The Prognostic Value of Left Ventricular Function on Sepsis Outcomes in Critical Care Unit Patients

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ABSTRACT

Background: Sepsis is the most prevalent life menacing condition presupposed patients' admission to intensive care units. The underlying cardiovascular consequences of sepsis comprehended marvelous increase of the cardiac output, reduction of the peripheral vascular resistance along with impaired capillary permeability.

Aim of the study: The present investigation was implemented to retrieve the prognostic value of LVF assessment using speckle tracking echocardiography (STE) among Egyptian adults, who admitted to the intensive care unit as a resultant impact of sepsis or septic shock.

Methods: Patients admitted at the Critical Care Unit, who initially diagnosed with sepsis or septic shock within 8 hours. After fulfilling their criteria and being aged more than 18 years, they were eligible for inclusion in the study. All participants were submitted to rigorous history taking, clinical evaluation, laboratory assessment, and STE. The study embraced an overall 50 patients..

Results: Left ventricular longitudinal strain (LVGLS) was the only parameter which attained statistically significant highly positive correlation with SOFA score among septic shock patients (r = 0.794, p = 0.021). The results of this model revealed that LVGLS (p<0.001) attained high ability in the prediction of Sepsis-related Organ Failure Assessment (SOFA) score and Acute Physiologic and Chronic Health Evaluation (APACHE) score.

Conclusions: The capability of STE investigation for the detection of left ventricular dysfunction among septic or septic shocked critically ill patients is a promising and feasible approach, which have a crucial impact on the prognosis of such patients.

Keywords: Septic shock, Sepsis, speckle tracking echocardiography.

INTRODUCTION

Sepsis is the most prevalent life menacing condition presupposed patients' admission to intensive care units [1]. This is because its underlying sequels such as hemodynamic instability, inadequate tissue oxygenation, and multi-organ failure, which in turn leads to increased risk of mortality [2]. To date, approximately 750,000 septic cases are diagnosed annually in the United States, which unfortunately harvested more than 200,000 death per year [3, 4].

The underlying cardiovascular consequences of sepsis comprehended marvelous increase of the cardiac output, reduction of the peripheral vascular resistance along with impaired capillary permeability [5]. These complications altered significantly the cardiac function, which in turn develop septic cardiomyopathy [6, 7].

Throughout the past era, evaluation of cardiac function was assessed using Swan-Ganz Catheter; in addition, echocardiography has been established as a pivotal diagnostic tool in the appreciation of the morphological and functional characteristics of the heart among septic patients [8, 9]. Subsequent to that, new modalities have been established recently, particularly 3D echocardiography, speckle tracking echocardiography (STE) and tissue Doppler [10]. Not only did these techniques attain precise evaluation of the cellular function of the heart, but they also had a crucial rule in the prognosis and the detection of the appropriate treatment strategies [10, 11].

The myocardial function has been frequently evaluated based upon ejection fraction (EF), 2D echocardiography and M mode echocardiography [12]. Conversely, these diagnostic tools had several limitations in order that their results are influenced dramatically by pre-load, after load, and heart rate [13]. Thereafter, the optimal and the early detection of septic cardiomyopathy is remaining challengeable owed to the obscurity of adequate test with high sensitivity and specificity for early diagnosis and proper monitoring of the myocardial function [14]. To overcome these obstacles, STE has been evolved with a considerable quantitative and objective assessment of the left ventricular function (LVF) regardless of the insonation angle [15].

The present investigation was implemented to retrieve the prognostic value of LVF assessment using STE among Egyptian adults, who were admitted to the Intensive Care Unit at El-Hussein University Hospital as a resultant impact of sepsis or septic shock.

METHODS

This study is a prospective observational case-control study, which was implemented at the Internal Medicine Department, El-Hussein University Hospital, Faculty of Medicine, Al-Azhar University, Cairo throughout the entire period June 2018 to January 2019.

Ethical approval

The present study was approved by the Ethical Research Board of the Faculty of Medicine, Al-Azhar University, Cairo. The potential risk events and complications were illustrated obviously for included patients, legal trustee or their relatives prior to study implementation. Informed consents were obtained before study conduction. Furthermore, all clinical and interventional procedures were executed along with the guidelines of the Declaration of Helsinki.

Selection criteria

Patients admitted at the Critical Care Unit, who were initially diagnosed with sepsis or septic shock within 8 hours. After fulfilling their criteria and aged more than 18 years old, they were eligible for inclusion in the study.

Exclusion criteria: On the contrary, patients with valvular or congenital heart disease and patients with primary cardiomyopathy were excluded. Additionally, patients with interstitial lung disease, chronic obstructive pulmonary disease or other primary lung diseases were omitted. Patients with previous intense diseases which may alter the cardiac hemodynamics or cardiac dysfunction were excluded.

