Predicting septic shock in patients with sepsis at emergency department triage using systolic and diastolic shock index

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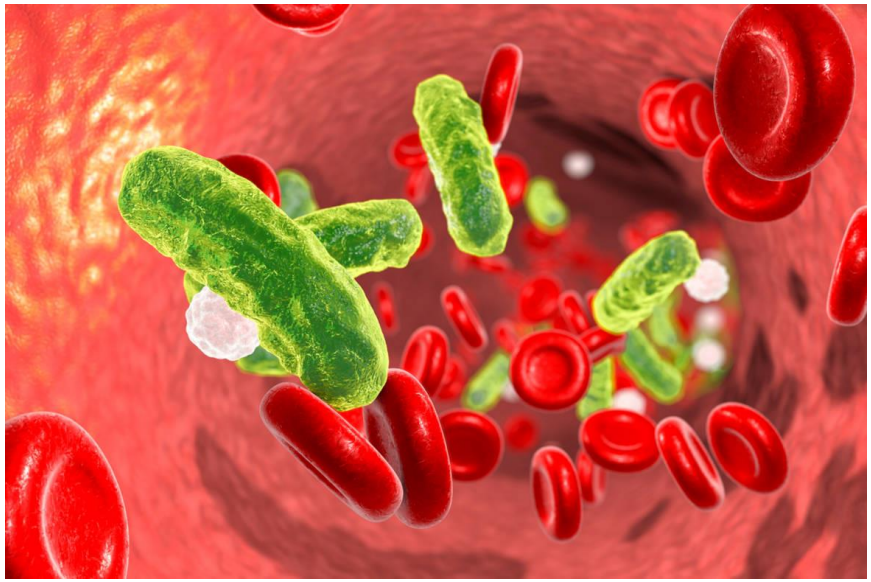

Presented by: Chaima Youssef

I. Introduction:

- Sepsis is a life-threatening condition caused by an uncontrolled response to infection, with a 10% mortality rate in hospitals. Septic shock, a severe form of sepsis, has a mortality rate over 40%.
- The Surviving Sepsis Campaign advises starting fluids and antibiotics immediately in suspected septic shock cases. Delays in treatment increase death risk, so early identification and treatment are critical.

- The shock index (SI) =heart rate (HR)/ systolic blood pressure (SBP)
- The diastolic shock index (DSI)=(HR) /diastolic blood pressure (DBP).
- This study examines how well SI and DSI, measured at ED triage, predict septic shock. Early SI and DSI could help quickly identify high-risk patients and guide early treatment, potentially improving survival.

II. Material and methods

1. Study design and settings

- This retrospective observational study used data from a prospectively collected sepsis registry at Korea University Ansan Hospital's emergency department (ED).
- Patients ***aged 18 or older*** who met the ***quick SOFA*** (qSOFA) criteria for ED admission between January 2016 and August 2022 were screened. The hospital uses qSOFA as part of its Intelligent Sepsis Management System, which automatically identifies potential sepsis cases. Physicians confirm infection and organ dysfunction before enrolling patients in the registry.

2. Definition:

- Sepsis = SOFA score ≥2.
- Septic shock =the need for vasopressors + lactate >2 after fluids.
- The SI = HR/SBP, and DSI = HR/DBP.
- Early warning scores (NEWS, NEWS2, and MEWS) were compared with SI and DSI to predict septic shock. These scores used six physiological parameters: respiratory rate, oxygen saturation, body temperature, SBP, pulse rate, and consciousness level.

3. Data collection and outcomes :

- Patient data were collected from hospital records. The primary outcome was the progression to septic shock during the emergency department stay, based on Sepsis-3 criteria. Secondary outcomes included time to vasopressor use, high-dose vasopressor needs, vasopressor dose, and mortality at 7, 14, and 30 days.
- Time to vasopressor use was calculated from admission to norepinephrine administration. High-dose vasopressor use was defined as 20

