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Modified Shock Index as a Predictor of Mortality in Patients with Septic Shock in the Emergency Department

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ABSTRACT

Introduction: The Modified Shock Index (MSI) is a rapid, cost-effective, and reproducible tool for identifying patients at risk of septic shock and multiorgan failure. Up to 2% of cases progress to septic shock, with a mortality rate of 90%. Early detection is crucial to prevent progression to multiorgan failure.
Objective: To evaluate the usefulness of the MSI as a predictor of in-hospital mortality in patients with septic shock treated at the High Specialty Hospital.
Material and methods: Observational, cross-sectional, retrospective, and analytical study. A total of 102 medical records of septic shock patients seen in the emergency department over five years were analyzed. Vital signs, infectious focus, comorbidities, Modified Shock Index calculation, and patient outcomes were recorded. Data were processed in SPSS V.25, obtaining measures of central tendency, dispersion, standard deviation, and Chi-square test ($p<0.05$).
Results: Fifty-two men and 49 women were included. Pulmonary infection was the most frequent focus (55%), and diabetes mellitus was the most common comorbidity. There were 86 deaths, 56 of them with MSI >1.3 ($p<0.001$, OR=3.47, 95% CI).
Conclusions: An MSI greater than 1.3 is associated with an increased risk of mortality in patients with septic shock, tripling the risk compared to those with MSI <1.29.

KEYWORDS:
Sepsis, shock index, Modified Shock Index, septic shock, mortality.

INTRODUCTION

Sepsis is an uncontrolled immune response to infection that can cause systemic inflammation and multiorgan damage. According to the World Health Organization (WHO), it represents a public health crisis, affecting 48.9 million people annually and causing nearly 11 million deaths.[1]

Its impact is more severe in low-income countries, where limited access to medical care and poor sanitary conditions increase its incidence.1 According to the Third International Consensus of 2016, sepsis is a syndrome of extreme immune response that can lead to irreversible organ dysfunction if not detected and treated in time. In more severe cases, progression to septic shock leads to severe hypotension and multiorgan failure, requiring management in intensive care units (ICU). It is estimated that around 2% of cases progress to severe forms, representing approximately 10% of ICU admissions.[2,3]

Globally, its burden varies considerably between regions. Each year, 20 million cases occur in children under five years, highlighting their vulnerability. The WHO stresses the need to strengthen early detection strategies, appropriate antimicrobial use, vaccination, and hospital hygiene measures to reduce its incidence and improve clinical outcomes. Furthermore, the hospital cost of sepsis is high, exceeding 32,000 dollars per patient in high-income countries.[1]

Sepsis has a significant impact on emergency departments, with a prevalence of 12.9% and a global mortality rate of 16.93%. In cases of septic shock, mortality increases to 65.85%, highlighting the need for early diagnosis and timely

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treatment. An average hospital stay of 9 days corresponds to a mortality rate of 33%.[4,5]

Sepsis is a dysregulated immune response to severe infection, triggered by the activation of TLR receptors on immune cells, promoting the release of proinflammatory cytokines such as IL-1, IL-2, IL-18, and TNF-α, amplifying inflammation. Simultaneously, the complement pathway generates molecules such as C3a and C5a, attracting neutrophils and macrophages to fight the infection.[6,7]

When inflammation becomes excessive, the vascular endothelium suffers progressive damage due to the action of free radicals and nitric oxide, leading to hypotension, a procoagulant state, and distributive shock. This alteration favors disseminated intravascular coagulation, worsening organ dysfunction.[8,9]

In patients with septic shock, the microvasculature becomes compromised, generating disseminated thrombosis, tissue necrosis, and symmetric peripheral gangrene, affecting lower and upper extremities. Dysfunction of natural anticoagulants such as protein C and antithrombin, along with hepatic failure, contributes to these phenomena. Although vasopressors have been suggested as a contributing factor, evidence indicates that coagulation alteration is the predominant cause.[10]

Endothelial injury in sepsis causes tissue hypoperfusion and interstitial edema, worsening organ damage. Disruption of the glycocalyx and intercellular junctions causes capillary leakage, increasing fluid and protein loss. Leukocyte adhesion to the endothelium perpetuates inflammation and microthrombus formation, compromising tissue oxygenation.[11]

