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Troponin I as a Diagnostic Biomarker of Left Ventricular Dysfunction in Septic Patients: A Prospective Study

Yahya Abd El Tawab*
ICU Department, Military Medical academy, Cairo, Egypt
***Corresponding author:** Yahya Abdel Tawab, **Mobile:** (+20) 1002993242, **E-mail:** Y_icu@yahoo.com

ABSTRACT

Background: One of sepsis's most well-known side effects is decreased left ventricular systolic function. In the first stages of sepsis, cardiac index drops left ventricular dilatation, and reduced left ventricular ejection force occur due to myocardial depression. Although ventricular depression is common in sepsis, its causes are poorly characterized. Troponin l, troponin T, and Pro Bnp are examples of biomarkers that can be used to identify myocardial damage. Myocardial damage can be diagnosed with increasing sensitivity and specificity thanks to cardiac troponins, which allow for early risk assessment.

Objective: This work aimed to decrease morbidities and mortalities of septic patients and to assess the validity (accuracy) of serum troponin I in the detection of left ventricular dysfunction in septic patients

Patients and Methods: A total of 30 patients were enrolled in a prospective study. They were hospitalized with a diagnosis of sepsis with normal cardiac functions before admission and then they were admitted to the Intensive Care Units Department, Maadi Medical Complex during the period from 2018 to 2019.

Results: Non-survived subjects had statistically significant higher SOFA score (10.25 ± 1.39 vs. 8.95 ± 0.72), higher APACHE II score (23.25 ± 3.01 vs. 20.55 ± 2.77), higher Physiology Score (16.75 ± 2.71 vs. 12.23 ± 3.82), longer duration of MV (8 ± 1.69 vs5.83 ± 1.72) and longer ICU stay (10.63 ± 2.00 vs. 7.91 ± 3.08), than survived subjects. There was no statistically significant difference regarding age, sex, and source of sepsis. The heart rate, serum troponin (at admission and on 3rd day), WBCs, serum Na, K, and serum Procalcitonin level were statistically significantly higher in non-survived than in survived subjects. In contrast, LVEF% at admission and on 3rd day was statistically significantly lower in non-survived than in survived subjects.

Conclusion: We discovered a statistically significant difference when comparing those with and without LV dysfunction. In addition, a blood troponin level of > 1.17 on the third day had a sensitivity of 94.1% and a specificity of 92.3% for predicting LV dysfunction. To sum up, troponin is the best marker for identifying left ventricular dysfunction patients with sepsis.

Keywords: Troponin I, Sepsis, Myocardial depression, Septic shock, Mortality.

INTRODUCTION

In the intensive care unit, sepsis is a major cause of mortality and disability [(1)]. Sepsis is a potentially fatal condition due, in large part, to the circulatory abnormalities that are present. One of sepsis's most well-known side effects is decreased left ventricular systolic function [(2)]. Myocardial damage/increased cardiac biomarkers, abnormalities on echocardiography, and hemodynamic instability are all signs of cardiac abnormalities [(3)].

In the first stages of sepsis, cardiac index drops and left ventricular dilatation, and decreased left ventricular ejection force occur due to myocardial depression. Circulating myocardial depressants, elevated catecholamines, and toxic mediators are some of the other causes of myocardial dysfunction alongside global ischemia. Although, ventricular depression is common in sepsis, its causes are poorly characterized [(4)].

Troponin l, troponin T, and Pro Bnp are examples of biomarkers that can be used to identify myocardial damage. Myocardial damage can be diagnosed with increasing sensitivity and specificity thanks to cardiac troponins, which allow for early risk assessment [(5)]. Actin thin filaments in muscle cells include a protein called troponins, and one of these troponins is named troponins I. Cardiac troponin I (cTnI) is more selective than the creatine kinase (CK)-MB isoenzyme for identifying myocardial injury since it is only expressed in cardiac tissue. When compared to more conventional enzyme methods, cTnI's high sensitivity and specificity allow it to detect damage to cardiac cells that would otherwise go undetected [(6)]. Heart arrhythmias and elevated levels of troponin I have been observed in cases with sepsis and septic shock. This research aimed to assess whether daily measurements of serum cardiac troponin I might be utilized as a predictor of outcome in cases with septic patients by analyzing the association between high cTnI and myocardial dysfunction.

PATIENTS AND METHODS

Study design and patient criteria: A total of 30 patients who were diagnosed as sepsis with normal cardiac functions were enrolled in this prospective study. They were admitted to the intensive care unit (ICU) Department, Maadi Medical Complex during the period from 2018 to 2019.

Inclusion criteria: Adult patients more than 18 years old both male and female who were admitted to ICU with sepsis.

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Exclusion criteria: Patient known to have chronic kidney disease, patient less than 18 years old, recent myocardial infarction within two months, known cases with low cardiac function, patient with acute coronary syndrome, pulmonary embolism, aortic stenosis, hypertrophic cardiomyopathy, restrictive cardiomyopathy, and pregnant females.

Sample size estimation: As mentioned in **Punukollu *et al.* [7],** the correlation coefficient between ejection fraction and serum cardiac troponin I was 0.6, so to get this strength of association at a power of 95% and confidence level of 95%, the minimum required sample size is 30 subjects.

All patients were subjected to: Complete history taking [personal history (name, age, occupation, residence and particular habits of medical importance especially smoking), source of sepsis, onset, and course of symptoms, history of sensitivity to drugs, medical history (cardiac problems, hypertension, chest diseases, renal diseases, liver diseases, blood diseases or bleeding tendency) and past surgical history as the history of previous operations.

