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Vasoactive-inotropic score for prediction of critical patient mortality: A systematic review

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Abstract

Background: A medical emergency is a clinical situation that requires immediate and planned treatment to prevent permanent disability or death. It involves sudden, progressive, and often life-threatening disturbances in vital body functions, such as cardiovascular, respiratory, or neurological disorders. The Vasoactive-Inotropic Score (VIS) is a clinical tool used to assess the need for vasoactive and inotropic drugs in critically ill patients. The VIS plays an important role as a prognostic indicator in critically ill patients, with higher VIS scores associated with increased risk of death.
Purpose: To evaluate vasoactive-inotropic score for prediction of critical patient mortality.
Method: A literature review with the aim of reviewing and evaluating previous research related to the use of VIS in predicting mortality in medical emergency patients using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram method. The search for scientific articles was conducted in October-November 2024 by determining the population/problem, intervention, comparison, and outcome (PICO) method. The database search process was carried out through the Publish or Perish application from PubMed, Scopus, Crossref, Semantic Scholar, and CINAHL. Determination of the article year range was focused on articles from 2018-2024 through keywords consisting of "inotrope" AND "predictor" AND "mortality", "VIS" AND "Patient critical ill", "VIS" OR Predictor mortality, "VIS" OR "ICU".
Results: The Vasoactive-Inotropic Score (VIS) is an effective and practical clinical tool to be used as a predictor of mortality in emergency and critical patients. VIS provides a quantitative picture of the severity of hemodynamic disorders as well as the pharmacological need to maintain the patient's cardiovascular stability. Its use has been shown to be significant in a variety of critical conditions, such as postoperative cardiac surgery, cardiogenic shock, sepsis, and out-of-hospital cardiac arrest, where higher VIS values are often correlated with an increased risk of mortality. The accuracy of VIS in predicting mortality risk can be improved through integration with other clinical parameters, such as inflammatory biomarkers and organ dysfunction scores, which provide a more comprehensive picture of the patient's physiological status.
Conclusion: VIS is consistently used as a predictive tool with varying morbidity-mortality thresholds in critically ill patients depending on population size. Factors that influence VIS values include patient demographic characteristics, hemodynamic status, disease severity, and quality of therapy received by the patient.

Keywords: Patient Mortality; Prediction of Critical; Vasoactive-Inotropic Score (VIS).

INTRODUCTION

A medical emergency is a clinical situation that requires immediate and planned treatment to prevent permanent disability or death. This condition involves sudden, progressive, and often life-threatening impairment of vital body functions, such as disorders of the cardiovascular, respiratory, or neurological systems (Nickson, 2023). Medical emergency conditions if not handled properly will lead to death.

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This is shown by the high prevalence of morbidity rates in emergencies, the American Heart Association (AHA) report states that emergency conditions such as coronary heart disease are one of the main causes of global deaths that infect 9.4 million people per year (American Heart Association, 2022). In addition, the World Health Organization (WHO) reports 49 million cases of sepsis every year worldwide, with a death toll of 11 million cases (World Health Organization, 2024). The need for early identification as a consideration in reducing the death rate in critical and emergency conditions.

Early identification of emergency conditions is important in handling patients. The triage system, as a first step in emergency management, aims to classify patients based on the severity of the condition and the need for priority medical interventions. In this context, the use of clinical aids, such as the Early Warning Score (EWS) or Vasoactive-Inotropic Score (VIS) can improve the accuracy of predicting mortality risk and aid in therapeutic decision-making (Jeong, Kook, Lee, Joo, Park, Hong, & Yu, 2024; Sanchez-Pinto, Bennett, DeWitt, Russell, Rebull, Martin, & Wynn, 2024). The use of clinical tools is generally difficult to implement and takes longer, this is because the use of some other methods such as APACHE II and III is more complex and requires many other variables. Longer times will cause delays in intervention, which will have a significant impact on the patient's prognosis (Rojas-García, Turner, Pizzo, Hudson, Thomas, & Raine, 2018).

