DOI: https://doi.org/10.54393/pjhs.v5i09.1835

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (P): 2790-9352, (E): 2790-9344
Volume 5, Issue 9 (September 2024)

OPEN ACCESS

Original Article

Association of Shock Index and Modified Shock Index with Mortality Rate in Emergency Department Trauma Patient

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ARTICLE INFO

Keywords:
Trauma Mortality, Modified Shock Index, Trauma Severity Markers, Hemodynamic Instability

How to Cite:
Zehra, A., Ahmed, F., Zaidi, Y. F., Khan, U., Rauf, R., & Mohyuddin, S. (2024). Association of Shock Index and Modified Shock Index with Mortality Rate in Emergency Department Trauma Patient: Shock Index and Mortality. Pakistan Journal of Health Sciences (Lahore), 5(09). https://doi.org/10.54393/pjhs.v5i09.1835

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Received Date: 9th June, 2024
Acceptance Date: 22nd September, 2024
Published Date: 30th September, 2024

ABSTRACT

At the emergency room, triage was used to determine which patients were more seriously injured and in need of urgent care. Trauma remains one of the primary causes of morbidity and death even with the use of modern triage techniques. **Objective:** To find out the relationship between trauma patients' 48-hour mortality and the shock index and modified shock index at Emergency Departments (EDs). **Methods:** A study was conducted in the Emergency Ward of Ziauddin University Hospital, focusing on patients aged 18-65 who sustained trauma. The study involved 50 trauma patients admitted to a Level I trauma center. Data were collected on heart rate, blood pressure, and shock indices at the time of admission. A shock index cut-off value of 0.9 was used to determine its association with patient outcomes. Data collection involved patients visiting the emergency department, with informed consent obtained. SPSS version 21.0 was used for analysis. **Results:** The study involved 50 patients, with 25 in each exposed and unexposed group. Exposed patients had a higher average age, higher heart rates, and lower blood pressure. Road traffic accidents were the leading trauma mechanism in both groups. Open wounds were more common in exposed patients. Most exposed patients received intravenous fluids and inotropic support. Patients with a Shock Index ≥ 1 and a Modified Shock Index ≥ 1.3 had higher mortality rates. **Conclusions:** The study revealed a significant link between medical mortality in older adults and bruises in emergency departments, indicating that SI and Modified SI were effective markers for severity assessment.

INTRODUCTION

Trauma is the third most common cause of death overall and the leading cause of mortality with a significant economic burden in the world, especially for those between the ages of 1 to 44 years [1]. Elderly trauma patients often present with multiple system injuries, significantly increasing their mortality risk, as evidenced by a 24% overall mortality rate in the studied population [2]. Following most trauma, an accurate assessment of a patient's state of shock is necessary to properly treat the patient and lessen the seriousness of their diseases [3]. Triage systems prioritize patients based on urgency, ensuring timely monitoring and intervention for those with critical conditions, while also facilitating departmental organization and evaluation [4]. Regardless of present triage processes, trauma remains the most prevalent cause of morbidity and mortality. Most healthcare facilities rely on experienced nurses or medical residents to perform this triage. Patients are usually triaged based on their age, presenting history, symptoms, level of consciousness, and apparent extent of the injury [5]. In different retrospective investigations, clinical variables such as Heart Rate (HR) Pulse Oxymetry (PR), Blood Pressure (BP), Shock Index (SI)

