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Effectiveness of the Emergency Severity Index in Early Identification of Sepsis in a Tertiary Care Hospital of a Low-resource Setting

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Sepsis is life-threatening organ dysfunction, and a global issue, with incidence and mortality are around 49 M cases in 2017. Annual sepsis incidence from Pakistan is around 1600-2500 per 100, 000 cases with high mortality of approx. 30%. This huge mortality among sepsis and septic shock cases from low-income settings it is necessary to implement a focused and effective triage tool to prioritize and categorize the sick patients from huge bulk of sick patients who attend the ED and to identify those who need to be seen and manage accordingly.

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Emergency severity index (ESI), a widely acceptable tool that was developed to assess illness severity, hence able to identify the sick patients that need immediate attention at triage.
Objectives: Our objective is to determine the effectiveness of ESI triage acuity in early recognition of patient with sepsis and septic shock at triage in a busy ED.
Methods: This was a single center, cross sectional and observational study, we include 240 cases who present to the ED of a tertiary care hospital. We follow ESI v. 4.0. All cases presenting to the ED with suspected diagnosis of sepsis or septic shock were included.
Data was collected on a predesigned data sheet. Participants were followed by their electronic medical record number through patient care information software where patient's medical diagnosis and discharge diagnosis are present.
Results: Total of 240 patients in the inclusion criteria, area under curve (AUC) for the ESI score I, for septic shock was 0.943 [0.921 - 0.964] with the optimal cutoff value of 2.0, sensitivity of 88.5% and specificity 100%. Similarly, the receiver operating curve (ROC) with area under the curve of ESI Score II for sepsis is found 0.2 [0.129-0.270] with sensitivity 23% and specificity was 12.7%.
Conclusion: ESI is a reliable tool which is both sensitive and specific in screening patients with septic shock in a busy emergency department.

Keywords: Emergency department; triage; emergency severity index.

1. INTRODUCTION

Sepsis is a serious and life-threatening multi-organ dysfunction which is mainly due to a dysregulated response to infection [1]. Sepsis is one of the global health problems with a high mortality as emphasized from several studies. Global estimates for sepsis during 2017 identify around 49 million cases, with 20% deaths, however this rose to 55% from in-hospital sepsis [2]. United State data from ED identified half a million annual visits with suspected sepsis [3]. A study demonstrate that an hour delay of appropriate antimicrobial will increased the mortality from sepsis to 7.6% [4]. one of the important aspect of sepsis-related deaths is attributed to "septic shock" characterized by persistent hypotension requiring vasopressors and hyper-lactatemia, mortality from septic shock is around 24% to 41% [5].

Universally, we found the huge sepsis burden from low and middle-income countries, with almost 90% of the deaths were from meningitis and pneumonia and majority of deaths occur in Asia and sub-Saharan Africa [6]. Annual incidence of sepsis related death from Pakistan was 1600-2500 per 100,000, with a high mortality rate of 30% [7].

The burden and significant mortality rates of patients with sepsis need to be prioritized and timely management is utmost important to prevent adverse outcomes. Door to management time is even more challenging in overcrowded Emergency Departments (EDs) especially in resource-limited settings like Pakistan. ED overcrowding, delay throughput, influx of high acuity patient all are directly related to delay of timely and inadequate antibiotics administration and other appropriate management of septic patients [8]. Therefore this is essential to introduce a purposeful and effective triage tool for ED nurses and physicians to prioritize and manage the patients according to their triage severity and clinical illness [9].

Emergency severity index (ESI), a widely accepted tool that was designed to assess illness severity, hence, to identify the sick patients that need immediate attention at triage. ESI algorithm is a reliable tool which has 04 decision points to provide good assistance regarding early and reliable identification of patients with sepsis [9].

While triage with the ESI, patients are assigned to I to V level triage, level 1, categorized the most acute and life threatening, while ESI level V being the least acute category, levels 1 and 2 are critical patients who should not wait and need to be seen immediately and treated [1]. Level II are also clinically unstable (septic or not) while III are with abnormal vitals [1].

This study aimed to identify the effectiveness of ESI tool in early recognition of patients with sepsis and septic shock presented at the triage of the emergency department to help minimize the delay in appropriate management of sepsis patients.

