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UTILITY OF MODIFIED SHOCK INDEX IN EVALUATION OF SEVERITY OF SEPSIS

Emergency Medicine

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ABSTRACT

Background- Sepsis is a major cause of morbidity and mortality worldwide, with increased burden in low and middle resource settings. To improve outcomes for patients who present to hospital with suspected sepsis, it is necessary to accurately identify those at high risk of adverse outcomes. Modified shock index is a feasible marker which is calculated by dividing heart rate by mean arterial pressure and can be used easily in emergency. Although shock index, national early warning score,SIRS, qSOFA are used for triage screening in ED, we evaluated if modified shock index can be used for screening patients with fever for diagnosis and grading of sepsis. **Objective-** To evaluate the utility of Modified shock index in identifying and grading the severity of sepsis. **Design-** Prospective observational study. **Duration-**January 2022 to June 2022 **Setting-** Patients presenting to Emergency Department, GMCH **Materials And Methods-** The patients presenting to emergency department who are febrile with a temperature of 380C or more were assessed for heart rate and mean arterial pressure and modified shock index was calculated. The patients were followed up and assessed for whether modified shock index could identify patients with sepsis and determine its severity. **Outcome Measures-** Sepsis and sepsis-related outcomes such as hyperlactatemia, ICU admission, and in hospital mortality **Sample Size-** 100 **Results-** 100 patients met our inclusion/exclusion criteria. Of the 100 patients, 57 patients (57%) were septic, 57 patients (57%) had hyperlactatemia, 20 patients admitted to the ICU, and 6 patients died during hospital stay. We have noted significant association of MSI cut off values of 1.22, 1.49, 1.75 with sepsis, ICU admission and in hospital mortality. **Conclusion:** MSI was found to be promising predictor in triaging febrile patients. However no single cut-off values of MSI was found to have an optimal accuracy for prediction of sepsis and sepsis-related outcomes. Further studies are required to assess the incorporation of MSI in a multi-item scaling system for the prediction of sepsis and its related outcomes. **Limitation:** Small single center study and the results may not be generalizable.

KEYWORDS

INTRODUCTION

Sepsis is defined as "life threatening organ dysfunction due to a dysregulated host response to infection"[1]. Sepsis and septic shock are medical emergencies that require immediate recognition and management. Sepsis remains a major cause of morbidity and mortality worldwide, with increased burden in low and middle resource settings[2].

The incidence of the disease is rising[3,4] and mortality is correlated with the severity of the disease[5]. Several studies confirmed that early recognition and treatment of sepsis can avert progression of the disease and decrease the associated morbidity and mortality as well as the financial costs[6,7,8]. According to the Surviving Sepsis Campaign 2021, the 1st hour for the identification and starting the management for sepsis starts from the patient's arrival at triage[9].

Fever is a common finding in Emergency Departments' (EDs)triage and is caused by a broad spectrum of diseases. It is the first clue for sepsis as found in 55–76% of septic patients[10,11]. In order to improve the assessment of febrile patients presenting to EDs we need simple screening parameters to optimize the triaging process, improve risk stratification and contribute to the early identification of severely ill patients in a shorter time.

Few triage tools have been studied to predict and risk stratify the suspected patient with sepsis in the ED triage. A commonly referred tool is the qSOFA (Quick Sepsis Related Organ Failure Assessment),which had a great prognostication power revealed from Critical Care literature. However, when qSOFA was assessed in ED triage it was found to have poor sensitivity in predicting sepsis-related adverse outcomes[12,13,14,15,16]. National Early Warning Score (NEWS) is another scoring system that was found to be more accurate as a predictor of severe sepsis or septic shock with sensitivity of 92.6%and a specificity of 77%[17,18]. However, NEWS is composed of seven variables, and each variable is categorized into three to seven subdivisions each scored from 0 to 3 based on specific values. The complexity of the NEWS scoring system may limit the practicality of its use in dynamic areas such as ED triage or pre-hospital sit-ting. Furthermore, both qSOFA and NEWS were calculated based on Glasgow Coma Scale (GCS), which limits its utility to those with intellectual disability, dementia or with altered mental status.