Complete clinical examinations: General examinations like vital signs (temperature, respiratory rate, blood pressure & heart rate), other signs (pallor, jaundice, cyanosis & lymph node enlargement), and body mass index (BMI).

Local cardiac examination (Inspection, Palpation, and Auscultation**):**

S1 and S2 sounds, as well as systolic murmurs, can be heard in the atrial and mitral areas, as detailed above. The S3 and S4 heart sounds can be differentiated by auscultation at the left lower sternal boundary. S3 heart sound is common in individuals with heart failure but can also be physiological in young children and athletes. Blood ejection into a stiff ventricle causes the S4 heart sound, which is also present in heart failure. The diastolic murmur caused by mitral stenosis is easier to hear when the patient is lying on their side. The diaphragm of the stethoscope is used to listen for S1 and S2 sounds and systolic and diastolic murmurs once the patient is seated. As the patient holds their breath in this position, the tester can better hear any signs of aortic regurgitation or friction rubs. The timing of systolic and diastolic murmurs in relation to S1 and S2 is critical. S1 and S2 can be reliably identified by their timing relative to the carotid pulse. S1 is the tone heard just before the carotid pulse, while S2 is the tone heard immediately after. Due to the long lag time between the S2 sound and the pulsation, this method can only be used to the carotid pulse and not the radial.

Laboratory investigations: CBC (RBCs, hemoglobin concentration (Hb %), WBCs, platelet count using an Automated Hematology Analyzer (Sysmex XT 1800i, Japan), CRP, PCT, Na, K**,** cultures sensitivity according to source of sepsis (blood, urine, sputum, infected wound) and cardiac troponin I was drawn on admission to ICU and 48 h of admission.

Radiological Investigations: According to the source of sepsis (CT chest, abdomen, brain).

Transthoracic echocardiographic evaluation was done within 72h of admission, and wall motion abnormalities and left ventricular ejection fraction were visually assessed. All study participants were subjected to echocardiographic evaluation using the commercially available echocardiography system in the Cardiology Department Unit with a 1.5–3.6 MHz multi-frequency phased array probe.

EF by M-mode and Modified Simpson Method: M-mode and 2- 2-dimensional (2D) echocardiography were used for the left ventricular ejection fraction (EF %); 2- 2-dimensional (2D) echocardiography was used for the left ventricular (LV) end-systolic volume (LVESV), end-diastolic volume (LVEDV) and ejection Fraction (EF% by modified Simpson method), while the M-mode was used for EF after measuring the LVEDD, LVESD. LV systolic dysfunction is defined as LVEF < 52% in males and < 54% in females.

Left ventricular pulsed wave Doppler study: A pulsed wave (PW) Doppler investigation was carried out in the apical 4-chamber view, inside a 3 mm sample volume at the tip of the mitral leaflets, to evaluate left ventricular (LV) filling. After obtaining peak early (E) and late (A) diastolic (D) wave velocities with PW Doppler, then the E/A ratio was computed. DT = (peak of E wave - baseline)/100 is the period of deceleration. The isovolumic relaxation time (IVRT) was determined to be in milliseconds**.**

Left ventricular Tissue Doppler imaging (TDI): Mitral annular s', septal, and lateral e' and a' wave velocities were acquired via PW tissue Doppler imaging (TDI), and the sample volume was positioned at or 1 cm within the mitral leaflets. The average E/e ratio was then calculated. S' values above 10 cm/s are considered normal. Diastolic dysfunction and elevated LAP are indicated by an E/e′ ratio greater than 14.

Myocardial performance index (MPI): Left ventricular MPI was evaluated using TDI techniques. To determine the Tei index, we divided the sum of the ejection time (ET) and the isovolumetric relaxation time (IVRT) to get the contraction time (IVCT). The value of 0.39 plus or minus 0.05 is deemed normal. An MPI greater than 0.5 indicates pathology.

The SOFA Score: Review the SOFA score to determine the degree of sepsis (mild, moderate, severe).

Potential risks: Minimal blood sampling.

Confidentiality of data: Patients' data were dealt with in complete confidentiality, and no one had the right to read their medical information except the investigators in this study. After completing the research, they were informed regarding their results and further information regarding their health status.

Right to refuse or withdraw: Anyone who is asked to take part in this study is under no obligation to do so. They are free to withdraw their involvement at any moment. Before signing this permission form, please make sure you fully understand that your participation in this study is entirely optional and that you can stop at any time without losing any benefits to which you are otherwise entitled. Whether or not you choose to participate in this study will not impact the quality of care that you receive. No identifying information about participants will be included in any reports or papers that come out of this project.

Ethical consideration: Informed written consents were obtained from all patients prior to enrolment. Study details and the nature of the investigations were explained to all patients. Approval of the Research Ethics Committee of Maadi Medical Complex, Egypt was obtained and the study was conducted in accordance with the Declaration of Helsinki.

Statistical analysis

The findings were tabulated and statistically evaluated using Microsoft Excel 2019 and SPSS version 25 (SPSS Inc., Chicago, IL, USA) on a personal computer. Relative frequency distributions were used to display categorical variables, and the Chi-square test (Fisher or Monte Carlo) was used to assess descriptive variables. Logistic regression analysis, ROC curve analysis, and the cumulative odds of variable outcomes were compared by utilizing the Kaplan-Meier survival estimator. At $p \leq 0.05$, statistical significance was determined.

