# Prediction of Hospital Outcome in Septic Shock
# Prognostic Value of Procalcitonin, Tissue Doppler Echocardiography and Cardiac Biomarkers

**Thesis**
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**Master Degree in Critical Care**


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# Abstract

## INTRODUCTION:

Refractory hypotension and cardiovascular collapse are frequently observed in the terminal phases of septic shock. While impaired systolic function has been identified as the major culprit, the contribution of diastolic dysfunction to cardiovascular morbidity and mortality in septic shock is not fully understood.

## OBJECTIVES:

to evaluate the prognostic significance of NTproBNP, Troponin I, and Tissue Doppler echocardiographic variables to septic shock mortality, and to assess the rule of serum procalcitonin as a useful marker for mortality in septic shock.

## METHODS:

Thirty Patients with septic shock were enrolled in the study After exclusion of patients with cardiomyopathy and significant valvular heart diseases. Each patient was subjected to the following:

Measurement of serum NTproBNP, Troponin I, and procalcitonin, routine echocardiographic study with measuring of LV end-diastolic volume index (LVEDVI), LV end-systolic volume index (LVESVI) and calculation of LV ejection fraction (LVEF) and cardiac output index (COI), LV diastolic function was assessed with measuring of transmitral peak E and A velocities, E/A ratio and E deceleration time. Tissue Doppler echocardiography was performed with measuring of septal mitral annulus peak e', a' and s' velocities, the E/e' was then calculated. All the above measurements were done within 72 hours of development of septic shock.

## RESULTS:

The study population were divided into two groups according to 28$^{th}$ day mortality, group I (survivors, 12 patients, 6 males and 6 females) and group II (non survivors, 18 patients, 8 males and 10 females). No significant

difference between groups regarding age and sex distribution, associated co-morbidities and SAPS II score on admission. The most common source of sepsis in both groups was chest infection followed by infected surgical wounds and urinary tract infection in group I, and abdominal sepsis and infected surgical wounds in group II. 27 patients (85%) had positive culture (9 in group I & 18 in group II). The most common organisms were klebseilla in group I (13%), Klebseilla & MRSA in group II (25% each). Inspite of higher level of NTproBNP, troponin I, and procalcitonin in group II (617.89±354.75, 1.624± 1.582, and 4.898±5.578 respectively) compared to group I (464.67±417.39, 0.283±0.129, and 0.661±0.879 respectively), the p value was non-significant (0.37, 0.047, and 0.051 respectively). According to the echocardiographic variables; the only predictor factor of mortality was higher E/e' with a cut off limit of 7.6, sensitivity 83%, and specificity of 50% (E/e' was 7.87 ± 1.38 in group I and 11.62 ± 5.08 in group II, p value: 0.019). None of the other variables showed any relation to mortality.

## CONCLUSIONS:

the only predictor factor of mortality was higher E/e' with a cut off limit of 7.6, sensitivity 83%, and specificity of 50% (E/e' was 7.87 ± 1.38 in group I and 11.62 ± 5.08 in group II, p value: 0.019).
None of the other variables showed any relation to mortality.

- **Key words:**
- Septic shock
- Tissue Doppler imaging
- Procalcitonin
- Cardiac biomarkers (NTproBNP and Troponin I)

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**Amira Ismail**

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# List of Abbreviations

| | |
|---|---|
| 2-D | two-dimensional |
| Ant. | Anterior |
| Ao | Aorta |
| cTnC | Troponin C |
| cTnI | Troponin I |
| cTnT | Troponin T |
| DBP | Diastolic blood pressure |
| DD | Diastolic dysfunction |
| DHF | Diastolic heart failure |
| DM | Diabetes mellitus |
| TDI | Tissue Doppler Imaging |
| DT | Deceleration time |
| A | Late mitral inflow velocity |
| E | Early mitral inflow velocity |
| e' | Peak early diastolic velocity of mitral annulus |
| a' | Peak late diastolic velocity of mitral annulus |
| s' | Peak systolic velocity |
| ECG | Electrocardiogram |

| | |
|---|---|
| IVRT | Isovolumic relaxation time |
| LA | Left atrium |
| LAD | Left atrial diameter |
| PW | Pulsed wave |
| PW-TDI | Pulsed wave tissue Doppler image |
| SV | Stroke volume |
| TVI | Tissue velocity imaging |
| PCT | Procalcitonin |
| MODS | Multi organ dysfunction syndrome |

