Journal of Society Medicine
Research & Review Articles on Diseases
Journal of Society Medicine. 2026; 5 (10)

The Role of Echocardiography as an Additional Parameter to the SOFA Score in Predicting In-Hospital Mortality among Patients with Sepsis in the Intensive Care Unit

Defany Novita Sary [1*], Kamal Kharrazi Ilyas [1], Anggia Chairuddin Lubis [1], Hilfan Ade Putra Lubis [1], Abdul Halim Raynaldo [1]

[1] *Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, North Sumatra, Indonesia*

***Corresponding Author**: Defany Novita Sary, Email: defanynovitasary@gmail.com

ARTICLE INFO

Article history:
Received
20 July 2026

Revised
12 August 2026

Accepted
31 October 2026

Manuscript ID:
JSOCMED-20072026-510-1

Checked for Plagiarism: Yes

Language Editor:
Rebecca

Editor-Chief:
Prof. Aznan Lelo, PhD

ABSTRACT

Introduction: Sepsis remains a leading cause of death in intensive care units (ICUs). The cardiovascular component of the Sequential Organ Failure Assessment (SOFA) score relies on blood pressure and vasopressor requirements and may not capture myocardial dysfunction. This study evaluated whether adding echocardiographic parameters to SOFA improves the prediction of in-hospital mortality in sepsis.

Methods: This ambispective cohort study enrolled 52 adults with Sepsis-3-defined sepsis in the ICU of H. Adam Malik General Hospital, Medan, Indonesia (retrospective: January 2024–July 2025; prospective: August–November 2025), stratified equally by history of cardiac disease. SOFA scoring and transthoracic echocardiography (LVEF, LVOT VTI, E/A ratio, E/e′ ratio, TAPSE, stroke volume, cardiac output, and systemic vascular resistance) were performed within 24 hours of ICU admission or sepsis diagnosis. Associations with in-hospital mortality were assessed using logistic regression, and discrimination using receiver operating characteristic analysis.

Results: In-hospital mortality was 65.4% (34/52). The mean age was 61.8 ± 13.5 years, 65.4% were men, and pneumonia was the predominant infection source (78.8%). Mechanical ventilation was more frequent among non-survivors (85.3% vs. 50.0%; p=0.006). SOFA was associated with mortality (OR 1.389; 95% CI 1.029–1.875; p=0.032). TAPSE was the only echocardiographic parameter associated with mortality (OR 0.788; 95% CI 0.631–0.985; p=0.036). The area under the curve was 0.669 for SOFA, 0.665 for TAPSE, and 0.708 for the combined SOFA–TAPSE model.

Conclusion: Adding TAPSE to SOFA modestly improved mortality discrimination. Bedside assessment of right-ventricular function may complement organ failure scoring for early risk stratification in sepsis, pending external validation.

Keywords

Sepsis, SOFA Score, Echocardiography, TAPSE, Right-Ventricular Function, Mortality, Intensive Care Unit

How to cite: Sary DN, Ilyas KK, Lubis AC, Lubis HAP, Raynaldo AH. The Role of Echocardiography as an Additional Parameter to the SOFA Score in Predicting In-Hospital Mortality among Patients with Sepsis in the Intensive Care Unit. *Journal of Society Medicine*. 2026; 5 (10): 380-386. **DOI: https://10.71197/jsocmed.v5i10.306**

INTRODUCTION

Sepsis is defined as life-threatening organ dysfunction caused by dysregulated host response to infection [1]. It remains one of the leading causes of death worldwide; the Global Burden of Disease analysis estimated 48.9 million incident cases and 11.0 million sepsis-related deaths in 2017, and pooled data from high-income regions continue to show substantial short-term mortality, particularly in patients with septic shock [2,3]. The burden is disproportionately high in low- and middle-income countries, including Indonesia, where sepsis is associated with high mortality, prolonged hospitalization, and considerable health care costs [4]. Institutional data from the intensive care unit (ICU) of H. Adam Malik General Hospital, Medan, have also reported high

© 2026 Sary et al. This work is published by CoinReads Media Prima Ltd. The full terms of this license are available at https://www.coinreads.com/terms.php and attribution 4.0 International (https://creativecommons.org/licenses/by/4.0/). The article has been reviewed and approved by the author before being submitted for publication. Journals, editor in chief and editorial board have no right or obligation to correct or be responsible for inaccurate and misleading data if any. It is the responsibility of the author.

mortality rates among patients with sepsis, underscoring the need for early and reliable prognostic assessment in this setting [5].

