Original Research Paper

Volume - 11 | Issue - 11 | November - 2021 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Medicine

PROSPECTIVE OBSERVATIONAL STUDY OF SHOCK INDEX (SI), MODIFIED SHOCK INDEX (MSI), AGE SHOCK INDEX (ASI) FOR PREDICTION OF MORTALITY IN EMERGENCY SEVERITY INDEX (ESI) LEVEL 2 PATIENTS IN TERTIARY CARE HOSPITAL IN INDIA.

Dr Krunal Desai* DNB Emergency Medicine Sterling Hospital Rajkot 360005 Gujrat. *Corresponding Author

Dr Manish Mehta MD Internal Medicine Max Super Speciality Hospital, Saket New Delhi.

Dr Suneel Garg MD, Intensivist Saiman Healthcare New Delhi

Dr Sandeep Jain MS, FNB Trauma Surgery Max Super Speciality Hospital, Saket New Delhi

ABSTRACT Shock Index (SI) is considered to be predictor of mortality in many medical and trauma patients. Many studies have shown its superiority to conventional vitals signs for mortality prediction.

AIMS: Elucidate capability of Shock Index (SI), Modified Shock Index (MSI) and Age Shock Index (ASI) for prediction of mortality in Emergency Severity (ESI) Level 2 patients.

METHODS AND MATERIAL: This prospective observational study was performed in emergency department of a tertiary care hospital in India in ESI level 2 adult patients with follow up during hospital stay on 599 patients. SI, MSI and ASI were calculated initially at the time of triaging. Follow up was done for hospital mortality and ICU admission.

Statistical analysis used: Final analysis was done with ROC curve for each index for in hospital mortality and ICU admission from ED.

RESULTS: Total 599 patients triaged as ESI level 2 were enrolled in the study. Sensitivity of each index for in hospital mortality and ICU admission based on ROC curve were SI 33.7%/51.3 %, MSI 88.2%/63.9% and ASI 72.1%/38.4%.

CONCLUSIONS: In medical patients, MSI showed superior result than SI and ASI for prediction of mortality in ESI level 2 patients.

KEYWORDS : Shock Index (SI), Modified Shock Index (MSI), Age Shock Index (ASI), Emergency severity level 2 (ESI 2)

INTRODUCTION:

The shock index (SI) is a bedside assessment defined as heart rate divided by systolic blood pressure, with a normal range of 0.5 to 0.7 in healthy adults. SI is known as hemodynamic stability indicator. This index is used to assess the amount of blood loss and the degree of hypovolemic shock. It is considered as a better marker for assessing the severity of shock than HR and BP alone. Thus, in clinical practice, SI has been used to assess the severity of emergency patients.[1]

Modified Shock Index (MSI) indicates stroke volume and systemic vascular resistance. A high MSI denotes a value of stroke volume and low systemic vascular resistance, a sign of hypodynamic circulation. Thus the patient may be compensating and the decompensation is rapid. A low MSI indicates that SI and SVR are high, and the patient is in a hyperdynamic state, which can also be a sign for serious conditions.

Age Shock Index (ASI) is defined as age multiplied by SI, accounts for the age of the patient in addition to the factors addressed by SI. This index was shown to be correlated with a higher mortality rate when increased to more than 50 in trauma patients.[2]

The Emergency Severity Index (ESI) is a five-level emergency department triage algorithm, initially developed in 1999. It is maintained by the Agency for Healthcare Research and Quality (AHRQ).[3]

The ESI levels are numbered one through five, with level one indicating the greatest urgency. The levels are as follows (table-1):

Table-1 (Emergency Severity Index levels)

Level	Name	Description	Examples
1	Resuscitation	Immediate, life-saving intervention required without delay	Cardiac arrest Massive bleeding
2	Emergent	High risk of deterioration, or signs of a time-critical problem	Cardiac-related chest pain Asthma attack
3	Urgent	Stable, with multiple types of resources needed to investigate or treat (such as lab tests plus X-ray imaging)	Abdominal pain High fever with cough
4	Less Urgent	Stable, with only one type of resource anticipated (such as only an X-ray, or only sutures)	Simple laceration Pain on urination
5	Non urgent	Stable, with no resources anticipated except oral or topical medications, or prescriptions	Rash Prescription refill

ESI is most commonly used triaging system in united states and also other countries because it includes both acuity of patient condition and resources needed for patient diagnosis and management.

