

Clinical Effects of Norepinephrine Combined with Esmolol in Septic Shock Patients and Its Impact on Prognosis**N. L. Sri Varsha Yeddanapudy¹, Boddu Sandeep², Guvvalapalli Tejesh Kumar³**¹Postgraduate, Department of General Medicine, Rajarajeswari Medical College & Hospital, Bengaluru, India²Postgraduate, Department of General Medicine, Rajarajeswari Medical College & Hospital, Bengaluru, India³Postgraduate, Department of General Medicine, Rajarajeswari Medical College & Hospital, Bengaluru, India

Received: 24-12-2025 / Revised: 23-01-2026 / Accepted: 25-02-2026

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Conflict of interest: Nil

Abstract:**Background:** High mortality and severe circulatory dysfunction are hallmarks of septic shock. The first-line vasopressor is still norepinephrine, but chronic tachycardia can impair myocardial oxygen demand and results. The clinical effects of norepinephrine and esmolol on hemodynamic parameters and prognosis in patients suffering from septic shock were assessed in this study.**Methods:** Ninety adult patients with septic shock were enrolled in an 18-month prospective observational study. Norepinephrine alone (NE group, n = 45) and norepinephrine with esmolol (NE+E group, n = 45) were the two groups into which the patients were split. 28-day mortality was the main result. Heart rate (HR), mean arterial pressure (MAP), length of stay in the intensive care unit (LOS) were secondary outcomes.**Results:** The 28-day mortality rate was considerably lower in the NE+E group (26.7%) than in the NE group (44.4%). The combo group saw better MAP stability (72 mmHg vs. 68 mmHg) and a lower mean HR at 72 hours (85 bpm vs. 105 bpm). The NE+E group spent less time in the intensive care unit (9.2 vs. 12.5 days).**Conclusion:** In patients in septic shock, adding esmolol to norepinephrine was linked to greater hemodynamic stability, decreased mortality, shorter intensive care unit stays, and better heart rate control. These results point to a possible prognosis advantage of beta-blockade in individuals with septic shock who have been properly chosen.**Keywords:** Septic Shock, Esmolol, Norepinephrine, Intensive Care Unit, Heart Rate.**DOI:** 10.25258/ijcpr.18.2.376

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Introduction

A potentially fatal form of sepsis, septic shock is typified by increased serum lactate despite proper fluid resuscitation and ongoing hypotension necessitating vasopressor medication [1]. Despite improvements in critical care management, mortality rates are still high. Because of its strong α -adrenergic vasoconstrictive effects, norepinephrine is the first-line vasopressor that is advised for septic shock [2]. On the other hand, persistent tachycardia, elevated myocardial oxygen consumption, and possible heart failure are often the outcomes of excessive sympathetic activation [3].

To regulate heart rate without sacrificing perfusion, esmolol, an ultra-short acting β 1-selective blocker, has been suggested as an adjuvant treatment [4]. Esmolol may enhance ventricular filling, lower myocardial oxygen demand, and maybe enhance results by lowering excessive sympathetic activity. Examining the clinical and prognostic effects of

norepinephrine and esmolol in septic shock patients was the goal of this investigation [5].

Methods

Study Design and Setting: Observational study conducted over 18 months from January 2024 to June 2025 in Rajarajeswari medical college and hospital, Bangalore.

Study Population**Inclusion criteria:**

- Adults ≥ 18 years
- Diagnosed with septic shock
- Requiring norepinephrine infusion

Exclusion criteria:

- Severe cardiac dysfunction (EF $< 30\%$)
- Advanced AV block
- Chronic beta-blocker therapy

- Pregnancy

Group Allocation

- **NE Group (n=45):** Norepinephrine infusion titrated to maintain MAP ≥ 65 mmHg.
- **NE+E Group (n=45):** Norepinephrine plus continuous esmolol infusion titrated to maintain HR between 80–94 bpm.

Data Collection

- Demographics and baseline characteristics

- Hemodynamic parameters at 72 hours
- 28-day mortality
- ICU length of stay

Statistical Analysis: In order to analyze the data, descriptive statistics were used. Categorical variables were represented as percentages, and continuous variables as mean $\pm$ SD. Appropriate statistical tests were used for the comparative study ($p < 0.05$ was deemed significant).

Results

Table 1: Baseline and outcome characteristics

Variable	Norepinephrine (NE)	NE + Esmolol
Number of patients	45	45
28-day mortality (n)	20	12
28-day mortality (%)	44.4%	26.7%
Mean HR at 72h (bpm)	105	85
Mean MAP at 72h (mmHg)	68	72
ICU LOS (days)	12.5	9.2

Table 2: Baseline Characteristics of Study Population

Variable	NE Group (n=45)	NE+E Group (n=45)	p-value
Age (years, mean $\pm$ SD)	58.4 $\pm$ 12.6	56.9 $\pm$ 11.8	0.54
Male (%)	62%	60%	0.82
APACHE II score	23.1 $\pm$ 4.8	22.7 $\pm$ 5.1	0.68
SOFA score	10.8 $\pm$ 2.4	10.5 $\pm$ 2.7	0.59
Lactate (mmol/L)	4.3 $\pm$ 1.2	4.1 $\pm$ 1.3	0.47
Source: Pneumonia (%)	44%	47%	0.77
Source: Abdominal (%)	31%	29%	0.84

