventilation Procedures and the Proportion of Treatment Costs in the ICU

The relationship between mechanical ventilation procedures and the proportion of care costs in the ICU is presented in Table 4.5. Based on the results of the analysis, patients who did

not use ventilators had a high cost proportion score of 4 patients (33.3%) and a low cost proportion score of 8 patients (66.7%). Meanwhile, patients who used ventilators had a high cost proportion score of 5 patients (14.7%) and a low cost proportion score of 29 patients (85.3%).

Table 4.5 Relationship between Mechanical Ventilation Procedures and the Proportion of Cost of Care in the ICU

Ventilator	Cost Proportion Score		P value	RR(95%CI)
	≤1	>1		
	(n=37)	(n=9)		
No	8(66,7)	4(33,3)	0,211	0,782 (0,512—1,194)
Ya	29(85,3)	5(14,7)		

Based on the results of the analysis, p=0.211 showed that there was no statistically significant relationship between ventilator use and the proportion of costs in the ICU

Confounding *Analysis*

Confounding analysis was carried out to see the existence of *confounding* variables that affect the relationship between independent variables and bound variables. The test process is carried out by comparing the *value of crude* RR (gross risk ratio) with *adjusted* RR (*risk ratio* adjusted to potential *confounding* variables). If the delta RR ≥ 10%, then the variable is considered *confounding*.

1. Confounding Test of Treatment Length Variable to Cost Proportion

The results of this *confounding test* wanted to prove whether age, comorbidities, and nutritional status affected the relationship between length of treatment and the proportion of treatment costs in the ICU. It was found that age, comorbidities, and nutritional status had a delta RR of ≥ 10%, thus, it can be concluded that age, comorbidities, and nutritional status are *confounding*.

Table 4.6 Confounding Test Results of Treatment Length Variable to Cost Proportion

	Crude OR	Adjusted	Delta RR (%)	Conclusion
Age	0,947	1,077	13,7%	Confounding
Komorbid	0,947	1,112	17,4%	Confounding
Nutritional status	0,947	0,650	31,4%	Confounding

2. Confounding Test of Hemodialysis Variables to Cost Proportion

The results of this *confounding test* want to prove whether age, comorbidities, and nutritional status affect the relationship between hemodialysis and the proportion of treatment costs in the ICU. It was found that comorbidities, and nutritional status have a delta RR of ≥ 10%, thus, it can be concluded that comorbidities, and nutritional status are *confounding*, while age is not *confounding*.

Table 4.7 Results of *the Confounding Test* of Hemodialysis Variables to the Proportion of Costs

	Crude OR	Adjusted	Delta RR (%)	Conclusion
Age	0,947	1,026	8,3%	Bukan Confounding
Komorbid	0,947	0,714	24,6%	Confounding

	Crude OR	Adjusted	Delta RR (%)	Conclusion
Nutritional status	0,947	0,488	48,5%	confounding

3. Confounding Test of Ventilator Use Variables to Cost Proportions

The results of this *confounding test* want to prove whether age, comorbidities, and nutritional status affect the relationship between ventilator use and the proportion of treatment costs in the ICU. It was found that age, comorbidities, and nutritional status had a delta RR of ≥ 10%, thus, it can be concluded that age, comorbidities, and nutritional status are *confounding*.

Table 4.8 Confounding Test Results of Ventilator Use Variables to Cost Proportion

	Crude OR	Adjusted	Delta RR (%)	Conclusion
Age	0,947	0,344	63,7%	Confounding
Komorbid	0,947	0,326	65,6%	Confounding
Nutritional status	0,947	0,420	55,6%	confounding

Research Characteristics

This study wants to determine the relationship between mSOFA and the proportion of financing treatment in the ICU in critical patients treated in the ICU of Dr. Cipto Mangunkusumo Hospital. The prospective cohort design was used because researchers had difficulty controlling for variables that were likely to confuse the results. Variables that are estimated to affect the results of the data taken and analyzed for their influence on the results of the study include age, comorbidities, and nutritional status.

The research was conducted in the tertiary ICU of type A hospitals with standardized service flows. The implementation of the research has been carried out in accordance with the established protocol, starting from the assessment of the condition of the initial patient in accordance with the inclusion and exclusion criteria, and the management of patients by intensive therapy consultants. This is important to minimize the possibility of procedural bias affecting the results of the study.

Proportion of Treatment Costs in the ICU

The BPJS payment system through the INACBGs mechanism calculates payments based on the average cost per case, which is based on historical data and assumptions of maintenance activities. The gap between actual costs and rates of INACBGs has been reported in various studies, where factors such as remission, surgical procedures, and intensive care use play a role in shifting the difference. On the other hand, the severity of patients measured by the mSOFA score has the potential to explain the variability of care costs, as the higher the mSOFA score, it is usually characterized by more organ damage and the need for more intensive medical interventions (Taofik et al., 2015).

