Correlation between vasoactive-inotropic score and enteral nutrition absorption ability in critically ill patients

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Abstract

***Objective*: To identify the correlation between vasoactive-inotropic score (VIS) and enteral nutrition absorption ability in critically ill patients.**

***Design*: This was an observational analytical study with a prospective approach and cohort study design.**

***Setting*: The study was conducted in the Intensive Care Unit (ICU) of Dr. Wahidin Sudirohusodo Hospital, Makassar, Indonesia, from August to October 2024.**

***Patients*: This study included all patients treated in the ICU who used vasopressors, inotropic, or a combination of both to maintain hemodynamics.**

***Interventions*: Twenty-five patients underwent nasogastric tube (NGT) insertion. Enteral nutrition was given a 10 ml/hour bolus via NGT. In the sixth hour, after being closed for 30 minutes, the NGT lid was opened, and gastric residue was aspirated and assessed.**

***Measurements and results*: There was a significant difference between VIS in patients with low and high enteral residue (p=0.001), where VIS was found to be higher in patients with high residue compared to low residue (23.8±2.74 vs 16.5±5.95). There was a high linear correlation between VIS and residue volume. The receiver operating characteristic (ROC) curve using the Youden index found that the VIS cut-off point value to determine the occurrence of high enteral residue (>60 ml) was 21 (sensitivity 83%, specificity 84%).**

***Conclusions*: The higher the VIS, the lower the absorption of enteral nutrition in critically ill patients. The VIS cut-off value of 21 might predict high enteral residue.**

Key words: Vasoactive-inotropic score, enteral nutrition, intensive care.

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Introduction

Patients treated in the intensive care unit (ICU) mostly experience hemodynamic instability or are at risk of becoming unstable due to conditions such as hypovolemia, cardiac dysfunction, or changes in vasomotor function that cause organ dysfunction, which progresses to multiorgan failure and ultimately causes death. Patients with hemodynamic instability need to receive rapid and intensive treatment to restore homeostasis. Therapeutic actions conducted in the ICU include fluid resuscitation and administration of vasopressors or inotropic agents, which are carried out to increase blood pressure to adapt to organ and tissue perfusion. (1,2)

The vasoactive-inotropic score (VIS) is used to measure the level of hemodynamic support objec-

tively. This score is calculated as the weighted sum of all inotropic and vasoconstrictors given to the patient and reflects pharmacological support to the cardiovascular system. Several studies have shown a correlation between high VIS and poor outcomes in cardiac surgery patients. (3,4)

Enteral nutrition therapy (ENT) is an essential part of patient care in the ICU. Early initiation of nutrition therapy has benefits for improving outcomes, such as reducing length of stay and reducing mortality. Several studies have shown better results when nutrition support is initiated 24 to 48 hours after admission to the ICU. (2) Nutrition therapy could be started when the patient has been successfully resuscitated and has stable hemodynamics. However, the use of vasoactive and inotropic drugs to maintain hemodynamic stability needs to be considered when initiating nutrition therapy. At high doses, these drugs could have systemic effects, increasing the risk of food intolerance/feeding intolerance due to non-occlusive intestinal ischemia. (2,5)

Previous studies reported conflicting results. A study regarding the correlation between VIS, tube feeding (TF), and intestinal ischemic complications in post-cardiac surgery patients reported that eight non-TF patients (n=2,839) experienced intestinal ischemia. In comparison, only three (n=249) patients from the TF group experienced intestinal ischemia. It is concluded that TF, even in patients with moderate to high inotropic and vasopressor needs, is not associated with increased intestinal ischemic complications. (6) This study aimed to identify the correlation between VIS and enteral nutrition absorption ability in critically ill patients.

Materials and methods

Study design

This was an analytical observational study with a prospective approach and cohort study design. It was conducted from August to October 2024 in the ICU of Dr. Wahidin Sudirohusodo Hospital in Makassar, Indonesia.