2. METHODS

This is a single center, cross-sectional, and observational study conducted at the Emergency

Department of a tertiary care hospital with an annual visit of over 85,000 patients. Departmental ethical approval was opted, as this was an observative study involving the charts review and there was no direct involvement of cases/patients, though formal approval from the study center was opted.

Adult patients (≥18yrs) presented to the ED over a period of 06 months from December 2021 to May 2022 with initial diagnosis of sepsis and septic shock were enrolled. These were non-probability consecutive sampling via calculating the sepsis prevalence of 7% (Pakistan), with 95% confidence interval (CI), 3% margin of error and 0.05 level of significance, the WHO sample size calculator estimates the sample size of 240.

The exclusion criteria were any major surgery in past 30 days, pregnancy, poly trauma, prior do-not- resuscitate orders or any chronic deliberated disease like new onset cerebrovascular accident and seizure disorder. The data were gathered on a predesigned form, no delay in diagnosis or management as per the institutional policy.

Data were analyzed on SPSS v 22, the demography and descriptive analysis were tested with Mean ± SD, frequency, and percentages. The ESI as of sepsis were looked for proportions and percentage for gender, sepsis, and septic shock. ROC area under curve was also analyzed to see overall efficacy of ESI in diagnosing sepsis and septic shock with 95% confidence interval (CI). The results have been analyzed using the R-programming software version (3.5.2). The sensitivity and specificity of ESI was also assessed.

3. RESULTS

We enrolled 240 patients, 139 (57.9%) male, mean age was 52.7±15.3 years, 143 (60%) were above 50 years of age. The ESI index criteria I, include 58 (24.2%), 154 (64.2%) were ESI II and 28 (11.6%) were of ESI III category. Mean hospital stay was 2.2±1.1. 183 (76%) patients were diagnosed with sepsis and 57 (24%) with septic shock. A total of 179 (74.6%) patients recovered from their illness and were discharged home. Regarding the mortality, we found a higher rate 47 (19.6%) patients, mostly were in septic shock i.e. 30 (64%) and was statistically significant. Only 14 (5.8) left against medical advice hence we are unable to identify their fate. We identified more elderly cases among the sepsis group as compared to septic shock (P-value<0.001). 156 (65%) of septic patients recovered and discharged, statistically significant (P-value<0.001). The clinical and demographic characteristics of patients stratified by sepsis/septic shock are presented in Table 1.

Length of hospital stay didn't have significance correlation same for the p value. Disposition of patients has good correlation with p value of < 0.001. most were discharged home.

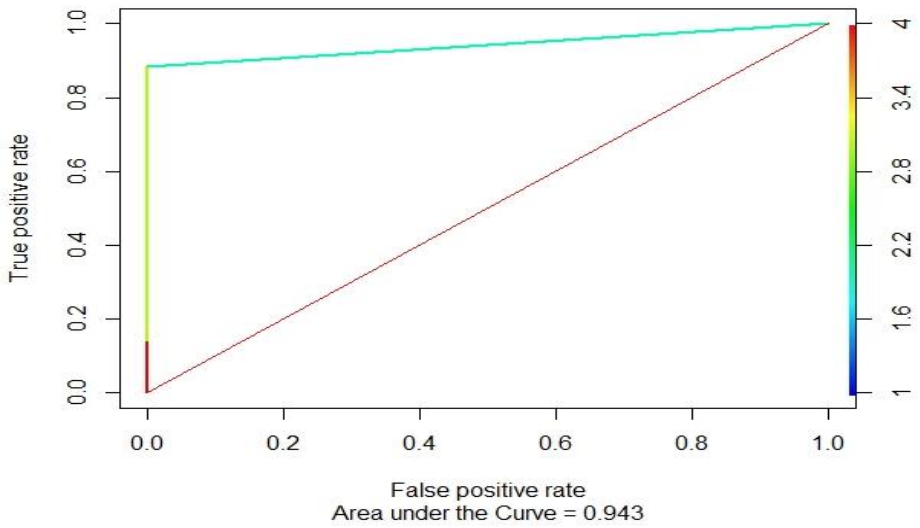

Fig. 1. Validation of Emergency Severity Index (ESI) I with septic shock

Table 1. Association of remarks with different demographics and study characteristics