RESULTS

A flowchart of the study population. Of the 40 patients conducted to evaluate troponin I as a diagnostic biomarker of left ventricular dysfunction in septic patients. 10 subjects were excluded from the study (3 patients declined consent and 7 patients did not meet the inclusion criteria, 30 patients were willing to participate. 22 of them were survivor and 8 patients died **(Figure 1)**.

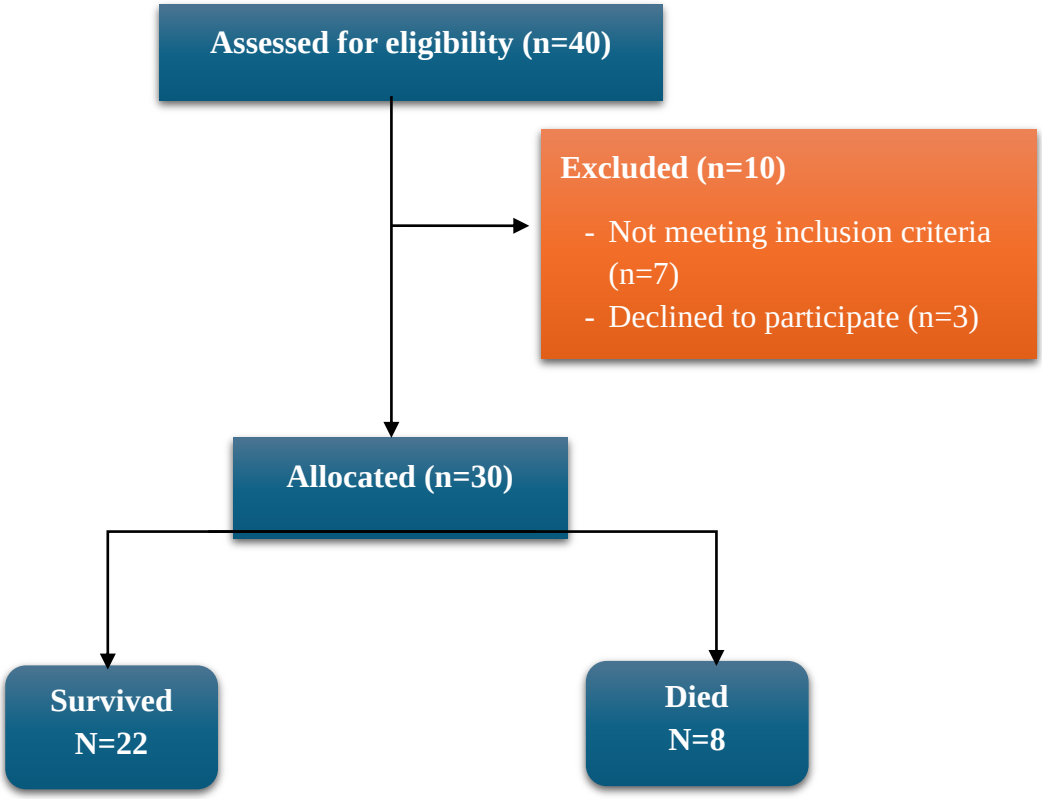

Figure (1): Flowchart of the studied patients.

Non-survived subjects had statistically significant higher SOFA scores (10.25 ± 1.39 vs. 8.95 ± 0.72), higher APACHE II scores (23.25 ± 3.01 vs. 20.55 ± 2.77), higher Physiology Scores (16.75 ± 2.71 vs. 12.23 ± 3.82), longer duration of MV (8 ± 1.69 vs 5.83 ± 1.72) and longer ICU stay (10.63 ± 2.00 vs. 7.91 ± 3.08) than survived subjects. While, there was no statistically significant difference regarding age, sex, and source of sepsis **(Table 1).**

Table (1): Comparison of clinical data about outcomes in the studied population

	Survived (n=22)		Died (n=8)		Sig. test	
	Mean	SD	Mean	SD	*t*	*P-value*
Age (year)	69.91	5.58	69.88	6.73	0.014	0.989
BMI (kg/m^2)	27.25	2.28	26.36	2.12	0.966	0.342
SOFA score	8.95	0.72	10.25	1.39	3.358	0.002*
APACHEII score	20.55	2.77	23.25	3.01	2.311	0.028*
Physiology score	12.23	3.82	16.75	2.71	3.066	0.005*
MV duration (day)	5.83	1.72	8.00	1.69	2.355	0.036*
ICU stay (day)	7.91	3.08	10.63	2.00	2.307	0.029*
Sex	N	%	N	%	X^2	*P-value*
Male	14	63.6%	6	75%	0.341	0.559
Female	8	36.4%	2	25%		
Source of sepsis	N	%	N	%	X2	P-value
Wound	1	4.5%	0	0%	1.875a	759
Pulmonary	12	54.5%	4	50%		
Urogenital	2	9.1%	2	25%		
Intra-abdominal	2	9.1%	1	12.5%		
Unknown	5	22.7%	1	12.5%		

Also, heart rate, serum troponin both at admission and on 3rd day, WBCs, serum Na, K, and serum procalcitonin level were statistically significantly higher in non-survived than in survived subjects while LVEF% both at admission and on 3rd day were statistically significantly lower in non-survived than in survived subjects. The requirement of MV was statistically significantly higher in non-survived than in survived subjects (100% vs 27.3%). LV dysfunction at admission was statistically significantly higher in non-survived than survived subjects (75% vs 9.1%). LV dysfunction at 3rd day was statistically significantly higher in non-survived than in survived subjects (87.5% vs 45.5%), **(Table 2).**

