

Fluid Balance Profile in Patients Admitted to the Intensive Care Unit (ICU) of Haji Adam Malik Central General Hospital, Medan, January–June 2025

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ABSTRACT

Introduction: Fluid balance is a critical component of intensive care unit (ICU) patient management, and both positive and negative imbalances are associated with increased morbidity and mortality. Evidence regarding the cumulative fluid balance in Indonesian ICUs remains limited. To determine the fluid balance profile of ICU patients and its relationship with patient outcome and length of stay

Methods: A descriptive-analytical observational study with a cross-sectional design was conducted at the ICU of Haji Adam Malik Central General Hospital, Medan, from January to June 2025. Of 222 patients screened, 64 adults (≥ 18 years) treated for ≥ 24 h were selected by total sampling from medical records. Cumulative fluid balance was categorized as positive or negative, and bivariate associations with outcome and length of stay were assessed using the chi-square test ($p < 0.05$).

Results: The majority of patients (59.4%) had a negative cumulative fluid balance. Negative balance predominated among patients aged 25–65 years, males, those with medical admissions, and obese patients, whereas positive balance predominated among those aged > 65 years, females, those with surgical admissions, and underweight patients. Fluid balance was significantly associated with patient outcomes ($p = 0.003$) and length of stay ($p = 0.001$). Negative balance was associated with survival (79.3%) and a stay > 7 days (80.5%), whereas positive balance was more frequent among deceased patients (57.1%) and those staying 1–3 days (81.8%).

Conclusion: Negative cumulative fluid balance predominated and was associated with survival and a longer ICU stay. Close monitoring and individualized fluid management are essential for optimizing patient outcomes.

Fluid Balance, ICU, Patient Outcome, Length of Stay, Profile

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INTRODUCTION

The intensive care unit (ICU) is a specialized hospital facility equipped with advanced technology and staffed by trained personnel to manage patients with critical or life-threatening conditions. Critically ill patients frequently present with vital-organ dysfunction and require complex medical interventions, including close monitoring and advanced therapeutic support [1]. Globally, the burden of critical illness is substantial: the World Health Organization estimates that 9.8–24.6 per 100,000 individuals experience a critical condition requiring intensive care, accounting for 1.1–7.4 million deaths annually as of 2019. In Indonesia, the prevalence of critically ill patients admitted to ICUs in 2019 reached 33,148, with a mortality rate of 36.5%, reflecting the high morbidity and mortality burden of intensive care units [2].

Maintaining physiological fluid homeostasis is fundamental to survival, as the balance between water and electrolyte intake and output governs cellular function and tissue perfusion [3,4]. One of the principal interventions for critically ill patients is intravenous fluid administration—using crystalloids (e.g., 0.9% sodium chloride and Ringer's lactate) or colloids (e.g., gelatin and albumin) for resuscitation, replacement, or maintenance [5]. During the acute phase, patients often require large fluid volumes to restore organ perfusion and hemodynamic stability. However, inappropriate fluid administration—whether excessive or insufficient—can adversely affect patient outcomes [6]. Delayed fluid resuscitation in sepsis or septic shock is associated with an increased risk of death, delayed resolution of hypotension, and prolonged length of stay [7]. Conversely, excessive fluid administration after the initial resuscitation phase increases the risk of pulmonary edema, prolonged mechanical ventilation, acute kidney injury, and higher mortality [8]. Cumulative fluid overload has been consistently linked to increased mortality in critically ill adults [9]. Cumulative fluid balance tends to become progressively more negative from day 1 to day 7 in both medical and surgical cohorts. A study at Dr. Mohammad Hoesin General Hospital, Palembang, found that non-survivors more frequently experienced fluid overload $\geq 10\%$ (73.3%) than $< 10\%$ (26.7%), whereas survivors more often had fluid overload $< 10\%$ (66.6%) [10]. To date, most publications on ICU fluid management remain dominated by studies from high-income countries whose patient characteristics and healthcare systems differ from the Indonesian context. Accordingly, this study aimed to determine the fluid balance profile and its relationship with patient outcome and length of stay at the ICU of Haji Adam Malik Central General Hospital, Medan, from January to June 2025.