In patients with septic shock, systemic proteolysis has emerged as a key determinant of mortality, due to the accumulation of metabolites such as N-formyl-methionine and N-lactoyl-phenylalanine, whose elevated levels are associated with greater clinical severity. Mitochondrial dysfunction caused by excessive proteolytic activity compromises cellular energy production and contributes to organ damage. These biomarkers have shown greater accuracy in predicting mortality than lactate, underscoring their potential use in risk stratification and clinical decision-making.[12–14]

Management of sepsis and septic shock focuses on early detection and modulation of the inflammatory response to prevent systemic complications. Among the tools available, the shock index, developed in 1967, has been fundamental in assessing circulatory stability by relating heart rate to systolic blood pressure. In the context of sepsis, this index has proven useful in predicting the risk of multiorgan failure, need for vasopressors, and 28-day mortality. Its modified version in 2012, which incorporates mean arterial pressure, has improved prediction of complications in critically ill patients.[15–18]

The Modified Shock Index (MSI) has emerged as a key tool for risk stratification in patients with sepsis and septic shock, as it allows rapid assessment of hemodynamic status and facilitates timely clinical decision-making. According to studies, MSI values correlate with clinical severity: <0.7: Hyperdynamic state with mortality near 9%. >1.3: Hypodynamic state with mortality of 7%. Between 0.7 and 1.3: Normal range with mortality between 1% and 2%.[19]

Recent studies have reaffirmed the usefulness of the Modified Shock Index (MSI) in predicting mortality risk in patients with septic shock. A retrospective analysis published in MOJ in 2023, involving 50 ICU patients, showed that 52% had an MSI greater than 1.3, and of these, 42% died, confirming its significant association with higher mortality risk. Additionally, pulmonary infection was the predominant focus in these cases, with statistical significance ($p < 0.05$).[20]

The study by Ulla highlights that incorporating mean arterial pressure together with heart rate improves hemodynamic assessment, facilitating accurate identification of at-risk patients. Unlike other scales, MSI is a rapid and accessible tool, especially useful in emergency and intensive care settings. Its combination with other predictive models, such as the Phoenix Sepsis Criteria, enhances identification of patients at higher risk of clinical deterioration, enabling earlier intervention and reducing mortality.[21]

In the systematic review by Diaztagle, which analyzed 17 studies, both the shock index and its modified variants were confirmed as reliable predictors of mortality in septic shock patients. In 11 studies, elevated values were associated with higher likelihood of death. Additionally, a relationship between MSI and myocardial depression was identified, reinforcing its prognostic value in the management of septic shock. Its repeated use may be beneficial to adjust treatment, particularly fluid administration and hemodynamic support.[18]

These findings underscore the importance of implementing the modified shock index as a continuous monitoring tool, facilitating more efficient detection and timely management of sepsis. The objective of the study was therefore to determine MSI as a predictor of mortality in patients with septic shock.

MATERIAL AND METHODS

The study was designed as a cross-sectional, retrospective, and observational analysis based on the review of clinical records of patients with confirmed septic shock. Patients with complete vital signs records, including blood pressure and heart rate upon admission, were included. Exclusion criteria were patients under 18 years, pregnant women, and incomplete records.

Data collected included vital signs, infection site, and clinical outcome, integrated into a structured database. Variables such as MSI were analyzed and categorized into: High (≥1.3), Normal/Low (<1.29).

Comorbidities and infection focus were also evaluated to establish their relationship with mortality.

For the statistical analysis, data were processed in SPSS V.25, applying measures of central tendency and dispersion. Pearson's Chi-square test was used to evaluate the relationship between the Modified Shock Index and mortality, along with logistic regression and Odds Ratio calculation.

RESULTS

Between January 2020 and November 2025, a total of 112 patients with a diagnosis of septic shock were identified. After applying inclusion criteria, 102 cases were retrospectively analyzed. The sex distribution was balanced, with a mean age of 57.5 years, predominantly in the 51–60 age group.