Table (2): Laboratory data, echo parameters and clinical course concerning outcome among the studied population

	Survived (n=22)		Died (n=8)		Sig. test	
	Mean	SD	Mean	SD	t	P-value
HR (Beat/min)	96.45	3.23	101.13	3.56	-3.409	0.002*
RR (Cycles/min)	22.23	2.37	23.38	2.62	-1.143	0.263
BlP	113.50	6.22	110.13	5.08	1.373	0.181
Temperature (^{o}C)	36.98	0.20	37.08	0.24	-1.069	0.294
LVEF at admission (%)	59.26	6.41	48.98	7.01	3.794	0.001*
LVEF at 3rd day (%)	51.70	6.78	42.24	5.63	3.521	0.001*
Troponin at admission (ng/ml)	1.65	1.67	4.42	2.14	-3.737	0.001*
Troponin at 3rd day (ng/ml)	1.82	1.68	4.63	2.17	-3.759	0.001*
Hb (gm/dl)	11.09	0.72	10.34	0.97	2.303	0.029*
WBC (10^3/ml)	13.18	1.47	14.75	1.67	-2.497	0.019*
Plat (10^3/ml)	212.00	7.69	213.00	7.29	-0.319	0.752
Na (mmol/l)	137.59	3.16	139.13	1.73	-1.296	0.206
K (mmol/l)	4.02	0.26	4.30	0.26	-2.654	0.013*
CRP (mg/l)	146.45	5.99	147.75	6.71	-0.508	0.616
Procalcitonin (ng/ml)	29.00	5.44	40.25	4.83	-5.145	0.0001*
	N	%	N	%	X^2	P value
MV	6	27.3%	8	100%	12.468	0.00001*
LV dysfunction at admission	2	9.1%	6	75%	13.023	0.00001*
LV dysfunction at 3 days	10	45.5%	7	87.5%	4.224	0.04*

As for age, male sex, SOFA, APACHE-II, physiological scores, MV duration, and ICU stay, they were statistically significantly higher in subjects with than without LV dysfunction (Table 3).

Table (3): Clinical data concerning LV dysfunction among the studied population

	No LV dysfunction (n=13)		**LV dysfunction (n=17)**		**Sig. test**	
	Mean	**SD**	**Mean**	**SD**	***t***	***P-value***
Age (year)	66.08	3.75	72.82	5.40	3.844	0.001*
BMI (kg/m^2)	26.88	2.42	27.12	2.15	0.295	0.770
SOFA score	8.54	0.66	9.88	0.99	4.21	0.0001*
APACHEII score	19.38	2.84	22.71	2.37	3.49	0.002*
Physiology score	11.08	3.43	15.24	3.61	3.19	0.003*
MV duration (day)	5.00	1.41	7.90	1.52	3.27	0.007*
ICU stay (day)	5.62	1.50	10.94	1.48	9.71	0.0001*
Sex	**N**	**%**	**N**	**%**	***X*^{2}**	***P-value***
Male	6	46.2%	14	82.4%	4.344	0.037*
Female	7	53.8%	3	17.0%		
Source						
Wound	1	7.7%	0	0%	6.584	0.160
Pulmonary	6	46.2%	10	58.8%		
Urogenital	0	0%	4	23.5%		
Intra-abdominal	2	15.4%	1	5.9%		
Unknown	4	30.8%	2	11.8%		

Regarding heart rate, respiratory rate, serum troponin both at admission and at 3rd day, WBCs, CRP and serum procalcitonin levels were statistically significantly higher in subjects with ATHN without LV dysfunction. In contrast, systolic blood pressure, Hb, and LVEF% both at admission and at 3rd day were statistically significantly lower in subjects with ATHN without LV dysfunction. Subjects who developed LV dysfunction had a statistically significant higher rate of MV (64.7%) than those who did not develop LV dysfunction (23.1%) (Table 4).

Table (4): Laboratory data and echo parameters concerning LV dysfunction in the studied population

	No LV dysfunction (n=13)		**LV dysfunction (n=17)**		***Sig. test***	
	Mean	SD	Mean	SD	*t*	*P-value*
HR (Beat/min)	94.54	2.47	100.12	2.89	5.569	0.0001*
RR (Cycles/min)	20.85	2.03	23.82	1.91	4.112	0.0001*
BlP	116.69	5.47	109.47	4.45	3.992	0.0001*
Temperature (^{o}C)	36.98	0.20	37.03	0.22	0.667	0.510
LVEF at admission (%)	63.65	2.93	51.07	5.92	7.01	0.0001*
LVEF at 3rd day (%)	56.41	4.19	43.65	4.36	8.073	0.0001*
Troponin at admission (ng/ml)	0.64	0.12	3.73	1.98	5.497	0.0001*
Troponin at 3rd day (ng/ml)	0.78	0.14	3.93	2.00	5.588	0.0001*
Hb (gm/dl)	11.28	0.78	10.59	0.79	2.346	0.026*
WBC (10^3/ml)	12.31	1.32	14.59	1.12	5.122	0.0001*
Plat (10^3/ml)	215.62	5.69	209.71	7.80	2.299	0.0291*
Na (mmol/l)	138.38	3.50	137.71	2.42	0.628	0.535
K (mmol/l)	4.10	0.30	4.09	0.28	0.111	0.912
CRP (mg/l)	142.92	5.63	149.76	4.70	3.627	0.001*
Procalcitonin (ng/ml)	26.77	4.25	36.00	6.54	4.42	0.0001*
MV	3	23.1%	11	64.7%	X^2=5.129	P=0.024