Based on the results of the study on 46 patients, the proportion of ICU treatment costs calculated as a comparison between the real cost of hospital in the ICU (X) to the simulation rate of INACBGs (Y) shows that in general most patients are still in the proportion of ≤1, but there are a small number of cases with a very high proportion. The median value of the proportion of ICU costs was 0.565 (IQR 0.4025–0.89), which means that in half of the patients, hospital-issued ICU costs were only about 56.5% of the INA CBGs rate paid. However, the average proportion reaches 1.48 with a large standard deviation, as well as a very wide range

(0.15 to 30.5). This striking difference between the median and the average indicates a skewness to the right, i.e. most patients have a low cost proportion, but there are some very high proportions that attract the average to be larger.

When viewed from the grouping of proportions, as many as 38 patients (82.6%) had a proportion of ≤1, while 8 patients (17.4%) had a proportion of >1. Interpretively, the proportion group >1 means that the actual cost of ICU incurred by hospitals is higher than the rate of INA CBGs, thus potentially causing a deficit in those episodes of care. However, the existence of a ≤1 proportion group does not necessarily mean that hospitals are "profitable" overall, as INA CBGs rates cover a wider range of service packages and cost components, and can be influenced by internal costing mechanisms, variations in clinical practice, as well as certain non-medical components (WHO, 2010; Ministry of Health of the Republic of Indonesia, guidelines for JKN/INA CBGs). However, as an early indicator of ICU financing efficiency, the X/Y ratio still provides an important picture of the compatibility between resource use intensity and prospective payments.

The relationship between the mSOFA Score and the Proportion of Cost of Care in the ICU

The mSOFA score has the potential to explain the variability of treatment costs, as the higher the mSOFA score, it is usually characterized by more organ damage and the need for more intensive medical interventions (Taofik et al., 2015).

The mSOFA score in this study is considered as an indicator of the severity of organ dysfunction which can theoretically affect the amount of ICU treatment, because the higher the mSOFA score, the more likely the patient is to require intensive interventions such as hemodynamic support, mechanical ventilation, strict monitoring, and repeated supportive examinations. This is in line with the concept that the mSOFA score is related to the need for resources during intensive care, which is ultimately the main driver of ICU costs (Chalfin et al., 1995; Moerer et al., 2007; Zilberberg, 2010). Descriptively, in the mSOFA <6 (n=37) group the median proportion of ICU costs was 0.66 (IQR 0.40–0.99), while in the mSOFA group ≥6 (n=9) the median proportion of costs was 0.52 (IQR 0.48–0.55). This pattern suggests that in these data, the high mSOFA group does not automatically have a greater proportion of costs than the low mSOFA group. The findings can be influenced by several things: (1) the smaller sample size of the mSOFA ≥6 group so that the range of values and variations is narrower, (2) the presence of very high cost proportion outliers in a small percentage of patients in the low mSOFA group which improves the cost summary in that group, and (3) the mSOFA score captures aspects of organ dysfunction, but does not necessarily capture all cost determinants such as procedure variation, length of treatment, and the use of certain tools/drugs that are very expensive (Moerer et al., 2007; Ramakrishnan et al., 2023). In addition, the use of organ failure scores (including SOFA modifications) is more validated for clinical outcomes such as mortality or prognosis, rather than specifically for cost prediction, so the relationship with financing can be non-linear and influenced by package payment system factors (Ghasemian-Nik & Ghorbani, 2018; Song et al., 2018; Taofik et al., 2015).

The results of this study showed that patients with an mSOFA score of ≥6 had a low proportion of treatment costs (≤1). These findings need to be interpreted with caution because they can lead to conclusions that are contrary to reality: the higher the mSOFA score, which reflects the severity of the disease, the lower the proportion of costs. This can be explained by

the amount of total financing received from BPJS Kesehatan in patients with high-complexity diseases. Patients with high mSOFA scores generally have more complex diagnoses, so the INA-CBG's claim rates paid by BPJS are also larger. As a result, even though the real cost of treatment in the ICU is high, the proportion of treatment costs to the total financing of BPJS appears to be smaller. This phenomenon suggests that cost proportions are not a stand-alone indicator in assessing the cost efficiency of ICU care, but rather must be interpreted in the context of payment mechanisms and overall cost composition.

