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A Study of Myocardial Dysfunction in Patients of Severe Sepsis and Septic Shock at Patna Medical College, Patna

[1]Dr. Sanjeev Kumar, MBBS, MD (Medicine) Student, Department of General Medicine, Patna Medical College and Hospital, Patna.

[2]Dr. (Prof.) Kaushal Kishore, MBBS, MD (Medicine), DMRD Professor, Department of General Medicine, Patna Medical College and Hospital, Patna.

[3]Dr. Devendra Kumar Sinha, MBBS, MD (Medicine), Assistant Professor, Department of General Medicine, Patna Medical College and Hospital, Patna.

Corresponding Author: Dr. Sanjeev Kumar, MBBS, MD (Medicine) Student, Department of General Medicine, Patna Medical College and Hospital, Patna.

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Abstract

Introduction: In this study, Septic shock and sepsis are serious medical ailments often characterized by an abnormal host inflammatory reaction to acute and chronic infections. Septic shock management involves targeted treatment to control infections, reduce end-organ damage and reverse the injury. Sepsis-induced myocardial dysfunction and one main characteristic of septic shock is the systemic inflammatory response syndrome (SIRS), that is defined as an immunological response to infection that is dysregulated.

Methods: This study is based on cross-sectional, non-randomized, non-interventional. Department of General Medicine, Patna Medical College, Patna, from January 2023 to June 2024. In this study, cohort included those suffering from septic shcok and severe sepsis admitted to the CCU. Around 50 with septic shock or sepsis were selected for this investigation.

Result: In this study, fifty people participated 26 were male and 24 were female. Male patients had a mean age of 48 and female patients a mean age of 44. The average weight of the male population was 86.2 kg, while the average weight of the female population was 74.9 kg. 65.3% of men and 54.1% of women had diabetes mellitus, whereas 46.1% of men and 33.3% of women had hypertension.

Conclusion: This study highlights the prognostic significance of diastolic dysfunction and hemodynamic parameters in predicting death, and it offers insightful information about the clinical and echocardiographic

features of individuals with sepsis- associated myocardial dysfunction.

Keywords: Myocardial Dysfunction, Septic Shock, Ejection Fraction, Abnormalities, Cardiomyopathy

Introduction

Septic shock and sepsis are serious medical ailments often characterized by an abnormal host inflammatory reaction to acute and chronic infections, resulting in organ dysfunction which might be fatal to patients. Septic shock affects a multitude of patients on a global scale every year, highlighting their substantial influence on public health. Myocardial dysfunction (MD) is one of the prevalent and clinically significant consequences that arise from septic shock and sepsis. MD is prevalent as well as clinically significant in this population; indications of it are present in about 50% of septic patients. A joint task force led by the European Society of Intensive Care Medicine (ESICM) and the Society of Critical Care Medicine (SCCM) in 2016 defined sepsis to be a severe illness in which an uncontrollably high immune reaction arising due to infection results in organ dysfunction which could be fatal. An advanced stage of this illness called severe sepsis is characterized by further organ failure or tissue hypoperfusion. Severe sepsis is defined by a number of signs, including hypotension brought on by sepsis, increased lactate levels, decreased urine production, acute injury to the lungs, and anomalies in the kidney functions, liver, platelets, and coagulation. The hallmark of septic shock, a crucial subtype of sepsis, is ongoing hypotension that persists after appropriate fluid replacement. One main characteristic of septic shock is the systemic inflammatory response syndrome (SIRS), that is defined as an immunological response to infection that is dysregulated. A circulatory problem leads to the development of septic shock, which first manifests as a hyper dynamic state with lowering of peripheral vascular resistance and increased cardiac output. But this leads to a hypodynamic phase that eventually results in organ failure, reduced cardiac output, and inadequate tissue perfusion. Myocardial dysfunction (MD) presents a significant problem in the context of sepsis because of its propensity to raise mortality rates and contribute to multi-organ failure. Being a vital part of the circulatory system, the heart is especially vulnerable to the negative consequences of dysregulation brought on by sepsis. Reduced ejection fraction (EF), compromised diastolic dysfunction and contractility are the hallmarks of MD in sepsis, and they can all have a substantial influence on cardiac function and patient prognosis. Differentiating the direct effects of septic shock on the heart and other hemodynamic abnormalities is difficult, making diagnosing MD in septic patients particularly difficult. However, for assessing myocardial function in this population, transthoracic echocardiography (TTE) has become a useful noninvasive technique. TTE makes it possible to evaluate both diastolic and systolic dysfunction and to find anatomical anomalies like ventricular dilatation. Although TTE is useful for identifying MD in sepsis, there are still issues with its interpretation and its prognostic consequences. Furthermore, even though sepsis- induced cardiomyopathy (SICM) is known to be a reversible consequence, more research is needed to determine its exact etiology and clinical importance. In light of this, the current investigation attempts to examine the early prevalence rates of the cardiac malfunctioning of the left and right ventricle in those diagnosed with severe septic shock and sepsis utilizing tissue Doppler imaging indices and standard echocardiography-based measures.

