

Comparison of Ketamine and Etomidate for Rapid Sequence Intubation in Critically Ill Patients Presenting to the Emergency Department: A Prospective Comparative Study

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ABSTRACT:

Background: Rapid sequence intubation (RSI) had been frequently required for airway management in critically ill patients presenting to emergency departments. The choice of induction agent had been important because ketamine and etomidate differed in their effects on hemodynamic stability, respiratory physiology, and post-intubation outcomes. However, comparative evidence regarding their effectiveness and safety in critically ill emergency patients had remained clinically relevant.

Aim: The study had aimed to compare ketamine and etomidate as induction agents for rapid sequence intubation in critically ill patients presenting to the emergency department, with particular emphasis on hemodynamic changes, intubation conditions, and immediate adverse outcomes.

Methods: A prospective comparative study had been conducted at Shifa International Hospital, Lahore, from October 2025 to March 2026. A total of 90 critically ill patients requiring rapid sequence intubation had been enrolled. Participants had been divided into two equal groups of 45 patients each. One group had received ketamine for induction, while the other group had received etomidate. Baseline characteristics, heart rate, systolic and diastolic blood pressure, oxygen saturation, intubation conditions, first-pass success, and immediate adverse events had been recorded. Data had been analyzed using appropriate statistical tests, and a p-value of <0.05 had been considered statistically significant.

Results: The mean age of the study participants had been approximately 52 years, with a predominance of male patients. Both ketamine and etomidate had provided effective induction and satisfactory intubating conditions. First-pass intubation success had been high in both groups. Patients receiving ketamine had demonstrated greater preservation of blood pressure and a relatively more favorable hemodynamic profile, whereas etomidate had been associated with comparatively stable heart rate responses. The incidence of immediate complications had remained low in both groups, although transient hypotension had been observed more frequently among patients receiving etomidate. Overall, ketamine had demonstrated comparable intubation efficacy with favorable hemodynamic outcomes in critically ill patients.

Conclusion: Both ketamine and etomidate had been effective induction agents for rapid sequence intubation in critically ill emergency patients. Ketamine had demonstrated a favorable hemodynamic profile while maintaining effective intubation conditions and high first-pass success. It had therefore represented

a suitable alternative to etomidate, particularly in critically ill patients in whom maintenance of cardiovascular stability had been important.

Keywords: Ketamine; Etomidate; Rapid Sequence Intubation; Critically Ill Patients; Emergency Department; Hemodynamic Stability; Airway Management.

INTRODUCTION:

Rapid sequence intubation (RSI) had remained one of the most frequently performed and time-sensitive procedures in emergency medicine for critically ill patients requiring immediate airway protection and mechanical ventilation. It had been commonly indicated in patients presenting with severe respiratory failure, impaired consciousness, traumatic brain injury, shock, and other conditions associated with inadequate oxygenation or ventilation. Successful RSI had depended on rapid administration of an induction agent followed by a neuromuscular blocking agent to facilitate tracheal intubation while minimizing aspiration risk and physiological deterioration [1]. However, critically ill patients had often demonstrated limited physiological reserves, and the choice of induction agent had therefore played an important role in maintaining cardiovascular stability and preventing peri-intubation complications.

Ketamine had been widely used as an induction agent for emergency airway management because of its rapid onset, short duration of action, and favorable effects on airway reflexes and respiratory function [2]. Its sympathomimetic properties had generally resulted in maintenance or elevation of blood pressure and heart rate, making it an attractive option for patients at risk of peri-intubation hypotension. Ketamine had also provided analgesic properties and had been associated with preservation of spontaneous respiratory effort and airway tone during certain stages of sedation [3]. Nevertheless, its use had not been without concerns. Increased secretions, emergence reactions, tachycardia, and potential cardiovascular effects had been reported, while its hemodynamic response could have varied according to the patient's underlying physiological condition and catecholamine reserve.

Etomidate had also been frequently selected for RSI because of its rapid onset and relatively short duration of action. Unlike several other induction agents, etomidate had generally produced limited direct myocardial depression and had been associated with comparatively stable hemodynamic parameters during induction. These characteristics had made it particularly attractive for critically ill patients in whom hypotension could have resulted in serious consequences [4]. However, concerns regarding transient adrenal suppression following etomidate administration had generated considerable debate regarding its routine use in critically ill patients. Although the clinical significance of a single induction dose had remained controversial, this potential effect had continued to influence the selection of induction agents in emergency and critical care settings.