Serum troponin had a statistically significant negative correlation with LVEF%, systolic BP and Hb level either on admission or at 3 days later and statistically significant positive correlation with HR, RR, WBCs, CRP, procalcitonin, SOFA, APACHE-II, physiological score, MV duration and hospital stay duration either on admission or at three days later**.** LVEF% has a statistically significant positive correlation with systolic BP and Hb level either on admission or at 3 days later and a statistically significant negative correlation with HR, RR, WBCs, CRP, procalcitonin, SOFA, APACHE-II, physiological score, MV duration, and hospital stay duration either on admission or at 3 days later (Table 5).

Table (5): The correlation of serum troponin and LVEF% with clinical data in the studied population

	Troponin at admission		**Troponin at 3-day**		**LVEF% at admission**		**LVEF at 3 days**	
	r	***p-value***	***r***	***p-value***	***r***	***p-value***	***r***	***p-value***
LVEF at admission (%)	-0.830	0.000	-0.838	0.000	---	---	---	---
LVEF at 3rd day (%)	-0.855	0.000	-0.873	0.000	---	---	---	---
BMI (kg/m^2)	-0.019	0.922	-0.071	0.710	0.012	0.950	0.095	0.618
Temperature (^{o}C)	0.104	0.583	0.110	0.563	-0.257	0.171	-0.145	0.443
HR (Beat/min)	0.691	0.000	0.701	0.000	-0.723	0.000	-0.683	0.000
Blood Pressure	-0.535	0.002	-0.517	0.003	0.596	0.001	0.620	0.000
RR (Cycles/min)	0.512	0.004	0.502	0.005	-0.609	0.000	-0.539	0.002
Hb (gm/dl)	-0.431	0.017	-0.435-	0.016	0.453	0.012	0.363	0.049
WBC (10^3/ml)	0.515	0.004	0.529	0.003	-0.572	0.001	-0.556	0.001
Plat (10^3/ml)	-0.236	0.210	-0.208-	0.270	0.115	0.546	0.195	0.301
Na (mmol/l)	0.069	0.715	0.048	0.800	-0.033	0.862	0.029	0.880
K (mmol/l)	0.188	0.319	0.177	0.350	-0.064	0.735	-0.170	0.370
CRP (mg/l)	0.660	0.000	0.628	0.000	-0.527	0.003	-0.532	0.002
Procalcitonin (ng/ml)	0.704	0.000	0.720	0.000	-0.770	0.000	-0.720	0.000
SOFA	0.749	0.000	0.757	0.000	-0.724	0.000	-0.673	0.000
APACHEII	0.619	0.000	0.626	0.000	-0.564	0.001	-0.691	0.000
Physiology Score	0.520	0.003	0.518	0.003	-0.621	0.000	-0.565	0.001
MV duration (day)	0.703	0.005	0.699	0.005	-0.711	0.004	-0.681	0.007
ICU stay (day)	0.731	0.000	0.735	0.000	-0.834	0.000	-0.817	0.000
Age (year)	0.266	0.155	0.278	0.137	-0.347	0.060	-0.412	0.024

At cutoff point > 1.1, serum troponin level at admission had 94.1% sensitivity and 92.3% specificity to predict LV dysfunction. At cutoff point > 1.17, serum troponin level at 3rd day had 94.1% sensitivity and 92.3% specificity to predict LV dysfunction. At cutoff point > 144 CRP level had 76.5% sensitivity and 69.2% specificity to predict LV dysfunction. At cutoff point > 24 serum procalcitonin level had 94.1% sensitivity and 69.2% specificity to predict LV dysfunction. At cutoff point > 8.5 SOFA score had 100% sensitivity and 53.8% specificity to predict LV dysfunction. At cutoff point > 18.5 APACHE II score had 100% sensitivity and 48.5% specificity to predict LV dysfunction. At cutoff point > 10.5 acute physiology score had 88.2% sensitivity and 46.2% specificity to predict LV dysfunction (Table 6 and figure 2).

Table (6): Sensitivity and specificity of troponin, CRP, procalcitonin, and clinical scores as predictors of LV dysfunction.

Variable	**Cut off point**	**AUC**	**S. E**	**Sensitivity %**	**Specificity %**	**Asymptotic 95% Confidence Interval**	
						Lower Bound	**Upper Bound**
Troponin atadmission	1.1	0.991	0.012	94.1	92.3	0.967	1.000
Troponin at 3rd day	1.17	0.991	0.012	94.1	92.3	0.967	1.000
CRP	144	0.846	0.074	76.5	69.2	0.701	0.992
Procalcitonin	24	0.882	0.062	94.1	69.2	0.762	1.000
SOFA	8.5	0.873	0.065	100	53.8	0.747	1.000
APACHEII	18.5	0.808	0.081	100	48.5	0.649	0.966
Acute physiology Score	10.5	0.801	0.086	88.2	46.2	0.633	0.969