By using extensive echocardiographic evaluations, the goal is to measure the degree of MD and its correlation with indicators of inflammation and endothelial dysfunction. In addition, this investigation intends to clarify the influence of MD on intrahospital mortality, offering important information about its function as a predictive marker in patients having sepsis. Furthermore, the present work is expected to add to the existing body of literature of MD in septic shock and sepsis by examining the connections between myocardial function, inflammatory markers, and patient outcomes. This will ultimately influence clinical management options and enhance patient care.

Aim: The present investigation aims to examine the incidence as well as range of myocardial dysfunction in individuals with septic shock as well as sepsis. It also plans to investigate the effects of several therapy approaches meant to treat cardiac abnormalities in this particular patient cohort.

Objective: This work aims to:

- Establish the incidence rates and features of cardiac failure by means of thorough echocardiographic evaluations.
- Determine whether individuals with septic shock and severe sepsis have changes in their diastolic function, ejection fraction, or cardiac contractility.
- Assess the outcome of different treatment approaches, such as medication and fluid control techniques, intended to treat heart failure.
- Examine how different treatment approaches affect patient outcomes, such as hospital stay duration and death rates.

Materials and Method

Type of study: Cross-sectional, non-randomized, non-interventional hospital-based study.

Design of study: Prospective open-label study.

Place of study: CCU, Department of General Medicine, Patna Medical College, Patna.

Duration of study: 1 year from January 2023 to June 2024.

Study population: The study cohort included those suffering from septic shock and severe sepsis admitted to the CCU.

Sample size: Around 50 with septic shock or sepsis were selected for this investigation.

Source of data: Data will be collected from patient interviews, clinical examinations, and medical records.

Inclusion criteria

- People between 18 to 50 years of age were included in this study
- Criteria for Sepsis:
- Quick sepsis-related organ failure assessment (qSOFA) score≥ 2, which takes into account changes in mental state, systolic blood pressure < 100 mmHg, and respiration rate > 22/min, indicates a possible infection.
- Acute changes in the sepsis-related organ failure assessment (SOFA) variables, which include parameters such as the PaO2/FiO2 ratio < 300, Glasgow Coma Scale score < 15, serum creatinine > 1.2 mg/dl or urine output < 0.5 ml/kg, serum bilirubin > 1.2 mg/dl, platelet count < 150 X 103 /µl, indicate organ dysfunction, and mean arterial blood pressure (MAP) < 70 mmHg,
- Criteria for Septic Shock:
- Chronic low blood pressure requiring vasopressors to maintain MAP > 65 mmHg.
- Despite adequate molecular resuscitation, the treat Serum lactate level ≥ 2 mmol/L despite adequate volume resuscitation.

- Patients whose parents or who themselves did not attain the written informed consent and were therefore not a part of the study. Patients informed consent obtained from each patient or their next of kin.

Exclusion criteria

- Individuals suffering from primary cardio-vascular diseases including arrhythmias, acute or chronic cor-pulmonale due to any cause.
- Patients with severe anaemia or severe hypoxemia.
- Individuals with known pre-existing thyroid dysfunction or thyrotoxicosis, myopathy, or pulmonary vascular disorders.
- Individuals who have known metabolic disorders of nutritional origin like beri-beri.
- Women who were pregnant were also excluded from this research.