The Sequential Organ Failure Assessment (SOFA) score is the most widely used instrument for quantifying organ dysfunction and estimating prognosis in critically ill patients [6]. An acute increase of at least two points from baseline is central to the Sepsis-3 definition [1]. Despite its clinical utility, the cardiovascular component of SOFA is derived mainly from mean arterial pressure and vasopressor requirements, parameters that were defined decades ago and no longer fully reflect contemporary hemodynamic management [7,8]. These variables are indirect markers of circulatory support rather than direct measures of cardiac performance, and they may fail to identify septic myocardial dysfunction involving either the left or right ventricle. Sepsis-induced cardiovascular dysfunction arises from a complex interplay of systemic inflammation, vasoplegia, endothelial injury, microcirculatory impairment, mitochondrial dysfunction, disturbed calcium handling, and reduced β-adrenergic responsiveness [9]. The resulting septic cardiomyopathy may manifest as left-ventricular systolic dysfunction, left-ventricular diastolic dysfunction, right-ventricular dysfunction, or combinations thereof. Because clinically relevant cardiac dysfunction may coexist with an apparently acceptable blood pressure, particularly under vasopressor support, direct evaluation of cardiac function could provide prognostic information complementary to pressure-based assessment [10].

Transthoracic echocardiography is a noninvasive, repeatable bedside technique that allows direct assessment of myocardial function and hemodynamic status in critically ill patients [11]. Commonly obtained measurements include left ventricular ejection fraction (LVEF), left ventricular outflow tract velocity–time integral (LVOT VTI), E/A and E/e′ ratios, stroke volume, cardiac output, systemic vascular resistance, and tricuspid annular plane systolic excursion (TAPSE) [12]. However, whether these parameters add incremental prognostic value to an established organ failure score remains uncertain, and evidence from Indonesian tertiary-care ICUs is scarce. Therefore, this study aimed to evaluate the association between early echocardiographic parameters and in-hospital mortality among patients with sepsis and to determine whether adding an echocardiographic parameter to the SOFA score improves mortality prediction.

METHODS

This analytic observational study used an ambispective cohort design and was conducted in the ICUs of H. Adam Malik General Hospital, a tertiary referral hospital in Medan, North Sumatra, Indonesia. Retrospective data were obtained from the medical records of patients treated between January 2024 and July 2025. Prospective enrollment was conducted from August to November 2025 or until the required sample size was reached.

Eligible participants were adults aged ≥18 years with sepsis diagnosed according to the Sepsis-3 criteria, defined as suspected or documented infection accompanied by acute organ dysfunction, reflected by an increase of at least two SOFA points from baseline. All participants were required to have undergone transthoracic echocardiography within the first 24 hours after ICU admission or sepsis diagnosis. Patients were excluded if the echocardiographic image quality was inadequate for reliable assessment, if death occurred before the required clinical, laboratory, and echocardiographic data were completed, or if a known structural cardiac disorder substantially altered ventricular geometry or function, including significant valvular heart disease, non-septic cardiomyopathy, and congenital heart disease. A total of 52 participants were included using stratified consecutive sampling, comprising 26 patients with a documented history of cardiac disease and 26 without such a history. Demographic variables included age and sex. Clinical variables included comorbidities, source of infection, mean arterial pressure (MAP), heart rate, use of mechanical ventilation, and the vasoactive–inotropic score (VIS). The total SOFA score was recorded at the initial assessment. The primary outcome was in-hospital mortality, with patients classified as survivors or non-survivors at the end of hospitalization; time to death was recorded when applicable.