Sepsis was identified based on the coexistence of more than two of the following criteria; fever ($> 38^{\circ}$C) or hypothermia ($< 35^{\circ}$C), respiratory rate >20 breaths/minute, heart rate > 90 beats per minute or arterial partial pressure of carbon dioxide < 32 mm Hg, white cell count < 4000 cells/mm^3 or >12000 cells/mm^3, or presence of immature forms $>10\%$. Consequently, septic shock was established when the systolic blood pressure dropped abruptly more than 40 mm Hg from initial values or the value of SBP < 90mm Hg, even though all patients were subjected adequate fluid resuscitation which required vasopressor administration.

Clinical evaluation

All participants were submitted to rigorous history talking and clinical evaluation to reveal the following parameters; patients age, sex, co-morbidities, cause of sepsis, Glasgow Coma Scale (GCS), heart rate, temperature, respiratory rate, systolic blood pressure, diastolic blood pressure, mean arterial blood pressure, and central venous pressure.

To appreciate the severity of sepsis, Sepsis-related Organ Failure Assessment (SOFA) score and Acute Physiologic and Chronic Health Evaluation (APACHE) score were performed for all patients along with close monitoring of the arterial blood lactate concentration.

Laboratory evaluation

Laboratory evaluation was implemented for all participants comprehending blood profile, random blood sugar (RBS), arterial blood gases, electrolyte profile, serum creatinine, Alanine Transaminase (ALT), Aspartate Amino-transferase (AST), total bilirubin, and direct bilirubin.

Echocardiography

Based on the recommendations of the American and European Societies of Echocardiography [16], Echocardiography was executed within 1 day of admission and at the day of discharge using the same device (iE33, Philips Medical System, Andover, MA)[17]. Strain measurements were performed using a validated, vendor-independent, 2D speckle-tracking echocardiographic tracking software (2D Cardiac Performance Analysis v1.1; TomTec Imaging Systems, Unterschleissheim, Germany) [17] and using frame rates of 40-70 fps/sec for all measurements. All images were interpreted in a blinded approach by two Echo-cardiologists, regardless of admission time or clinical diagnosis, to ensure the highest level of quality.

The images were obtained while the patients lying in the left lateral position or supine position. All candidates were subjected to comprehensive evaluation using 2-dimensional (2D) and color flow Doppler valvular. Left ventricular ejection fraction was evaluated by 2 plane approach based on the Simpson's methodology [18].

The Strain was evaluated by tracing the endocardial border of the left ventricle, whereby the best endocardial border was recognized when it passed the maximal number of segments. Additionally, the longitudinal strain was assessed in the apical view of the four chambers. On the other hand, circumferential and radial strains were appreciated in the parasternal short axes view. Subsequent to that, peak systolic strain was assessed using an average of three successive cardiac cycles.

Statistical analysis

Statistical analysis was performed using SPSS software version 23 for Windows (SPSS Inc., Chicago, IL, USA), and MedCalc software version 14.8 (MedCalc Software, Mariakerke, Belgium). Continuous normally distributed parameters were explicated in the form of mean and standard deviation (SD), and its specific groups were compared using student t-test. Conversely, non-normally distributed data were expressed using median and range and were compared

using Man Whitney U test. Additionally, continuous normally distributed paired data were contrasted using paired T-test. Categorical variables were illustrated using the number, and percentage and its particular groups were compared using Pearson's chi-square test with Fisher's exact test. Correlation analysis was implemented using Pearson correlation coefficient for continuous normally distributed data. The univariate linear regression model was performed to retrieve the potential independent predictors of SOFA and APACHE scores using t-test analysis. The significant difference was established when $P < 0.05$.