The physiological response to tracheal intubation had been particularly important in critically ill patients because both induction and laryngoscopy could have produced substantial changes in blood pressure, heart rate, oxygen saturation, and other hemodynamic parameters [5]. Peri-intubation hypotension had been associated with adverse outcomes, particularly among patients with sepsis, hypovolemia, cardiovascular compromise, or severe systemic illness. Consequently, comparison of ketamine and etomidate had been clinically relevant because both agents had been considered suitable for RSI, but their pharmacological profiles and effects on cardiovascular stability had differed.

Previous clinical investigations had reported variable findings regarding the comparative effectiveness and safety of ketamine and etomidate during emergency intubation. Differences in patient populations, illness severity, induction protocols, and outcome definitions had contributed to inconsistent conclusions [6]. Therefore, prospective comparative assessment in patients presenting to emergency departments had been important for evaluating their effects under real-world acute-care conditions.

The present prospective comparative study had been conducted to compare ketamine and etomidate as induction agents for RSI among critically ill patients presenting to the Emergency Department. The study had focused on important peri-intubation outcomes, including hemodynamic changes, oxygen saturation,

intubation conditions, and immediate complications [7]. By comparing these two commonly used agents, the study had aimed to provide clinically relevant evidence regarding their efficacy and safety and to assist emergency physicians in selecting an appropriate induction agent for critically ill patients requiring urgent airway management [8].

MATERIALS AND METHODS:

Study Design and Setting

A prospective comparative study had been conducted at the Emergency Department of Shifa International Hospital, Lahore, from October 2025 to March 2026. The study had been designed to compare the clinical effects and hemodynamic responses associated with ketamine and etomidate when used as induction agents for rapid sequence intubation (RSI) in critically ill patients. The study had been carried out according to institutional ethical standards and had received approval from the relevant hospital ethical review committee before commencement.

Study Population and Sample Size

The study population had consisted of 90 critically ill adult patients who had presented to the emergency department and required emergency endotracheal intubation using the RSI technique. The participants had been divided equally into two groups. Group K had received ketamine as the induction agent, while Group E had received etomidate. Each group had included 45 patients. Patients had been enrolled consecutively according to predefined eligibility criteria.

Inclusion and Exclusion Criteria

Adult patients of either sex who had required emergency RSI because of acute respiratory failure, reduced level of consciousness, hemodynamic instability, severe trauma, or other critical conditions had been included. Patients had been considered eligible when emergency endotracheal intubation had been clinically indicated and either ketamine or etomidate had been considered appropriate by the treating emergency physician.

Patients had been excluded if they had known hypersensitivity to ketamine or etomidate, had already received an induction agent before arrival, had a documented adrenal insufficiency, had undergone previous intubation during the same emergency episode, or had incomplete clinical records. Patients who had refused participation or whose attendants had declined consent had also been excluded.

Data Collection Procedure

After initial assessment and stabilization, baseline demographic and clinical information had been recorded, including age, sex, presenting diagnosis, Glasgow Coma Scale score, heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation. Standard monitoring had been established before induction, including electrocardiography, non-invasive blood pressure monitoring, and pulse oximetry.

For RSI, patients in Group K had been administered intravenous ketamine at a dose of 1–2 mg/kg, whereas patients in Group E had received intravenous etomidate at a dose of 0.3 mg/kg. The induction agent had been administered according to the patient's clinical condition and institutional emergency airway protocol. A neuromuscular blocking agent had subsequently been administered to facilitate intubation, and endotracheal intubation had been performed by trained emergency physicians or anesthesiology personnel using standard RSI techniques.

Hemodynamic parameters had been recorded at baseline, immediately after induction, and at predetermined intervals following intubation. Changes in heart rate and blood pressure had been assessed to determine the cardiovascular response associated with each induction agent. Oxygen saturation, intubation success, number of intubation attempts, and immediate complications had also been documented.

Outcome Measures

The primary outcome had been the change in hemodynamic parameters following administration of ketamine or etomidate. Secondary outcomes had included first-pass intubation success, number of

intubation attempts, oxygen saturation changes, and occurrence of adverse events such as hypotension, hypertension, tachycardia, bradycardia, hypoxia, or other clinically significant complications.

Statistical Analysis

The collected data had been entered and analyzed using SPSS. Continuous variables had been presented as mean $\pm$ standard deviation, while categorical variables had been expressed as frequencies and percentages. Independent-samples t-test or an appropriate non-parametric test had been used for comparison of continuous variables between the two groups, while the chi-square or Fisher's exact test had been applied to categorical variables. A p-value <0.05 had been considered statistically significant.

Ethical Considerations

Written informed consent had been obtained from patients or their legally authorized representatives whenever the clinical situation permitted. Patient confidentiality had been maintained throughout the study, and collected information had been used exclusively for research purposes. The study had been conducted in accordance with accepted ethical principles for research involving human participants.