There are several limitations in this study. First, the hospital rate used in the calculation only covers the cost of treatment in the ICU, while the BPJS Kesehatan tariff simulation uses the INA-CBG's rate which is a global episode payment, which covers the entire cost of patient care from admission to hospital exit. This mismatch between the numerator (ICU cost) and denominator (INA-CBG's total rate of one episode) means that the proportion of costs calculated may not fully accurately reflect the contribution of ICU costs. Ideally, in order for the proportion of costs to be more meaningful, both the numerator and the denominator must have equal coverage — that is, the ICU cost is compared to the portion of the BPJS tariff allocated specifically for ICU services. However, INA-CBG's system does not disaggregate rates by unit of service, so the separation of ICU costs from total episode rates is not possible in the current payment framework.

The Relationship between Length of Stay in the ICU and the Proportion of Cost of Treatment in the ICU

ICU stay is one of the most consistent cost drivers in the literature because ICU costs are cumulative per day, including labor costs, continuous monitoring, actions, medications, and the use of organ support devices (Chalfin et al., 1995; Moerer et al., 2007; Ramakrishnan et al., 2023). In this study, the proportion of costs in patients with ICU stay duration of >4 days (n=23) had a median of 0.66 (IQR 0.515–0.94), higher than the length of treatment ≤4 days (n=23) with a median of 0.53 (IQR 0.305–0.85). Although the median difference appears to lead to a larger proportion of costs in the longer care group, the overall proportion distribution of costs in this study is very skewed to the right (in the case of "very high costs"), so it is not enough to simply look at the average. In prospective plan-rate-based payment systems such as INACBGs, extended length of care can lead to increased real costs while package rates are relatively fixed, so the X/Y ratio has the potential to increase to >1 in some patients (Prameswari et al., 2022; Sugiarto & Roziq, n.d.). These findings are in line with ICU economics studies that emphasize that patients with long stay are often the main contributors to the "high-cost" group, especially when accompanied by complications and prolonged need for organ support (Kaier et al., 2020; Lone & Walsh, 2011; Reardon et al., 2018). Therefore, the length of treatment needs to be understood not only as an indicator of bed utilization, but also as an indicator of financing burden and ICU service efficiency.

The Relationship between Hemodialysis Procedures and the Proportion of Treatment Costs in the ICU

Hemodialysis in the ICU is a generally high-cost intervention because it requires tools, consumables, certain medications, strict monitoring, and the involvement of trained personnel (Ramakrishnan et al., 2023). In this study, the group without hemodialysis (n=35) had a median cost proportion of 0.67 (IQR 0.415–0.99), while the group with hemodialysis (n=8) had a median of 0.525 (IQR 0.485–0.695). Descriptively, these results have not shown a high

proportion of costs in the hemodialysis group. However, the interpretation of the relationship between hemodialysis and financing in this study requires caution because: (1) the number of patients with hemodialysis is relatively small so the distribution is unbalanced, (2) variations in the duration and frequency of treatment can affect costs, and (3) the proportion of costs is also determined by the amount of INACBGs rates in each patient, so high costs do not always result in high ratios if the package rates are also high (Halim & Manggala, 2025; Ramakrishnan et al., 2023; Sugiarto & Roziq, n.d.). Thus, although the literature suggests that organ support measures such as the PRC often increase ICU costs, the relationship in these data may be overshadowed by variations in package rates (Bruyneel et al., 2023; Moerer et al., 2007; Ramakrishnan et al., 2023).

Relationship between Mechanical Ventilation Procedures and the Proportion of Treatment Costs in the ICU

Mechanical ventilation is one of the interventions in the ICU that generally reflects severe clinical conditions. The use of ventilators is often associated with increased direct and indirect cost components, including the need for sedation/analgesia, stricter monitoring of respiration and hemodynamics, serial supporting examinations (laboratory, radiology), the use of tools and consumables (e.g. suction systems, humidifiers/HME filters), as well as an increased risk of complications such as ventilator-associated pneumonia (VAP) or delirium that can prolong the length of treatment and increase costs total treatment (Kaier et al., 2020; Lone & Walsh, 2011; Ramakrishnan et al., 2023). Thus, in theory, patients with mechanical ventilation tend to have higher costs than patients without ventilators, as discussed in the literature that organ support (including mechanical ventilation) is one of the important cost drivers in ICU services (Kaier et al., 2020; Ramakrishnan et al., 2023).