VIS is a clinical tool used to measure the level of vasoactive and inotropic drug use in the management of critical patients, especially in medical emergency conditions. VIS is calculated based on the dose of medication administered, such as dopamine, adrenaline, noradrenaline, milrinon, and similar medications, which serve to support the patient's hemodynamic function (Gutierrez, 2023). This score provides a quantitative picture of the pharmacological therapy burden that patients receive to maintain cardiovascular stability, particularly in situations of cardiogenic shock, severe sepsis, or post-cardiac surgery. In the context of medical emergencies, VIS has an important role as an indicator of prognosis because higher scores are often associated with an increased risk of mortality (McPhail, Swann, Johnson, Barclay, Abd Elkader, Alvi, & You, 2022). In its implementation, the VIS clinical tool is considered more effective than other clinical aids because it has a higher level of accuracy, this is because the need for vasoactive and inotropic drugs with high doses will reflect the severity of blood circulation and heart function disorders (Belletti, Lerose, Zangrillo, & Landoni, 2021). In addition to high accuracy, VIS tools are considered more efficient and faster in decision-making for health workers to be able to take interventions according to the results obtained, and VIS dinlai has a more holistic approach value.

The use of VIS in predicting morbidity has been proven by previous studies. The results of previous studies showed that the VISmax value can predict mortality in the range of 30 days to 1 year (Koponen, Karttunen, Musialowicz, Pietiläinen, Uusaro, & Lahtinen, 2019). In addition, other studies also explain that the calculation of the VISmax value in the first 24 hours after surgery is a strong predictor of morbidity-mortality in post-cardiac surgery patients (Keleş, Yılmaz, Altınbaş, Zengin, & Yılmaz, 2024). From these studies, it is known that the advantage of VIS lies in its simplicity because it is easy to implement in various clinical settings, including emergency units and intensive care units. However, VIS is not free from limitations, such as the influence of individual variables, including age, comorbidities, and physiological responses to therapy (Belletti et al., 2021). Therefore, interpretation of these scores requires a thorough understanding of the clinical context of each patient.

RESEARCH METHOD

This study is a literature review with the aim of reviewing and evaluating previous research related to the use of VIS in predicting mortality in medical emergency patients using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram method. The search for scientific articles was conducted in October-November 2024 by determining the population/problem, intervention, comparison, and outcome (PICO) method.

The database search process was carried out through the Publish or Perish application from PubMed, Scopus, Crossref, Semantic Scholar, and CINAHL. Determination of the article year range was focused on articles from 2018-2024 through keywords consisting of "inotrope" AND "predictor" AND "mortality", "VIS" AND "Patient critical ill", "VIS" OR