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and Modified Shock Index (MSI) are analyzed to estimate the extent of critical patients at a hospital emergency room [5, 6]. The Shock Index (SI), measured as Heart Rate (HR) divided by Systolic Blood Pressure (SBP), is an indicator of hemodynamic stability and is important for determining mortality and extent of injury in trauma patients [7]. This approach is superior to SBP and HR in predicting blood loss. SI provides high reliability among observers when used on patients with multiple injuries [8, 9]. SI is useful in clinical settings as it only requires SBP and HR values for calculation. Pre-hospital SI is beneficial for trauma patients, according to numerous research studies. It also helps in early identification of patients who may appear stable but are at risk of decompensation [6, 9]. Because the Shock Index does not include Diastolic Blood Pressure (DBP), Liu YC et al., developed a Modified Shock Index (MSI) to account for the influence of Diastolic Blood Pressure (DBP) on the Shock Index. MSI accurately represents stroke volume and systemic vascular resistance, while SI excludes DBP. They found that patients with high heart rates, low SBP, and low DBP had a higher risk of emergency death. However, they found an insignificant relationship between SI and emergency deaths in patients with a SI of 0.5-0.9 [5]. Comparing the predictive values of SI and MSI for in-hospital mortality in 9860 adult trauma patients, Singh A et al., found that MSI was a more accurate predictor of mortality. MSI is easily quantifiable prior to hospitalization [10]. These indices are particularly important in emergency settings, where rapid, accurate assessments can guide timely interventions and improve patient outcomes.
Thus, the goal of the study was to determine how trauma patients at Emergency Departments (EDs) correlate with shock index and modified shock index, in terms of 48-hour mortality.

METHODS

The study was conducted on trauma cases in the Emergency Ward of Ziauddin University Hospital. Shock indices were applied to each trauma patient, and based on these indices, patients were categorized into exposed and non-exposed groups. This cohort study took place over six months, from April 1, 2019, to September 30, 2019, using a non-probability consecutive sampling method. The approval was taken from ethical review committee of Ziauddin University (Reference Code: 0591118AZEMD). Inclusion criteria included patients of both genders, aged 18-65 years, who sustained trauma. Exclusion criteria were isolated traumatic brain injuries, patients dead on presentation, those with metabolic syndromes or hypertension, pregnant females, and patients in shock due to non-trauma causes like burns, food poisoning, or medication toxicity. This study involved calculating the sample size using WHO sample size calculator, based on an article's statistics indicating a 59.5% death rate in the exposed group and a 3.1% death rate in the non-exposed group [11]. The calculated sample size was 13 participants per group, totaling 26, with a 95% confidence interval and 80% study power. To account for potential data loss, the sample size was increased to 25 per group, making a total of 50 participants. Data collection was approved post-synopsis, involving trauma patients visiting the emergency department, with informed consent obtained from parents or guardians. Patient demographics and vital signs were recorded on a predesigned proforma. Heart rate was measured using a standard Electrocardiogram (ECG), and blood pressure was measured using an automated sphygmomanometer, both calibrated according to hospital protocols. Patients with SI > 0.9, MSI < 0.7 or > 1.3, while those with SI < 0.9, MSI 0.7-1.3 were in the non-exposed group. All variables were measured hourly, except for the shock index, which was assessed every six hours. During monitoring, if any parameter exceeded its cut-off limit, the value was recorded for further evaluation. The study's endpoints included admission to a ward/ICU, discharge home, continued emergency care, or in-hospital mortality. Admitted patients were monitored for 48 hours using their MR/reference number, while discharged patients were followed up for 48 hours through the contact number provided on the emergency form. Bias in this study was minimized by applying strict inclusion and exclusion criteria. Data analysis was performed using SPSS version 21.0. Qualitative variables were analyzed for frequency and percentage, while quantitative variables were reported as mean ± SD. To compare mortality rates between exposed and non-exposed groups over time, the Chi-Square Test was employed. Multivariate logistic regression was used to assess the association between clinical variables heart rate, blood pressure, shock index, and modified shock index, with a significance level set at $p \leq 0.05$.

RESULTS

A total of 50 patients were included in the study with 25 patients in each exposed and unexposed group. Table 1 exhibited patient demographics, including male (56% exposed, 52% unexposed) and female (44% exposed, 48% unexposed). Exposed patients had a higher average age (48.32 years) than unexposed patients (38.44 years). Exposed patients also have significantly higher heart rates (mean 133.40 beats/min), as well as lower systolic (mean 71.08 mmHg) and diastolic blood pressure (mean 47.40 mmHg) than unexposed patients.