Transthoracic echocardiography was performed within the first 24 hours. The recorded parameters were LVEF, LVOT VTI, E/A ratio, E/e′ ratio, TAPSE, stroke volume, cardiac output, and systemic vascular resistance. LVEF was measured using the biplane Simpson method when feasible. LVOT VTI was obtained

using pulsed-wave Doppler. TAPSE was measured using M-mode at the lateral tricuspid annulus in the apical four-chamber view, in accordance with standard transthoracic echocardiographic methodology. All examinations were assessed by a cardiologist with expertise in critical-care echocardiography. Categorical variables were summarized as frequencies and percentages. Continuous variables were tested for normality and expressed as mean ± standard deviation for normally distributed data or as median and interquartile range otherwise. Comparisons between survivors and non-survivors were performed using the independent-samples test or the Mann–Whitney U test for continuous variables and the chi-square or Fisher 'sexact test for categorical variables, as appropriate. Binary logistic regression was used to evaluate associations between candidate variables and in-hospital mortality, and the results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Variables that were clinically relevant or statistically significant in bivariate analysis were considered for multivariable analysis, accounting for potential confounders such as age, comorbidities, mechanical ventilation, and vasopressor use. Receiver operating characteristic (ROC) curve analysis was performed to assess discrimination, and the area under the curve (AUC) was calculated for SOFA, TAPSE, and the combined SOFA–TAPSE model. A two-sided p-value <0.05 was considered statistically significant. All analyses were conducted using SPSS (IBM Corp., Armonk, NY, USA).

The study protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara/H. Adam Malik General Hospital, Medan. Written informed consent was obtained from the patients or their legally authorized representatives.

RESULTS

Table 1. Baseline Clinical and Echocardiographic Characteristics of the Study Population

Variable	Total (n=52)	Survivors (n=18)	Non-survivors (n=34)	p-value
Demographics				
Age, years	61.77 ± 13.49	64.89 ± 13.72	60.12 ± 13.27	0.229
Male sex, n (%)	34 (65.4)	11 (61.1)	23 (67.6)	0.637
Comorbidities				
Cardiovascular disease, n (%)	26 (50.0)	12 (66.7)	14 (41.2)	0.080
Diabetes mellitus, n (%)	13 (25.0)	4 (22.2)	9 (26.5)	0.736
Hypertension, n (%)	17 (32.7)	6 (33.3)	11 (32.4)	0.943
Congestive heart failure, n (%)	27 (51.9)	12 (66.7)	15 (44.1)	0.122
COPD, n (%)	7 (13.5)	1 (5.6)	6 (17.6)	0.224
Chronic kidney disease, n (%)	5 (9.6)	1 (5.6)	4 (11.8)	0.470
Clinical and hemodynamic variables				
Mechanical ventilation, n (%)	38 (73.1)	9 (50.0)	29 (85.3)	0.006
MAP, mmHg	85.92 ± 20.79	82.22 ± 20.05	87.88 ± 21.20	0.355
Heart rate, beats/min	95.65 ± 19.35	93.39 ± 19.80	96.85 ± 19.29	0.544
VIS	7 ± 10	1.5 ± 10	10 ± 33	0.376
SOFA score	7 ± 4	6 ± 3	7 ± 3	0.023
Echocardiographic parameters				
LVEF, %	49.5 ± 29	34 ± 34	51.5 ± 27	0.350
E/A ratio	1.07 ± 0.8	1 ± 0.8	1.12 ± 0.8	0.500
E/e′ ratio	10.10 ± 4.57	11.49 ± 4.19	11.20 ± 5.10	0.717
TAPSE, mm	18 ± 5	19 ± 3	18 ± 5	0.027
LVOT VTI, cm	17.18 ± 5.47	16.63 ± 5.62	17.47 ± 5.46	0.602
RAP, mmHg	8 ± 5	8 ± 5	8 ± 5	0.169
Stroke volume, mL	52.25 ± 29.33	47.10 ± 28.79	54.96 ± 30.85	0.608
Cardiac output, mL/min	5066.59 ± 1523.65	4738.22 ± 1722.27	5240.44 ± 1403.49	0.262
SVR, dyn·s·cm^{-5}	1247 ± 546	1239 ± 472	1285 ± 579	0.427