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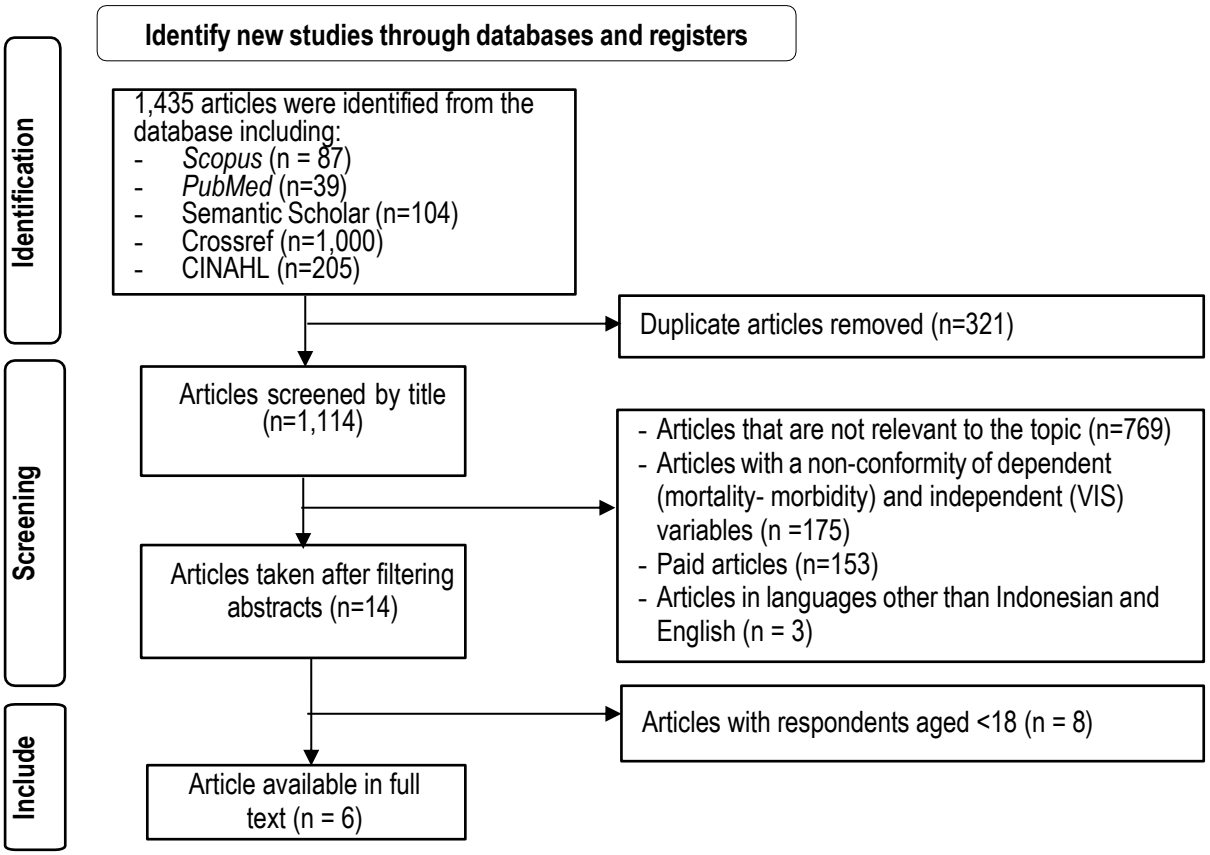
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Predictor mortality, "VIS" OR "ICU".

The criteria applied to the article selection process were carried out through PICO (Q: Patients with emergency and critical conditions; I: Use of VIS; C: -; O: Prediction of morbidity-mortality). The inclusion criteria applied to the article selection process were: 1) Respondents aged ≥18 years, 2) There was an ongoing VIS calculation, and 3) Articles in Indonesian or English. The exclusion criteria applied were articles that were inaccessible and not available in full text. The incubation criteria for this study refer more to adult patients because adult patients have a higher level of therapy complexity, with various medical conditions that affect therapy management. In adult patients, VIS is also more helpful in managing higher drug doses and more diverse responses to treatment, while for the exclusion criteria if the article is not fully accessible, it will result in confusion in the research results because the information to be obtained is not presented completely.

The quality of journal research (n: 6) can be analyzed by the Joanna Briggs Institute (JBI) Critical Appraisal research with a cross-sectional method. This assessment process is carried out using an assessment tool or checklist that is in accordance with the type of research design being evaluated. In this study, the JBI assessment uses 8 questions with a score of "yes" valued at one point and "no", "unknown" with a value or point of zero. The scores obtained are added up, if they meet 50% of the assessment or more, they can be agreed to be included in the inclusion criteria. Supervision will be carried out by the researcher.