METHODS

This descriptive-analytical observational study with a cross-sectional design was conducted at the ICU of Haji Adam Malik Central General Hospital, Medan—a class A tertiary referral hospital for the Northern Sumatra region—covering data from January to June 2025.

The study population comprised all patients admitted to the ICU whose medical records were documented during the study period. Sampling was performed by total sampling. The inclusion criteria were adult patients (≥ 18 years) of either sex who were treated for ≥ 24 h. The exclusion criteria were illegible, damaged, or missing medical records and pregnant patients. Of 222 recorded patients, 64 met the criteria and were analyzed. Data were secondary and obtained from medical records and comprised age group (18–24, 25–65, and > 65 years), sex, admission reason (medical/surgical), body mass index (BMI: underweight, normoweight, overweight, obese), patient outcome (alive/deceased), length of stay (1–3, 4–7, and > 7 days), type of fluid therapy, and comorbidity profile. Cumulative fluid balance was categorized as positive or negative based on the difference between recorded fluid intake and output during care. Data processing comprised editing, coding, transferring, and tabulating using statistical software. Univariate analysis described the characteristics of each variable, whereas bivariate analysis used the chi-square test to assess the association between fluid balance and both length of stay and patient outcome, with a significance level of $p < 0.05$. Ethical approval was obtained from the Health Research Ethics Committee (KEPK), Faculty of Medicine, Universitas Sumatera Utara. Data were drawn from medical records without intervention on subjects, and patient confidentiality was maintained throughout.

RESULTS

Of the 222 patients admitted to the ICU of Haji Adam Malik General Hospital, Medan, during January–June 2025, 43 did not meet the inclusion criteria (7 aged < 18 years and 36 treated for < 24 h). Of the 179 eligible patients, 115 were excluded (114 with incomplete medical records and 1 pregnant patient), yielding 64 patients as study subjects.

Characteristics and Distribution of Fluid Balance

Overall, 38 patients (59.4%) had a negative cumulative fluid balance, and 26 (40.6%) had a positive balance. Most patients were aged 25–65 years (64.1%), male (60.9%), admitted for medical reasons (65.6%), and obese

(42.2%). More than half were discharged from the ICU deceased (54.7%). The distribution of fluid balance by patient characteristics is presented in Table 1.

Table 1. Characteristics and distribution of cumulative fluid balance among ICU patients at Haji Adam Malik General Hospital, Medan

Variable	Total (n=64)	Positive (n=26)	Negative (n=38)
<i>Age group</i>			
18–24 years	12 (18.8)	4 (33.3)	8 (66.7)
25–65 years	41 (64.1)	14 (34.1)	27 (65.9)
>65 years	11 (17.2)	8 (72.7)	3 (27.3)
<i>Sex</i>			
Male	39 (60.9)	15 (38.5)	24 (61.5)
Female	25 (39.1)	11 (44.0)	14 (56.0)
<i>Admission reason</i>			
Medical	42 (65.6)	17 (40.5)	25 (59.5)
Surgical	22 (34.4)	9 (40.9)	13 (59.1)
<i>Body Mass Index</i>			
Underweight	3 (4.7)	2 (66.7)	1 (33.3)
Normoweight	21 (32.8)	9 (42.9)	12 (57.1)
Overweight	13 (20.3)	5 (38.5)	8 (61.5)
Obese	27 (42.2)	10 (37.0)	17 (63.0)
<i>Patient outcome</i>			
Alive	29 (45.3)	6 (20.7)	23 (79.3)
Deceased	35 (54.7)	20 (57.1)	15 (42.9)

Note: Values are presented as n (%). Percentages in the positive and negative columns are calculated across each row.

Patients aged 25–65 years (65.9%) had negative balance, whereas those aged >65 years (72.7%) had positive balance. Males (61.5%), females (56.0%), medical (59.5%), and surgical (59.1%) admissions had negative balance. Underweight (66.7%) had positive balance, obese (63.0%) negative; positive-balance patients died (57.1%), whereas negative-balance patients survived (79.3%).