RESULTS:

A total of 90 critically ill patients who had required rapid sequence intubation (RSI) in the Emergency Department of Shifa International Hospital, Lahore, during the study period from October 2025 to March 2026 were included. The patients were divided equally into two groups, with 45 patients receiving ketamine and 45 receiving etomidate for induction. The baseline demographic and clinical characteristics of both groups were generally comparable.

The mean age of patients in the ketamine group was 48.6 ± 15.2 years, while that in the etomidate group was 50.1 ± 14.8 years. Male patients constituted 62.2% (28/45) of the ketamine group and 64.4% (29/45) of the etomidate group. The mean baseline systolic blood pressure was 118.4 ± 18.7 mmHg in the ketamine group and 117.1 ± 19.3 mmHg in the etomidate group. Similarly, the mean baseline heart rate was 104.6 ± 17.5 beats/minute and 103.2 ± 16.9 beats/minute, respectively. No statistically significant differences were observed in these baseline characteristics ($p>0.05$).

Table 1. Baseline Characteristics of Study Participants:

Variable	Ketamine Group (n=45)	Etomidate Group (n=45)	p-value
Age (years), mean $\pm$ SD	48.6 ± 15.2	50.1 ± 14.8	0.641
Male sex, n (%)	28 (62.2%)	29 (64.4%)	0.823
Female sex, n (%)	17 (37.8%)	16 (35.6%)	0.823
Baseline SBP (mmHg), mean $\pm$ SD	118.4 ± 18.7	117.1 ± 19.3	0.750
Baseline HR (beats/min), mean $\pm$ SD	104.6 ± 17.5	103.2 ± 16.9	0.706
GCS score, mean $\pm$ SD	8.1 ± 2.4	8.3 ± 2.3	0.694
Hypotension at baseline, n (%)	10 (22.2%)	11 (24.4%)	0.805
Mechanical ventilation after RSI, n (%)	45 (100%)	45 (100%)	—

The primary procedural outcomes demonstrated that successful first-pass intubation had been achieved in 40 patients (88.9%) in the ketamine group compared with 37 patients (82.2%) in the etomidate group. Although the first-pass success rate had been numerically higher with ketamine, the difference had not reached statistical significance ($p=0.372$). The mean time required for successful intubation had been 43.8 ± 12.6 seconds with ketamine and 46.1 ± 13.4 seconds with etomidate ($p=0.405$).

Hemodynamic changes following induction showed a more favorable pattern in the ketamine group. The mean systolic blood pressure after induction had been 110.7 ± 17.9 mmHg in the ketamine group compared

with 101.8 ± 19.6 mmHg in the etomidate group. The corresponding mean reductions from baseline had been 7.7 mmHg and 15.3 mmHg, respectively, with a statistically significant between-group difference ($p=0.041$). Post-induction hypotension had occurred in 6 patients (13.3%) receiving ketamine and 13 patients (28.9%) receiving etomidate ($p=0.078$).

Table 2. Comparison of Intubation Outcomes and Hemodynamic Effects:

Outcome	Ketamine Group (n=45)	Etomidate Group (n=45)	p-value
First-pass intubation success, n (%)	40 (88.9%)	37 (82.2%)	0.372
Mean intubation time (seconds)	43.8 ± 12.6	46.1 ± 13.4	0.405
SBP after induction (mmHg)	110.7 ± 17.9	101.8 ± 19.6	0.041
Reduction in SBP (mmHg)	7.7 ± 12.5	15.3 ± 14.1	0.009
Post-induction hypotension, n (%)	6 (13.3%)	13 (28.9%)	0.078
Heart rate after induction (beats/min)	108.9 ± 18.2	99.4 ± 17.6	0.016
Need for vasopressor, n (%)	5 (11.1%)	10 (22.2%)	0.169
Oxygen desaturation during RSI, n (%)	7 (15.6%)	9 (20.0%)	0.571
Successful intubation within 2 attempts, n (%)	44 (97.8%)	42 (93.3%)	0.307
Vomiting/regurgitation, n (%)	2 (4.4%)	3 (6.7%)	0.645

The mean post-induction heart rate had been significantly higher in the ketamine group (108.9 ± 18.2 beats/minute) than in the etomidate group (99.4 ± 17.6 beats/minute; $p=0.016$). Vasopressor support had been required in 5 patients (11.1%) in the ketamine group and 10 patients (22.2%) in the etomidate group, although this difference had not been statistically significant ($p=0.169$). Oxygen desaturation during the intubation procedure had occurred in 7 patients (15.6%) receiving ketamine and 9 patients (20.0%) receiving etomidate ($p=0.571$).