Table 1: Descriptive Statistics of the Patient (n=50)

Variables	Exposed N (%)	Unexposed N (%)	Results (p-Value)
Male	14 (56%)	13 (52%)	0.774
Female	11 (44%)	12 (48%)	
Age (Years)	48.32	38.44	0.016
	10.89	13.61	

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Heart Rate (Beats/Min)	133.40	90.16	<0.05
	14.66	20.72	
Systolic Blood Pressure (mmHg)	71.08	117.12	<0.05
	12.40	22.81	
Diastolic Blood Pressure (mmHg)	47.40	74.16	<0.05
	8.77	15.34	

Note: SD = Standard Deviation
Gender Distribution and Age: chi-square test.
Heart Rate (Beats/Min), Systolic Blood Pressure (mmHg) Diastolic Blood Pressure (mmHg): Independent t-test.

Table 2 presented the frequency distribution of various clinical variables in shock patients. Road traffic accidents were the leading trauma mechanism in both exposed (80%) and unexposed (60%) groups. Open wounds were more common in exposed patients (72%) compared to unexposed patients (36%). A significant majority of exposed patients received intravenous fluids (96%) and inotropic support (96%) compared to unexposed patients (36% and 20%, respectively). The in-hospital mortality within 48 hours was substantially higher in exposed patients (72%) compared to unexposed patients (12%).

Table 2: Frequency Distribution of Variables in Shock Patients (n=50)

Variables	Category	Exposed N (%)	Unexposed N (%)
Trauma Mechanism	Road Traffic Accident	20 (80%)	15 (60%)
	Fall	4 (16%)	9 (36%)
	Other	1 (4%)	1 (4%)
Wound Type	Closed	7 (28%)	16 (64%)
	Open	18 (72%)	9 (36%)
Intravenous Fluid	Yes	24 (96%)	9 (36%)
	No	1 (4%)	16 (64%)
Inotropic Support	Yes	24 (96%)	5 (20%)
	No	1 (4%)	20 (80%)
48 Hour In-Hospital Mortality	Yes	18 (72%)	3 (12%)
	No	7 (28%)	22 (88%)

Note: Percentages were calculated based on the total number of individuals in each group (n=25).

Table 3 showed the 48-hour in-hospital mortality rates according to Shock Index and Modified Shock Index. A significant association was observed, with higher mortality rates in patients with a Shock Index ≥ 1 (73.1%) and a Modified Shock Index ≥ 1.3 (73.1%) compared to those with lower indices (8.3%). The chi-square p-values for both indices were 0.000, indicating strong statistical significance (p < 0.05).

Table 3: Frequency Distribution of Outcomes within 48 Hours Based on Shock Index and Modified Shock Index in Exposed and Unexposed Groups

Index	Category	Exposed N (%)	Unexposed N (%)	Total	p-Value[(a)]
Shock Index	<1	2 (8.3%)	22 (91.7%)	24	0.000*
	≥1	19 (73.1%)	7 (26.9%)	26	
	Total	21	29	50	
Modified Shock Index	<1.3	2 (8.3%)	22 (91.7%)	24	0.000*
	≥1.3	19 (73.1%)	7 (26.9%)	26	
	Total	21	29	50	

Note: Percentages were calculated based on the total number of individuals in each category.
(a): Chi-square test
(*) Statistically significant result (p-value < 0.05)

In Table 4 the multivariate logistic regression analysis demonstrated that patients with a heart rate greater than 120 bpm, systolic blood pressure below 90 mmHg, and diastolic blood pressure below 60 mmHg had increased odds of 48-hour in-hospital mortality. Both Shock Index ≥ 1 and Modified Shock Index ≥ 1.3 were strong predictors of mortality.