Statistical analysis

- SPSS version 26 was used for statistically analyzing the collected information.
- Using the Kolmogorov-Smirnov test, the normality of the information was evaluated, consequent to which each variable was found to have a normal distribution.
- While qualitative factors were reported as frequency and percentage (%) and examined using the chi-square test, quantitative data were presented as mean and standard deviation (SD) and compared using the paired t-test.
- To compare group survival, Kaplan-Meier survival analysis was employed, and independent factors would be found using the logistic regression analysis.
- A significant p-value of $p < 0.05$ was established.

Result

Table 1: Patient demographics (N=50):

	Male	Female
Total count	26	24
Age (mean ± std deviation)	48 ± 5	44 ± 7
Weight in kg (Mean ± std deviation)	86.2 ± 7.2	74.9 ± 3.8
Hypertension (%)	12 (46.1 %)	8 (33.3 %)

Graph 1: Patient Distribution Based On Gender

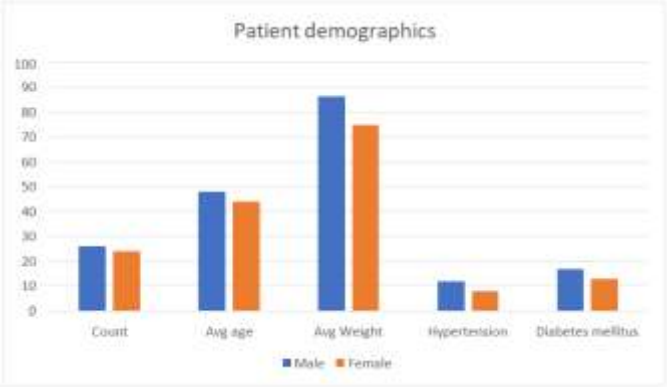


Table 2: Biological parameters in patients (N= 50):

	Normal myocardiac function (n = 21)	Myocardiac dysfunction (n=29)
Lactate (mmol/L), median (mean ± sd)	1.6 ± 1.3	2.8 ± 1.6
Troponin T (ng/mL), median (mean ± sd)	0.05 ± 0.06	0.10± 0.08
PaO2/FiO2 (mm Hg), median (mean ± sd)	208 ± 120	148 ± 155
Creatinine (mg/dL), median (mean ± sd)	1.6 ± 1.2	1.9 ± 1.5

Graph 2: Patient Distribution Based on Cardiac Function

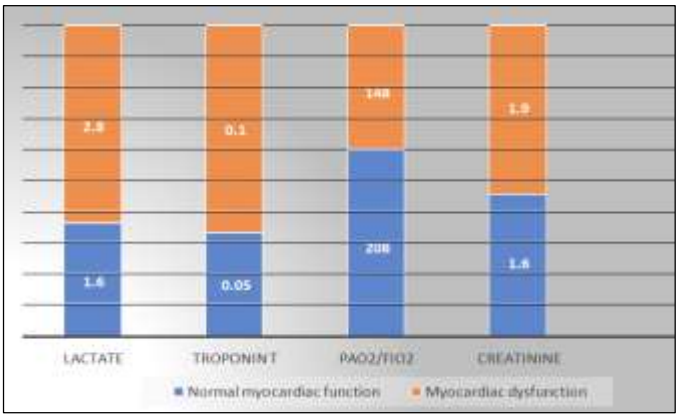


Table 3: Echocardiographic assessments of patients

	Normal myocardiac function (n =21)	Myocardiac dysfunction (n = 29)
LVDD (mm), mean ± SD	44.1±4.7	41.7±12.6
LVSD (mm), mean ± SD	31.7±5.2	24.9±12.1
CO (L/min), mean ±SD	6.31±1.21	7.01±1.33

Graph 3: Echocardiographic Parameters in Patients

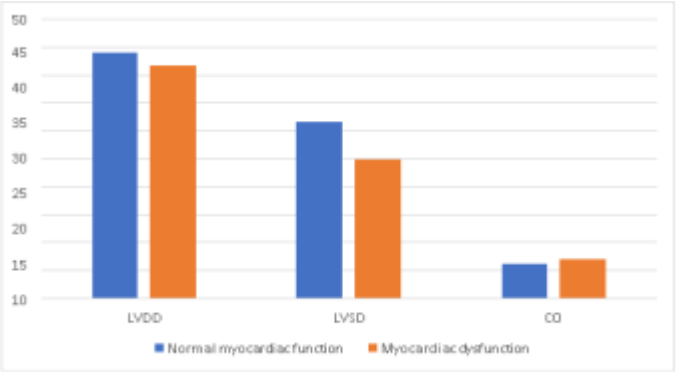


Table 4: Echocardiographic assessments of patients

	Normal myocardiac function (n = 21)	Myocardiac dysfunction(n = 29)
LVEF (%), mean ± SD	52.6±13	56.4±16
E/e′, mean ± SD	12.3±6	14.3±8