Examples of ESI 2 patients are diabetic ketoacidosis, sepsis, syncope, variety of other electrolyte abnormality, HR>100, RR>20, Confused, Disoriented[3].

The ESI as valid and reliable tool improving desirable outcomes` in the emergency department and has been recommended but it may not reveal optimal outcomes in developing countries comparing to what have been achieved in the developed countries.[4]However, no study has yet focused on evaluating all of these indices (SI, MSI, and Age SI) in one patient population and comparing with each other in a specific subgroup of triaged patients.

In this study, we have compared these 3 indices at ED in level 2 ESI patients to determine the association of each index with the mortality and ICU admission.

Subjects and Methods:

All patients older than 18 years with ESI triage level 2 were included in this study. The documented vital signs by the triage nurse were used for calculation of SI, Age SI, and MSI. In-hospital mortality and ICU admission were defined as the primary and secondary outcomes. ICU admission was chosen to be a secondary outcome measure because there may be some differences in interpretation among several physicians for labelling patients "ICU admitted."

Age, sex, SBP, DBP, pulse pressure (PP), SI, MSI, and Age SI were the variables considered to be potentially correlated with the outcomes in ESI level 2 patients. These variables are considered quantitatively for their association with mortality and ICU admission.

Following data was collected:

- Age/sex of patient
- Spo2
- temperature
- Heart rate / respiratory rate
- Blood pressure
- Chief complain
- Final diagnosis
- Shock index
- Modified shock index
- Age shock index
- In hospital mortality
- ICU admission from ED

RESULTS:

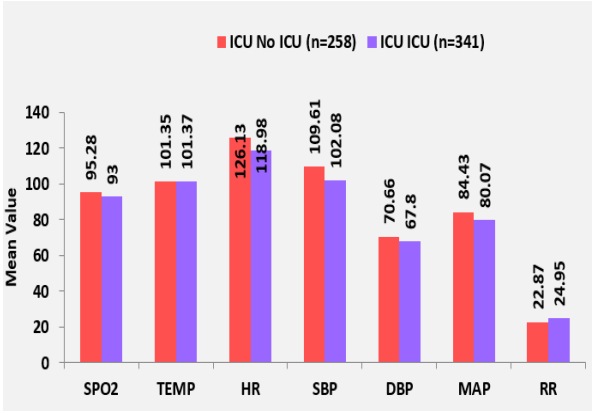
Out of 599 patients, 68 (11.4%) patients died in hospital, and 341 (56.9%) patients admitted in ICU from ED. Out of 68 patients died there were 20 (29.4%) females 48 (70%) males. There were 219 (64%) males and 122 (35%) females out of 341 patients admitted to ICU from ED.

We had calculated correlation of vitals – Spo2, Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), Temperature, respiratory rate (RR) with in hospital mortality and ICU admission. It was observed that mean values of temperature and heart rate did not showed statistically significance with hospital mortality and ICU admission. On other side, mean value of SBP, DBP, MAP and respiratory rate showed significance value with hospital mortality and ICU admission with statistically significant p value <0.001.

Table no 2: correlation between vitals and ICU admission.

	ICU		p value
	No ICU (n=258)	ICU (n=341)	
	Mean ± SD	Mean ± SD	
SPO2	95.28 ± 5.51	93.00 ± 6.30	<0.001
TEMP	101.35 ± 1.27	101.37 ± 1.30	0.946
HR	126.13 ± 33.25	118.98 ± 20.98	0.003
SBP	109.61 ± 15.10	102.08 ± 16.95	<0.001
DBP	70.66 ± 8.86	67.80 ± 10.27	<0.001
MAP	84.43 ± 10.55	80.07 ± 12.02	<0.001
RR	22.87 ± 4.40	24.95 ± 5.25	<0.001