The modified shock index (MSI) is a bedside assessment tool calculated by dividing heart rate (HR) over mean arterial pressure (MAB). MAP is the recommended indicator to be followed for deciding fluid resuscitations and vasopressors titration as it is believed to be a better marker for organs perfusion than SBP or DBP alone[9,19]. Nevertheless, a retrospective cohort study of ICU septic patients found that elevated MSI was associated with myocardial dysfunction and mortality[20]. In addition, MSI was found to be superior to the SI in predicting mortality in ED studies[21,22].Therefore, we hypothesized that MSI will be an important prognostic tool that will help in risk-stratifying febrile patients and facilitate early identification of sepsis and sepsis-related outcomes.

The purpose of our study is to assess the utility of MSI in triaging febrile adults as a predictor for sepsis and sepsis-related outcomes including hyperlactatemia ≥2 mmol/L, ICU admission and in hospital mortality.

MATERIALS AND METHODS

Institutional review board approval was obtained from the ethical research committee at Gauhati medical College and Hospital. All measures were taken to preserve the integrity and privacy of data. We conducted a prospective observational study among all patients presenting to the ED of Gauhati medical College and Hospital from June 2022 to December 2022. Patients included were adults >18 years age, triaged with a temperature ≥ 38◦C. We excluded immuno-compromised patients, temperature<38^{0}C, end-stage malignancies, patients with pacemakers, trauma cases, or non-infectious cause of hyperthermia (e.g. thyrotoxicosis, heat stroke).

Data were collected from the eligible patients according to the inclusion criteria. We identified 1542 visits matching our primary inclusion criteria. We only considered the first visits within the study period for the analysis and any repeated visits were removed after identified by the medical record number. Many cases were discharged as low triage categories and were not included in the study. Data collection process was monitored by the primary investigator. Eventually, the total number of eligible patients meeting the inclusion/exclusion criteria was 100; and those were analyzed in the study.

During triage SBP, DBP and MAP readings were documented based on the direct measurement by the aneroid sphygmomanometer,

temperatures were measured by oral or axillary digital thermometer and HR by manual palpation method. After completing the data collection process, the MSI was then calculated by dividing HR over mean arterial pressure and significant values were obtained from the ROC curves.

The outcomes of interest are diagnoses of sepsis, hyperlactatemia, ICU admission and in hospital mortality. Sepsis is defined as confirmed or suspected infection together with two or more presence of qSOFA (altered mental status, RR>22/min, SBP<100mmHg). Hyperlactatemia is defined as serum lactate ≥2.0 mmol/l as found to be an objective surrogate for sepsis severity and worse prognosis[28,29,30]. For SIRS criteria and lactate level, the initial ED laboratory results were considered for the analysis.

Data were analyzed by using Statistical Package for Social Studies (SPSS 22;) Continuous variables were expressed as mean ± standard deviation and categorical variables were expressed as percentages. The t-test was used for continuous variables and Chi square test was used for categorical variables. Sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV), and Area under the curve (AUC) were used to assess the performance of the predictors. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1

Patient Chracteristics(mean)	Total Patients=100	
	Number	%
Age(mean)	44.85	44.85
Male	71	71
Female	29	29
Cardiac disease	19	19
Diabetes mellitus	35	35
Hypertension	40	40
Chronic renal failure	8	8
Hypothyroidism	5	5
Axillary temperature	38.54	38.54
Heart rate	102.32	102.32
Respiratory rate	21.58	21.58
Systolic blood pressure	97.76	97.76
Diastolic blood pressure	64.08	64.08
Mean arterial pressure	75.01	75.01
Shock index	1.06	1.06
Modified shock index	1.39	1.39
Serum lactate	3.07	3.07
ICU admission	20	20
In hospital mortality	6	6

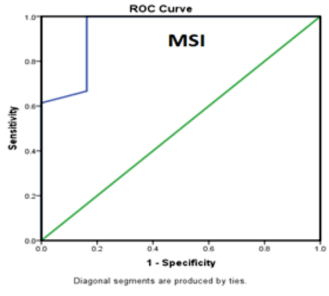

Fig-1 ROC curve for prediction of sepsis

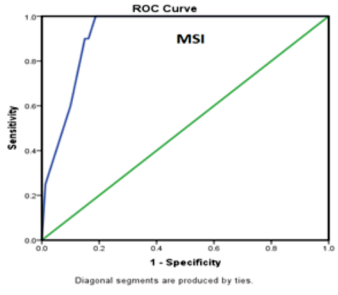

Fig-2 ROC curve for ICU admission

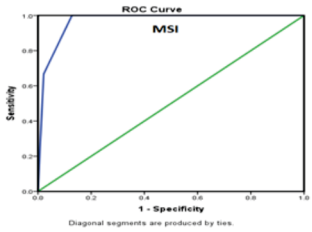

Fig-3 ROC curve for prediction of in hospital mortality

Table-2

MSI>1.22	Value	95% CI
Sensitivity	100.00%	93.73% to 100.00%
Specificity	83.72%	69.30% to 93.19%
PPV	89.06%	80.52% to 94.13%
NPV	100.00%	
Accuracy	93.00%	86.11% to 97.14%