Data are presented as n (%), mean ± standard deviation, or median ± interquartile range. Statistically significant p-values (<0.05) are bolded. COPD, chronic obstructive pulmonary disease; E/A, ratio of early to late transmitral flow velocity; E/e′, ratio of early transmitral flow velocity to early diastolic mitral annular velocity; LVEF, left ventricular ejection fraction; LVOT VTI, left ventricular outflow tract velocity–time integral; MAP, mean arterial pressure; RAP, right atrial pressure; SOFA, Sequential Organ Failure Assessment; SVR, systemic vascular resistance; TAPSE, tricuspid annular plane systolic excursion; VIS, vasoactive–inotropic score.

A total of 52 patients with sepsis were analyzed. Of these, 18 (34.6%) survived to hospital discharge, and 34 (65.4%) died during hospitalization. The mean age was 61.77 ± 13.49 years, and 34 patients (65.4%)

were male. Pneumonia was the predominant source of infection, occurring in 41 patients (78.8%). Cardiovascular disease was present in 26 patients (50.0%), and congestive heart failure was recorded in 27 patients (51.9%). Mechanical ventilation was used in 38 patients (73.1%) and was significantly more frequent among non-survivors than survivors (29/34 [85.3%] vs. 9/18 [50.0%]; p=0.006). The SOFA score was higher among non-survivors than survivors (7 vs. 6; p=0.023). No significant differences were observed between the outcome groups in terms of age, sex, diabetes mellitus, hypertension, chronic obstructive pulmonary disease, chronic kidney disease, MAP, or heart rate (Table 1). Among the echocardiographic parameters, only TAPSE differed significantly between the groups, being lower among non-survivors than survivors (18 vs. 19 mm; p=0.027). No significant differences were observed in LVEF, E/A ratio, E/e′ ratio, LVOT VTI, stroke volume, cardiac output, or systemic vascular resistance.

In the logistic regression analysis, the SOFA score was significantly associated with in-hospital mortality (OR 1.389; 95% CI 1.029–1.875; p=0.032), indicating a 38.9% increase in the odds of death per one-point increase in SOFA score. TAPSE was inversely associated with mortality (OR 0.788; 95% CI 0.631–0.985; p=0.036), indicating that a lower right ventricular longitudinal systolic excursion was associated with a higher likelihood of death. No other clinical or echocardiographic parameters were significantly associated with mortality (Table 2).

Table 2. Association between clinical and echocardiographic parameters and in-hospital mortality (binary logistic regression)

Variable	OR (95% CI)	p-value
Demographic characteristics		
Age (per 10 years)	0.752 (0.473–1.195)	0.228
Male sex	0.752 (0.229–2.468)	0.638
Comorbidities		
Hypertension	1.045 (0.310–3.524)	0.943
Diabetes mellitus	0.794 (0.206–3.053)	0.736
Chronic kidney disease	0.441 (0.046–4.273)	0.470
Congestive heart failure	2.533 (0.770–8.336)	0.122
Chronic pulmonary disease	0.275 (0.030–2.480)	0.224
Hemodynamic parameters and severity scores		
Mean arterial pressure	1.014 (0.985–1.044)	0.351
Heart rate	1.009 (0.980–1.040)	0.536
SOFA score	1.389 (1.029–1.875)	0.032
Vasoactive–inotropic score	1.011 (0.986–1.037)	0.378
Left-ventricular systolic function		
LVEF	1.016 (0.983–1.050)	0.343
LVOT VTI	1.029 (0.925–1.145)	0.594
Stroke volume	1.009 (0.975–1.044)	0.601
Cardiac output	1.000 (1.000–1.001)	0.259
Systemic vascular resistance	1.000 (0.998–1.001)	0.422
Left-ventricular diastolic function		
E/A ratio	1.434 (0.478–4.298)	0.520
E/e′ ratio	0.975 (0.855–1.113)	0.711
Right-ventricular systolic function		
TAPSE	0.788 (0.631–0.985)	0.036