Graph 4: Echocardiographic Parameters in Patients

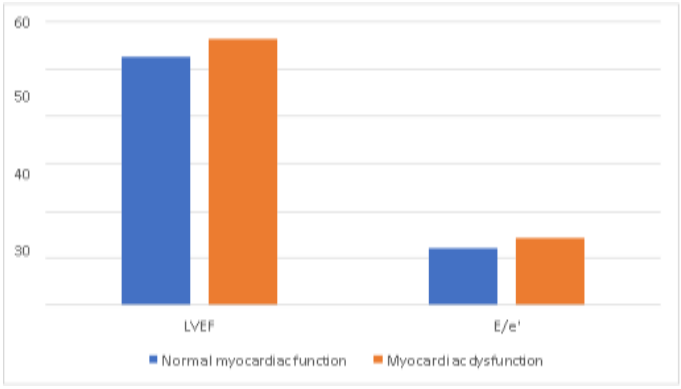


Table 5: Comparison of echocardiographic parameters in myocardiac dysfunction patients (N = 29):

		1st day	3rd day	7th day
Ejection fraction (%)	Normal	7 (25%)	21(73%)	27(95%)
	Impaired	22 (75%)	8(27%)	2 (5%)
Tricuspid annular systolic excursion (TAPSE in cm)	Normal (>1.6 cm)	9 (30%)	25(86%)	26(91%)
	Impaired (<1.6 cm)	20 (70%)	4(14%)	3 (9%)
Inferior vena cava (IVC in	Normal (1.5 to 2.5 cm)	17 (58%)	25 (87%)	28(97%)

Graph 5: Comparison of Echocardiographic Parameters in Myocardiac Dysfunction Patients

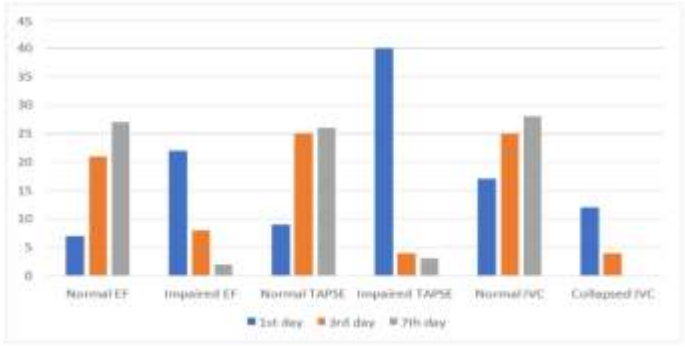


Table 6: Diastolic dysfunction seen in myocardiac dysfunction patients (N = 29):

		1st day	3rd day	7th day
Diastolic function	Normal	0 (0%)	3 (9%)	5 (18%)
	Impaired	29(100%)	26 (91%)	24 (82%)

Diastolic dysfunction grade	I	9 (32%)	13 (49%)	12 (48%)
	II	20 (68%)	13 (51%)	12 (52%)

Graph 6:

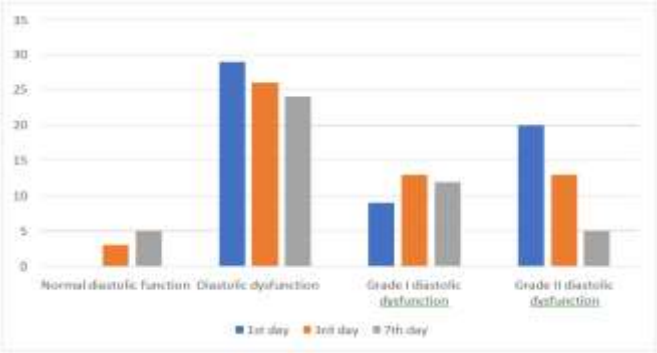


Table 7: Comparison of the surviving and mortality group on the 7th day on the basis of the electrocardiographic parameters:

		Surviving group (n =30)	Mortality group (n =20)
Ejection fraction (%)	Normal	23 (78%)	16 (81%)
	Impaired	7 (22%)	4 (29%)
Tricuspid annular systolic excursion (TAPSE in cm)	Normal (> 1.6 cm)	22 (72%)	15 (77%)
	Impaired (<1.6 cm)	8 (28%)	5 (23%)
Inferior vena cava (IVC incm)	Normal (1.5 to 2.5 cm)	20 (67%)	14 (72%)
	Collapsed (<1.5 cm)	10 (33%)	6 (28%)

Graph 7: Comparison electrocardiographic parameters between the surviving andmortality group on the 7th day

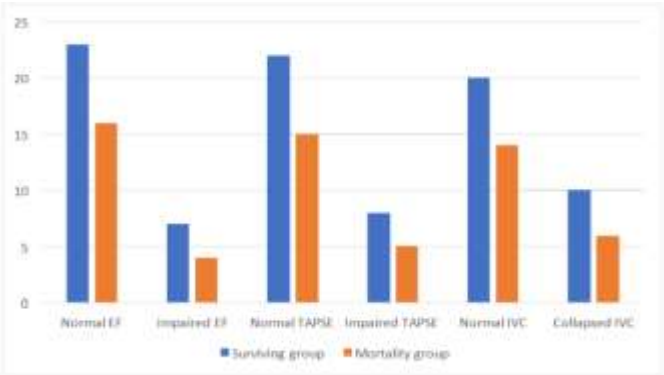
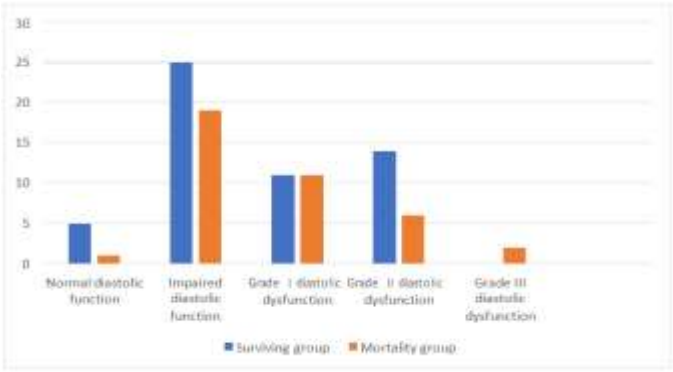


Table 8: Comparison of Diastolic dysfunction seen in surviving and mortality group:

		Surviving group (n =30)	Mortality group (n=20)
Diastolic function	Normal	5 (16%)	1 (5%)
	Impaired	25 (84%)	19 (95%)
Diastolic dysfunction grade	I	11 (46%)	11 (60%)
	II	14 (54%)	6 (28%)
	III	0 (0%)	2 (12%)

Graph 8: Comparison of Diastolic Dysfunction Seen in Surviving and Mortality Group



Discussion

The study was initiated to address the critical need for understanding myocardial dysfunction in patients with septic shock and severe sepsis on account of its impact on patient outcomes. Systemic inflammation and hypotension are hallmarks of the severe illness known as "septic shock," which frequently leads to organ failure and death. One common consequence of sepsis that significantly raises morbidity and death rates is myocardial dysfunction. For this reason, it is essential to look into the underlying processes and clinical implications of cardiac dysfunction in this setting in order to enhance treatment outcomes and management. It is important to comprehend the biology and etiology of cardiac dysfunction in sepsis to direct therapeutic approaches and enhance patient care. The study intends to uncover possible targets for intervention and