However, in this study, the descriptive results showed that the group with mechanical ventilation (n=34) had a median cost proportion of 0.565 (IQR 0.4425–0.85), while the group without ventilators (n=12) had a median cost proportion of 0.695 (IQR 0.29–1.495). This means that in this data, the median proportion of costs in the ventilator group is not higher than that of the non-ventilator group. This finding can be explained by several possibilities. First, the indicator used is the proportion of costs (X/Y), so that the results are not only influenced by the increase in the actual cost of ICU (X), but also by the small rate of the INACBGs (Y) package which can differ between patients based on the diagnosis code, procedure, and severity. In other words, even if mechanical ventilation can increase actual costs, the proportion of X/Y can still remain low if the patient also has a higher rate of INACBGs, so the ratio does not automatically increase (Prameswari et al., 2022; Sugiarto & Roziq, n.d.). Second, the non-ventilator group in this study had a wider IQR and an upper quartile that exceeded 1, indicating a large variation in cases and the possibility that there were certain patients who, although not on ventilators, remained requiring high-cost procedures/drugs, or experiencing complications that increase costs, resulting in a high proportion of costs in some non-ventilator patients (Chalfin et al., 1995; Moerer et al., 2007; Ramakrishnan et al., 2023; Sugiarto & Roziq, n.d.). Third, the sample size of the non-ventilator group is smaller (n=12), so one or two extreme cases will more easily affect the distribution (as seen from the very wide range of IQR). Thus, these results confirm that ICU costs are not a consequence of a single intervention, but rather the result of an interaction between disease severity, combination of interventions, complications that occur,

and length of treatment that accompanies treatment episodes (Chalfin et al., 1995; Moerer et al., 2007; Ramakrishnan et al., 2023).

In addition, it should be noted that mechanical ventilation has a major effect on financing, especially when prolonged mechanical ventilation, because the longer the use of the ventilator is usually followed by an increased risk of complications, an increase in the need for sedation/analgesia drugs, and the need for other supportive therapies that prolong treatment (Kaier et al., 2020; Lone & Walsh, 2011). Therefore, the analysis of mechanical ventilation as a binary "yes/no" variable in this study may not be sufficient sensitive to capture the relationship with the proportion of cost. To strengthen the interpretation, further research or additional analysis may consider more detailed variables such as ventilation duration (ventilator days) in order to more precisely identify patient groups that are high cost contributors (Kaier et al., 2020; Lone & Walsh, 2011; Ramakrishnan et al., 2023).

Advantages and Limitations of Research

This study is one of the early studies in Indonesia that specifically examines the relationship between the mSOFA score and the proportion of ICU care costs relative to the rate of INACBGs (X/Y), an important metric to assess financing efficiency, so that in the future it can be the basis for creating a predictive model for the amount of ICU care costs that are easy with clinical parameters and can improve the quality of service and the quality of life of critically ill patients.

The overall findings of the study illustrate that the proportion of high costs is not a reflection of demographic characteristics alone, but rather a clinical manifestation of a complex disease burden and high intensity of intervention. Factors such as nutritional status (underweight and obesity), presence of comorbidities, mSOFA score ≥6, duration of hospitalization ≥4 days, and use of critical supportive modalities, namely mechanical ventilation and hemodialysis, consistently showed a proportion of high costs that were much more dominant than the age or gender variables. This indicates that the cost of treatment is disease-driven and intervention-driven, not age-driven or gender-driven. In other words, the escalation of costs is not determined by who the patient is (age/gender), but by how severe the physiological condition is, how many organs are impaired, and how intense the technological support is required to maintain survival.

Conceptually, these findings reinforce the value-based healthcare paradigm, where cost efficiency must be assessed not only in terms of spending, but also from the perspective of outcomes achieved per unit of cost. The high-cost patients in this study—despite consuming more resources—were precisely the group most in need of precision interventions, close monitoring, and cross-disciplinary coordination. Therefore, cost control efforts should not lead to restrictions on access to critical interventions, but should be focused on early prevention, optimization of management before hospitalization, and improvement of procedure effectiveness—so that every dollar spent truly contributes to improving the clinical status and quality of life of patients.

CONCLUSION

In this study, it was concluded that there was no statistically significant difference between mSOFA scores of <6 and ≥6 in the proportion of ICU treatment costs, as well as in

cost proportion distribution (>1 vs. ≤1) based on length of stay (≤4 days vs. >4 days), hemodialysis use, and mechanical ventilation use.

However, factors such as age, comorbidities, and nutritional status were found to influence variations in ICU cost proportions. Based on the study findings, further research is recommended in more specific critically ill patient populations, as well as follow-up studies comparing actual hospital and ICU costs with INA-CBGs reimbursement rates that have been paid.

In addition, the highly dynamic condition of ICU patients causes treatment costs to not always be proportional to the initial actions recorded under the primary diagnosis or procedure codes, but rather to be influenced by unexpected clinical developments during treatment. Therefore, the INA-CBGs-based prospective payment system is considered less sensitive in reflecting the actual cost burden of ICU care episodes.

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