Note : CI, confidence interval; OR, odds ratio. Other abbreviations are listed in Table 1. Statistically significant p-values (<0.05) are shown in bold.

The SOFA score showed moderate discrimination for in-hospital mortality (AUC 0.669; optimal cutoff ≥8; sensitivity 47.1%; specificity 77.8%). TAPSE alone demonstrated comparable discrimination (AUC 0.665; cut-off ≤17.5 mm; sensitivity 44.1%; specificity 88.9%). The combined SOFA–TAPSE model yielded the highest discrimination (AUC 0.708; sensitivity 52.9%; specificity 77.8%), representing a moderate improvement over either measure alone (Table 3).

Table 3. Discriminative performance of the SOFA score, TAPSE, and the combined SOFA–TAPSE model for in-hospital mortality

Parameter	AUC	Cut-off	Sensitivity	Specificity	p-value
SOFA score	0.669	≥8	47.1%	77.8%	0.02
TAPSE	0.665	≤17.5 mm	44.1%	88.9%	0.02
Combined SOFA–TAPSE	0.708	>6.5	52.9%	77.8%	0.01

Note: AUC, area under the receiver operating characteristic curve (C-statistic). Other abbreviations are listed in Table 1.

DISCUSSION

This study evaluated whether early echocardiographic assessment improves mortality prediction beyond the SOFA score in critically ill patients with sepsis. The principal findings were as follows: in-hospital mortality was high; the SOFA score was associated with in-hospital mortality; TAPSE was the only echocardiographic parameter significantly associated with the outcome; and combining TAPSE with SOFA increased the AUC from 0.669 to 0.708.

The observed mortality of 65.4% reflects the severity of illness among patients admitted to the ICU of a tertiary referral hospital and is consistent with the high sepsis mortality previously reported in this institution and more broadly in Indonesia. Pneumonia was the dominant source of infection, highlighting the importance of respiratory infections as drivers of critical illness. Mechanical ventilation was significantly more common among non-survivors. Although ventilation itself is not necessarily a direct cause of death, its use generally reflects more severe respiratory failure and a greater overall disease burden. The association between a higher SOFA score and mortality is clinically plausible because the SOFA score integrates dysfunction across multiple organ systems and therefore reflects the cumulative burden of organ failure in sepsis [6]. However, the cardiovascular component of SOFA is based on blood pressure and vasopressor support and does not directly reflect myocardial performance [7,8]. A patient may maintain an apparently acceptable arterial pressure on vasopressors despite clinically important ventricular dysfunction, which supports the rationale for a complementary direct cardiovascular assessment [8]. In this cohort, TAPSE was the only echocardiographic parameter significantly associated with mortality. TAPSE quantifies longitudinal right-ventricular systolic function and is simple, reproducible, and readily obtainable at the bedside [11,12]. Right-ventricular dysfunction in sepsis may result from pulmonary vascular changes, hypoxic pulmonary vasoconstriction, acute respiratory distress syndrome, positive-pressure mechanical ventilation, increased pulmonary vascular resistance, and intrinsic impairment of myocardial contractility [13]. These mechanisms may reduce right-ventricular output and, through ventricular interdependence, impair left-ventricular filling, thereby worsening systemic perfusion. The high prevalence of pneumonia and mechanical ventilation in our cohort may have amplified this pathway. Our findings are consistent with previous work linking right-ventricular dysfunction to increased mortality, including a prospective cohort of patients with early sepsis and septic shock and a meta-analysis of 1,373 patients [14].