RESEARCH RESULTS



Prisma Flow Diagram Figure

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Article Data Mapping Results Table

(Author, Year) (Country)	Purpose	Method	Results
(Yamazaki et al., 2018) (Japan)	To evaluate VIS at the end of surgery as a predictor of morbidity and mortality in adult cardiac surgery.	Retrospective observational study design. The sample consisted of 129 postoperative cardiac patients with bypass criteria >20 years, using ventricular assist devices, scheduled intra-aortic balloon inflation, and patients without aortic cross-clamping. The instruments used were the Vasoactive-Inotropic Score (VIS) and the European System for Cardiac Surgery Risk Evaluation (EuroSCORE).	After adjusting for EuroSCORE, preoperative ejection fraction, and bypass time, high VIS at the end of surgery was associated with poor outcome with an adjusted odds ratio of 4.87 (95% confidence interval 1.51-18.94; p = 0.007). After controlling for EuroSCORE and bypass time, patients with high VIS had longer ICU stay (hazard ratio 1.62; 95% confidence interval 1.10-2.39; p = 0.015) and required longer ventilation (hazard ratio 1.87; 95% confidence interval 1.28-2.74, p = 0.001).
(Oh et al., 2019) (Korea)	To investigate the correlation between VIS and in-hospital mortality in out-of-hospital cardiac arrest (OHCA) patients who achieved return of sustained spontaneous circulation (ROSC) and were admitted to the intensive care unit (ICU).	The design used was Observational Retrospective Study. The research sample was 219 out-of-hospital cardiac arrest patients with criteria ≥18 years. The instrument used was Vasoactive-Inotropic Score (VIS).	Among 504 OHCA patients, 166 patients were admitted to the intensive care unit and 116 patients died during hospitalization. The probability of in-hospital death was significantly higher when the 24-hour peak VIS was higher than 33.3 [Odds ratio (OR) = 3.18, 95% CI = 1.22 - 8.29. p-value =0.018]. The 24-hour-Peak VIS can be a good scoring system for predicting in- hospital mortality in OHCA patients admitted to the ICU. AUC is 0.762 (95% CI = 0.690 to 0.825) and optimal cut-o value is 33.3 (sensitivity 0.764, specificity 0.610)
(Keleş et al., 2024) (Turkey)	To evaluate the prediction of vasoactive inotropic score (VIS) on early mortality and morbidity	The design used was a Retrospective Observational Study. The sample consisted of 221 patients undergoing coronary artery bypass surgery (CABG). Inclusion criteria: age >20	A total of 221 patients with a mean age of 63.49 ± 9.96 years were evaluated and 73 (33%) were in Group 1. The cut-off value for VISintra was set at 6.20, VISmax 6.05. VISintra and VISmax values were significantly higher in the

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(Author, Year) (Country)	Purpose	Method	Results
	after coronary artery bypass grafting (CABG) and to determine the ideal time for score calculation.	years. The instrument used was the Vasoactive-Inotropic Score (VIS).	poor outcome group. Multivariate analysis showed that only VISmax was the independent variable in mortality-morbidity. Our results imply that the vasoactive inotropic score is an easy and inexpensive score to calculate and can be used as a specific scoring system to predict poor early outcome in CABG patients. According to statistical analysis, the most predictive time between VIS measurements was VISmax, the highest value calculated in the ICU within the first 24 hours after surgery.
(Na et al., 2019) (Korea)	To investigate whether the vasoactive inotropic score (VIS) can independently predict mortality in cardiogenic shock (CS).	The design used was a Retrospective Observational Study. The sample consisted of 493 patients who were admitted to the cardiac intensive care unit and experienced Cardiogenic Shock. Inclusion criteria for respondents were aged ≥18 years, experiencing cardiogenic shock, requiring inotropic or vasopressor support to maintain systolic pressure >90 mmHg, and experiencing tissue hypoperfusion indicated by serum lactate levels of 2.0 mmol/L. The instruments used were the Vasoactive-Inotropic Score (VIS) and the Acute Physiology and Chronic Health Evaluation II (APACHE II).	In-hospital mortality rates in the 5 VIS groups were 8.2%, 14.1%, 21.1%, 32.0%, and 65.7%, respectively (P < .001). Multivariate analysis showed that VIS ranges of 39 to 85 (aOR, 3.85; 95% CI, 1.60-9.22; P = .003) and more than 85 (aOR, 10.83; 95% CI, 4.43-26.43; P < .001) remained significant predictors of inpatient mortality. With multiple logistic regression to remove confounding effects, we found that the local regression lines for the odds of death intersected (medical therapy alone and extracorporeal membrane oxygenation groups combined) at VIS = 130. In contrast to the linear correlation between VIS and death for patients treated with medical therapy alone, there was little association between a VIS of 130 or greater and the odds of in-hospital death for patients treated with extracorporeal membrane oxygenation.

