

Introduction

Sepsis causes life-threatening organ dysfunction; septic shock involves hypotension and elevated lactate despite fluids. Early resuscitation includes individualized fluid therapy, vasopressors, and antimicrobials. Intravascular volume assessment using IVC ultrasound offers non-invasive guidance but is limited by patient, physiological, and technical factors. Integrated multi-organ ultrasonography improves accuracy. Lung ultrasound detects interstitial edema, guides fluid management, evaluates ventilated lungs, monitors B-lines, atelectasis, and diaphragmatic function. The SAFE score standardizes ICU bedside ultrasound to assess intravascular volume (IVV) by evaluating heart function, lungs (B-lines), IVC, and IJV, scoring each from -1 to +1. Total scores indicate hypovolemia (-4 to -2), euvolemia (-1 to +1), or hypervolemia (+2 to +4). POCUS guides fluid management, monitors pulmonary edema, and predicts hemodynamic status, complementing clinical parameters. APACHE II, ranging 0-71, assesses illness severity within 24 hours of ICU admission, correlating higher scores with mortality risk and informing triage, treatment, and prognosis decisions.

Aim of the Work

This research set out to determine if septic shock patients benefited from using the SAFE score, which is a sonographic evaluation of intravascular fluid estimation.

Patients and Methods

This prospective observational cohort study included 38 adult patients admitted with septic shock to the Critical Care Department of Alexandria University Hospitals, following ethics approval and informed consent. Patients were included if they met the Third International Consensus criteria for septic shock and excluded if they had conditions such as pregnancy, burns, hepatic or renal failure, chronic heart failure, obesity, or poor ultrasound windows. Within the first 24 hours of ICU admission, demographic, clinical, laboratory, and radiological data were collected, including APACHE II scoring. Fluid resuscitation was performed using crystalloids (30 mL/kg) over the first three hours. Volume status was assessed using the SAFE score, which integrates echocardiography, lung B-lines, IVC collapsibility, and IJV respiratory variation. Each parameter was scored from -1 to +1, with total SAFE scores classifying patients as hypovolemic (-4 to -2), euvolemic (-1 to +1), or hypervolemic (+2 to +4). Patients were subsequently grouped by survival outcomes, and SAFE scores were compared with APACHE II to evaluate predictive accuracy.

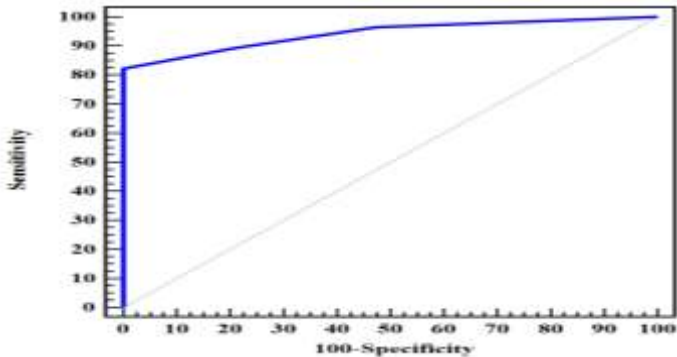
Results

Table (1) showed a significant elevation in the mean SAFE score among patients in Group I compared to Group II (2.32 ± 1.31 vs. -0.32 ± 0.82, respectively). A majority of patients in Group I (82.1%) had SAFE scores consistent with a hypervolemic intravascular volume status, where +4 represents the optimal value within the hypervolemic range (+2 to +4). Conversely, all patients in Group II (100%) had SAFE scores corresponding to euvolemia, with 0 as the ideal score within the euvolemic range (-1 to +1).

Table 1: Comparison between the two studied groups based on Sonographic Assessment of Intravascular Fluid Estimate (SAFE)

	Total (n = 47)		Group I (n = 28)		Group II (n = 19)		Test of Sig.	P
	No.	%	No.	%	No.	%		
SAFE score								
Represents IVV status of hypovolemia. -4 is the optimal result (-2 – -4)	0	0.0	0	0.0	0	0.0	$\chi^2=30.564^*$	<0.001*
Represents IVV status of euvolemia 0 is the optimal result (-1 – +1)	24	51.1	5	17.9	19	100.0		
Represents IVV status of hypervolemia. +4 is the optimal result (+2 – +4)	23	48.9	23	82.1	0	0.0		
Min. – Max.	-1.0 – 4.0		-1.0 – 4.0		-1.0 – 1.0		U=31.00*	<0.001*
Mean ± SD.	1.26 ± 1.73		2.32 ± 1.31		-0.32 ± 0.82			
Median (IQR)	1.0 (0.0 – 2.50)		2.0 (2.0 – 3.0)		-1.0 (-1.0 – 0.0)			

Table (2) illustrates the diagnostic performance of the SAFE score for predicting mortality in patients with septic shock. Using a cutoff value greater than 0, the SAFE score achieved a sensitivity of 89.29% and a specificity of 78.95%, with an area under the ROC curve (AUC) of 0.942, indicating excellent discriminatory ability. At a threshold above 1, the sensitivity slightly decreased to 82.14%, while specificity reached 100%, indicating a stronger ability to correctly identify non-survivors. When the cutoff was raised to >2, specificity remained at 100%, although sensitivity declined to 42.86%. These results suggest that the SAFE score is a useful and accurate non-invasive measure for evaluating intravascular volume status and estimating mortality risk in critically ill septic shock patients.



Pognostic performance for SAFE score to predict died septic shock:

Figure 1: ROC curve for SAFE score to predict died septic shock patients (n = 28) from Discharged septic shock patients (n = 19)

Table 2: Prognostic performance for SAFE score to predict died septic shock patients (n = 28) from Discharged septic shock patients (n = 19)

	AUC	p	95% C.I	Cut off	Sensitivity	Specificity	PPV	NPV
SAFE score	0.942	<0.001*	0.876 - 1.000	>0	89.29	78.95	86.2	83.3
				>1#	82.14	100.0	100.0	79.2
				>2	42.86	100.0	100.0	54.3

AUC: Area Under a Curve
CI: Confidence Intervals
NPV: Negative predictive value
*: Statistically significant at $p \leq 0.05$
#Cut off was choose according to Youden index
p value: Probability value
PPV: Positive predictive value

Conclusion

Septic shock carries high mortality, with fluid resuscitation being critical but challenging, as both hypovolemia and fluid overload worsen outcomes. The SAFE score (Sonographic Assessment of Intravascular Fluid Estimate) offers a non-invasive, bedside ultrasound method to dynamically assess fluid status. It integrates four parameters: left ventricular systolic function, lung B-lines, inferior vena cava (IVC) collapsibility index, and internal jugular vein (IJV) variability. In this study, SAFE scores above 0, reflecting hypervolemia, were strongly linked to mortality, while survivors generally remained in the euvolemic range. Patients with severe cardiac dysfunction were excluded to ensure accurate assessment of volume status. The SAFE score showed excellent predictive ability, with high sensitivity, specificity, and an AUC of 0.942. These findings suggest that SAFE-guided fluid management may enable individualized therapy, prevent fluid overload, and improve septic shock outcomes. Larger multicenter trials are needed to confirm its clinical utility.