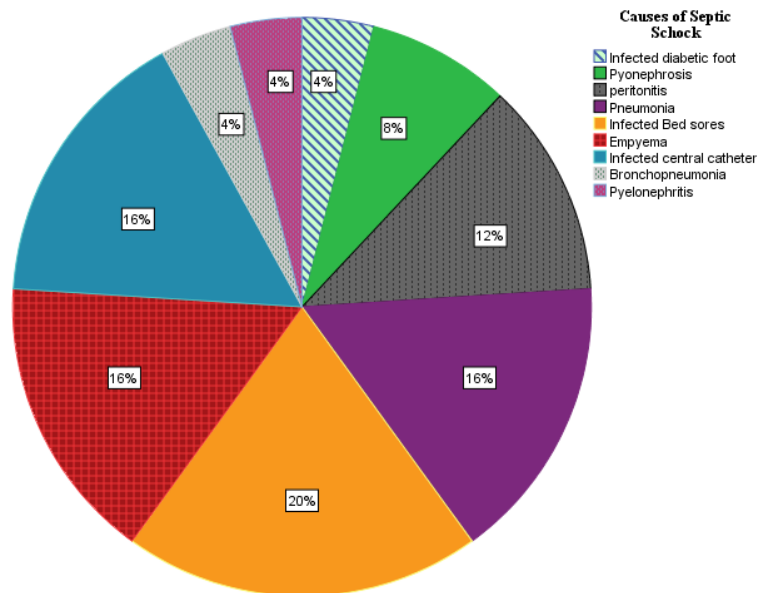## RESULTS

Patients demographic characteristics

This study embraced an overall 50 patients. Of them, 25 participants were assorted in the septic shock group, whilst the remaining 25 patients belonged to the sepsis group. The mean age of the included candidates was 60.88 ± 11.39 and 55.52 ± 10.71 years in the septic shock and sepsis groups, respectively. The main cause of sepsis was infected bedsores, whereby 20% of the patients enrolled in such groups experienced that cause. Furthermore, pneumonia contributed 16% and 20% of developing of septic shock and sepsis, respectively. There was a statistically significant difference between both groups in the term of GCS (P=0.026), respiratory rate (0.038), and SBP (0.29) (Table 1 and Figure 1).

Having the laboratory evaluation, patients enrolled in the septic shock and sepsis groups revealed statistically significant difference regarding the mean values of HB, RBS, PaO2, So2, total bilirubin, direct bilirubin, total lactate, SOFA score, and APACHE score with p-values of 0.003, 0.015, <0.001, <0.001, 0.002, 0.005, 0.005, 0.041, and 0.039, subsets, respectively. On the contrary, both groups did not elucidate a statistically significant difference in the meaning of TLC, PLT, PCV, HCO3, Na, K, AST, and ALT (Table 2 and Figure 2).

(1): Demographics and clinical characteristics of the included participants			
Variables	**Septic Shock**	**Sepsis**	**P-Value**
	Mean± SD / Number (%)	**Mean± SD / Number (%)**	
Age	60.88 ± 11.39	55.52 ± 10.71	0.535
Sex (Female)	16 (64%)	14 (56%)	0.387
Cause of sepsis			0.312
Infected diabetic foot	1 (4%)	2 (8%)	___
Pyonephrosis	2 (8%)	1 (4%)	___
peritonitis	3 (12%)	1 (4%)	___
Pneumonia	4 (16%)	5 (20%)	___
Infected Bed sores	5 (20%)	5 (20%)	___
Empyema	4 (16%)	0 (0%)	___
Infected central catheter	4 (16%)	3 (12%)	___
Bronchopneumonia	1 (4%)	0 (0%)	___
Pyelonephritis	1 (4%)	4 (16%)	___
Lung abscess	0 (0%)	2 (8%)	___
gluteal abscess	0 (0%)	1 (4%)	___
meningitis	0 (0%)	1 (4%)	___
GCS	11.40 ± 1.77	12.8 ± 1.2	0.026
Temperature	38.41 ± 0.746	38.85 ± 4.972	0.99
Heart rate	111.52 ± 9.79	102.48 ± 7.68	0.229
Respiratory rate	25.84 ± 2.034	24.32 ± 2.96	0.038
SBP	73.60 ± 9.52	102.8 ± 6.78	0.029
DBP	38 ± 7.07	63.60 ± 9.07	0.165
MAP	49.44 ± 5.22	76.32 ± 4.97	0.407
CVP	4.40 ± 1.89	4.64 ± 1.70	0.529
Abbreviations; GCS = Glasgow Coma Scale, **SBP** = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, **MAP** = Mean Arterial Pressure, **CVP** = Central Venous Pressure,			

Causes of Septic Schock

- Infected diabetic foot
- Pyonephrosis
- peritonitis
- Pneumonia
- Infected Bed sores
- Empyema
- Infected central catheter
- Bronchopneumonia
- Pyelonephritis

