Original Research Article

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To Study the Prognostic Value of Shock Index in Patients Presenting with Severe Sepsis and Septic Shock

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Abstract

Objective: Sepsis is a problem that presents a management challenge and its early recognition and intervention clearly improves the outcome. Development of cost effective clinical parameters that would effectively prognosticate the outcome of sepsis would be invaluable. Shock Index, defined as ratio of heart rate (HR) and systolic blood pressure (SBP) may be a good non invasive measure of haemodynamic instability than HR and SBP alone. We conducted a study-

1. To calculate shock index in patients with severe sepsis and septic shock at 0, 2 and 6 hours of admission .
2. To assess whether shock index (SI) at 0,2 and6 hours has any prognostic significance in patients of severe sepsis and septic shock.

Methods: Records of 57 patients from August 2015 to January 2016 were collected from Medical Records Department of the hospital and clinical data recorded. Shock index (SI) was calculated at 0, 2 and 6 hours. The patients were divided into two groups according to their outcome as Survival or Death. Mann Whittney test , Pear on coefficicent and Kaplan Mieir Survival analysis curve were used for calculations.

Results: SI at 2 and6 hours significantly predicts mortality with pvalue of 0.001 and 0.0014 respectively. The best predictor of mortality is where SI at 2 hours or 6 hours is greater than their cut off points .

Conclusion: From the present study, it may be concluded that SI at 2,6 hours was clinically relevant and easily calculated predictor of mortality.

Keywords: Sepsis; Prognosis; Shock Index.

Introduction

Sepsis is a major cause of mortality and morbidity throughout the world. Sepsis patients represent only 2% hospital admission but lead to an estimated 17% of in hospital deaths [1]. It is projected that sepsis patients in USA will increase by 1.5% per annum indicating an increase of additional 1 million sepsis patients by the year 2020 in USA alone [2]. The increasing number of sepsis patients imposes a financial burden to not only developing countries but also developed nations like USA. Average treatment cost of sepsis patient in a general intensive care unit in United Kingdom was USD$10,622 in the year 1998 [3].

Development of cost effective and easily available clinical parameters that would effectively prognosticate the outcome of sepsis would be invaluable. The shock index (SI) is defined as heart rate divided by systolic blood pressure with a normal range of 0.5 to 0.7 in healthy adults.This index was first introduced by Allgower and Buri [4] in 1967 as simple and effective tool in gauging hypovolemia in haemorrhagic and infectious shock state. Birkhan [5]

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studied shock index to identify ectopic pregnancy. And Rady et al [6] used it for evaluation of clinical shock in emergency department. There is paucity of data in role of of Shock Index in sepsis. We have conducted a retrospective observational study to prognosticate the value of shock index in patients presenting with severe sepsis and septic shock

Aims and Objectives

1. To calculate shock index in patients aged 12 to 70 years with severe sepsis and septic shock at 0, 2 and 6 hours of admission to emergency department.
2. To assess whether shock index (SI) at zero,two and six hours has any prognostic significance in patients of severe sepsis and septic shock.

Study Design

Retrospective observational pilot study. Records of 57 patients from August 2015 to January 2016 were collected from Medical Records Department of the hospital and data with respect to Demography, Clinical values, Laboratory values. The patients were divided into two groups according to their outcome as Survival or Death.

Materials and Methods

A retrospective observational study was conducted. Records of 57 patients from August 2015 to January 2016 were collected from Medical Records Department and data with respect to Demography, vitals, Laboratory values was observed. Shock index (SI) was calculated at zero (S1), two (S2) and six (S3) hours.

Inclusion Criteria

1. Patients aged 12 years to 70 years
2. Patients who had at least two of the four SIRS criteria and fulfilled requirements for either severe sepsis or septic shock.

SIRS Criteria's

- Body temperature less than 36°C or greater than 38°C
- Heart rate greater than 90 beats per minute
- Respiratory rate greater than 20 breaths per minute or, an arterial partial pressure of carbon dioxide less than (32 mmHg).
- White blood cell count less than 4000 cells/mm^3 (4 x 109 cells/L) or greater than 12,000 cells/mm^3 (12 x 109 cells/L), or the presence of greater than 10% immature neutrophil band forms.

