Original Article

Indian Journal of Emergency Medicine
Volume 7 Number 4, October– December 2021
DOI: http://dx.doi.org/10.21088/ijem.2395.311X.7421.1

Shock Index and Modified Shock Index as Predictors of 24 Hour Mortality in Patients with Polytrauma

Pratibha Jain Shah[1], Omprakash Sundrani[2], Lily Sharon Priyadharshini K[3]

Author's Affiliation: [1]Professor and HOD, [3]Final Year Resident, Department of Anesthesiology, [2]Associate Professor and HOD, Department of Critical Care Medicine, Pandit Jawaharlal Nehru Memorial Medical College and Dr. BR Ambedkar Hospital, Raipur, Chattisgarh 492001, India.

Corresponding Author: Pratibha Jain Shah, Professor and HOD, Department of Anaesthesiology, Pandit Jawaharlal Nehru Memorial Medical College and Dr. BR Ambedkar Hospital, Raipur, Chattisgarh 492001, India.

E mail: prati_jain@rediffmail.com

How to cite this article:

Pratibha Jain Shah, Omprakash Sundrani, Lily Sharon Priyadharshini K/Shock Index and Modified Shock Index as Predictors of 24 Hour Mortality in Patients with Polytrauma/ Indian J Emerg Med. 2021;7(4):143–148.

Abstract

Context: The failure of the vital signs to predict the severity of shock and the drawbacks of the trauma scoring systems has led to extensive research on shock index in polytrauma patients. This prospective, observational study was conducted to study efficacy of Shock Index (SI) and Modified Shock Index (MSI) as predictors of 24 h mortality in polytrauma patients.

Aim: To validate Shock index and Modified Shock index as predictors of 24 h mortality in polytrauma patients.

Method: All patients presenting with polytrauma meeting the inclusion criteria were evaluated using the following parameters: Heart rate, Systolic blood pressure, Diastolic blood pressure, following which SI and MSI were calculated. Abbreviated Injury Score (AIS) & Injury Severity Score (ISS) were formulated. The end point of the study was hospital stay, ICU stay and 24 h mortality.

Statistical Analysis: The sensitivity, specificity, positive predictive value, negative predictive value, odds ratio, positive likelihood ratio, negative likelihood ratio of SI and MSI were evaluated using Graphpad software. ROC curves and scatter diagrams were also plotted.

Results: SI >0.9 has sensitivity of 96% and negative predictive value (NPV) of 93.75%. Similarly, MSI >1.3 has sensitivity of 96% and NPV of 94.12%. Statistically significant correlation was observed between SI & MSI with ISS, ICU stay and hospital stay.

Conclusion: SI and MSI are effective predictors of 24 h mortality but less efficient in predicting mortality that does not occur before 24 h. Higher SI & MSI values are related to higher ISS, longer the duration of ICU & hospital stays.

Keywords: Polytrauma; Shock Index; Modified Shock Index; ISS; ICU Stay; Hospital Stay; 24 h Mortality.

Introduction

Trauma is a global health problem and a leading cause of mortality, producing 5 million deaths per year due to various causes such as head injury, blood loss, and associated complications such as respiratory failure and multi organ failure. Haemorrhagic shock after trauma is often under recognised, leading to inappropriate triage and transfers. This substantiates the need for an early diagnosis of haemorrhagic shock, which is the sine qua non for improved outcomes post-trauma.[1] Traditional vital signs such as Heart rate (HR), Systolic blood pressure (SBP) and Diastolic blood pressure (DBP) and the signs and symptoms related to change in volume status fail to predict the severity of shock.[2]

Though many scoring systems such as Revised Trauma Score (RTS), Triage Index (TI), TRISS (Trauma and Injury Severity score) have been introduced, a standard triage system has not been established till date. Though shock index (SI) was introduced long back by Allgower and Burri in 1967; the limitations of these widely used scoring systems and the unreliability of the vital signs and clinical examination has led to the resurgence of SI, necessitating its effective usage and re-establishment of its importance. SI is calculated as ratio of HR and SBP, with a normal range of 0.5-0.7 in healthy adults. This was studied by many researchers as an early predictor of hypovolemia in trauma, sepsis, ruptured ectopic pregnancy and gastrointestinal haemorrhage.[1]