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# Introduction

Septic shock in adults refers to a state of acute circulatory failure characterized by persistent arterial hypotension unexplained by other causes [(1)]. Although this clinical syndrome is heterogeneous with regard to factors such as causal micro-organism, patient predisposition, co-morbidity and response to therapy, a key element and unifying feature is the manifestation of cardiovascular dysfunction.

Although the underlying cause of death in septic shock is often multifactorial, refractory hypotension and cardiovascular collapse are frequently observed in the terminal phases of the condition [(2)].

Whilst impaired systolic function has been identified as the major culprit, the contribution of diastolic dysfunction (and hence ventricular filling) to cardiovascular morbidity and mortality in septic shock is not fully understood. Investigation of left ventricular (LV) diastolic function at the bedside is challenging, but techniques such as echocardiography and biomarkers such as B-type natriuretic peptide (BNP) are increasingly supported by current literature [(3-5)]. In particular, recent application of non-invasive, bedside technologies, such as tissue Doppler imaging (TDI), offer fresh insight [(6)].

Tissue Doppler imaging (TDI) is an echocardiographic technique that measures myocardial velocities [(7)], which are low frequency, high-amplitude signals filtered from conventional Doppler imaging [(8)]. TDI has

gained acceptance amongst cardiologists for the evaluation of diastolic function, particularly as a measure of ventricular relaxation and ventricular filling pressure [9]. However, there are scant data regarding its use in critical care. TDI has demonstrated prognostic utility in a range of cardiovascular diseases [10], including following myocardial infarction,[11,12] heart failure [13-16], abnormal LV function at dobutamine echocardiography,[17] nonvalvular atrial fibrillation [18], hypertension [19], and end-stage renal disease [20].

There has been evidence of diastolic dysfunction on TDI in critically ill patients [21]. The significance of this has been recently highlighted by Ikonomidis and colleagues, who demonstrated that TDI may be prognostically useful in the general ICU population [22]. To date, the prognostic significance of this technique has rarely been evaluated in septic shock.

Cardiac biomarkers including BNP [23-24], N-terminal proBNP (NTproBNP) [25] and troponin I in addition to procalcitonin [26] potentially offer prognostic information in the critically ill.

# Aim of the Study

This study sought to evaluate:

**(1)** The prognostic significance of TDI variables in patients with septic shock.

**(2)** The prognostic significance of cardiac biomarkers (NTproBNP and Troponin I) and procalcitonin in patients with septic shock.

# Sepsis and Septic Shock

Sepsis is a complex syndrome caused by an uncontrolled systemic inflammatory response, of infectious origin, characterized by multiple manifestations which can result in dysfunction or failure of one or more organs and even death [(27)].

## Definitions:

Infection is a pathologic process caused by the invasion of normally sterile tissue or fluid or body cavity by pathogenic or potentially pathogenic micro-organisms [(28)].

Sepsis is defined as infection plus systemic manifestations of infection. Severe sepsis is defined as sepsis plus sepsis-induced organ dysfunction or tissue hypoperfusion.

Sepsis-induced hypotension is defined as a systolic blood pressure (SBP) < 90 mmHg or mean arterial pressure (MAP) < 70 mm Hg or a SBP decrease > 40 mm Hg in the absence of other causes of hypotension.

Septic shock is defined as sepsis-induced hypotension persisting despite adequate fluid resuscitation. Sepsis-induced tissue hypoperfusion is defined as either septic shock, an elevated lactate or oliguria [(28)].