Figure (1): Pie chart depicted the underlying etiologies of septic shock

Table (2): Laboratory characteristics of the included participants			
Variables	**Septic Shock**	**Sepsis**	**P-Value**
	Mean± SD / Number (%)	**Mean± SD / Number (%)**	
HB (g/dL)	8.80 ± 0.59	9.75 ± 1.09	0.003
TLC	23.66 ± 5.115	19.84 ± 5.31	0.93
PLT (mcL)	90.88 ± 18.68	85.66 ± 20.22	0.73
PCV	28.69 ± 3.69	30.88 ± 3.52	0.83
RBS (mmol/l)	275.08 ± 92.79	207.36 ± 48.93	0.015
Serum Creatinine (mg/dL)	3.39 ± 1.66	2.30 ± 1.096	0.054
PH	7.142 ± 0.062	7.218 ± 0.063	0.85
HCO3 (mEq/L)	9.70 ± 2.81	13.92 ± 2.16	0.075
PaO2 (mmHg)	71.52 ± 15.7	88.04 ± 7.334	<0.001
PaCo2 (mmHg)	24.84 ± 2.57	28 ± 2.92	0.266
So2 (ppm)	88.72 ± 4.188	92.8 ± 2.08	<0.001
Na	126.68 ± 4.04	130.76 ± 3.33	0.240
K	4.64 ± 0.76	3.95 ± 0.823	0.89
AST (U/L)	44± 4*	34± 1*	0.54
ALT (U/L)	43 ± 1*	30± 1*	0.35
Total Bilirubin (μmol/L)	1.8 ±0.04*	0.9 ±0.04*	0.49
Direct Bilirubin (μmol/L)	0.8 ± 0.01*	0.4 ± 0.01*	0.002
Lactate	5.240 ± 1.65	4.39 ± 1.024	0.005
Culture			0.623
Positive blood	15 (60%)	13 (52%)	___
Positive Urine	3 (15%)	4 (20%)	___
Positive sputum	5 (25%)	5 (25%)	___
Positive blood& sputum	2 (10%)	1 (5%)	___
Negative	0 (0%)	2 (10%)	___
SOFA Score	7.72 ± 1.88	5.72 ± 1.69	0.041
APACH Score	27.04 ± 4.99	16.28 ± 4.72	0.039
Abbreviations; **Hb** = Hemoglobin, **TLC** = Total Leukocytic count, **PLT** = Platelets, **PCV** = Packed Cell Volume & **RBS** = Random Blood Sugar, **PH** = Power of Hydrogen, **HCO3⁻** = Bicarbonate, **mEq** = milli-Equivalent, **PaO2** = Partial Pressure of Oxygen, **PaCO2** = Partial Pressure of Carbon Dioxide, **S02** = Oxygen Saturation, **Na⁺** = sodium, **K⁺** = potassium, **AST** = Aspartate Amino-transferase, **ALT** = Alanine Amino-transferase, **BIL.T** = Total Bilirubin, **BIL.D** = Direct Bilirubin, , **SOFA** = Sequential (sepsis-related) Organ Failure Assessment, **APACHE** = Acute Physiologic and Chronic Health Evaluation, *data represented in the term of median and range,			
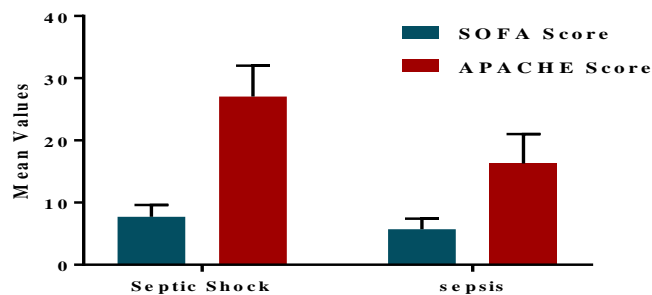
Figure (2): Error bar chart delineated the mean difference between SOFA and APACH scores among septic shock and sepsis groups.

Echocardiographic characteristics

The Echocardiographic characteristics of septic shock patients differed substantially between the day of admission and the day of discharge. In particular, the mean values of EF (p < 0.001), maximum flow velocity during late diastolic LV filling (p < 0.001), late diastolic annulus velocity (p < 0.001) and LV GLS (p = 0.033) with mean of 50.86 ± 4.003, 85.09 ± 15.47, 7.57 ± 1.07 and -13.04 ± 1.46 at admission and 60.68 ± 1.756, 59.5 ± 7.70, 9.172 ± 0.63 and -16.15 ± 8.064 at discharge, respectively (table 3). Turning to the remaining set of data, the Echocardiographic variables differed noticeably among septic patients at the day of admission and the day of discharge, whereby the functional outcomes enhanced dramatically at the day of discharge in the merits of EF, maximum flow velocity during early LV diastolic filling, maximum flow velocity during late diastolic LV filling, Early diastolic annulus velocity, late diastolic annulus velocity, and LV GLS with mean values of 63.30 ± 2.40, 69.21 ± 10.81, 55.56 ± 8.54, 10.813 ± 0.651, 11.25 ± 1.245, 6.44 ± 1.21, and -18.55 ± 0.899, respectively, at the day of discharge (Table 4).