In the studies by Liu et al, the complex pattern of patients presenting in emergency necessitates the inclusion of DBP in the prediction of severity. Hence, Modified Shock Index (MSI) was introduced which is calculated as ratio of HR & mean arterial pressure (MAP).[3]

The researchers have approached SI & MSI in a retrospective manner so far which had its own limitations such as discrepancies of data collection and inability to evaluate their predictive value over a longer period[4-9], with the exception of study by Singh A et al, which is prospective study. [3]

Hence, this prospective, observational study was planned with the aim to evaluate SI & MSI as a predictor of 24 h mortality in polytrauma patients presenting to Emergency department (ED) as the primary outcome and its correlation with Injury severity score (ISS), ICU stay and hospital stay as the secondary outcome. This study will help in exploring SI & MSI as a mortality as well as long-term morbidity predictor, effective triage, availability of timely interventions and effective resource utilisation.

Methods

This prospective observational study was conducted after seeking approval from the Institutional Scientific and Ethics committee, on patients aged 18-60 years presenting with acute polytrauma in the ED of Dr. B.R.A.M. Hospital (C.G.) from January 2019 – September 2020. Patients who were referred from another hospital after resuscitation, early mortality (mortality <6 hrs), had hypertension, metabolic syndrome, diabetes mellitus and minor injuries were excluded from the study.

The patients with acute polytrauma on admission were evaluated using the following parameters: Heart rate, SBP, DBP. SI & MSI were calculated. Each injury was assigned an AIS (Abbreviated Injury score) and was allocated to one of six body regions (Head, Face, Chest, Abdomen, Pelvis & extremities). Only the highest AIS score in the 3 most severely injured body regions were squared and added together to produce the ISS score. The ISS score values range from 0 to 75. If an injury was assigned an ASI of 6 (non-survivable), the ISS score was automatically be 75.

The patients were divided into 2 groups on the basis of SI (<0.9 and ≥0.9) and MSI (<0.7-1.3 and >1.3) and was correlated with age, sex, no. of sites involved, type of injury, 24 h mortality, ISS, duration of ICU stay and hospital stay. The end point of this study was 24 h mortality, ICU stay and hospital stay.

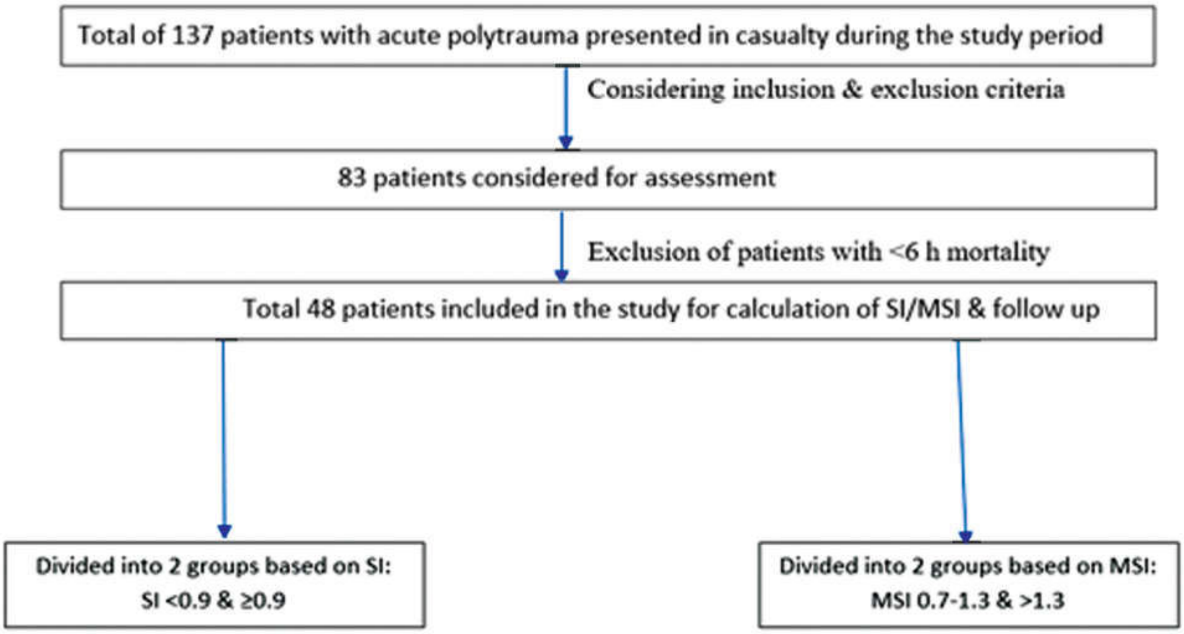
The sample size was calculated using the data from Montoya F. et al and Singh A. S. et al. Taking into consideration Confidence Level of 95%, α error probability is 0.005 in 80% power and minimum of 48 patients are required as calculated by Epitools software.