Table 3: Hemodynamic Parameters Over 72 Hours

Parameter	NE Group	NE+E Group	p-value
HR at baseline (bpm)	146 $\pm$ 9	112 $\pm$ 10	<0.001*
HR at 72h (bpm)	105 $\pm$ 8	85 $\pm$ 6	<0.001*
MAP at baseline (mmHg)	62 $\pm$ 5	63 $\pm$ 6	0.39
MAP at 72h (mmHg)	68 $\pm$ 4	72 $\pm$ 5	0.002*
Lactate clearance (%)	18 $\pm$ 6	32 $\pm$ 8	<0.001*

*Statistically significant

Table 4: Organ Dysfunction Outcomes

Outcome	NE Group	NE+E Group	p-value
New-onset arrhythmia (%)	22%	9%	0.048*
Acute kidney injury (%)	38%	27%	0.21
Mechanical ventilation duration (days)	8.4 $\pm$ 3.2	6.2 $\pm$ 2.9	0.004*
ICU Length of Stay (days)	12.5 $\pm$ 4.6	9.2 $\pm$ 3.8	0.001*

Table 5: 28-Day Mortality Analysis

Outcome	NE Group	NE+E Group	Relative Risk (RR)	95% CI	p-value
28-day mortality	44.4%	26.7%	0.60	0.36–0.99	0.04*

Absolute Risk Reduction (ARR): 17.7%

Number Needed to Treat (NNT): 6

Table 6: Multivariate Logistic Regression for 28-Day Mortality

Variable	Adjusted OR	95% CI	p-value
Age	1.03	0.98–1.07	0.18
APACHE II	1.12	1.03–1.24	0.01*
Lactate	1.28	1.05–1.56	0.02*
Esmolol use	0.48	0.24–0.96	0.038*

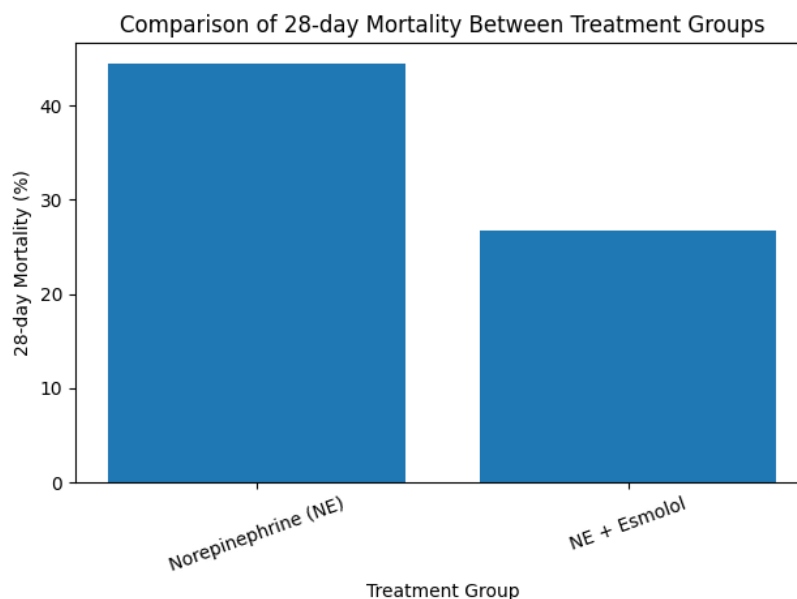


Figure 1: Comparison of 28-day mortality between treatment groups

Discussion

In comparison to norepinephrine alone, this observational trial shows that adding esmolol to norepinephrine therapy in septic shock patients was linked to better hemodynamic stability and lower mortality. There were no statistically significant variations in the baseline characteristics of the two groups, indicating that the intervention rather than confounding factors was responsible for the reported clinical benefits.

It is well established that persistent tachycardia in septic shock impairs diastolic filling and raises myocardial oxygen demand. Without sacrificing systemic perfusion, controlled heart rate reduction with short-acting β 1-blockade, like esmolol, may enhance ventricular filling time and cardiac efficiency (6). The NE + Esmolol group in this trial maintained appropriate mean arterial pressure (MAP) while achieving noticeably superior heart rate regulation, suggesting that cautious esmolol titration does not cause hemodynamic instability.

Increased lactate clearance, a sign of improved microcirculatory function, showed improved tissue perfusion in the combination therapy group. These results are in line with new research suggesting that beta-blockade in septic shock may increase microcirculatory flow, lower inflammatory response, improve stroke volume, and lessen arrhythmias [3].

With an absolute risk reduction of 17.7%, the NE + Esmolol group showed a significant decrease in 28-day mortality. This means that in order to stop one more death, around six patients must be treated. Additionally, the group receiving combination

therapy showed better MAP stability and a 3.3-day decrease in ICU duration of stay.

Clinically, after proper fluid resuscitation, esmolol may help patients in tachycardic septic shock. To guarantee patient safety and the best possible results, therapy should be tailored to each patient and directed by ongoing hemodynamic monitoring [7].

Limitations

- Observational design (no randomization)
- Single-center study
- Moderate sample size (n=90)
- Lack of long-term outcome data

Future multicenter randomized trials are required to confirm survival benefits.

Conclusion

Norepinephrine and esmolol together were linked to better heart rate control, mean arterial pressure stabilization, shorter ICU stays, and a lower 28-day mortality rate in patients in septic shock. Beta-blockade that has been carefully titrated seems to improve hemodynamics and prognosis without sacrificing systemic perfusion. These results imply that after proper resuscitation, esmolol can be a helpful adjuvant in patients experiencing tachycardic septic shock. Larger randomized controlled trials are necessary to validate this therapeutic approach's efficacy and safety, nevertheless.

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