(3): The Echocardiographic characteristics of patients with septic shock on Admission & on Discharge

Variables	At admission Mean ± SD	At Discharge Mean ± SD	P-Value
EF %	50.86 ± 4.003	60.68 ± 1.756	<0.001
E (cm/sec)	94.45 ± 11.96	76.72 ± 9.077	0.006
A (cm/sec)	85.09 ± 15.47	59.5 ± 7.70	<0.001
E/A	1.12 ± 0.195	1.29 ± 0.17	0.22
e`	7.57 ± 1.07	9.172 ± 0.63	<0.001
a`	9.76 ± 1.97	11.63 ± 0.876	<0.001
e`/a`	0.774 ± 0.076	0.75 ± 0.169	0.385
E/e`	12.51 ± 0.821	8.353 ± 0.753	0.113
LV GLS (%)	-13.04 ± 1.46	-16.15 ± 8.064	0.033

Abbreviations; **EF**= Ejection Fraction, E = maximum flow velocity during early LV diastolic filling, **A** = maximum flow velocity during late diastolic LV filling, LV **GLS** =global systolic strain, **e`** = Early diastolic annulus velocity, **a`** = late diastolic annulus velocity.

(4): The Echocardiographic characteristics of patients with sepsis on Admission & on Discharge

Variables	At admission Mean ± SD	At Discharge Mean ± SD	P-Value
EF %	59.26 ± 4.53	63.30 ± 2.40	<0.001
E (cm/sec)	101.6 ± 11.51	69.21 ± 10.81	<0.001
A (cm/sec)	81 ± 9.44	55.56 ± 8.54	<0.001
E/A	1.25 ± 0.091	1.248 ± 0.159	0.89
e`	9.96 ± 0.593	10.813 ± 0.651	<0.001
a`	9.96 ± 1.458	11.25 ± 1.245	<0.001
e`/a`	1.01 ± 0.12	0.963 ± 0.085	0.016
E/e`	10.27 ± 1.616	6.44 ± 1.21	<0.001
LV GLS (%)	-15.77 ± 1.35	-18.55 ± 0.899	<0.001

Abbreviations, **EF**= Ejection Fraction, E = maximum flow velocity during early LV diastolic filling, **A** = maximum flow velocity during late diastolic LV filling, LV **GLS** =global systolic strain, **e`** = Early diastolic annulus velocity, **a`** = late diastolic annulus velocity.

Correlation and regression analysis

Having the septic shock group, LVGLS was the only parameter, which attained statically significant highly positive correlation with SOFA score (r = 0.794, p = 0.021). On the contrary, among septic patients, EF (r = -0.475, p = 0.016), E (0.457, p = 0.022), e` (r = -0.419, p = 0.037), and a` (r = -0.428, p = 0.032) accomplished statistically significant correlation with SOFA score. In addition, LVGLS revealed statically very high positive correlation (r = 0.847, p = 0.0015) with SOFA score (Table 5 and Figure 3).

Of note, among septic shock participants, heart rate accomplished statistically significant high positive correlation with APACHE score (r = 0.619, p < 0.001). In addition, LV GLS attained very high positive correlation with APACHE score (r = 0.895, p < 0.001). Regarding the septic patients, EF revealed very high inverse correlation (r = -0.804, p < 0.001) with APACHE score, whereas LV GLS parameter achieved very high positive correlation (r = 0.903, p < 0.001) with APACHE score (Table 6 and figure 4).

Univariate regression model was implemented to retrieve the potential predictors of SOFA and APACHE score. The results of this model revealed that LV GLS (p < 0.001), EF (p < 0.001) and early diastolic annulus velocity (p < 0.001) attained high ability in the prediction of SOFA score. Similarly, these parameters accomplished highly predictive ability of the APACHE score (Table 7).

(5): Correlation between the clinical and echocardiological parameters and SOFA score

Variables	Septic shock		Sepsis	
	Correlation Co-efficient (r)	P-Value	Correlation Co-efficient (r)	P-Value
Heart rate	0.236	0.25	-0.238	0.25
SBP	0.174	0.40	0.034	0.86
DBP	-0.075	0.72	-0.04	0.84
MAP	0.038	0.85	-0.038	0.85
EF %	-0.342	0.09	-0.475	0.016
E (cm/sec)	-0.474	0.017	0.457	0.022
A (cm/sec)	-0.27	0.18	0.233	0.261
E/A	-0.106	0.61	0.298	0.147
e`	-0.394	0.051	-0.419	0.037
a`	-0.371	0.067	-0.428	0.032
e`/a`	0.321	0.116	0.389	0.054
E/e`	-0.167	0.42	0.490	0.083
LV GLS (%)	0.794	0.021	0.847	0.0015