The absence of significant associations between mortality and LVEF, LVOT VTI, E/A ratio, E/e′ ratio, stroke volume, cardiac output, or systemic vascular resistance may have several explanations. Sepsis produces dynamic and heterogeneous hemodynamic phenotypes, and a single measurement may not capture an individual patient's trajectory [15]. LVEF is highly load-dependent, particularly in distributive shock, and its relationship with mortality may be nonlinear, with both depressed and hyperdynamic function carrying prognostic significance [16]. Similarly, cardiac output may be normal or elevated during the hyperdynamic phase and decline later in the course of illness. Previous studies, including an Indonesian cohort of patients with septic shock, have reported heterogeneous prognostic findings for conventional echocardiographic measurements [17]. In addition, the limited sample size may have reduced statistical power to detect smaller effects of other parameters. The increase in AUC from 0.669 for SOFA alone to 0.708 for the combined SOFA–TAPSE model suggests that direct assessment of right-ventricular function provides prognostic information that is not captured by the pressure-based cardiovascular component of SOFA. This concept aligns with recent work showing that extending the cardiovascular SOFA component with direct markers of cardiac dysfunction improves survival prediction in sepsis [8]. From a practical perspective, TAPSE requires minimal equipment

and training and can be incorporated into routine point-of-care ultrasound protocols, making it particularly attractive in resource-limited ICUs.

Nevertheless, the improvement in discrimination was modest and should be interpreted cautiously. The study was not powered to establish clinical utility, and the combined model requires external validation before it can be recommended for routine decision-making. Echocardiography should therefore be regarded as an adjunct to, rather than a replacement for, comprehensive clinical assessment and established severity scores. The strengths of this study include the standardized acquisition of echocardiographic data within 24 hours of ICU admission or sepsis diagnosis, assessment by a single cardiologist experienced in critical-care echocardiography, and stratified sampling that ensured balanced representation of patients with and without pre-existing cardiac disease. Several limitations should be acknowledged. First, the sample size was small and derived from a single tertiary-care hospital, limiting statistical precision and generalizability. Second, the ambispective design may have introduced information and selection bias, as the completeness and quality of retrospective measurements may differ from those of prospective data. Third, echocardiography was performed at a single early time point; serial examinations may better characterize the dynamic nature of septic cardiovascular dysfunction. Fourth, calibration, internal validation, and decision-curve analysis of the combined model were not performed. Finally, residual confounding by illness severity, treatment timing, ventilator settings, fluid status, and vasopressor exposure cannot be excluded.

CONCLUSION

Among adult patients with sepsis admitted to the ICU, both the SOFA score and TAPSE were associated with in-hospital mortality, and TAPSE was the only echocardiographic parameter significantly associated with the outcome. Adding TAPSE to SOFA moderately improved mortality discrimination, increasing the AUC from 0.669 to 0.708. Therefore, bedside echocardiographic assessment of right-ventricular function may complement standard organ-failure scoring in the early risk stratification of patients with sepsis. Larger, multicenter prospective studies incorporating serial echocardiography and formal model validation are warranted.

DECLARATIONS

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara/H. Adam Malik General Hospital, Medan, Indonesia. Written informed consent was obtained from all prospectively enrolled patients and their legally authorized representatives.

CONSENT FOR PUBLICATION

The Authors agree to be published in the Journal of Society Medicine.

FUNDING

None

COMPETING INTERESTS

The authors declare no conflicts of interest in this case report.

AUTHORS' CONTRIBUTIONS

All authors have read and approved the final version of the manuscript and agree to be held accountable for all aspects of the work presented.

ACKNOWLEDGMENTS

The authors thank the Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Sumatera Utara, and the medical records staff of H. Adam Malik General Hospital, Medan for their administrative support during data retrieval.