III. Results

1. Demographics:

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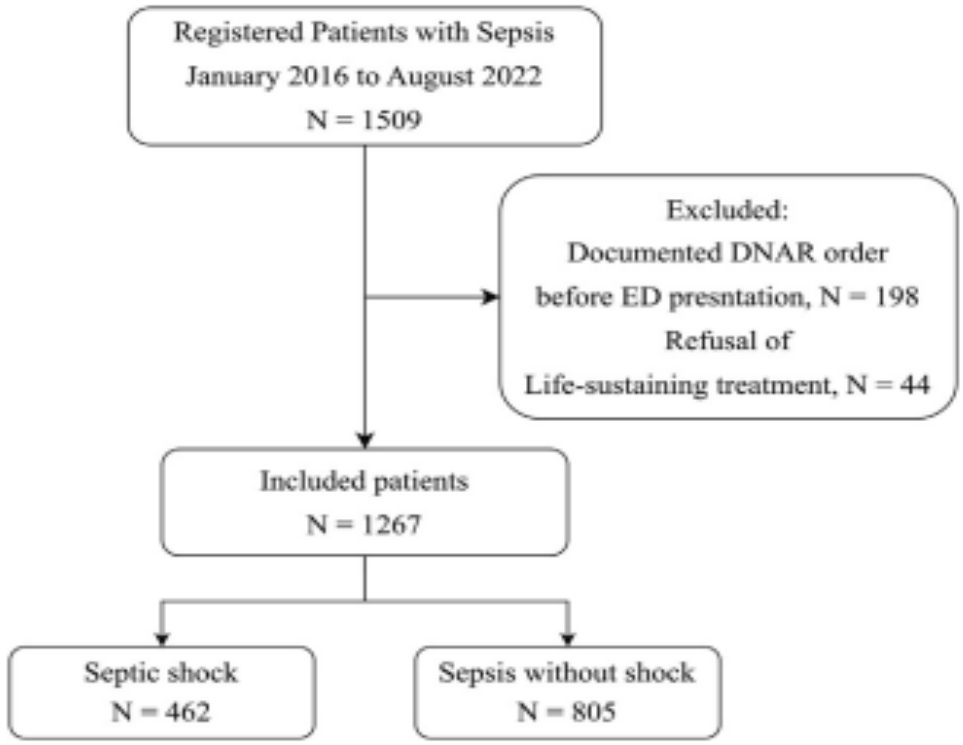

Fig. 1. Flowchart of the number of included and excluded patients.
DNAR, Do Not Attempt Resuscitation; ED, emergency department.

2. Predicting septic shock using SI and DSI:

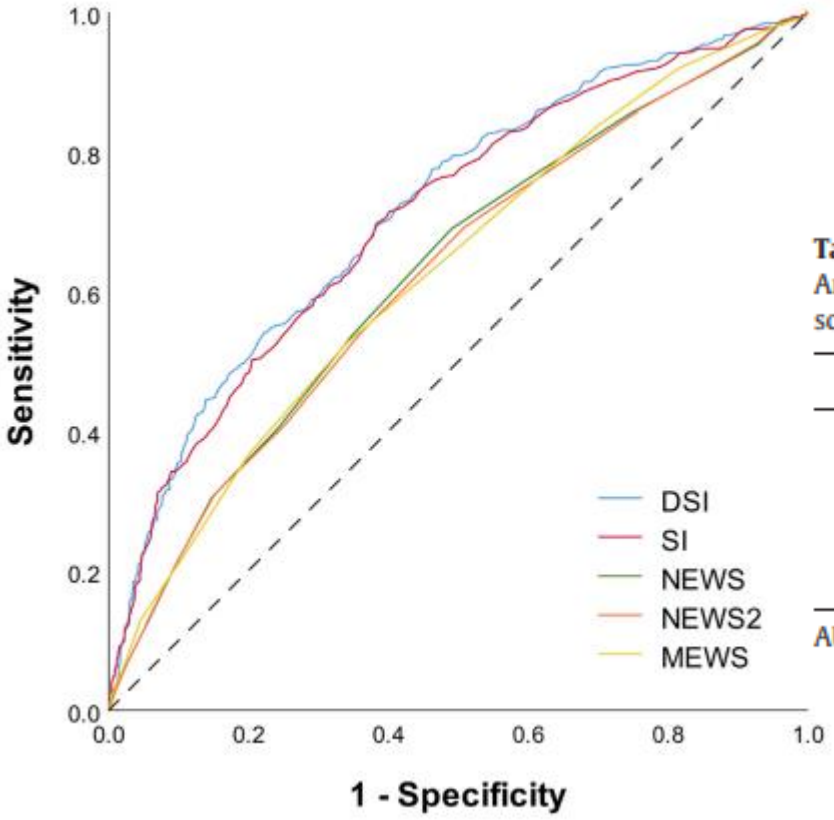

Table 1
Area under the receiver operating characteristic curve and confidence interval of each scoring system for predicting progression to septic shock among patients with sepsis.