Length of Stay

Most patients were treated for >7 days (41 patients, 64.1%), followed by 4–7 days (12 patients, 18.8%) and 1–3 days (11 patients, 17.2%) (Table 2).

Table 2. Distribution of patients by length of stay

Length of stay	n	%
1–3 days	11	17.2
4–7 days	12	18.8
>7 days	41	64.1
Total	64	100.0

Type of Fluid Therapy

Ecosol 0.9% NaCl (98.4%) was administered most frequently, followed by Ringer's lactate (79.7%), and Ringer's acetate and solution were administered to 25 patients (39.1%; Table 3).

Table 3. Distribution of patients by type of fluid therapy

Type of fluid therapy	n	%
Ecosol 0.9% NaCl	63	98.4
Ringer's lactate	51	79.7
Ringer's acetate	25	39.1
Ringer's solution	25	39.1
Mannitol 20%	24	37.5
Glucose Otsu D40%	20	31.3
Albunorm 25%	14	21.9
NaHCO ₃ 8.4% (Meylon)	7	10.9

Note: A single patient could receive more than one type of fluid therapy; therefore, the total percentage exceeds 100%.

Comorbidities

Half of the patients (50%) had no comorbidity. Single comorbidities of hypertension, diabetes mellitus, and renal failure were each found in seven patients (10.9%). The combination of hypertension and diabetes mellitus was the most common dual comorbidity (7.8%), whereas the triple combination of hypertension, renal failure, and diabetes mellitus occurred in 3 patients (4.7%) (Table 4).

Table 4. Distribution of patients by comorbidity profile

Comorbidity profile	n	%
None	32	50.0
Hypertension	7	10.9
Diabetes mellitus	7	10.9
Renal failure	7	10.9
Hypertension and DM	5	7.8
Hypertension, DM, and renal failure	3	4.7
DM and renal failure	2	3.1
Hypertension and renal failure	1	1.6
Total	64	100.0

Association of Fluid Balance with Length of Stay and Patient Outcome

The chi-square test showed a significant association between fluid balance and length of stay ($p=0.001$). Patients with a stay of 1–3 days (81.8%) and 4–7 days (75.0%) tended to have a positive balance, whereas those with a stay >7 days predominantly had a negative balance (80.5%) (Table 5).

Table 5. Association between fluid balance and length of stay in the ICU

Length of stay	Positive n (%)	Negative n (%)	p-value
1–3 days	9 (81.8)	2 (18.2)	0.001
4–7 days	9 (75.0)	3 (25.0)	
>7 days	8 (19.5)	33 (80.5)	
Total	26	38	

Chi-square test.

A significant association was also found between fluid balance and patient outcomes ($p=0.003$). Most surviving patients had a negative balance (79.3%), whereas deceased patients more frequently had a positive balance (57.1%) (Table 6).

Table 6. Association between fluid balance and patient outcome in the ICU

Patient outcome	Positive n (%)	Negative n (%)	p-value
Alive	6 (20.7)	23 (79.3)	0.003
Deceased	20 (57.1)	15 (42.9)	
Total	26	38	

Chi-square test.

DISCUSSION

Most patients in this study were aged 25–65 years (64.1%), consistent with a cross-sectional ICU study reporting that 65.96% of patients fell within this range [11]. The distribution of fluid balance showed that patients aged ≥ 65 years tended to have a positive balance. Elderly populations are less able to adapt to rapid hemodynamic changes and therefore have greater difficulty maintaining fluid homeostasis, requiring a more individualized fluid therapy approach [12].

The patients were predominantly male (60.9%), with a tendency toward a negative balance in both sexes. This is consistent with a retrospective cohort study that found that male patients tended to predominate among those with a negative cumulative balance (56.3%), although the difference was not statistically significant [1]. The principal driver of fluid imbalance in critically ill patients is the disease process itself, which impairs organ function and maintains fluid and electrolyte balance [13]. Most patients were admitted for medical reasons

(65.6%). ICU patients admitted for medical reasons generally have chronic or complex critical illnesses, such as respiratory failure, septic shock, and severe metabolic disorders, reflecting the substantial health burden of non-surgical diseases requiring intensive management [14]. According to BMI, obese patients predominated (42.2%). In obese individuals, the regulation of water and sodium balance is often disturbed; increased adipose tissue alters body fluid distribution, reduces the proportion of total body water per unit body weight [15], and increases the risk of fluid overload [16].