Requirements for Severe Sepsis Patients

i. Fulfilling at least 2 or more of SIRS criteria

ii. Has an associated or suspected source of infection

iii. Has one or more of the following

- Evidence of end organ damage (eg. Elevated creatinine levels, > 120 μmol/L or altered mental status, GCS < 14)
- Serum lactate levels of equal or > 4mg/dL)
- Episode of hypotension (<90/60 mmHg), which responds to initial fluid resuscitation

Requirements for Septic Shock Patients

i. Fulfilling at least 2 or more of SIRS criteria.

ii. Has an associated or suspected source of infection.

iii. Has persistent hypotension (<90/60 mmHg) which does not respond to adequate fluid resuscitation (adequate fluids referred to as CVP 8-12 cmH20).

Exclusion Criteria's

1. Patients aged < 12 years old.
2. Patients taking medications that have significant atriaventricular blockage effect. (Beta blockers, calcium channel blockers, digoxin and amiodarone).
3. Patients with end-stage malignancie
4. Patients with internal pacemakers.
5. Patients with associated diagnosis of acute coronary Syndrome or with atrial fibrillation.
6. Patients presenting with associated upper gastrointestinal bleeding (having presenting complaints of hematemesis or diagnosed by an OGDS).
7. Patients with imuno-compromised states (on chronic steroid therapy or retroviral disease).

Data was collected manually from case records of medical record department of the hospital as the case records in the hospital are not computerized. Heart rate and systolic blood pressures on arrival, that is, O hour, 2 hour and 6 hour was noted and SI at 0 (S 1), 2 hour (S 2) and 6 hour (S 3), was calculated. Demograhic profile, total leucocyte count, haemoglobin, and diagnosis of the patients included in the study were also recorded.

Statistical Analysis

The patients were divided into two groups according to their outcome as Survival or Death. ROC curve was used to calculate the cut off point of shock index for predicting mortality. Mann Whittney test was used to compare qualitative variables. Pearso on coefficicent and Kaplan Mieir Survival analysis curve were used for calculation of correlation and OS respectively.

Sample Size

Formula used is:

		Disease +	
Test	+	*a*	*b*
		e	*d*
		(a+c)	*(b+d)*

$$n = \frac{Z^2 \quad P(1 \quad P)}{2} \qquad (1)$$

n will be *(a+c)* if we use Sensitivity ad *P*, and n will be *(b+d)* if we use Specificity as *P* in formula (1).

$$N = \frac{(a+c)}{Prevalence} \qquad (2)$$

$$N = \frac{(b+d)}{(1 \quad Prevalence)} \qquad (3)$$

Where Zis value of Z at two sided alpha error of 5% and is desired precision.

Result

A total of 57 patients were studied. Demographic profile of the patients is as follows:

1. *Males*: Females 26 : 31
2. Age Range 12 to 70
3. Median Age 35

In our study group, 18 patients were admitted under Obstetrics and Gynaecology, 24 patients underMedicine and 15 patients under Surgery department. There were 20 (35.08%)patients with gastrointestinal causes, 12 (21.05%) patients of pneumonia and chest infections, 10 (17.54%) patients of different types of abortion, 8 (14.03%) patients of other obstetric and gynaecological diagnosis and 7 (12.28%) other infections. There were 28 deaths and 29 survivors.

Shock index was calculated at 0 hour (S1), 2 hours (S2) and 6 hours (S3) and it was found that s1 does not predict mortality whereas s2 and s3, that is Shock Index at 2 hours and 6 hours significantly predicts mortality. P<0.001 and p<0.0014 respectively (Table 2). Haemoglobin and total leukocyte count (WBC) was correlated with shock index and it was observed that Only Shock index at 6 hours is significantly positively correlated with WBC as WBC Increases, Shock index also increases with correlation coefficient of .2972 (Table 1).

Figures 1, 2, 3 and 4 show ROC curves against S1, S2 and S3. ROC analyses sensitivity reflecting an objective measure of performance for a diagnostic test. It analyses sensitivity , compares true positive versus false positive rate.