Variable	AUROC (95% CI)
Diastolic shock index	0.717 (0.688–0.747)
Shock index	0.707 (0.677–0.737)
National Early Warning Score	0.627 (0.596–0.659)
National Early Warning Score 2	0.622 (0.590–0.654)
Modified Early Warning Score	0.627 (0.596–0.659)

AUROC, area under the receiver operating characteristic curve; CI, confidence interval.

Fig. 2. Receiver operating characteristic curves for predicting septic shock using the shock index, diastolic shock index, and early warning scores.
MEWS, Modified Early Warning Score; NEWS, National Early Warning Score.

3. Development of classification models using SI and DSI:

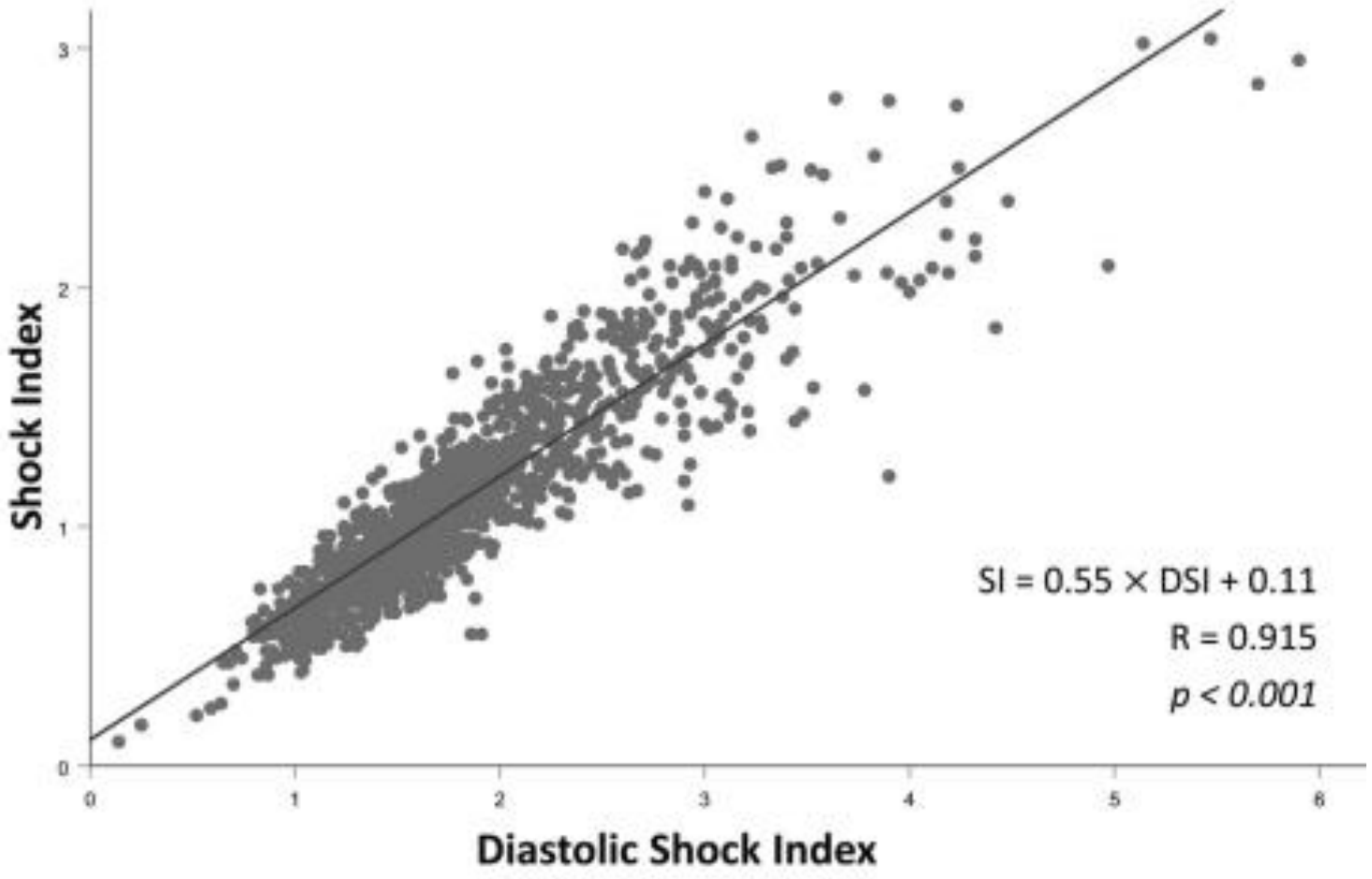

Fig. 3. Scatter plot of diastolic shock index and shock index with linear regression.
DSI, diastolic shock index; SI, shock index.