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(Author, Year) (Country)	Purpose	Method	Results
(Song et al., 2021) (Korea)	To investigate the association between VISmax and short-term mortality in patients diagnosed with sepsis in the ED according to the latest Sepsis-3 definition.	The design used was a Single Center Retrospective Study. The sample consisted of 910 sepsis patients registered in the Emergency Department aged ≥18 years. The instruments used were the Vasoactive-Inotropic Score (VIS), Organ Failure Assessment (SOFA) score, and Acute Physiology and Chronic Health Evaluation II (APACHE II).	VISmax for 30-day mortality was significantly higher in non-survivors than in survivors. Mortality rates in the five VISmax groups were 17.2%, 20.8%, 33.3%, 54.6%, and 70.0%, respectively. The optimal VISmax cutoff value for predicting 30-day mortality was 31. VISmax had better prognostic value than cardiovascular component of SOFA score and initial lactate level. VISmax was comparable to APACHE II score in predicting 30-day mortality. Multivariate analysis showed that VISmax 16-30, 31-45, and >45 were independent risk factors for 30-day mortality. VISmax in the ED can help clinicians to identify sepsis patients with poor prognosis.
(Mete et al., 2023) (Turkey)	To investigate the efficacy of vasoactive inotrope score at the 24th postoperative hour for mortality and morbidity in elective adult cardiac surgery.	The design used was a Single Center Prospective Study. The sample consisted of 287 adult patients undergoing cardiac surgery. The instruments used were the Vasoactive-Inotropic Score (VIS), and the European System for Cardiac Surgery Risk Evaluation II (EuroSCORE II).	The study involved 287 patients, of which 69 (24.0%) were in an inotropic condition at the 24th hour postoperatively. Vasoactive inotrop scores were higher (21.6±22.5 vs 0.94±2.7, p=0.001) in patients with poor outcomes. One unit improvement in vasoactive inorope score has an odds ratio of 1.24 (95% confidence interval: 1.14-1.35) for poor outcomes. The recipient operative characteristic curve of the vasoactive inorope score for poor outcomes has an area below the curve of 0.857. Vasoactive inorope score at 24 hours can be a very valuable parameter for risk calculation in the early postoperative period.

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DISCUSSION

VIS is one of the predictors of mortality in post-cardiac surgery patients. VIS ≥ 5.5 gives a worse prognosis in patients after undergoing coronary bypass surgery and prolongs the length of stay in the ICU (Yamazaki et al., 2018). These results are supported by a recent study with the same population, VISmax 6.05 is the threshold for predicting worsening patient conditions (Keleş et al., 2024). VIS in post-cardiac surgery patients is the strongest predictor of patient morbidity-mortality compared to the results of the APACHE II and SAPS II instrument scores (Koponen et al., 2019). Increased VIS shows significance for worsening patient conditions, length of stay in the ICU, and mortality up to 1 year after cardiac surgery. In addition to post-cardiac surgery patients, VIS can also be a predictor of mortality in out-of-hospital cardiac arrest patients.

VIS measurement within the first 24 hours after out-of-hospital cardiac arrest treatment with a cutoff value of 33.3 is a predictor of neurologically intact survival (Oh et al., 2019). In cases of cardiogenic shock, patients with VIS ≥39 are significant prognostic predictors of in-hospital mortality (Na et al., 2019). Meanwhile, in cases of sepsis, VIS 31 is the threshold for predicting mortality to patient death for 30 days (Song et al., 2021). The best time to calculate VIS in patients with emergency to critical conditions is the first 24 hours (Keleş et al., 2024; Mete et al., 2023; Oh et al., 2019).