management techniques by clarifying the mechanisms behind cardiac failure, such as sepsis-induced cardiomyopathy, inflammatory responses, and changes in cellular signaling networks. This information can guide the creation of customized treatment plans meant to lessen heart failure and enhance patient outcomes. Furthermore, the study aims to examine the diagnostic and prognostic implications of different cardiac measures, including echocardiographic findings and find predictive markers to identify the severity of the disease and prognosis in individuals with severe sepsis and septic shock by connecting these measures with clinical outcomes. Clinicians can use this information to help with risk assessment and to make decisions about patient care and resource allocation. Additionally, the study attempts to evaluate how well various treatment interventions—such as inotropic support, vasopressor therapy, and fluid resuscitation—improve patient outcomes and myocardial function. The study seeks to provide evidence-based recommendations for managing myocardial failure in septic patients by assessing the effects of different interventions on hemodynamic parameters, organ function, and survival rates. In clinical practice, this can help enhance treatment plans and enhance patient results. Additionally, the study intends to close any gaps in the literature that may exist about the prevalence, clinical features, and results of myocardial dysfunction in patients with septic shock. This project intends to produce important insights into the epidemiology and clinical implications of cardiac dysfunction in this patient population by undertaking a thorough review of patient data and outcomes. The creation of focused therapies and clinical recommendations for the treatment of cardiac dysfunction in sepsis patients can benefit from this information. Overall, by examining the genesis, clinical relevance, and therapy of myocardial failure in patient's septic shock, this work fills a vital gap in the field of critical care medicine. The goal of the study is to better understand this complicated condition in order to improve clinical outcomes, lower the morbidity and death rate related to severe sepsis and septic shock, and ultimately improve patient care.

Strengths of the Study

- Comprehensive Assessment: The research examined a group of critically ill patients admitted to the ICU for septic shock and evaluated their echocardiographic data, haemodynamic variables, and outcome clinically. Based on the evaluation of various parameters such as heart rate, mean arterial pressure, and diastolic function among others, this study offers a comprehensive understanding of the patients' cardiac status and haemodynamic profile.
- Longitudinal Analysis: By tracking changes in hemodynamic and echocardiographic measures over time, particularly on the 1st, 3rd, and 7th days of the patients' ICU stay, the study used a longitudinal methodology. Through the study of dynamic changes in heart function and hemodynamics during sepsis or septic shock, this longitudinal research offers important insights into the development and resolution of myocardial dysfunction in these critically ill patients.
- Clinical Relevance: The study's results directly relate to clinical practice since they show that diastolic dysfunction is a strong indicator of death in patients in the intensive care unit who are septic. The study helps with risk assessment and guides therapeutic decision-making for managing and treating septic patients by demonstrating the

predictive importance of diastolic dysfunction and other echocardiographic characteristics. These realizations may result in better patient outcomes and more efficient use of resources in the ICU.

Limitations of the Study

- Sample Size and Generalizability: The study's extremely small sample size could be one of its limitations, which could have an impact on how well the results apply to larger patient populations. The study's sample size might not be sufficient to capture the wide range of comorbidities, clinical presentations, and patient demographics that are prevalent in septic patients across various healthcare environments. As a result, not all septic patients may benefit from the findings, and care should be taken when extending the findings to broader demographics.
- Single-Center Design: The study's single-center design is another drawback, as it raises the possibility of institutional biases and reduces the findings' external validity. Variability in patient demographics, management procedures, and clinical practices among various healthcare facilities may affect how repeatable and broadly applicable the study's findings are. To confirm the results and strengthen the conclusions' resilience, multi-center investigations including a range of patient demographics are required.
- Retrospective Nature and Potential Confounders: The study's retrospective approach may have built-in drawbacks, such as the need for data collecting from medical records and the potential for missing or insufficient data. Furthermore, the research could be influenced by confounding factors such variations in baseline features, concurrent treatments, and the severity of the illness that were not taken into consideration throughout the analysis. The accuracy and dependability of the study's conclusions could be impacted if these possible confounders are not taken into account. To eliminate biases and corroborate the observed relationships, prospective studies with strict data collection techniques and thorough correction for confounding factors are required.

Conclusion

This study highlights the prognostic significance of diastolic dysfunction and hemodynamic parameters in predicting death, and it offers insightful information about the clinical and echocardiographic features of individuals with sepsis- associated myocardial dysfunction. Notwithstanding various constraints, such as sample size and retrospective design, the results highlight the complex character of myocardial dysfunction in sepsis and the necessity of more investigation to clarify its fundamental causes and best practices. These discoveries could potentially lead to better risk assessment, early identification, and focused therapies meant to lessen the negative effects of cardiac failure on patient outcomes in the setting of sepsis and septic shock.

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