Statistical analysis was carried out using Graphpad software after collection and tabulation of data in the master chart. Demographic data was presented as mean (standard deviation, range) and evaluated using the student's t-test. The SI and MSI on admission and 24 h mortality were correlated to evaluate the sensitivity, specificity, positive predictive value, negative predictive value, odds ratio, positive likelihood ratio, negative likelihood ratio of SI and MSI, ROC curve to analyse the predictive power of the chosen cut off and scatter diagrams to evaluate the correlation between ISS, ICU stay & hospital stay with SI & MSI.

The ROC curve was used to test the discriminatory power of the SI >0.9 and MSI >1.3 to detect mortality and no mortality in 24 h. The scatter diagram was used to evaluate the correlation between SI & MSI with ISS, ICU stay and hospital stay depending on the slope of the scatter diagram.

Results

In the present study, maximum number of patients were in the 21-30 years age group [17 (35.42%)] and male (81.25%). Overall 24 hour mortality was 52.08%. SI ≥0.9 and MSI ≥1.3 was observed in 66.67% of patients. The proportion of patients with



blunt trauma was more than penetrating trauma (68.75% vs. 31.25%). SI of ≥0.9 has sensitivity of 96%, specificity of 65.22%, PPV of 75%, NPV of 93.75%, diagnostic accuracy of 81.25%, odds ratio of 45, positive likelihood ratio of 2.76 and negative likelihood ratio of 0.06.

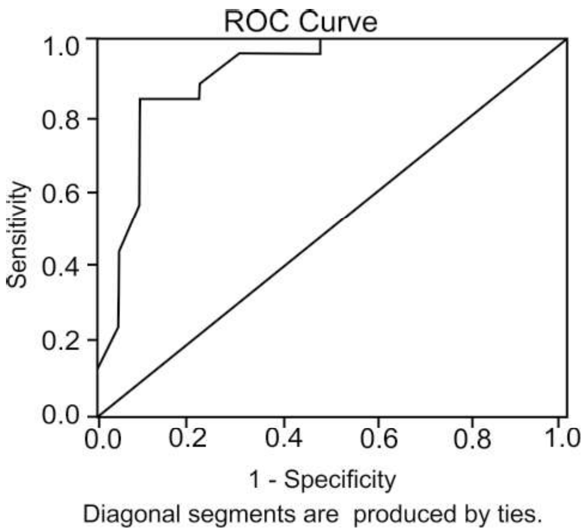


Fig. 1: ROC Curve for Shock Index >0.9 as A 24H Mortality Predictor.