VIS in critically ill patients is influenced by various factors related to physiological conditions, hemodynamic responses, and therapeutic interventions. In post-cardiac surgery patients, VIS tends to be influenced by the degree of myocardial damage (Koponen et al., 2019; Mete et al., 2023). The success of the surgical procedure and the presence of complications, such as bleeding or cardiac tamponade that require pharmacological support for cardiovascular stabilization (Keleş et al., 2024; Yamazaki et al., 2018). In addition, age factors, comorbidities such as diabetes mellitus or hypertension, and the time of cardiac function recovery after surgery also affect the need for vasoactive and inotropic agents (Koponen et al., 2019).

In cases of out-of-hospital cardiac arrest, VIS is influenced by the degree of ischemic-reperfusion injury that occurs due to the period of myocardial ischemia and the cardiopulmonary resuscitation process (Oh et al., 2019). This condition can also be exacerbated by complications such as pulmonary edema or multiple organ dysfunction syndrome due to systemic hypoxia (Oh et al., 2019). In cardiogenic shock, VIS is influenced by the degree of ventricular dysfunction, both left and right, and the patient's dependence on inotropic agents to overcome low cardiac output (Na et al., 2019). The combination of low tissue perfusion and increased systemic vascular resistance necessitates the use of additional vasoactive agents such as norepinephrine, thereby increasing VIS (Na et al., 2019).

On the other hand, in patients with sepsis, VIS is influenced by the degree of systemic vasodilation caused by the release of inflammatory mediators. A combination of inotropic agents to increase cardiac contractility and vasoactive agents to stabilize arterial blood pressure is often required to manage complex hemodynamic dysfunction in this condition (Song et al., 2021). Overall, VIS is influenced by the dose of drugs required by the patient, the time of measurement, the patient's demographic and clinical factors, the patient's health condition, hemodynamic status, the duration of exposure to the patient's disease or critical cause, and the quality of treatment.

VIS has been recognized as an effective tool in predicting mortality in critically ill patients, particularly those who require intensive hemodynamic support. The VIS provides a quantitative picture of the total doses of vasoactive and inotropic agents administered to patients, reflecting the severity of cardiovascular disorders and the need for pharmacological interventions to maintain hemodynamic stability (Gutierrez, 2023). Various studies have shown that higher VIS values are significantly correlated with an increased risk of mortality, in both adult and pediatric patients, especially in intensive care units and after cardiac surgical procedures. A high VIS often reflects the inability of the heart to maintain adequate cardiac output despite maximum therapy, as well as indicates organ perfusion disorders that have the potential to lead to multiple organ failure (Bojan & Pouard, 2023).

VIS also serves as an indicator to monitor the patient's response to therapy. VIS values that remain high or continue to increase despite interventions reflect a poor prognosis and the possible need for

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more aggressive therapeutic approaches, such as the use of mechanical devices for circulatory support (Bojan & Pouard, 2023; Llwyd, Fan, & Müller, 2022). The advantage of VIS as a predictor of mortality lies in the simplicity of its calculation and its adaptable application in a variety of clinical settings (Keleş et al., 2024). However, VIS also has limitations, including its dependence on drug dosage which can be affected by variations in institutional protocols or individual pharmacodynamic responses of patients (Mete et al., 2023). In the context of critical patients, the integration of VIS with other clinical indicators, such as organ dysfunction scores or inflammatory biomarkers, can improve prediction accuracy and support more informed clinical decision-making (Koponen et al., 2019). The use of VIS as a predictor of mortality not only aids in risk assessment, but also provides guidance for healthcare professionals to prioritize interventions and prepare the necessary resources to improve patient safety opportunities (Gutierrez, 2023).