	Sepsis [n=183] (%) f	Septic Shock [n=57] (%) f	Total [n=240] (%) f	P-value
Age Groups				
<= 50 Years	35% (84)	5.4% (13)	40.4% (97)	0.002*
> 50 Years	41.3% (99)	18.3% (44)	59.6% (143)	
Total	76.3% (183)	23.8% (57)	100% (240)	
Length Hospital				
<=2 Days	49.6% (119)	13.8% (33)	63.3% (152)	0.329
> 2 Days	26.7% (64)	10% (24)	36.7% (88)	
Total	76.3% (183)	23.8% (57)	100% (240)	
Gender				
Male	45.8% (110)	12.1% (29)	57.9% (139)	0.218
Female	30.4% (73)	11.7% (28)	42.1% (101)	
Total	76.3% (183)	23.8% (57)	100% (240)	
ESI Criteria				
ESI I	0.4% (1)	23.8% (57)	24.2% (58)	<0.001*
ESI II	64.2% (154)	0% (0)	64.2% (154)	
ESI III	11.7% (28)	0% (0)	11.7% (28)	
Total	76.3% (183)	23.8% (57)	100% (240)	
Disposition				
Critical Area	41.3% (99)	11.7% (28)	52.9% (127)	0.755
Resuscitation	14.6% (35)	4.6% (11)	19.2% (46)	
Step Down	20.4% (49)	7.5% (18)	27.9% (67)	
Total	76.3% (183)	23.8% (57)	100% (240)	
Fate				
Discharged	65% (156)	9.6% (23)	74.6% (179)	<0.001*
Expired	7.1% (17)	12.5% (30)	19.6% (47)	
Left against medical advice	4.2% (10)	1.7% (4)	5.8% (14)	
Total	76.3% (183)	23.8% (57)	100% (240)	

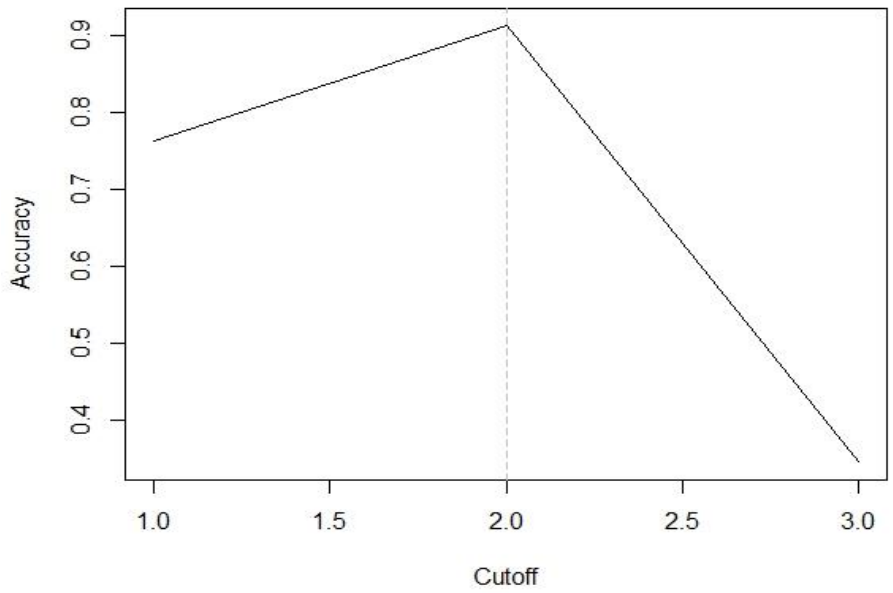

Fig. 2. Youden index cut off for Validation of Emergency Severity Index with sepsis and septic shock