Graph no 1:



Mean values of Shock Index (SI), Modified Shock Index (MSI) and Age Shock Index (ASI) was 1.308+/-0.29, 1.643+/-0.32 and 74+/-24 respectively for in hospital mortality. These value are statistically significant with p value of <0.001, <0.001 and <0.017. [Table 3]

Table no 3: Correlation between Mean value of index and Hospital mortality

	Hosp. Mortality		p value
	No Mortality	Mortality	
	Mean ± SD	Mean ± SD	
SI	1.133 ± 0.28	1.308 ± 0.29	<0.001
MSI	1.457 ± 0.35	1.643 ± 0.32	<0.001
ASI	67.69 ± 23.02	74.85 ± 24.91	0.017

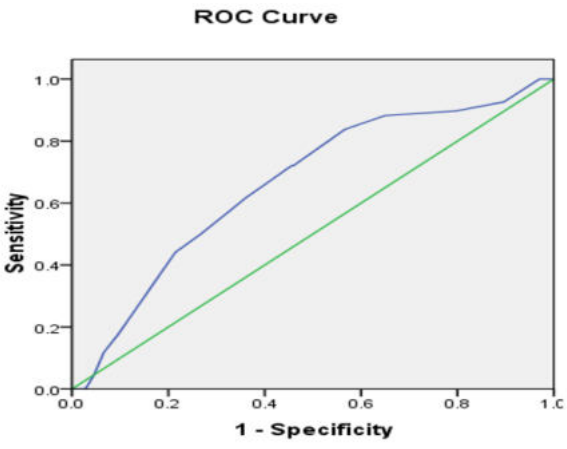
For ICU admission, mean values of Shock index (SI) 1.17+/-0.28 and Modified shock index (MSI) 1.48+/-0.33 did not show significance for ICU admission. But Age shock index (ASI) 70.84+/-24.43 showed statistically significance for ICU admission with p value of 0.004. [Table 4]

Table no 4: correlation between mean values of index and ICU admission.

	ICU		p value
	No ICU	ICU	
	Mean ± SD	Mean ± SD	
SI	1.14 ± 0.29	1.17 ± 0.28	0.198
MSI	1.47 ± 0.39	1.48 ± 0.33	0.787
ASI	65.42 ± 21.47	70.84 ± 24.43	0.004

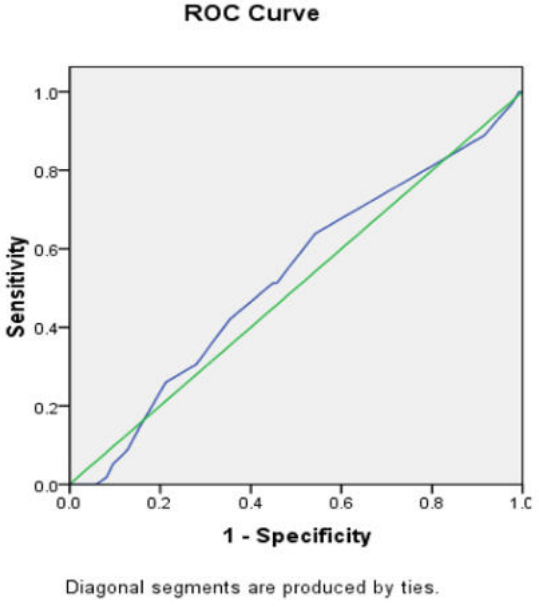
We had drawn a receiver operating characteristic (ROC) curve of SI, MSI and ASI for prediction of mortality and ICU admission. We had calculated Sensitivity, Specificity, PPV, NPV, Area under curve for each index. [Table 5].

Table no 5: ROC curve for MSI for mortality:



Sensitivity	Specificity	PPV	NPV	Accuracy
88.2%	35.0%	14.8%	95.9%	41.1%

Table no 6: ROC curve for MSI for ICU admission.