The difference in the Vasoactive-Inotropic Score (VIS) threshold as a predictor of mortality reported in various studies can be explained by the variation in patient population characteristics and the clinical approach used in each study. Demographic factors, such as the age of the patient, play an important role because the response to vasoactive and inotropic agents can differ significantly between the young, adult, and elderly age groups (Song et al., 2021). In pediatric patients, for example, sensitivity to certain inotropic agents is higher than in the adult population, so VIS values may be lower despite similar disease severity (Kallekkattu, Rameshkumar, Chidambaram, Krishnamurthy, Selvan, & Mahadevan, 2022). The patient's hemodynamic status, including initial blood pressure, systemic vascular resistance, and cardiovascular compensatory ability, also affects pharmacological needs to the extent that it affects the VIS value (Koponen et al., 2019; Na et al., 2019). An underlying disease, such as sepsis, cardiogenic shock, or postoperative dysfunction of cardiac surgery, also determines the threshold value of VIS as a predictor. In addition, the quality of treatment in health facilities, such as the protocol for the use of vasoactive drugs, the skills of medical personnel, and the availability of supporting technology, can affect the pattern of therapy administration and VIS calculation. Therefore, the interpretation of VIS should consider the clinical context of each patient, including demographics, hemodynamic status, and quality of care, to ensure that the score is accurately used as a predictor of mortality. The integration of VIS with other clinical parameters can help overcome these variations and improve the validity of predictions (Hyland, Faltys, Hüser, Lyu, Gumbsch, Esteban, & Merz, 2020).

The use of VIS as a predictive tool is one of the strategic steps in the early prevention of morbidity and mortality in critically ill patients. VIS serves as a quantitative indicator that reflects the patient's pharmacological need to support hemodynamic stability, allowing for real- time evaluation of the severity of clinical conditions (Gutierrez, 2023). VIS calculations with a high degree of accuracy can help medical personnel detect changes in hemodynamic status early, provide early warning of the risk of multiple organ failure, and guide timely therapy decision-making. For example, significantly increased VIS indicates a high dependence on vasoactive and inotropic agents, which often indicates a worsening prognosis without further intervention (Keleş et al., 2024).

The accuracy of VIS calculations depends on consistent drug dose documentation as well as integration with other clinical parameters, such as invasive blood pressure, cardiac output, and systemic vascular resistance (Gutierrez, 2023). The utilization of advanced monitoring technology allows for more precise VIS calculations, minimizes the risk of measurement errors, and ensures that the scores obtained truly reflect the patient's physiological condition. In addition, training medical personnel in understanding and applying VIS correctly is essential to optimize its use as a predictive tool (Keleş et al., 2024). In a broader context, VIS can be integrated with clinical algorithms to prioritize interventions, such as the need for intensive pharmacological therapy, mechanical assistive devices, or other invasive measures. By utilizing VIS accurately and systematically, the risk of morbidity-mortality of critically ill patients can be reduced through early detection of worsening conditions and the provision of more targeted interventions. The integration of VIS into critical patient management protocols also has the potential to improve the efficiency of medical resources, accelerate decision-making, and support efforts to improve the overall quality of patient care (Mete et al., 2023).

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The limitations of this study lie in the researcher's access to databases other than those listed, thus limiting the scope of articles obtained. In addition, the researcher only reviewed articles with adult respondents and did not compare them with respondents in other age categories. With this study, it is hoped that it can increase awareness to utilize and develop VIS as an objective predictor of morbidity-mortality in emergencies and critical patients.

CONCLUSION

The Vasoactive-Inotropic Score (VIS) is an effective and practical clinical tool to be used as a predictor of mortality in emergencies and critical patients. VIS provides a quantitative picture of the severity of hemodynamic disorders as well as the pharmacological need to maintain the patient's cardiovascular stability. Its use has been shown to be significant in a variety of critical conditions, such as postoperative cardiac surgery, cardiogenic shock, sepsis, and out-of-hospital cardiac arrest, where higher VIS values are often correlated with an increased risk of mortality. The accuracy of VIS in predicting mortality risk can be improved through integration with other clinical parameters, such as inflammatory biomarkers and organ dysfunction scores, which provide a more comprehensive picture of the patient's physiological status.

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