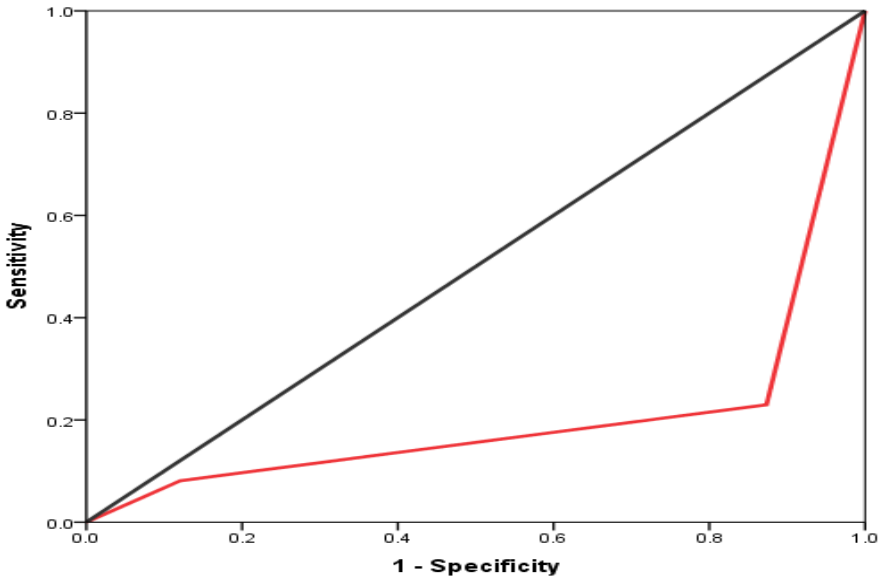

Fig. 3. Validation of Emergency Severity Index (ESI) II with Sepsis

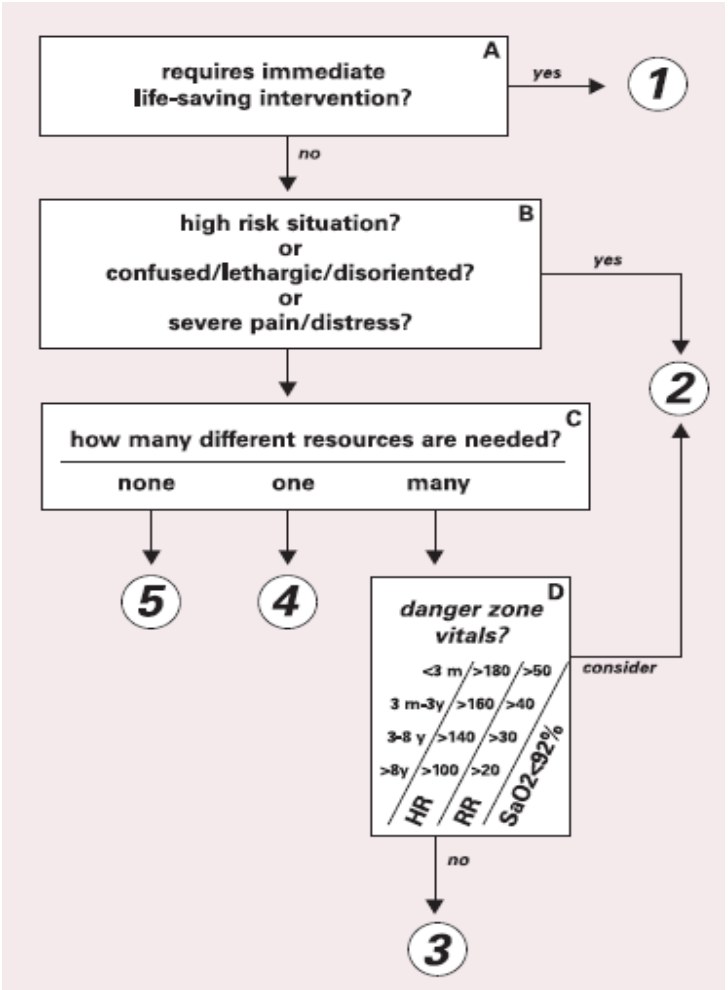

Fig. 4. Emergency severity index algorithm

Table 2. AUC, sensitivity and specificity of validation of Emergency Severity Index (ESI) at triage with sepsis or severe sepsis

ESI Criteria	Statistics
Cutoff	1.5
AUC (95% CI)	(95% C.I: 0.919 - 0.996)
P-value	<0.001*
TP	162
FP	0
TN	57
FN	21
TP proportion (Sensitivity)	0.885
TN proportion (Specificity)	1

Considering sepsis as reference category, the area under the curve (AUC) for the ESI score I for septic shock was 0.943 [0.921 - 0.964], the optimal cutoff value of 2.0 with sensitivity of 88.5% and specificity of 100% as presented in Table 2 & Fig. 1. Likewise, receiver operating characteristic (ROC) curves with area under the curve of ESI II for sepsis, we found 0.2 [0.129-0.270], sensitivity of 23% and specificity 12.7%. Fig. 3 and are statistically non significance. Cumulative area under curve of 0.592 (95% CI: 0.509-0.674), ESI of ≤2 with sensitivity of 95.59% (CI 87.81–98.80%) and specificity of 21.74% (CI 15.18-30.12%).