Study population and sample

This study's population included all patients treated in the ICU who used vasopressors, inotropic, or a combination of both to maintain hemodynamics. Sampling was carried out using purposive sampling; the entire study population that met the inclusion criteria was used as research samples. The number of samples in this study included all patients treated in the ICU of Dr. Wahidin Sudirohusodo General Hospital from August to October 2024 who met the inclusion criteria.

The inclusion criteria in this study were patients who were treated in the ICU and used vasoactive and/or inotropic agents for at least 24 hours, aged 18-50 years, underwent treatment >24 hours in intensive care, achieved a mean arterial pressure (MAP) ≥65 mmHg after administration of vasopressors and/or inotropic agents, and patients who could be programmed for enteral nutrition.

The exclusion criteria in this study were patients with diabetes mellitus comorbid, experiencing active bleeding from the upper gastrointestinal tract, having primary problems in the gastrointestinal system and not allowing nutrition within 24-72 hours in the ICU, using post-pyloric nutrition access, having initial gastric residue >500 ml, critical patients who had not been programmed to receive enteral nutrition within 24-72 hours of intensive care, having abdominal compartment syndrome, and patients with productive intestinal fistula. The drop-out criteria in this study were patients who experienced signs of malabsorption after enteral nutrition, hemodynamic deterioration, gastrointestinal bleeding, emergency surgery, and sensitivity or allergic reactions to enteral nutrition during the study.

Ethical clearance

Before conducting the research, the researcher requested information on ethical eligibility (ethical clearance) from the Human Biomedical Research Ethics Commission of the Faculty of Medicine, Hasanuddin University. The request was approved with the registration number 591/UN4.6.4.5.31/PP36/2024.

Study procedure

Patients treated in the intensive care unit who met the inclusion criteria were installed with a nasogastric tube (NGT). After the NGT was installed, the initial residue was assessed. Calculation of nutritional needs in patients was carried out using the requirement of 25 kcal/kgBW. Intermittent nutrition was given as much as 10 ml/hour bolus through the NGT. The NGT was then closed. Nutrition was given every hour for 6 hours. In the sixth hour, after being closed for 30 minutes, the NGT cover was opened, the gastric residue was aspirated, and the gastric residue was assessed. The patient's VIS value was recorded. The formula used to calculate VIS is as follows:

Dopamine dose (μg/kgBW/minute) + dobutamine dose (μg/kgBW/minute) + epinephrine dose (μg /kgBW/minute) + 10 x milrinone dose (μg/kgBW/minute) + 10,000 x vasopressin dose (U/kgBW/minute) + 100 x norepinephrine dose

(μg/kgBW/minute)

Statistical analysis

The data obtained are processed, and the results are displayed in narrative form, tables, or graphs in the form of averages and standard deviations, as well as frequencies and percentages, using SPSS 25 for Windows. The normality test was performed using the Shapiro-Wilk test. Independent and dependent variables for nominal data were tested using Pearson correlation for normally distributed data and Spearman correlation for non-normally distributed data. For interpretation of the results using the degree of significance α (p alpha) of 5% with the note that if $p<0.05$, then H0 was rejected (there was a correlation between the independent and dependent variables).

Results

Age group, gender, and body mass index were homogeneous after being tested between low and high residue groups (**Table 1**). Most samples had a high VIS of ≥10 (24 people), followed by moderate VIS between ≥5 and <10 (one person), and no sample for low VIS between 0 and <5 (**Table 2**). The characteristics of enteral residue were found most with a residue volume of 0-20 ml with 10 samples, followed by a residue volume of 41-60 ml and >60 ml, each with six patients (**Table 3**).

There was a significant difference between low VIS and high enteral residue ($p=0.001$), with VIS found to be higher in patients with high residue (**Table 4**). The correlation between VIS and the amount of enteral residue in critical patients was $r=0.712$, indicating a strong, linear correlation (**Table 5**). From the measurement results using the receiver operating characteristic (ROC) curve and the Youden index, it could be seen that the VIS cut-off point value for determining the occurrence of high enteral residue (>60 ml) was 21 with a sensitivity of 83% and a specificity of 84% (**Figure 1**).