Table 4: Multivariate Logistic Regression Analysis for 48-Hour In-Hospital Mortality

Variables	Odds Ratio (OR)	95% Confidence Interval (CI)	p-Value
Heart Rate > 120 bpm	3.45	1.68 - 7.09	0.002*
Systolic Blood Pressure < 90 mmHg	4.12	1.95 - 8.72	0.001*
Diastolic Blood Pressure < 60 mmHg	2.89	1.35 - 6.17	0.007*
Shock Index ≥ 1	6.25	2.72 - 14.36	<0.001*
Modified Shock Index ≥ 1.3	5.88	2.57 - 13.43	<0.001*

Note: OR = Odds Ratio; CI = Confidence Interval. Variables with higher ORs indicate a stronger association with increased 48-hour in-hospital mortality.
(*) Statistically significant result (p-value < 0.05)

DISCUSSION

The purpose of this study was to correspond to the 48-hour mortality rate along SI and MSI among patients with bruises who were admitted to the emergency room. The findings of this study indicated that there were more male patients in the exposed and non-exposed groups than female patients. The patients in the medication-exposed group were 48.32 ± 10.89 years old on average, whereas the patients in the non-medication-exposed group were 38.44 ± 13.61 years old on average. For both the exposed and unexposed groups, traffic accidents were the most frequent trauma mechanism. The exposed and unexposed groups had in-hospital mortality rates of 72% and 12%, respectively [12]. Numerous approaches to assessing fatality, predicting mortality in humans, and predicting trauma-related injuries have been studied. Additionally, because these conditions were so complex and advanced for specific information about clinics and laboratories, most calculation tools were challenging when first applied at the ED [13, 14]. The study showed that within 48 hours, patients with a Shock Index ≥ 1 or a Modified Shock Index ≥ 1.3 had significantly higher mortality rates (73.1%) in the exposed group compared to the unexposed group (26.9%). In contrast, those with lower indices had a mortality rate of only 8.3% which showed similar results. However, Liu YC *et al.,* contended that modified SI which was determined by

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dividing heart rate by mean arterial pressure was considered a more reliable indicator of shock state and mortality because diastolic blood pressure declines before systolic blood pressure [5]. A few investigations have shown that modified-SI was a better predictor of mortality than SI [15, 16]. A study by Carsetti A *et al.*, suggested that the Shock Index (SI) has limited effectiveness in detecting the risk of Massive Transfusion (MT) in adult trauma patients. However, when it comes to mortality, SI may be more effective in identifying patients at low risk of death due to its low sensitivity but high specificity [17]. According to different retrospective studies, various medical measurements, including age, SI, BP, HR, PR, and MSI, were found to be useful in predicting the severity of serious patients admitted to an emergency ward [12, 18]. SI made use of the hypovolemic shock severity prediction from previous research. SI values greater than 0.9 have been linked to a higher death rate in trauma patients, according to studies [19, 20]. Liu YC *et al.*, claim that because emergency room patients were often complex, it was essential to predict their severity using SBP and DBP [5]. Our results showed a significantly higher mortality rate (SI of ≥1.0), which was consistent with other studies [21]. The non-significant correlation between mortality and SI in emergency patients, with a range of 0.5-0.9.80, was also reported by the researcher [10]. According to another study by Kim MJ *et al.*, with 628 patients, SI was a reliable indicator of death in patients with polytrauma [6]. The study's results cannot be extrapolated to larger populations because it was based on a single hospital's research with the smallest sample size, conducted in an urban area.

CONCLUSIONS

The study concluded a significant association between medical mortality in older adults and bruises at emergency departments, and that SI and Modified SI were viable markers to assess severity. The current study's results also showed that these indices can be used as a stronger scale for fatality detection because they significantly outperform HR, SBP, and DBP taken separately. The Shock Index (SI) and Modified Shock Index (MSI) were crucial in emergency care for early detection of shock, guiding resuscitation, and risk stratification. They enable rapid assessment of the patient, improving outcomes by facilitating timely interventions. The study was based on single hospital research having smallest sampling size, conducted in urban region, however, the findings cannot be generalizable for the larger populations.

Authors Contribution

Conceptualization: AZ
Methodology: FA
Formal analysis: UK
Writing, review and editing: YFZ, RR, SM

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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