Pearson co-efficicent and Kaplan Mieir Survival analysis curve were used for calculation of correlation and OS respectively.

Table 3 and Figures 5, 6 and 7 show Kaplan Mier Survival analysis and Table 4 shows logistic regression. We observed that S2, S3 and S2+S3 are the significant predictors of mortality.

Only Shock index at 6 hours is significantly positively correlated with WBC as WBC Increases, Shock index also increases with correlation coefficient of .2972.

Shock Index at 0 hour does not predict mortality with non significant p value

Shock Index at 2 hours and 6 hours significantly predict mortality.

Table 1: Correlation of Parameters with shock index

	Correlation coefficient r	P value	95% Confidence interval for r
S1(Log) with Hb	-0.1622	0.228	-0.4056 to 0.1027
S1(Log) with WBC(Log)	0.1493	0.2676	-0.1158 to 0.3945
S2(Log) with Hb	0.078	0.5641	-0.1864 to 0.3318
S2(Log) with WBC(Log)	0.2566	0.054	-0.004210 to 0.4848
S3(Log) with Hb	-0.04111	0.7614	-0.2985 to 0.2218
S3(Log) with WBC(Log)	0.2972	0.0248	0.03967 to 0.5177

The best predictor of mortality is when any of shock index at 2 hours or 6 hours is greater than cut off point with minimum standard error. 053 and maximum AUC. Figure 1 Figure 2 Figure 3.

The risk of mortality in S2 (>1), S3 (>.8491) and S2 (>1) or S3 (>.849) are significantly higher with odds ratio of 9.6, 8.5 and 13.3 respectively.

Table 2:

	Area under the ROC curve (AUC)	Standard Error	95% Confidence interval	P value	Cut off point	Sensitivity	Specificity
S1	0.624339	0.0813	0.486123 to 0.749164	0.1261	>1.2	57.14	69.44
S2	0.732804	0.0706	0.599027 to 0.841333	0.001	>1	76.19	75
S3	0.734127	0.0733	0.600449 to 0.842410	0.0014	>0.8491	80.95	66.67
S2(>1) or S3(>.849)	0.744048	0.053	0.611156 to 0.850441	<0.0001		90.48	58.33

Table 3:

	OS for 1 month	Mean of survival time	Median of survival time	P value
Shock Index at 0 hours				
S1>1.2	0.00%	13.97	15	0.201
S1<=1.2	45.15%	17.63	15	
Shock Index at 2 hours				
S1>1	0.00%	11.30	8	0.003
S1<=1	36.28%	19.36	19	
Shock Index at 6 hours				
S1>.849	0.00%	13.20	10	0.016
S1<=.849	0.00%	16.38	19	