The average hospital stay was 10.35 days, although some patients had prolonged stays exceeding 50 days. Regarding comorbidities, diabetes mellitus was the most frequent (41 cases), followed by chronic nephropathy. Concerning infectious focus, most cases originated in the lungs (56 cases), followed by soft tissue and abdominal infections.

No significant association was identified between mortality and comorbidities ($X^2 = 4.962$, df = 6, p = 0.549) or infectious focus ($X^2 = 7.577$). (Table 1)

A statistically significant association was observed between elevated shock index and mortality. Patients with a high shock index had a higher frequency of mortality (56 cases) compared to those with normal or low index (30 cases). This difference was confirmed using a Chi-square test ($X^2 = 11.893$; $p < 0.001$), suggesting that a high shock index may be a predictive factor for mortality in this population. (Table 2)

DISCUSSION

The Shock Index has been a key tool in identifying patients at risk of clinical deterioration and multiorgan failure since its introduction in 1967. Its modification in 2012 improved its detection capacity, allowing earlier intervention in critically ill patients.15–17

Its usefulness as a predictor of mortality has been reported in multiple systematic reviews, such as the one published in Medicina Intensiva by Díaztagle in 2024, which analyzed its performance in septic shock. Of the 17 studies evaluated, 11 supported its usefulness as a mortality predictor, and 7 of them showed significant differences between survivors and non-survivors.[18]

Prospective studies have shown that MSI is associated with myocardial depression and mortality in severe sepsis. Its value in guiding fluid resuscitation and adjusting dobutamine doses in critically ill patients has also been explored.[18]

Compared to other studies, a meta-analysis by Vang et al. in 2022 reported that a shock index ≥1 in trauma patients had a four-fold increased risk of in-hospital mortality, while in this study mortality was more closely related to an index >1.3, confirming its relevance in the initial evaluation of critically ill patients.[22]

In the study by García-Peña (2025), the most frequent comorbidities were arterial hypertension (15.9%), COPD (5%), and diabetes mellitus (4.6%), in contrast to the present study where diabetes ranked first (40.2%). Furthermore, the results suggest that an MSI >0.9 achieves high specificity and a positive likelihood ratio >2.5.[19]

The most common infectious focus was pulmonary (55%), consistent with the Global Burden of Disease cited by Pérez-Padilla et al. in 2021, where lower respiratory tract infections are the main cause of sepsis worldwide.[23]

Regarding its relationship with mortality, MSI ≥1.3 was present in 65% of deaths, regardless of infection site, and showed statistical significance (p<0.001, Chi-square), confirming it as a reliable predictor of mortality, a finding consistent with international studies such as that of González et al. (2022).[24]

The results regarding clinical prognosis suggest that MSI ≥1.3 is associated with greater clinical and biochemical deterioration, reflecting systemic impairment due to hypoperfusion and an unfavorable prognosis if corrective measures are not promptly implemented.31 These findings reinforce the importance of MSI as a prognostic tool in the management of sepsis, allowing timely interventions to improve survival.

CONCLUSIONS

The studied population presented a mean age of 57.5 years. The average hospital stay was 10.35 days, with some cases of prolonged hospitalization (>50 days). Pulmonary infection predominated as the primary infectious focus. Diabetes mellitus was the most frequent comorbidity, followed by chronic nephropathy.

An association was observed between elevated shock index and mortality compared with those with normal and low index who presented comorbidities and infection focus but did not show fatal outcomes, indicating that other clinical factors influence disease progression.

- Conflict of interest: The authors declare no conflict of interest.
- The article has not been published in any journal

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Table 1. Association between mortality and clinical variables in Patients With Septic Shock

Mortality	X^2	df	p*.
with shock index	11.893	1	<0.001
with comorbidities	4.962	6	0.549
with infectious focus	7.577	3	0.056

***p-value obtained from Chi-square test.**

Table 2. Mortality related to shock index in Patients With Septic Shock

		Shock Index			
		Normal/Low	**High**	**X^2**	**p***
Mortality	**yes**	30	56	11.893	<0.001
	no	13	3		

***p-value obtained from Chi-square test.**