More than half of the patients were discharged deceased (54.7%). Both insufficient and excessive fluid volumes are associated with increased mortality. Excessive positive fluid balance was independently correlated with increased mortality in critically ill trauma patients, and most publications demonstrate the superiority of a restrictive fluid strategy over a liberal fluid strategy [17]. Most patients were treated for >7 days (64.1%), indicating that the majority required more than one week to achieve stability or further evaluation of vital-organ recovery [18]. Ecosol 0.9% NaCl was the most frequently used fluid in both medical and surgical groups, followed by Ringer's lactate. Balanced crystalloids, such as Ringer's acetate and Ringer's lactate, have been reported to yield better outcomes than normal saline in terms of mortality, postoperative infection, need for renal replacement therapy, electrolyte disturbance, and acidosis [19]. Crystalloids and colloids are frequently used together, particularly in critically ill, trauma, and surgical patients requiring large fluid volumes [20]. Half of the patients had no comorbidities (50%), in contrast to previous research reporting a predominance of hypertension (56.3%), diabetes mellitus (44.5%), and chronic kidney disease (41.8%) in the ICU [21]. This difference may arise because most patients were relatively young and admitted for acute conditions unrelated to chronic disease. Comorbidities such as hypertension, diabetes mellitus, and renal failure are known to worsen the prognosis of ICU patients by exacerbating organ failure and the body's response to critical stress [22].

Bivariate analysis showed a significant association between fluid balance and length of hospital stay ($p=0.001$). In this study, patients with a hospital stay >7 days predominantly had a negative fluid balance (80.5%). This differs from previous research, which found that patients with a more positive balance on day 7 had a longer ICU stay; the group with a fluid balance ≥ 8 L had a median stay of 11.6 days compared to 5.03 days in the group with a balance of ≤ 0 L [23]. This difference likely reflects fluid de-resuscitation practices in prolonged care, whereby fluid balance shifts negatively as patients stabilize. Fluid balance was also significantly associated with the patient outcomes ($p=0.003$). Most deceased patients had a positive balance (57.1%), whereas most survivors had a negative balance (79.3%). This finding aligns with a study of more than 15,000 ICU patients, showing that each 1-L increase in positive fluid balance was associated with a 4% increase in the risk of death ($HR=1.04$) [24]. A study of patients with traumatic brain injury found that each 0.1-litre increase in the mean daily positive fluid balance increased the odds of ICU mortality by 10% ($OR=1.10$; 95% CI 1.07–1.12) [25]. These findings underscore the importance of avoiding excessive positive fluid accumulation in critically ill patients. This study had several limitations. The cross-sectional design precluded the establishment of causal relationships. The use of secondary medical record data resulted in the exclusion of a large number of patients owing to incomplete data, potentially introducing selection bias. Fluid balance was assessed cumulatively without accounting for daily trends or confounders, such as disease severity. Finally, the study was single-center; therefore, the generalization of the findings should be made with caution.

CONCLUSION

At Haji Adam Malik Hospital, Medan, patients during January–June 2025 had a negative fluid balance (59.4%). Negative balance was common among patients aged 25–65 years, males, medical admissions, and obese patients; positive balance was common among patients aged >65 years, females, surgical admissions, and underweight patients. Fluid balance was associated with length of stay ($p=0.001$) and outcomes ($p=0.003$). Monitoring, fluid-balance, guidelines, and audits are needed.

DECLARATIONS

None

CONSENT FOR PUBLICATION

The Authors agree to be published in the Journal of Society Medicine.

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COMPETING INTERESTS

The authors declare no conflicts of interest in this case report.

AUTHORS' CONTRIBUTIONS

MS conceived and designed the study, collected and analyzed the data, and drafted the manuscript. AYH supervised the study, provided clinical and methodological guidance, critically revised the manuscript for important intellectual content, and approved the final version. Both authors read and approved the final manuscript and agreed to be accountable for all aspects of the work.

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