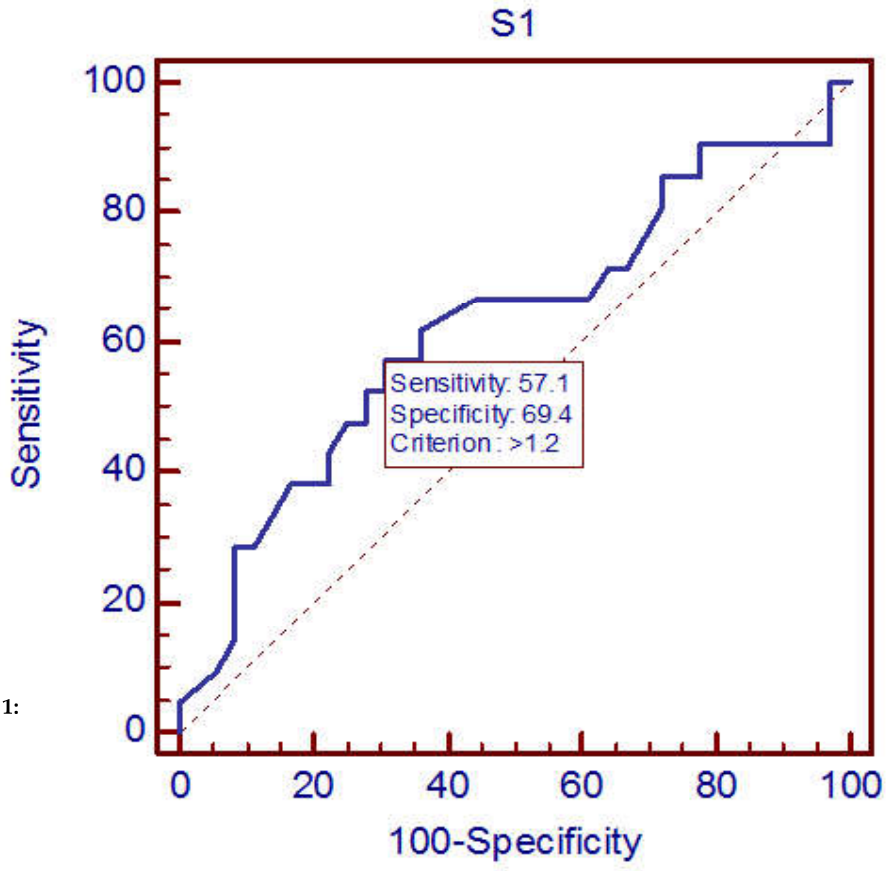

Fig. 1:

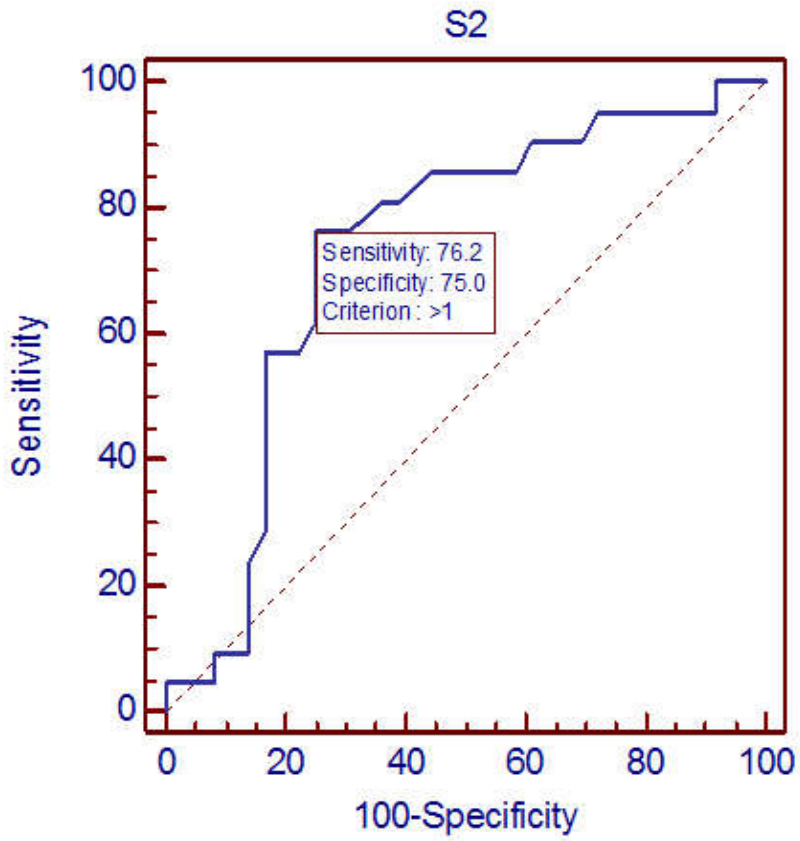
S2
Sensitivity: 76.2
Specificity: 75.0
Criterion : >1
Sensitivity
100-Specificity
0
20
40
60
80
100

Fig. 2:

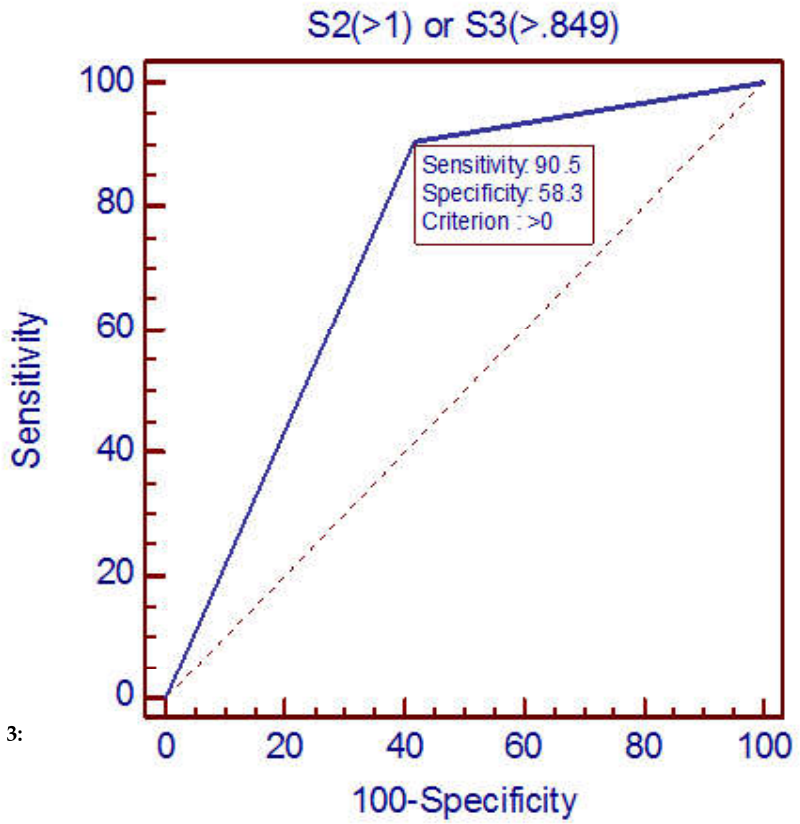
S2(>1) or S3(>.849)
Sensitivity: 90.5
Specificity: 58.3
Criterion : >0
Sensitivity
100-Specificity
0
20
40
60
80
100

Fig. 3:

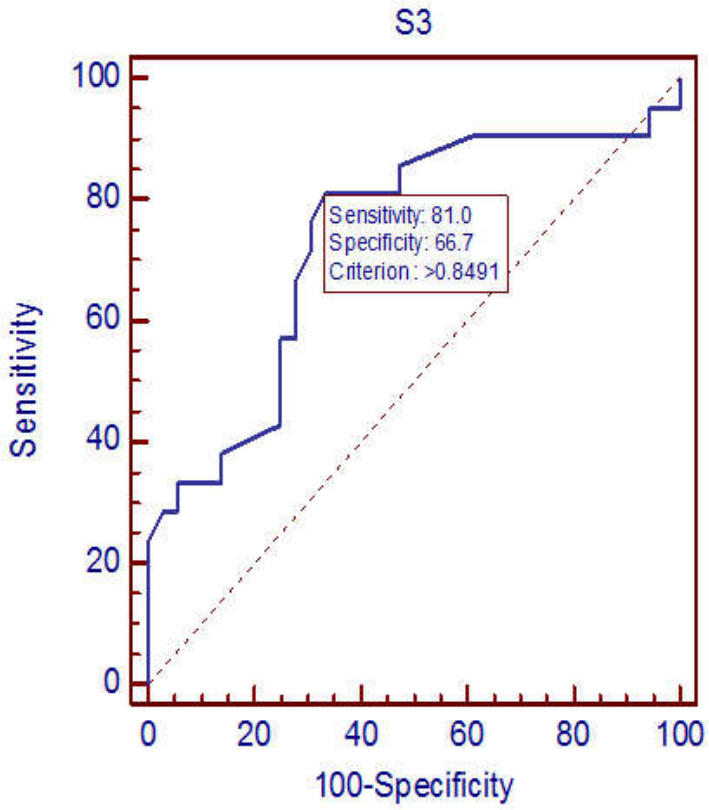
S3
Sensitivity: 81.0
Specificity: 66.7
Criterion: >0.8491
Sensitivity
100-Specificity
0
20
40
60
80
100

Fig. 4:

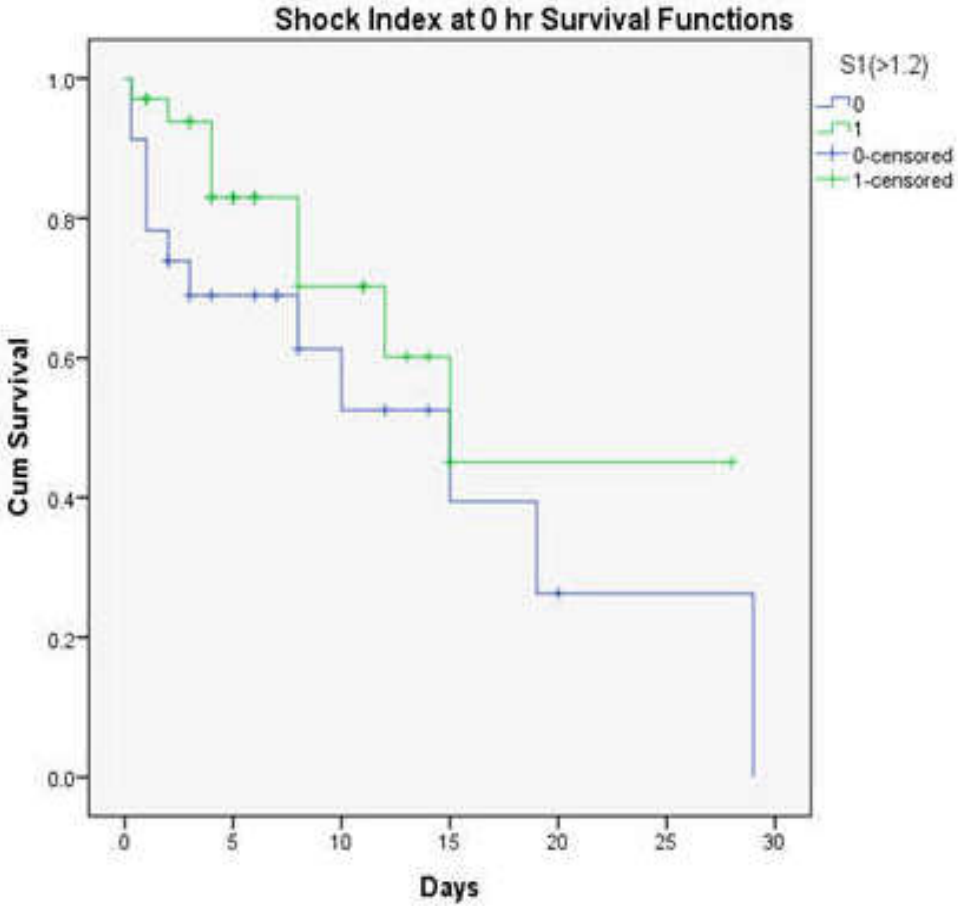
Shock Index at 0 hr Survival Functions
S1(>1.2)
0
1
0-censored
1-censored
Cum Survival
Days
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30

Fig. 5:

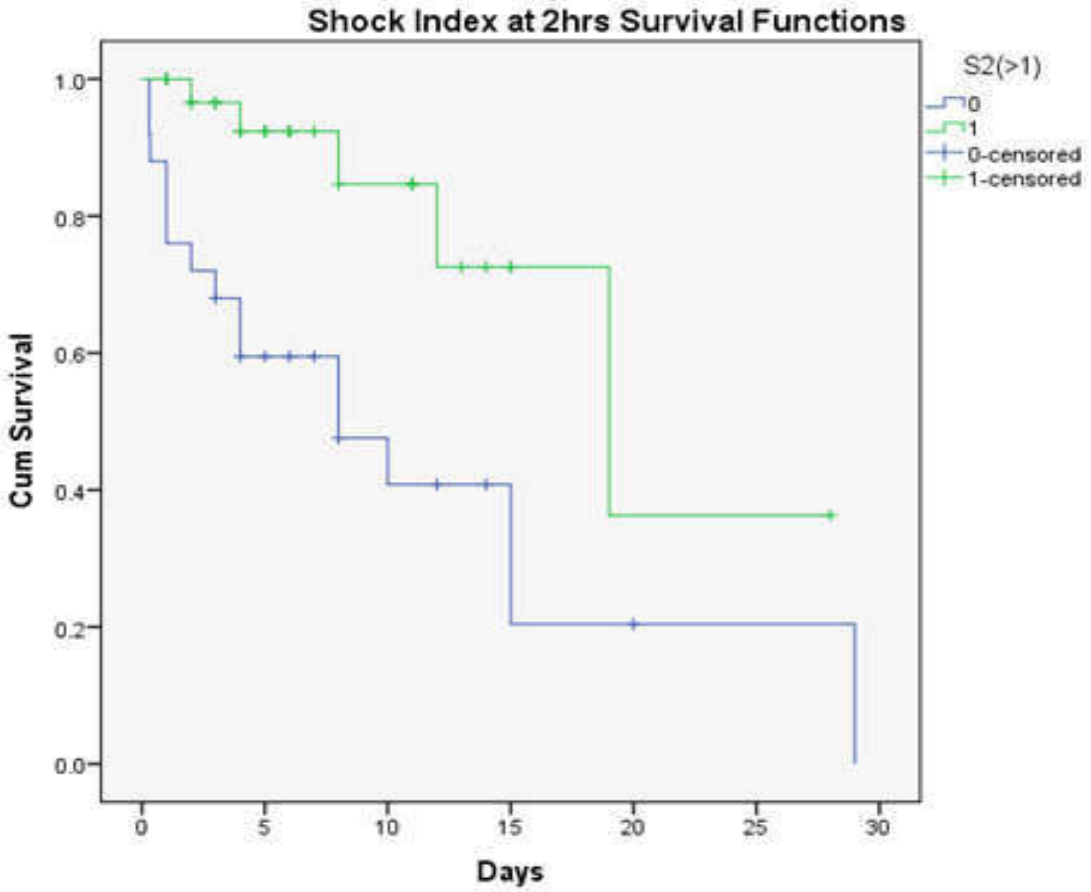
Shock Index at 2hrs Survival Functions
S2(>1)
0
1
0-censored
1-censored
Cum Survival
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
Days

Fig. 6:

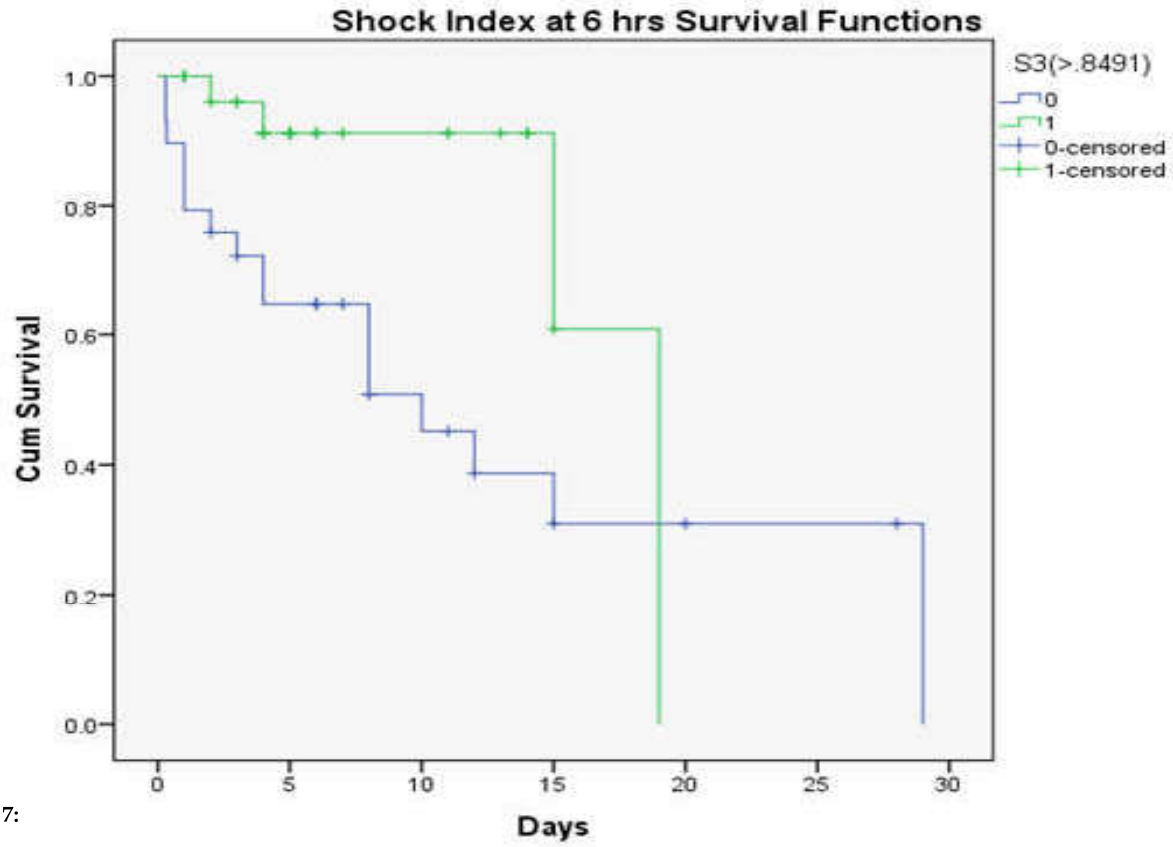
Shock Index at 6 hrs Survival Functions
S3(>.8491)
0
1
0-censored
1-censored
Cum Survival
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
Days