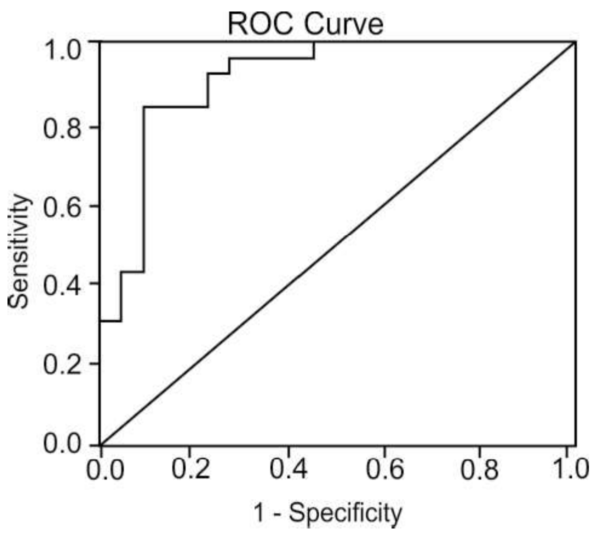


Fig. 2: ROC Curve for Modified Shock Index >1.3 as a 24 HPO.

MSI of >1.3 has sensitivity of 96%, specificity of 69.57%, PPV of 77.42%, NPV of 94.12%, diagnostic accuracy of 83.33%, odds ratio of 54.8, positive likelihood ratio of 3.15 and negative likelihood ratio of 0.06.

Positive correlation was observed between ISS with SI and MSI, which was statistically significant

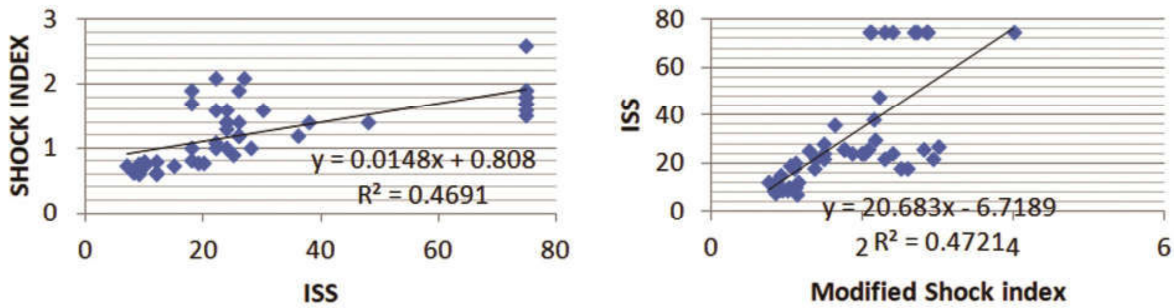


Fig. 3: Scatter Diagram Showing Correlation Between ISS & SI/MSI.

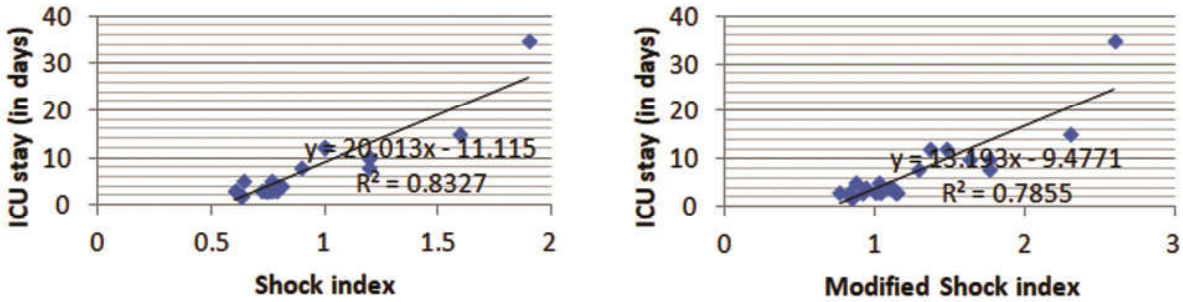


Fig. 4: Scatter Diagram Showing Correlation between ICU Stay & SI/MSI.