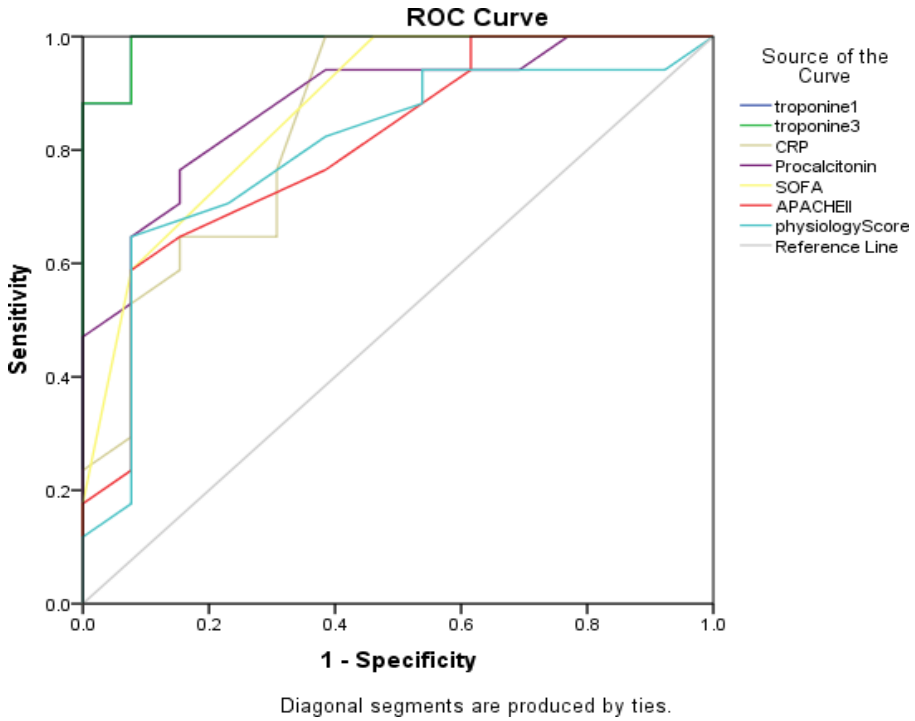

Figure (2): ROC curve for predictors of LV dysfunction.

DISCUSSION

Our findings agreed with those of **ver Elst *et al.* [8],** who investigated the correlation between cardiac troponins I and T and left ventricular (LV) dysfunction in the earliest stages of septic shock. Forty-six participants (ages 18 to 93; median 66; male-to-female ratio 30/16) were included in their study. Out of these septic complications, 34 were diagnosed with pneumonia, 3 with uremic sepsis, 4 with wound infection, 3 with catheter sepsis, and 3 with meningitis.

Our findings showed that heart rate ranged between 90-106 beats/min, the respiratory rate ranged between 18-27 cycles/min, the temperature ranged between 36.7- 37.4 ˚C, and systolic blood pressure ranged between 104-126 mmHg. SOFA score ranged between 8-12, APACHE II score ranged between 15-27, and Physiology Score ranged between 7-20, mechanical ventilation duration ranged between 4-9 days with a mean value of 7.07 ± 1.98 days, and the duration of ICU stay ranged between 3-12 days with a mean value of 8.63 ± 3.06 days. The average SOFA score reported by **Hai *et al.*** [9] was 8.9, and the average APACHE II score was 19.1. Our findings corroborate their findings. Three-hundred-and-eighty-five patients (71.5%) were diagnosed with septic shock, whereas thirty-three patients (28.5%) had sepsis. Mechanical ventilation was used for 90 patients (79.3%), and CRT was given to 53 patients (45.7%). Hospital mortality was 34.5%. Furthermore, **ver Elst *et al.*** [8] demonstrated that APACHE II scores 24 (20–30).

In our current study regarding laboratory investigations of included subjects, it was demonstrated that Hb ranged between 9.5-12.3 gm/dl, WBCs count ranged between 11-16 thousand/mm^3, platelet count ranged between 201 - 224 thousand/mm^3, and Na level ranged between 134-145 mmol/l, K level ranged between 3.6 - 4.7 mmol/L, CRP ranged between 134 - 157 mg/L, and procalcitonin level ranged between 21-46 ng/ml with a mean value of 32 ±7.26. Follow up of LVEF% and serum troponin at admission and 3 days later of participating subjects showed that LVEF% declined from 56.52 ± 7.94 at admission to 49.18 ±7.69 on the 3rd day and serum troponin increased from 2.39 ± 2.16 at admission to 2.57 ± 2.18 at the 3rd day. At admission, 26.7% of included subjects had LV dysfunction, which increased to 56.7% on the 3rd day of admission. In around half of all septic patients, a condition known as sepsis-induced myocardial dysfunction manifests itself by decrease in ventricular function [10]**.** When assessing shifts in LV function and assisting in diagnosing SIMD, echocardiography is the gold standard. Traditional echocardiogram measures LV function by measuring LV ejection fraction (LVEF), although LVEF is sensitive to preload and afterload [11]**.** Speckle-tracking echocardiography has recently been used in clinical practice to assess intrinsic LV systolic function in septic patients to alleviate many limitations of LVEF [12]**.**