Table 2
Clinical characteristics by tertiles according to the first principal component of shock index and diastolic shock index.

Variable	Lower tertile (T1) (n = 422)	Middle tertile (T2) (n = 422)	Upper tertile (T3) (n = 423)	p-value
Sex, male, n (%)	252 (59.7%)	236 (55.9%)	242 (57.2%)	0.610
Mean age, years (IQR)	76 (64–82)	76 (66–83)	77 (65–83)	0.526
Underlying disease, n (%)				
Diabetes mellitus	155 (36.7%)	170 (40.3%)	183 (38.6%)	0.152
Hypertension	212 (50.2%)	235 (55.7%)	228 (53.9%)	0.270
Chronic liver diseases	16 (3.8%)	23 (5.5%)	25 (5.9%)	0.335
Chronic kidney disease	53 (12.6%)	53 (12.6%)	55 (13.0%)	0.975
Chronic respiratory disease	106 (22.7%)	88 (20.9%)	62 (14.7%)	0.008
Cardiovascular disease	69 (16.4%)	88 (20.9%)	70 (16.5%)	0.151
Malignancy	83 (19.7%)	79 (18.7%)	82 (19.4%)	0.938
Initial vital sign at triage (IQR)				
Systolic blood pressure, mmHg	100 (87–130)	98 (82–131)	92 (75–113)	<0.001
Diastolic blood pressure, mmHg	69 (60–86)	60 (53–74)	50 (42–59)	<0.001
Heart rate	97 (80–114)	104 (91–120)	102 (118–134)	<0.001
Respiratory rate	24 (22–26)	24 (20–28)	24 (20–28)	0.154
Body Temperature, °C	36.9 (36.3–37.7)	37.2 (36.4–38.0)	37.4 (36.5–38.3)	<0.001
Suspected infection source, n (%)				
Genitourinary infection	145 (34.4%)	145 (34.4%)	165 (39.0%)	0.267
Respiratory infection	280 (66.4%)	253 (60.0%)	261 (61.7%)	0.139
Gastrointestinal infection	31 (7.3%)	45 (10.7%)	43 (10.2%)	0.204
Other infection sources	61 (14.5%)	76 (18.0%)	66 (15.6%)	0.356
Progression to septic shock, n (%)	107 (25.4%)	139 (32.9%)	216 (51.1%)	<0.001
Time to vasopressor, min (IQR)	145 (72–309)	129 (67–250)	109 (47–209)	0.003
Vasoactive-Inotrope Score (IQR)	23.0 (16.5–39.2)	24.4 (16.8–40.1)	26.7 (19.4–51.5)	0.005
High dose vasopressor requirement, n (%)	46 (10.9%)	58 (13.7%)	97 (22.9%)	<0.001
Amount of fluid administration in the first 3 h, ml (IQR)	1360 (680–1860)	1360 (800–1900)	1660 (1160–2300)	<0.001
Laboratory findings				
Lactate, mmol/L (IQR)	2.4 (1.6–4.1)	2.7 (1.7–4.8)	3.9 (2.3–7.2)	<0.001
WBC, 10^3/μL (IQR)	12.00 (7.94–17.12)	11.58 (7.83–17.24)	12.22 (7.2–17.90)	0.934
CRP, mg/dL (IQR)	9.2 (4.0–17.1)	10.5 (5.2–17.7)	11.1 (5.1–20.2)	0.053
Procalcitonin, ng/dL (IQR)	0.75 (0.19–6.22)	1.44 (0.38–9.19)	3.10 (0.61–17.6)	<0.001
Severity index				
SOFA (IQR)	7 (5–10)	8 (5–11)	9 (7–12)	<0.001
APACHE II (IQR)	17 (13—21)	17 (14–21)	20 (16–24)	<0.001
Mortality, n (%)				
7-day	62/416 (14.9%)	62/413 (15.0%)	86/417 (20.6%)	0.042
14-day	85/414 (20.5%)	80/411 (19.5%)	108/413 (26.2%)	0.045
30-day	97/407 (23.8%)	109/400 (27.3%)	128/405(31.6%)	0.046

APACHE, Acute Physiology and Chronic Health Evaluation; CRP, C-reactive protein; IQR, interquartile range; SOFA, Sepsis-related Organ Failure Assessment; WBC, white blood cell.

Table 3
Multiple comparison of clinical characteristics between two groups by tertiles according to the first principal component of shock index and diastolic shock index.