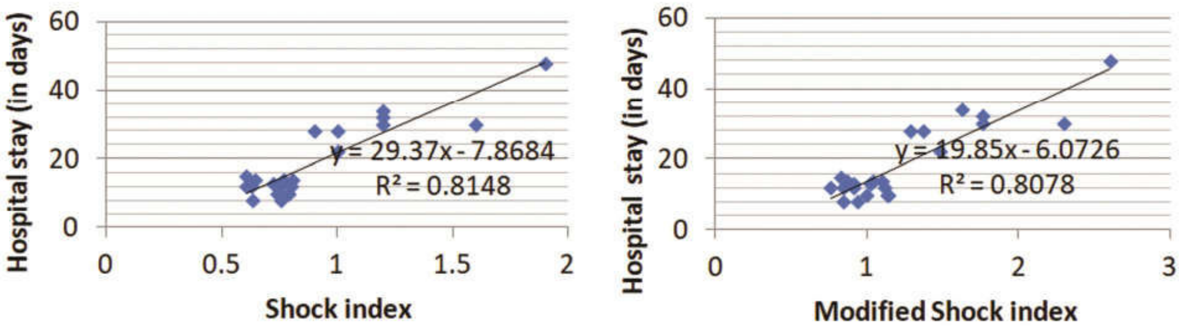


Fig. 5: Scatter Diagram Showing Correlation Between Si & Hospital Stay:

[coefficient of correlation = 0.4691(SI & ISS) and 0.4721 (MSI & ISS)]. Similarly, positive correlation was observed between SI & MSI with ICU stay (coefficient of correlation = 0.8327 & 0.7855 for SI and MSI, respectively). Hospital stay was found to have significant correlation with SI & MSI (coefficient of correlation = 0.90 & 0.89 for SI and MSI, respectively).

Discussion

Trauma continues to be a public health problem in the foreseeable future. Simple scores such as SI and MSI are considered to be more practical, easily calculated and effective indicators of hemodynamic instability and an ideal marker of injury severity when compared to traditional vital sign.

In the present study, maximum number of patients were found to be male (81.25%). Overall 24 hour mortality was 52.08%. SI of ≥0.9 has high sensitivity of 96% and high NPV of 93.75% and diagnostic accuracy of 81.25. MSI of >1.3 has sensitivity of 96%, NPV of 94.12%, diagnostic accuracy of 83.33%.

Positive correlation was observed between ISS with SI and MSI, which was statistically significant. Similarly, positive correlation was observed between SI & MSI with ICU stay. Hospital stay was found to have significant correlation with SI & MSI.

In the present study, the higher proportion of male patients (81.25%) may be due to the increased prevalence of alcoholism, vehicle usage and risk taking behaviour among men.

Shock index of >0.9 was observed as an effective predictor of 24 h mortality in 96% of patients similar to the studies of King RW et al, Cannon CM et al, McNab A et al, Bruijns SR et al and Montoya KF et al. MSI >1.3 was an effective predictor of mortality in the studies of Singh A et al (2014) and Terceros-Almanza LJ et al (2016).

SI >0.9 and MSI >1.3 was associated with higher ISS. The studies by Cannon CM et al (2009)[1], Vandromme MJ et al (2011)[10], Pandit V et al (2014)[11], Montoya KF et al (2015)[9] and Terceros-Almanza LJ et al (2016)[12] showed a similar relationship, but were associated with lesser ISS. The higher ISS among patients with SI>0.9 and MSI >1.3 in our study when compared to other studies is due to the inclusion of patients with head injury in our study.

SI>0.9 was associated with increased duration of ICU stay similar to the studies of McNab A et al (2012)[7], McNab A et al (2013)[8], Pandit V et al (2014)[11] and Terceros-Almanza LJ et al (2016).[12] MSI>1.3 was also associated with increased duration of ICU stay similar to the study of Terceros-Almanza LJ et al (2016).[12] Less studies have been conducted on the association between MSI and increased duration of ICU stay.

Positive correlation was observed between SI>0.9 and length of hospital stay similar to the studies of Vandromme MJ et al (2011)[10], McNab A et al (2012)[7] and Pandit V et al (2014).[11] McNab A et al (2013)[8] showed no significant correlation between SI and hospital stay in patients>60 years which may be due to the polypharmacy and frequently associated comorbid conditions in elderly patients.

MSI >1.3 was associated with increased duration of hospital stay. To the best of our knowledge, no other studies have evaluated the correlation between MSI and duration of hospital stay.