In our current study regarding the outcome of included subjects, 48.3% required MV, and the mortality rate was 26.7%. Non-survived subjects had statistically significant higher SOFA scores (10.25 ± 1.39 vs. 8.95 ± 0.72), higher APACHE II scores (23.25 ± 3.01 vs. 20.55 ± 2.77), higher Physiology score (16.75 ± 2.71 vs. 12.23 ± 3.82), longer duration of MV (8 ± 1.69 vs. 5.83 ± 1.72) and longer ICU stay (10.63 ± 2.00 vs. 7.91 ± 3.08). Then, the subjects survived

while there was no statistically significant difference regarding age, sex, and source of sepsis. Like our findings, **ver Elst *et al.*** [8] observed no significant sex differences in the studied populations. They also found large differences in APACHEII score amongst the different groups. Otherwise, they demonstrated that differences in age were statistically significant. Testing for troponin in patients with septic shock is helpful in gauging the severity of cardiac dysfunction due to sepsis [13]**.** When comparing SIMD Based on TTE n = 139 and SIMD (+) Based on TTE n = 258, the researchers discovered no significant differences in age, male sex, or causes of sepsis. Our findings showed that the LVEF% of non-survivors was lower on both days and that their heart rates, serum troponin levels (both on admission and on day 3), white blood cell counts, serum sodium levels, serum potassium levels, and serum procalcitonin levels were all greater than those of survivors. In contrast to **ver Elst *et al.*** [8] findings**,** we detected a significant variation in LVEF% between the groups we analyzed. Heart rate and white blood cell count showed no significant differences across groups, as reported by **Kim *et al.*** [13]**.**

Non-survivors required MV at a significantly higher rate (100%) than survivors (27.3%). Subjects who did not make it past hospitalization had a much greater prevalence of LV dysfunction (75% vs. 9.1%). LV dysfunction was significantly more common among those who did not make it to day 3 (87.5% vs 45.5%) than those who did. Significant differences in LV dysfunction were seen between the groups tested, as reported by **Kim *et al.*** [13]**.** Patients with LV failure was shown to have significantly higher mean ages, male sex, SOFA, APACHEII, physiological score, MV lengths, and ICU stays than those without LV failure. We showed that serum hs-cTnT measurements were helpful for early diagnosis of critically ill individuals' subclinical left ventricular systolic dysfunction (LVSD). Using speckle-tracking echocardiography, they postulated that an increased hs-cTnT level is linked to LVSD in sepsis patients. There were 116 unique cases studied. The averages of the three metrics (SOFA, APACHEII, and MV length) showed statistically significant variations between the groups. There was no obvious difference in age or sex across the groups. Our results showed that subjects with LV dysfunction had higher systolic blood pressure, hemoglobin, and LVEF% on admission and day three, while subjects without LV dysfunction had lower systolic blood pressure, respiratory rate, serum troponin, white blood cells, C-reactive protein, and serum procalcitonin levels. There was no statistically significant difference between the groups regarding inflammatory indicators such as procalcitonin (PCT; p = 0.440) and white blood cell (WBC; p = 0.994), as reported by the study by **Hai *et al.*** [9]**.**

Patients with LVSD also had a substantially higher median hs-cTnT level and a more significant percentage of patients with elevated hs-cTnT levels (>14 ng/L) than those without LVSD. While there was no statistically significant difference in heart rate or blood pressure between the two groups, patients with LVSD did have significantly lower mean arterial pressure (p<0.001). Patients with LVSD were more likely to experience septic shock (56% vs. 92%) than those without. **Ammann *et al.*** [14] observed that patients with elevated troponin levels had a poorer left ventricular ejection fraction (LVEF). Two-dimensional transesophageal echocardiography demonstrated an association between cTnI and cTnT with LV dysfunction in septic individuals.

Our data showed that the MV rate was much more significant (64.7% vs. 23.0%) in subjects who acquired LV dysfunction than those who did not. Our findings align with **Hai *et al.*** [9] who found that the percentage of patients requiring mechanical ventilation was more significant among those with LVSD than those without LVSD. Furthermore, our findings are at odds with those of **Albeiruti *et al.*** [15] assessed the effect of newly developed left ventricular dysfunction on hospital outcomes for patients undergoing mechanical ventilation for severe sepsis and septic shock. They found that patients with LVSD or LVDD did not fare any better than those without the conditions. To the contrary, we found a statistically significant positive correlation between serum troponin and HR, RR, WBCs, CRP, procalcitonin, SOFA, APACHE-II, physiological score, MV duration, and hospital stay duration. Also, a statistically significant negative correlation with LVEF%, systolic BP, and Hb level upon admission or three days later. Systolic blood pressure and hemoglobin level positively correlated with LVEF% on admission and 3 days later. In contrast, HR, RR, WBCs, CRP, procalcitonin, SOFA, APACHE-II, physiological score, MV duration, and hospital stay duration negatively correlated with LVEF% on admission and 3 days later.

The relationships between each variable and subclinical LVSD were investigated using a univariate analysis based on the logistic regression model. Our results corroborate with those of **Hai *et al.*** [9]**.** Patients with septic shock, those who needed mechanical ventilation, and those with elevated hs-cTnT levels were found to have a greater risk of developing LVSD. After adjusting for confounding factors, the hs-cTnT level remained a significant predictor of LVSD in sepsis (HR, 1.002; 95% CI, 1.000 to 1.004; p= 0.025). Another considerable predictor was septic shock (hazard ratio [HR], 7.6; 95% CI, 2.25 to 25.76; p = 0.001). **ver Elst *et al.*** [8] found a significant correlation (P =.004) between the APACHE II score at admission and peak cTn levels. Spearman's correlation coefficients for cTnT and cTnI were P = 0.001 and P = 0.0004, respectively. Both groups had similar rates of gram-negative shock, inotrope use, and doses of individual catecholamines. Atrial fibrillation, atrial flutter, and supraventricular tachycardia were often reported by patients regardless of cTnI status (data not

shown). No one in the trial had acute ischemia, as measured by ECG, in the first two days. Patients with septic shock were studied by **Mehta *et al.*** [16] to identify myocardial injury by measuring serum cardiac troponin I (cTnI), to assess the correlation between high cTnI and myocardial dysfunction and to determine whether cTnI is a prognostic factor in this population. The effects of septic shock were evaluated in 37 consecutive cases.