Discussion

Correlation between VIS and enteral residue in critical patients

The results of this study indicated that VIS was significantly associated with the amount of enteral residue in critical patients. A study by Knebusch et al. reported that patients with high VIS had zero adequacies for enteral calories and protein compared to patients with low VIS on day 3, and an upward change in VIS score on day 3 was also associated with zero enteral adequacies compared to patients with unchanged VIS. (7)

In this study, a high VIS was associated with higher gastric residue in critical patients. These results align with the study of Ong et al., which reported that moderate to high VIS was associated with an increased risk of intestinal ischemia. (6) A study by Efremoz et al. reported that early enteral nutrition was well tolerated and safe in patients with vasopressor or inotropic support if the patient's dose and hemodynamic status were stable and careful monitoring of the stomach and enteral nutrition were given. Nutritional support for patients with moderate to high vasopressor support should be increased to improve enteral protein-energy delivery. (8) This is because patients with food intolerance lead to reduced enteral nutrient intake. Therefore, patients with higher gastric volume allow for higher enteral nutrient caloric intake. (9)

VIS represents the weighted amount of all vasoactive-inotropic agents administered. (10) Meanwhile, gastric residual volume is the amount of fluid excreted from the stomach after enteral feeding. Gastric residual volume is an indicator in measuring food intolerance. (11) Increased gastric residual volume is considered a parameter indicating impaired gastrointestinal motility in general and slow gastric emptying in particular. (9) Thus, these results indicate that the higher weighted amount of all vasoactive-inotropic agents administered might improve food intolerance characterized by high gastric volume.

The mechanism of the correlation between VIS and gastric volume could be explained by the effect of vasopressors/inotropics on gastrointestinal perfusion. Vasopressors have a dose-response correlation with intestinal injury. The effects of vasopressors combined with inotropic drugs on intestinal perfusion and oxygen supply/consumption are more complex than vasopressors alone. Blood flow in the superior mesenteric artery and microcirculation in the jejunal and pancreatic mucosa were significantly reduced during norepinephrine and epinephrine infusion. Epinephrine has been reported to impair gastrointestinal perfusion in patients with septic shock. Epinephrine increases gastrointestinal mucosal perfusion. In shock patients receiving vasopressors, inadequate early enteral nutrition might worsen gastrointestinal dysfunction and even cause non-occlusive mesenteric ischemia or non-occlusive intestinal necrosis. (12)

Use of VIS as a predictor of enteral residue in critical patients

This study found that VIS with a cut-off of 21 was helpful in determining the occurrence of high enteral residue (>60 ml) with a sensitivity of 83% and a specificity of 84%. These results were in line with

the study of Cao et al., who reported that max VIS could predict the development of enteral nutrition intolerance with an area under the curve (AUC) of 0.942 with a cut-off value of 30.35 (sensitivity=0.926, specificity=0.890) and a Yoden index of 0.816, which is more efficient than the sequential organ failure assessment (SOFA) score, acute physiology and chronic health evaluation (APACHE) II score, and blood lactic acid. A max VIS of 24 could predict the development of enteral nutrition intolerance in patients with septic shock, and the possibility of intolerance to enteral nutrition below a score of 30.35 is low. (13) In a study by Hu et al., they stated that VIS greater than 20 was an independent risk factor for in-hospital mortality and 30-day survival. (14)

The use of VIS as a predictor of enteral nutrition intolerance is still very limited. Other studies have reported using VIS to predict poor outcomes in critically ill patients. Increased early postoperative VIS is associated with poor outcomes such as acute kidney injury (AKI), duration of mechanical ventilation, mortality, and length of stay (LOS) in the ICU. The optimal VIS cut-off value as a predictor of poor outcomes has been reported to vary between 10 and 30, and no study has reported the same VIS cut-off value. Differences related to VIS cut-offs are likely due to differences in outcome definitions, baseline characteristics, and surgical procedures. (15)

Research limitations

This study had several limitations. First, it was conducted in one center, so it cannot be generalized to the general population. Second, no analysis of factors influencing enteral nutrition absorption in critically ill patients was performed.