Abbreviations; **SBP** = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, **MAP** = Mean Arterial Pressure, **EF**= Ejection Fraction, E = maximum flow velocity during early LV diastolic filling, **A** = maximum flow velocity during late diastolic LV filling, LV **GLS** =global systolic strain, **e`** = Early diastolic annulus velocity, **a`** = late diastolic annulus velocity.
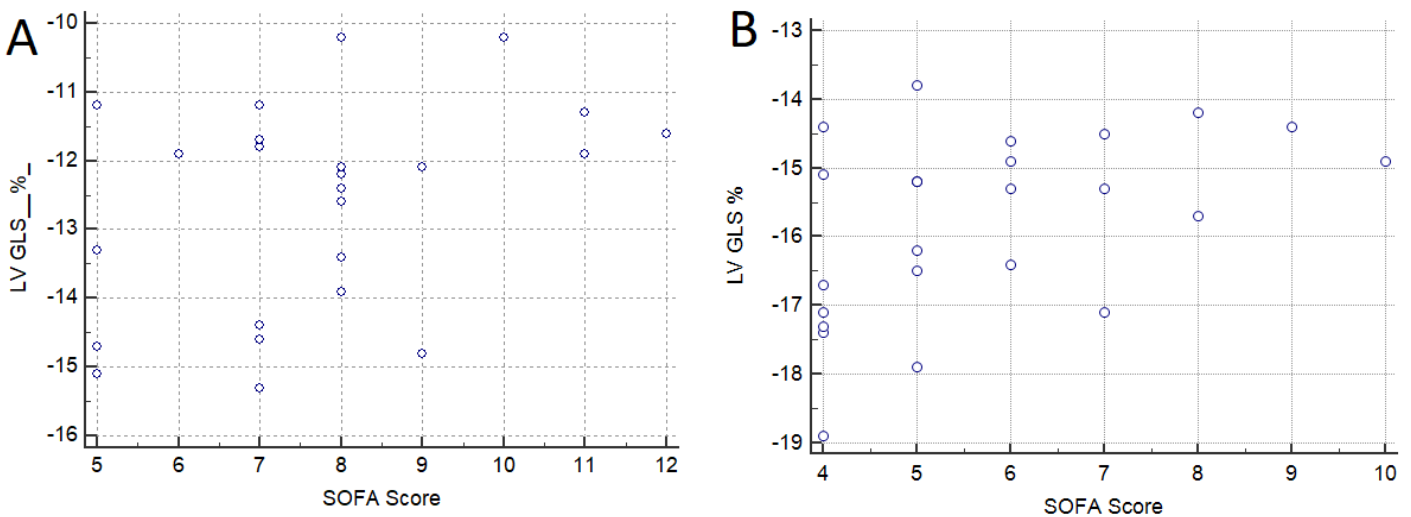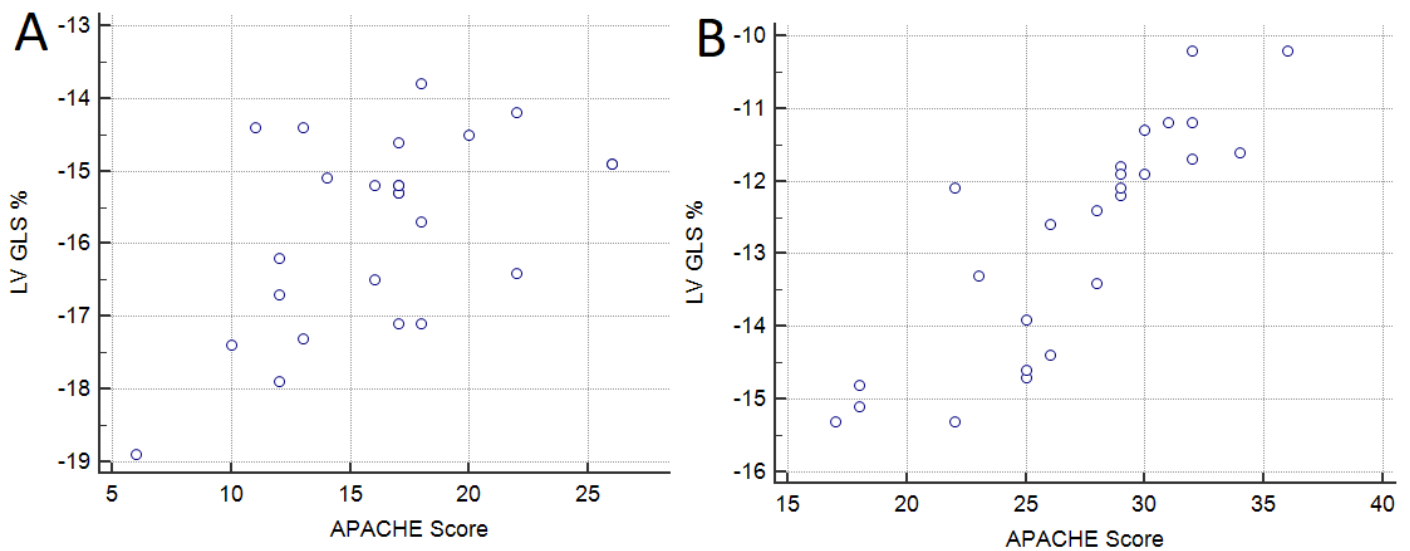