REFERENCE

1. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA. 2016;315(8):10-801.
2. Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, et al. Global, regional, and national sepsis incidence and mortality, 1990–2017: analysis for the Global Burden of Disease Study. Lancet. 2020;395(10219):11-200.
3. Bauer M, Gerlach H, Vogelmann T, Preissing F, Stiefel J, Adam D. Mortality in sepsis and septic shock in Europe, North America and Australia between 2009 and 2019—results from a systematic review and meta-analysis. Crit Care. 2020;24(1):239.
4. Purba AKR, Mariana N, Aliska G, Wijaya SH, Wulandari RR, Hadi U, et al. The burden and costs of sepsis and reimbursement of its treatment in a developing country: an observational study on focal infections in Indonesia. Int J Infect Dis. 2020;96:8-211.
5. Hanif RS, Hamdi T, Kadri A, Megawati ER. Initial SOFA score and mortality of sepsis patients in the intensive care unit of Haji Adam Malik Hospital Medan: does it correlate? Indones J Anesthesiol Reanim. 2024;6(2):9-73.
6. Shin TG. Assessment of organ failure in sepsis patients in the emergency department: clinical evaluation, Sequential Organ Failure Assessment (SOFA) score, and future perspectives. Clin Exp Emerg Med. 2024;11(4):30-327.
7. Moreno R, Rhodes A, Piquilloud L, Hernandez G, Takala J, Gershengorn HB, et al. The Sequential Organ Failure Assessment (SOFA) score: has the time come for an update? Crit Care. 2023;27(1):15.
8. Lörstad S, Wang Y, Tehrani S, Shekarestan S, Åstrand P, Gille-Johnson P, et al. Development of an extended cardiovascular SOFA score component reflecting cardiac dysfunction with improved survival prediction in sepsis: an exploratory analysis in the Sepsis and Elevated Troponin (SET) study. J Intensive Care Med. 2025;40(3):30-320.
9. Hollenberg SM, Singer M. Pathophysiology of sepsis-induced cardiomyopathy. Nat Rev Cardiol. 2021;18(6):34-424.
10. L'Heureux M, Sternberg M, Brath L, Turlington J, Kashiouris MG. Sepsis-induced cardiomyopathy: a comprehensive review. Curr Cardiol Rep. 2020;22(5):35.
11. Keller M, Magunia H, Rosenberger P, Koeppen M. Echocardiography as a tool to assess cardiac function in critical care—a review. Diagnostics (Basel). 2023;13(5):839.
12. Mitchell C, Rahko PS, Blauwet LA, Canaday B, Finstuen JA, Foster MC, et al. Guidelines for performing a comprehensive transthoracic echocardiographic examination in adults: recommendations from the American Society of Echocardiography. J Am Soc Echocardiogr. 2019;32(1):1-64.
13. Lanspa MJ, Cirulis MM, Wiley BM, Olsen TD, Wilson EL, Beesley SJ, et al. Right ventricular dysfunction in early sepsis and septic shock. Chest. 2021;159(3):63-1055.
14. Vallabhajosyula S, Shankar A, Vojjini R, Cheungpasitporn W, Sundaragiri PR, DuBrock HM, et al. Impact of right ventricular dysfunction on short-term and long-term mortality in sepsis: a meta-analysis of 1,373 patients. Chest. 2021;159(6):63-2254.
15. Ehrman RR, Favot MJ, Harrison NE, Khait L, Ottenhoff JE, Welch RD, et al. Early echocardiographic assessment of cardiac function may be prognostically informative in unresuscitated patients with sepsis: a prospective observational study. PLoS One. 2022;17(7):e0269814.
16. Dugar S, Sato R, Chawla S, You JY, Wang X, Grimm R, et al. Is left ventricular systolic dysfunction associated with increased mortality among patients with sepsis and septic shock? Chest. 2023;163(6):47-1437.
17. Rahasto P, Setianto B, Timan IS, Suhendro, Sukrisman L, Sukamawan R, et al. Cardiac performance by echocardiography, cardiovascular biomarker, kidney function, and venous oxygen saturation as mortality predictors of septic shock. Acta Med Indones. 2019;51(1):47-53.