Serum cTnI levels were significantly elevated in 16 individuals (43%). These patients had a greater incidence of regional wall motion abnormalities on echocardiography (56% vs. 6%, p=0.002), a lower ejection fraction (46% vs. 62%, p=0.04), and a higher mortality (56% vs. 24%, p=0.04). They also had a higher APACHE II score (28 vs. 20, p=0.004). Multivariate logistic regression identified serum cTnI and the APACHE II score as independent predictors of death and length of ICU stay, respectively. When predicting mortality in septic shock, serum cTnI demonstrated statistically significant receiver-operating characteristics. Serum cTnI levels correlated inversely with left ventricular ejection fraction.

Our findings demonstrated a positive correlation between LVEF% and systolic BP and Hb level at admission and three days later and a negative correlation between LVEF% and HR, RR, WBCs, CRP, procalcitonin, SOFA, APACHE-II, physiological score, MV duration, and hospital stay duration. Unlike the results discovered by **Ellrodt *et al.*** [17] who sought to evaluate left ventricular performance in septic shock by measuring HR, BP, and PCWP, we observed no such link. The significance of LVSD in septic shock patients and its associated outcome was also investigated, and our findings corroborate with those of **Prabhu *et al.*** [18] who reported that non-survivors had lower mean blood pressure, ejection fraction, and APACHE III score. A blood troponin level > 1.1 (ng/ml) at admission was highly predictive of LV dysfunction, with a sensitivity of 94.1% and a specificity of 92.3%. The sensitivity and specificity for predicting LV dysfunction are 94.1% and 92.3%, respectively, at a serum troponin cutoff of > 1.17 on day 3. A CRP threshold of >144 has a sensitivity of 76.5% and a specificity of 69.2% for predicting LV dysfunction. The predictive value of a blood procalcitonin level > 24 for LV dysfunction is 94.1% and 69.2%, respectively.

With a sensitivity of 100% and a specificity of 53.8%, predicting LV dysfunction when the SOFA score is more than 8.5. An APACHE II score > 18.5 has a 100% sensitivity and a 48.5% specificity for predicting LV dysfunction. The acute physiology score was 88.2% sensitive and 46.2% specific at a threshold of > 10.5 for predicting LV dysfunction.

The findings of **Hai *et al.*** [9] about the use of ROC analysis to identify asymptomatic LV systolic failure are supported by our research. There was a 0.73 AUC beneath the curve. To predict subclinical LV systolic dysfunction in sepsis, a serum hs-cTnT level of 40 ng/L was proposed as the best cutoff value, with a sensitivity of 84% and specificity of 53%. Combining hs- cTnT with septic shock increased the AUC for predicting LVSD in sepsis from 0.73 to 0.80, statistically significant compared to using either variable alone. The combined model showed excellent sensitivity and specificity. For the SACB Text: Since hs-cTnT is the most sensitive and specific marker of cardiomyocyte necrosis, it is commonly utilized to identify people with acute coronary syndromes [19].

According to two investigations, serum hs-cTnT levels are significantly greater in septic patients [8, 20]. There was a 58.6% sensitivity and 59.1% specificity (area under the curve [AUC] = 0.668) for the diagnosis of SIMD when an elevated hs-cTnI level was present at admission, using a threshold of 40 ng/L. The findings here are consistent with those of **Kim *et al.*** [13].

The probability of having SIMD increased by 8% (95% CI, 1.01 to 1.06) for every unit increase in hs-cTnI. In patients with severe sepsis and septic shock, the hs-cTnT level was linked to LV diastolic dysfunction and RV dilatation, as described by **Landesberg *et al.*** [20]. Increases in global strain, strain-rate imaging, and three-dimensional ventricular volume analysis were also related to LV diastolic dysfunction and RV dilatation, as was a rise in high-sensitivity troponin-T concentration. Patients with increased troponins but no evidence of ACS were studied by **Ammann *et al.*** [14] to determine the cause and prognostic significance of this finding. A poorer LVEF (p = 0.0006) and increased mortality risk (22.4% vs. 5.2%, p = 0.018) were linked to positive troponin levels.

Mehta *et al.* [16] found that serum cTnI could be used to evaluate myocardial damage in patients with septic shock. Serum cTnI levels are associated with myocardial dysfunction in septic shock. Serum cTnI levels are predictive of sepsis severity and mortality. Septic shock patients with elevated cTnI levels require strict monitoring.

CONCLUSION

Based on our results, there was a significant divide between those with and without LV dysfunction. The sensitivity for predicting LV dysfunction was 94.1%, and the specificity was 92.3% if the serum troponin level was more than 1.17 after three days. Given these findings, troponin can be considered the gold standard for diagnosing left ventricular dysfunction and severe sepsis in patients. We discovered a statistically significant difference when comparing those with and without LV dysfunction. In addition, a blood troponin level of > 1.17 on the third day had a sensitivity of 94.1% and a specificity of 92.3% for predicting LV dysfunction. To

summarize, troponin is the best marker for identifying left ventricular dysfunction in patients with sepsis.

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