Variable	T1 vs T2	T2 vs T3	T1 vs T3
	p values (Bonferroni-corrected cutoff <0.05 ÷ 3)		
Progression to septic shock	**0.015***	**<0.001***	**<0.001***
Time to vasopressor, min	0.113	0.058	**0.001***
Vasoactive Inotrope Score	0.365	0.029	**0.002***
High dose vasopressor requirement	0.209	**0.001***	**<0.001***
Amount of fluid administration in the first 3 h, mL	0.271	**<0.001***	**<0.001***
Laboratory findings			
Lactate	0.037	**<0.001**	**<0.001***
CRP	0.060	0.602	0.026
Procalcitonin	**0.001***	**0.007**	**<0.001***
Severity index			
SOFA	**0.001***	**<0.001***	**<0.001***
APACHE II	0.033	**<0.001***	**<0.001***
Mortality			
7-day	0.965	0.035	0.031
14-day	0.702	0.022	0.056
30-day	0.266	0.175	**0.013***

T1, lower tertile; T2, middle tertile; T3, upper tertile; APACHE, Acute Physiology and Chronic Health Evaluation; CRP, C-reactive protein; IQR, interquartile range; SOFA, Sepsis-related Organ Failure Assessment; WBC, white blood cell.
* Statistical significant p-value based on Bonferroni correction

Table 4
Multivariate logistic regression for progression to septic shock and high dose vasopressor requirement according to principal components and the tertiles of the first principal component of shock index and diastolic shock index.

Variables	aOR[a]	95% CI	*p*-value
Progression to septic shock			
The first principal component	1.871	1.613–2.171	<0.001
The second principal component	1.864	1.633–2.126	<0.001
Progression to septic shock			
Lower tertile (T1)	Reference		
Middle tertile (T2)	1.448	1.074–1.953	0.015
Upper tertile (T3)	3.074	2.299–4.111	<0.001
High dose vasopressor requirement[b]			
Lower tertile (T1)	Reference		
Middle tertile (T2)	1.308	0.865–1.977	0.203
Upper tertile (T3)	2.436	1.664–3.567	<0.001

aOR, adjusted odds ratio; CI, confidence interval.
[a] Adjusted variables were age and sex.
[b] High dose vasopressor requirement was defined as 20 micrograms per minute or more of norepinephrine infusion.

Table 5

Multivariate Cox regression for 7-day, 14-day and 30-day mortality according to the tertiles of the first principal component of shock index and diastolic shock index.

Group	aHR[a]	95% CI	*p*-value
7-day Mortality			
Lower tertile (T1)	Reference		
Middle tertile (T2)	0.996	0.810–1.727	0.982
Upper tertile (T3)	1.412	1.108–1.957	0.038
14-day Mortality			
Lower tertile (T1)	Reference		
Middle tertile (T2)	0.934	0.689–1.268	0.663
Upper tertile (T3)	1.315	1.989–1.747	0.059
30-day Mortality			
Lower tertile (T1)	Reference		
Middle tertile (T2)	1.131	0.861–1.488	0.377
Upper tertile (T3)	1.380	1.060–1.798	<0.001

aHR, adjusted hazard ratio; CI, confidence interval.

[a] Adjusted variables were age and sex.

IV. Discussion:

- This study showed that SI and DSI were strong predictors of septic shock. There was no significant difference in AUC between SI and DSI. Both were highly correlated, making it hard to combine them.
- Patients were classified into low risk (T1), intermediate risk (T2), and high risk (T3) for septic shock. T3 patients should be prioritized for resuscitation. T2 patients were more likely to develop septic shock than T1 but had similar vasopressor needs. This system helps

- Quick treatment for septic shock is crucial. Guidelines recommend giving antibiotics within **one hour** for septic shock and within **three hours** for sepsis.
- This study showed that blood pressure and heart rate could predict shock at triage. DSI predicted shock earlier than hypotension. Adding lactate measurements could improve accuracy, but more research is needed.
- This study had some **limitations**. It was retrospective, making it hard to avoid confounding factors. It was also a single-center study, limiting its generalizability. They only included patients with qSOFA-positive sepsis, which may have caused selection bias. Larger, multicenter studies are needed to confirm these findings.

V. Conclusion:

The present study demonstrated that the SI and DSI significantly predicted the progression to septic shock and performed better than early warning scores. By combining SI and DSI, it is possible to predict the progression to septic shock and its severity, including the vasopressor requirement, at ED triage. Larger multicenter studies are needed to validate the findings.

Thank you for your attention