Figure (3): Scatter dots demonstrated the correlation between LV GLS and SOFA score in **(A)** Septic shock group, **(B)** Sepsis group.

Figure (6): Correlation between the clinical and echocardiological parameters and APACHE score

Variables	Septic shock		Sepsis	
	Correlation Co-efficient (r)	P-Value	Correlation Co-efficient (r)	P-Value
Heart rate	0.619	<0.001	-0.178	0.39
SBP	0.187	0.37	0.156	0.45
DBP	-0.103	0.612	-0.33	0.1
MAP	-0.214	0.303	-0.34	0.09
EF %	-0.915	<0.001	-0.804	<0.001
E (cm/sec)	-0.895	<0.001	0.720	<0.001
A (cm/sec)	0.794	<0.001	0.31	0.12
E/A	0.148	0.478	0.56	0.003
e`	-0.739	<0.001	-0.887	<0.001
a`	-0.749	<0.001	-0.897	<0.001
e`/a`	0.537	<0.001	0.764	<0.001
E/e`	0.289	0.16	0.847	<0.001
LV GLS (%)	0.859	<0.001	0.903	<0.001

Abbreviations; **SBP** = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, **MAP** = Mean Arterial Pressure, **EF**= Ejection Fraction, E = maximum flow velocity during early LV diastolic filling, **A** = maximum flow velocity during late diastolic LV filling, **LV GLS** =global systolic strain, **e`** = Early diastolic annulus velocity, **a`** = late diastolic annulus velocity.

Figure (4): Scatter dots demonstrated the correlation between LV GLS and APACHE score in (**A**) Septic shock group, (**B**) Sepsis group.

(7): Univariate regression model to predict SOFA and APACH Scores among septic patients

	SOFA Score		APACHE Score	
	β	P-Value	β	P-Value
LV GLS (%)	0.608	<0.001	0.968	<0.001
EF %	-0.597	<0.001	-0.854	<0.001
E (cm/sec)	-0.262	0.066	-0.41	0.003
A (cm/sec)	-0.057	0.69	-0.216	0.13
e`	-0.598	<0.001	-0.750	<0.001
a`	-0.397	0.004	-0.65	<0.001

Abbreviations, **LV GLS** =global systolic strain, **EF**= Ejection Fraction, E = maximum flow velocity during early LV diastolic filling, **A** = maximum flow velocity during late diastolic LV filling, **e`** = Early diastolic annulus velocity, **a`** = late diastolic annulus velocity.

Outcomes

There were three and two deaths among the septic shock and the septic groups. The mean days of ICU stay among the septic shock was 13.63 ± 2.68 while the sepsis group was 10.86 ± 2.65 that differed substantially (p = 0.001). Additionally, acute kidney injury developed in 15 patients in the septic shock group and in 11 patients in the sepsis group. Subsequent to that, three and four patients experienced arrhythmias among the septic shock and the sepsis groups respectively (Figure 5).
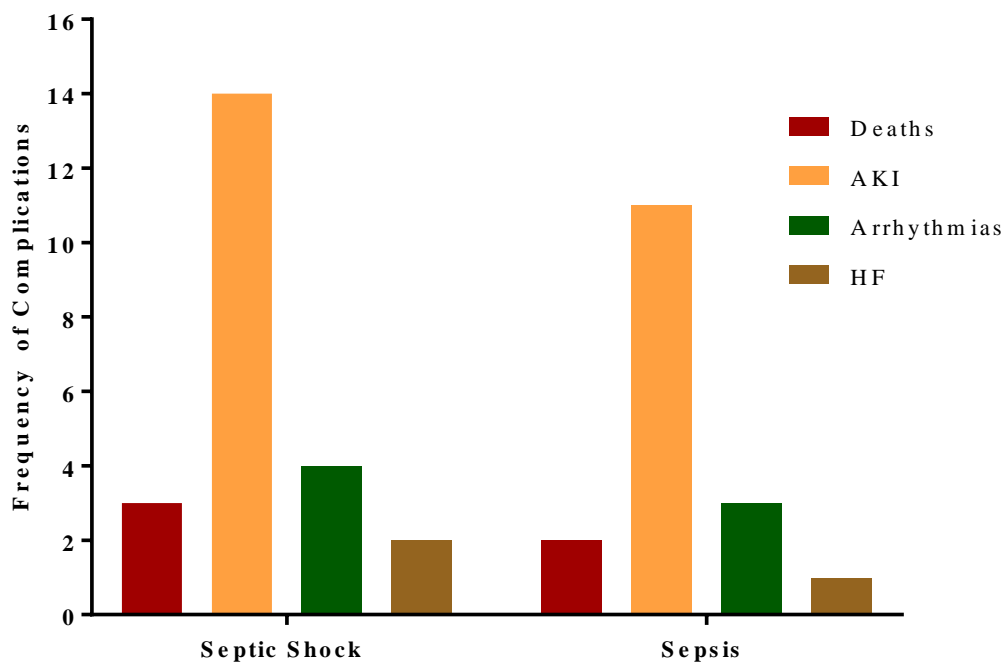
Figure (5): Bar chart delineated the pattern of complications among septic and septic shocked patients