Conclusion

Higher VIS is associated with lower enteral nutrition absorption in critical patients. The VIS cut-off of 21 could tolerate enteral nutrition in critical patients with a sensitivity of 83% and a specificity of 84%. A vasoactive-inotropic score of more than 21 can be recommended for clinical application in predicting high gastric residual volume or low enteral nutrition absorption in critical patients. Factors that can affect enteral nutrition absorption in critical patients can be considered in further research in other centers and with larger samples to overcome bias in the research results.

Table 1. Characteristics of research samples

		Low residue (mean±SD)	High residue (mean±SD)	p-value
Age (years)		49.3±15.38	43.7±13.75	0.514[ns]
Sex	Male (%)	9 (47.3)	3 (50)	0.213[ns]
	Female (%)	10 (52.7)	3 (50)	
Body mass index(kg/m^2)		23.3±1.65	23.7±1.68	0.221[ns]

Legend: SD=standard deviation.
[ns]Non-significant (homogeneous data).
Sex data was processed using the Chi-square test; other variables were processed using the Mann-Whitney U test.

Table 2. Characteristics of vasoactive-inotropic score of critical patients

Vasoactive-inotropic score	Frequency (n)
Low (between 0 and <5)	0
Moderate (between ≥5 and <10)	1
High (≥10)	24

Table 3. Characteristics of enteral residue volume of critical patients

Volume of enteral residue	Frequency (n)
0-20 ml	10
21-40 ml	3
41-60 l	6
>60 ml	6

Table 4. Correlation between VIS and enteral residue

	Low residue (mean±SD)	High residue (mean±SD)	p-value
VIS	16.5±5.95	23.8±2.74	0.001*

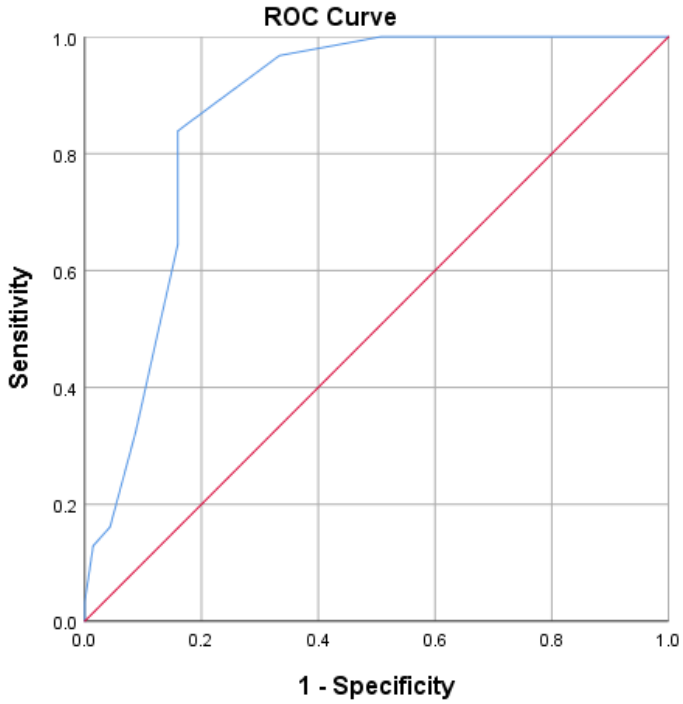
Legend: VIS=vasoactive-inotropic score; SD=standard deviation.
*Significant.
Data were tested using the Mann-Whitney U test.

Table 5. Correlation between VIS and enteral residue of critical patients

	r-value	p-value
VIS and enteral residue	0.712	<0.001*

Legend: VIS=vasoactive-inotropic score.
*Significant.
Data were tested using the Spearman test.

Figure 1. ROC curve on the VIS for enteral residual volume



Legend: ROC=receiver operating characteristic; VIS=vasoactive-inotropic score.

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