Fig. 7:

Table 4: S2, S3 and S2+S3 are the significant predictors of mortality

	B	S.E.	P value	Odds ratio	95% C.I. for odds ratio Lower	Upper
S2(>1) or S3(>.849)	2.588	.817	.002	13.300	2.684	65.915
S3(>.8491)	2.140	.659	.001	8.500	2.338	30.908
S2(>1)	2.262	.641	.0004	9.600	2.734	33.708
S1(>1.2)	1.109	.570	.052	3.030	.991	9.269

Discussion

Sepsis is a cause of high mortality among admitted patients [1]. It has increased financial burden in developed and developing nations [3]. Need of the hour is to effectively manage these patients and cut down the cost of treatment without compromising the health of patients. Shock Index is easy to use, accurate, cost effective bedside tools for early diagnosis of sepsis [7].

We observed that Shock index at 2 hours and 6 hours significantly predicts mortality in a patient with sepsis or septic shock whereas SI at 0 hour does not predict mortality. Our findings were consistent with Mohd Yusuf et. al. [8]. They tested seven clinical parameters to prognosticate the outcome in sepsis, namely, Shock index at presentation, shock index at 2 hours, Age, gender Temperature, Heart Rate and Respiratory Rate. They found that shock index at presentation and shock index at two hours were significant variables but shock index at 2 hours is more sensitive predictor as compared to shock index at presentation.

Utility of SI in predicting mortality among community acquired pneumonia was studied by Myint et al [9] but they did not include serial readings and based their findings on single finding, that is, SI at 0 hour. Zarzaur et al [10] also included single reading of shock index in their study involving mortality in trauma patients.

Isaac B et. al. [11] collected vital signs at 4 hourly interval from admission to discharge from ICU. They defined a "sustained SI elevation" as having an SI greater than 0.7 for at least 50% of the readings and concluded that sustained elevation of the SI is associated with increased morbidity and mortality in patients admitted to the ICU with severe sepsis.

In the present study we correlated WBC count and haemoglobin with shock index and found Only Shock index at 6 hours is significantly positively correlated with WBC as WBC Increases, Shock index also increases with correlation coefficient of .2972. Tony B(2013) [12] repored that an elevated shock index(0.7) performed identically to full SIRS criteria (including WBC) and low risk patients with normal SI may forgo (or not urgently need) routine triage laboratory screening for sepsis, especially from triage and before full evaluation.

These results taken together confirm that SI can be applied in clinical practice and the immediate clinical relevance of our findings is that SI, Shock Index, is cost effective and easily available clinical parameter which can prognosticate sepsis.

Conclusion

From the present study, it may be concluded that SI at 2, 6 hours was clinically relevant and easily calculated predictor of mortality. It should be added to heart rate and systolic blood pressure, allowing for early recognition of severe sepsis and septic.

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