The limitations of the study were consideration of only on admission vitals, smaller sample size due to exclusion of 6h mortality, unavailability of prehospital vitals, inclusion of head injury leading to higher ISS.

SI and MSI can be further studied in relation to the no. of ventilator days and as a predictor for need of massive transfusion. Various shock indices such as SIPA and SIA can be compared as a triage tool. Increasing trends of SI and MSI can be assessed till discharge or in hospital mortality.

Prehospital SI can be recorded and the relationship between prehospital SI and ED SI can be enumerated to evaluate the association of increasing SI with 24h mortality. SI and MSI can be utilized by the trauma team in deciding early intervention and channelization of resources in polytrauma patients.

Conclusion

From this prospective study, we conclude that Shock Index and modified Shock Index are effective predictors of 24h mortality in polytrauma patients but less efficient in predicting mortality that does not occur before 24h. Higher SI and MSI values are also associated with higher Injury Severity score, longer duration of ICU and hospital stay.

References

1. Cannon CM, Braxton C.C, Kling-Smith M, Mahnken J, Carlton E and Moncure M. Utility of the Shock Index in Preceding Mortality in Traumatically Injured Patients. The Journal of Trauma. 2009 Dec; 67(6): 1426-30.
2. Bajwa EK, Malhotra A and Thompson TB. Methods of monitoring Shock. Semin Respir Crit care Med. 2004 Dec; 25(6):629-644.
3. Singh A, Ali S, Agarwal A, Srivastava RN. Correlation of Shock Index and Modified Shock Index with the Outcome of Adult Trauma Patients: A Prospective Study of 9860 Patients. N Am Med Sci. 2014 Sep;6(9):450-2.
4. Bruijins SR, Guly RH, Bouamra O, Lecky F and Lee WA. The value of traditional vital signs, shock index, and age-based markers in predicting trauma mortality. J Trauma Acute Care Surg. 2012;74(6):1432-7.
5. El-Manyar A, Goyal P, Tilley E and Latifi R. The clinical utility of shock index to predict the need for blood transfusion and outcomes in trauma. Journal Of Surgical Research. 2018 Jul; 227: 52-59.
6. Kim SY, Hong KJ, Shin SD, Ro YS, Ahn KO, Kim YJ et al. Validation of the Shock Index, Modified Shock Index, and Age Shock Index for Predicting Mortality of Geriatric Trauma Patients in Emergency Departments. J Korean Med Sci. 2016 Dec ;31(12): 2026-32.
7. McNab A, Burns B, Bhullar I, Chesire D and Kerwin A. A prehospital shock index for trauma correlates with measures of hospital resource use and mortality. Surgery 2012 Sep;152(3):473-6.
8. McNab A, Burns B, Bhullar I, Chesire D and Kerwin A. An analysis of shock index as a correlate for outcomes in trauma by age group. Surgery 2013 Aug;154(2):384-7.
9. Montoya KF, Charry J, Calle-Toro J, Niñez L and Poveda G. Shock index as a mortality predictor in patients with acute polytrauma. Journal Of Acute Disease.2015 Jul;4(3):1-3.
10. Vandromme MJ, Griffin RL, Kerby JD, McGwin G Jr, Rue LW 3rd, Weinberg JA. Identifying Risk for Massive Transfusion in the Relatively Normotensive

Patient: Utility of the Prehospital Shock Index. J Trauma.2011 Feb;70 (2):384-390.

11. Pandit V, Rhee P, Hashmi A, Kulvatunyou N, Tang A, Khalil M et al. Shock index predicts mortality in geriatric trauma patients: An analysis of the National Trauma Data Bank. J Trauma Acute Care Surg. 2014 Apr;76 (4):1111-5.

12. Terceros-Almanza LJ, Garcia-Fuentes C, Bermejo-Aznares S, Prieto-Del Portillo IJ, Mudarra-Reche C, Saez-de la Fuente I et al. Prediction of massive bleeding. Shock index and modified shock index. Med Intensiva. 2017 Dec;41(9):532-8.