4. DISCUSSION

Early recognition of sepsis in adults presenting to the ED is utmost important to reduce morbidity and mortality. This study identified mortality of 20% with sepsis, like the global statistics of 19.7%.[2] However, mortality from septic shock in this study was 64, almost double rate as reported from other studies.[5] Surviving Sepsis Campaign focused on 1-hour bundle stressed on importance of time-sensitive measures. Our study statistically validates the relevance of ESI at triage as a tool to identify and screen patients with sepsis/septic shock. ESI I was found to be 88.5% sensitive and 100% specific in identifying septic shock from triage, it may be related to the hemodynamic instability of septic shock cases on presentation at triage like low blood pressure or other sign of shock, hence categorize higher ESI category for immediate intervention and timely management of these patients during the initial 1st hour, to reduce the detrimental effect on the clinical outcome.

Categorizing cases in ESI II, this study revealed low sensitivity of 23% and 12.7% specificity in identifying sepsis, this may be due to variable presentation, complaints, and vital signs. Study conducted by Geier F. et.al[10], ESI also didn't demonstrate significant diagnostic accuracy in identifying patients with sepsis (AUC 0.609; 95% CI: 0.704-0.853). ESI has some grey areas between category II and III, which was described by Geier F et. al. an elderly patient aged 73 years with fever of 39.2^{O}C, cough and yellow discoloration, had organ transplantation, but he was unable to identified at triage, and was assigned as ESI III, and waited hours before been seen by physician, however patient with septic shock can identify reliably as with our results [10].

Study be R. Nieves Ortega et al. [5] identified ESI $\leq$ III were 32.5% specific and 97.4% sensitive in identifying sepsis with high number of false positives.[6] However the results were more sensitive and significant because this study include all cases who fall in ESI $\leq$ III, however we identified that ESI II identify a large number of the septic patients, this might be the reason of such a low sensitivity and specificity in this study. We found 11.6% of cases categorized as ESI III, a high number considering the significant mortality associated with sepsis and further studies are required to assess the factors associated with the variation in categorization of these patients in ESI III and above.

Sensitive and simple decision tools are required to promptly identify patients at risk of sepsis, as waiting times and resource allocation rely mostly on clinical information alone [11,12]. Sepsis and septic shock is one of the major concerns in the lower to middle income country and is one of the major diagnoses responsible for morbidity and mortality in patients presenting to emergency departments [13]. Identifying such patients in whom the first hour is claimed to be a golden hour and is decisive of patient's outcome is important and life saving measure. Having a

reliable triage tool is of paramount importance which enables emergency physicians not to miss out on any patient especially elderly with sepsis and septic shock [14].

ESI has a significant limitation, in which there are huge number of patients falling under category 3 (ESI III), with even a minor change in vitals. Hence, we observe a huge number of cases under a high false negative rate for sepsis as categorized under ESI. Moreover**,** with this falsely high rate of categorizing cases at a higher level may put burden on already compromised system, on other hand this may lead to a lesser chance of missed septic cases via this ESI system.

5. CONCLUSION

ESI tool is a universally accepted triage method with a high sensitivity and specificity in the identification and prioritization of patients with septic shock in a busy emergency department, however we were unable to identify all patients with septic shock as ESI category I. This would help physicians manage the sickest patient first to improve outcomes in terms of mortality. Similarly, the ESI tool helps in identification of critical patients with age >50 years with a sigh sensitivity and specificity and has the highest sensitivity for predicting in-hospital mortality. Hence, our recommendation is to use ESI triage so as to prioritize sick patients like those in septic shock, although we also recommend further studies and analyze ESI and other triage tools and scoring and to compare the efficacy.

6. LIMITATIONS

The limitations of this study were that we were unable to compare ESI with sepsis scores like SOFA and APACHE. Other facts we might need to analyze and were missing were the influence of changing sepsis and septic shock definitions.

To discuss the other limitations, like who and how to implement ESI at triage, the level of experience of triage staff, number of staffs available, their training status and available resources and infrastructure are out of the scope of this paper, however this need to be discussed for a better outcome and picture of triage efficacy.

DISCLAIMER

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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