Sensitivity	Specificity	PPV	NPV	Accuracy
82.7%	24.8%	59.2%	52.0%	57.8%

DISCUSSION:

CORRELATION OF VITALS:

In our study we also observed correlation of vitals which we have collected in study for hospital mortality. Mean Spo2 level 89.9+/-8 showed significance with mortality. **Monica linea vold et al** done **Tromso cross sectional study** published in 2015 on 5125 patients with 10 year follow up. They found that low Spo2 level associated with increased all cause mortality.[5]

Mean Systolic blood pressure (SBP) 94.41+/-14.5 mmHg and Diastolic blood pressure 63.38+/-7.45 mmHg showed significance with mortality. **Post Hospers G et al** found that low DBP was associated with an increased all-cause mortality risk.[6]

Mean value of Mean arterial pressure 75+/-9.06 mmHg showed significance with high hospital mortality. This finding correlates with study done on 800 chronic dialysis patients by **Wang SM et al** in 2009. They showed low mean arterial pressure < 90 mmHg associated with

high mortality in chronic dialysis patients.[7]

We found that Respiratory rate (RR) 27+/-5 associated with mortality with correlates with study done by **Katsunori Mochizuk et al.** They had done study on patients who discharged from ED and revisited within 2 days again. They compared this group with control group of patients to find out which abnormal vitals made them to revisit ED. They found that increased respiratory rate > 21/min associated with early clinical deterioration if discharged from ED.[7]

Mehdi Torabi MD et al also found nearby all vitals which were in our study for mortality in emergency severity level 2.[8]

CORRELATION WITH INDICES:

When we put our values on ROC curve cut off value of shock index for mortality and ICU admission is 1.25 and 1.15. In our study SI did not show significant sensitivity and specificity for mortality and ICU admission.

One pilot retrospective study done by **Berger T et al** on 2500 patients with comparison of hyperlactemia, SI and SIRS criteria. These done on patients who presented to ED and suspicious of infection. They concluded that SI >0.7 associated with mortality in sepsis patients and as important marker in early recognition of ill patients .[9]

Kobayashi et al done retrospective study on 481 patients of NSTEMI who undergone angiography and concluded that SI>0.7 in NSTEMI patients associated with high mortality.[10]

In 2011 one prospective study on patients with diagnosis of pneumonia by **Sankaran et al**. They concluded that SI>1 associated with high mortality in community acquired pneumonia.[11]

One retrospective study done by **Keller AS et al** on patients who initially admitted in ward and then shifted to ICU from ward. They calculated SI on those patients and showed that SI > 0.85 needed intensive care.[12]

All these studies done to predict SI value in individual group of patients with single morbid condition like sepsis group, NSTEMI group, CAP group. When we took all patients who come to ED with different illness than SI did not show significance value.

M Torabi et al done two studies on **ESI level 2**[8] 1285 patients and **ESI level 3**[13] 3375 patients. They have done comparison of these indices in ESI level 3 patients and comparison of these indices with triage time vitals in ESI level 2 patients. They also found similar results.

In our study we had made association of mortality with distribution of MSI values. So, we found that MSI values between 1.3-1.5 and 1.7-1.9 associated with highest mortality.

Ye change liu[14] **et al** had done study of Modified shock index and mortality in emergency patients. They have done retrospective study for all emergency patients who had received IV fluids in ED. They found that MSI is clinical significant mortality for emergency patients.
Bruijns SR[15] **et al** done study in trauma patients and found that ASI better prediction for mortality than traditional vital signs.

Zarzaur[16] **et al** also state that ASI better prediction for mortality than traditional vital signs. These all studies done only in trauma patients.

Other two studies done in non trauma patients in ESI level 2[8] and 3[13]. Both studies done by **M Torabi et al.** They found that in ESI level 2 patients ASI superior to blood pressure but they had not compared them with other index and also advised for make them use as an adjunct. In ESI level 3 also ASI showed better than SI or MSI in predicting mortality but capability is modest.

So in our study MSI showed better than SI and ASI for predicting mortality in emergency severity level 2 patients. However, these variables alone or in combination can be considered as adjuncts to patient subcategorization according to their potential prognosis in ED. These are better to be considered case by case and as adjunctive measure to predict the probable outcome of each patient.

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