Overall, the findings had indicated that both induction agents had provided acceptable conditions for RSI. Ketamine had been associated with a significantly smaller reduction in systolic blood pressure and a higher post-induction heart rate, whereas first-pass intubation success and intubation time had not differed significantly between the two groups.

DISCUSSION:

The present prospective comparative study had evaluated the clinical outcomes of ketamine and etomidate for rapid sequence intubation (RSI) among critically ill patients presenting to the emergency department. The findings had highlighted the importance of selecting an induction agent that provided adequate sedation and favorable intubation conditions while maintaining cardiovascular and respiratory stability. In critically ill patients, physiological disturbances such as hypotension, hypoxemia, metabolic abnormalities, and altered consciousness had increased the risk associated with airway management [9]. Therefore, the choice of induction medication had remained an important determinant of peri-intubation safety.

Ketamine had been considered advantageous because of its rapid onset of action, effective dissociative anesthesia, and relative preservation of airway reflexes and spontaneous respiratory activity. Its sympathomimetic effects had generally resulted in maintenance or improvement of blood pressure and heart rate, which had made it particularly useful in patients with hemodynamic compromise [10]. In the present study, patients receiving ketamine had demonstrated favorable intubation conditions, supporting its role as

an effective induction agent for emergency airway management. The clinical benefits observed with ketamine had been consistent with its established pharmacological profile and its frequent use in critically ill patients requiring urgent intubation.

Etomidate had also provided rapid and effective induction, with the major advantage of producing comparatively limited cardiovascular depression. This characteristic had made etomidate an attractive option for patients in whom preservation of hemodynamic stability had been considered essential [11]. The patients receiving etomidate in the present study had also achieved satisfactory intubation conditions, demonstrating that both agents had been suitable for RSI. However, differences between the two agents had been clinically relevant when individual patient characteristics and hemodynamic status had been considered.

Hemodynamic responses following induction had represented an important component of the comparison. Critically ill patients had often had limited physiological reserves, and even a brief reduction in blood pressure had potentially compromised cerebral, coronary, and renal perfusion [12]. Ketamine had generally been associated with better maintenance of blood pressure because of sympathetic stimulation, whereas etomidate had been recognized for its relative cardiovascular stability. The findings of the present study had therefore emphasized that the choice between these agents should not have been based solely on their ability to facilitate intubation but also on the baseline hemodynamic condition of the patient [13].

Another important consideration had been the occurrence of adverse effects. Ketamine had potentially been associated with tachycardia, hypertension, increased secretions, and emergence-related phenomena, whereas etomidate had commonly been associated with myoclonus, nausea, vomiting, and transient adrenal suppression. In critically ill patients, these adverse effects had required careful clinical consideration. The overall safety profile observed in the present study had suggested that both drugs could have been used effectively when administered by appropriately trained emergency physicians with continuous physiological monitoring [14].

The findings had also supported the concept that no single induction agent had been universally superior for every critically ill patient. Patient-specific factors, including baseline blood pressure, cardiovascular status, neurological condition, severity of illness, and anticipated response to sympathetic stimulation, had influenced the selection of an appropriate induction drug. Ketamine had appeared particularly useful when preservation of sympathetic tone had been desirable, while etomidate had remained a reasonable alternative when a predictable and hemodynamically controlled induction had been required [15].

Overall, the study had demonstrated that both ketamine and etomidate had provided effective conditions for rapid sequence intubation in critically ill emergency department patients. The comparative findings had reinforced the importance of individualized drug selection based on clinical presentation and physiological stability. Appropriate dosing, experienced airway management, and close monitoring had remained essential regardless of the induction agent used. Further multicenter studies with larger sample sizes and assessment of post-intubation outcomes had been warranted to establish the longer-term clinical implications of choosing ketamine versus etomidate for emergency RSI.

CONCLUSION:

The study concluded that both ketamine and etomidate had provided effective induction for rapid sequence intubation in critically ill patients presenting to the emergency department. Ketamine had demonstrated the additional advantage of maintaining cardiovascular stability and had been associated with favorable hemodynamic responses during and after intubation. Etomidate had also provided satisfactory intubating conditions and had generally maintained blood pressure and heart rate; however, its use had been associated with concerns regarding transient adrenal suppression. Overall, ketamine had appeared to be a suitable and effective induction agent, particularly in critically ill patients in whom preservation of hemodynamic stability had been considered important. The findings suggested that the choice between ketamine and etomidate should have been individualized according to the patient's clinical condition, cardiovascular

status, and underlying illness. Both agents had remained valuable options for emergency rapid sequence intubation when administered with appropriate monitoring and clinical judgment.

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