Table-3

MSI>1.49	Value	95% CI
Sensitivity	100.00%	83.16% to 100.00%
Specificity	81.25%	70.97% to 89.11%
PPV	57.14%	45.80% to 67.78%
NPV	100.00%	
Accuracy	85.00%	76.47% to 91.35%

Table-4

MSI>1.75	Value	95% CI
Sensitivity	100.00%	54.07% to 100.00%
Specificity	87.23%	78.76% to 93.23%
PPV	33.33%	22.77% to 45.89%
NPV	100.00%	
Accuracy	88.00%	79.98% to 93.64%

During the research period, 1542 patients triaged with tem-perature ≥ 38◦and 1442 patient were excluded based on immuno-compromised state, end stage malignancies, on pacemakers and those who were discharged without laboratory results. Of the 100 included patients, the mean age was 48 years and 71% of them were males. Tables 1 demonstrate the sample characteristics.

Table 1 revealed the major comorbidities were Cardiac(Ischemic Heart Diseases or Heart Failure) in 19%, Diabetes in 35%,Hypertension in 40% and Chronic Renal Failure in 8% of cases. In our sample 100 of the patients 57% were having sepsis and 72 patients (72) developed hyperlactatemia more than 2.0 mmol/l, 20% admitted to the ICU and six patients (6%) died during the hospital stay.

Fig 1 demonstrate the ROC curve of MSI for prediction of sepsis and it was found that MSI of 1.22 had significant association with detection of sepsis. Table 2 shows that it has a sensitivity of 100% and specificity of 83.72% with PPV and NPV of 89.06% and 100% for sepsis detection.

Fig 2 demonstrate the ROC curve of MSI for prediction of ICU admission and it was found that MSI of 1.49 had significant association for determination of ICU admission. Table3 shows that it has a sensitivity of 100% and specificity of 81.25% with PPV and NPV of 57.14% and 100% for admission into intensive care unit.

Fig 3 demonstrate the ROC curve of MSI for prediction of in hospital mortality and it was found that MSI of 1.75 had significant association for predicting in hospital mortality. Table4 shows that it has a sensitivity of 100% and specificity of 87.23% with PPV and NPV of 33.33% and 100% for prediction in hospital mortality.

DISCUSSION

To the best of our knowledge, this is the first study to assess the relationship between triage MSI and sepsis or sepsis-related outcomes in Assam. Our findings indicate that an MSI of ≥1.22 was associated with prediction of sepsis, ≥1.49 was associated with prediction of ICU admission and ≥1.75 associated with in hospotal mortality with a good specificity ranging from 81.25% to 87.23%.

Table 5

STUDY	MSI CUT OFF FOR ICU ADMISSION	MSI CUT OFF FOR MORTALITY

Our study	1.49	1.75
Avci M et al23	1.3	1.3
Cannon CM et al24	1.3	1.3
Shangguan Q et al25		1.4
Smischney et al.26		1.8
Jayaprakash et al.27		1.3

Despite our study having revealed that MSI is a promising predictor tool that could help in the risk stratification process of the febrile patients, qSOFA is considered to have a sub-optimal accuracy for the prediction of sepsis-related outcomes. This might indicate the need for further studies that incorporate MSI in a multi-item scaling system to provide the desired accuracy instead of relying on a single cut-off value. Nevertheless, further larger multicenter prospective studies are required to assess the MSI as a predictor of sepsis and sepsis-related outcomes.

We acknowledge that there are some limitations to our study. First, it is a single center prospective study. In addition, we recognized lab results that were based on a single set of initial laboratory results while sepsis development is more of a dynamic process. Additionally, not every patient with sepsis presents with fever, and therefore this study is only applicable for patients presenting to ED with fever from suspected sepsis.

CONCLUSION

We have noted significant association of MSI cut off values of 1.22, 1.49, 1.75 with sepsis, ICU admission and in hospital mortality respectively. Though few studies have found a single cut off value for predicting sepsis related outcomes, we found different values for different outcomes.MSI was found to be promising predictor in evaluation of sepsis and sepsis related outcomes.

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