DISCUSSION

Recently, the guidelines of Surviving Sepsis campaign focused on the early diagnosis and management of sepsis-related cardiomyopathy [19]. This is because the plurality of septic or septic shock patients developed myocardial insufficiency, even though those patients did not experience any symptoms or signs of cardiovascular dysfunction before death [20]. Furthermore, many studies evident the presence of a reversible sepsis-induced cardiac dysfunction, which requires intense management [21, 22]. Thereafter, the current study was carried out to evaluate the impact of early detection of LV dysfunction using STE on the sepsis and septic shock outcomes.

The evidence abbreviated in the current investigation brings to light that STE plays a crucial rule in the early detection of LV dysfunction as a sequel of sepsis or septic shock. In particular septic patients, who diagnosed early using STE, experienced a lower rate of mortality and complications relative to patients with septic shock. In addition, LVGLS proved highly association with the sepsis outcomes in the terms of SOFA and APACHE scores. In addition, it was an independent predictor of sepsis sequels, whereas patients with high LVGLS were more vulnerable to experience bad consequences of sepsis and septic shock. Furthermore, the significant difference between sepsis and septic shook groups regarding the SOFA and APACHE scores brings to light that the early

appreciation of LV dysfunction is a crucial factor for detection of sepsis outcomes.

Septic cardiomyopathy may be evolved as an eventual sequel of mitochondrial dysfunction, oxidative stress, myocardial injury and inflammatory process [23]. This phenomenon is difficult to be detected based on EF owed to the fact that it altered considerably by preload and after load [24]. On the one hand, more than 33% of patients with LVEF was missed when they were assessed using EF [25].

In compliance with our results, **Orde et al.** [25] notified that the predictive ability of STE in the detection of septic cardiomyopathy was relatively high when compared with convention Echocardiography. It is extremely pivotal to put into consideration that the normal values for STE are not internationally detected. On the contrary, the value at which the LV dysfunction was established was previously identified at -15 [25, 26]. Subsequent to that, **Ng et al.** [27] reported that there was a statistically significant difference between the sepsis and the septic shock patients regarding the measurements of STE. however, conventional Echocardiographic measurements of the left ventricle failed to detect the difference between such groups.

The association between LV dysfunction and the prognosis of sepsis and septic shock was also examined in previous studies [28]. For instance, **Innocenti et al.** [29] showed that the prognostic value of LV systolic dysfunction was established and the positive correlation

between LV dysfunction and SOFA score was also evolved.

STE has evolved as a direct, angle-independent, and a reproducible assessment of left ventricular function [30]. Its employment in conditions such as cardiac impairment has shown a prognostic impact in the appreciation of left ventricular performance among critically ill patients [11]. This is because it enables the early detection of hidden left ventricular impairment in the beginning of sepsis or septic shock [31].

The present investigation had many limitations such as; it is a single-center study with a limited sample size, which reflect only a small number of populations. Additionally, the clinical spectrum of septic shock is highly dynamic and even though all patients were selected for the study within the first day of admission, time from primary presentation of disease to STE performance varies.

CONCLUSIONS

The capability of STE investigation for the detection of left ventricular dysfunction among septic or septic shocked critically ill patients is a promising and feasible approach. Thereafter, health care providers should employ STE as a routine investigation for such patients to reduce the potential consequences. However, large randomized clinical trials are mandatory to address the possible limitations of the present investigation.

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