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Brief Report

Association Between Paralytic Agent Choice and Time to Post-Intubation Sedation in the Emergency Department

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Abstract

Background/Objectives: Rapid sequence intubation (RSI) involves nearly simultaneous administration of a rapid-acting induction agent and a neuromuscular blocking agent (NMBA) to facilitate ideal intubation conditions. The NMBAs most commonly used for RSI are succinylcholine and rocuronium, which cause paralysis for 5–15 min and 45–70 min, respectively. Awareness with paralysis can occur in patients who are given longer-acting NMBAs with delayed initiation of post-intubation sedation or insufficient sedation depth. The previous literature has associated the use of rocuronium with a significantly longer time to sedation and analgesia. However, a recent study found no difference. The purpose of this study was to assess the association between paralytic agent choice and time to initiation of analgesia and/or sedation after RSI in the emergency department (ED) of a large tertiary care hospital. Methods: This study was an institutional review board (IRB)-approved, single-center, retrospective cohort evaluation of adult patients (≥18 years of age) who received succinylcholine or rocuronium following administration of an induction agent in the ED for RSI during the study time period. The primary outcome was time to initiation of post-intubation analgesia and/or sedation. Continuous data were analyzed by using Mann–Whitney U or Student's *t*-test, and categorical data were analyzed using the Chi Square test or Fisher's Exact test. Results: A total of 400 patients were included in this study. The median time to sedation with succinylcholine was 9 min compared to 14 min with rocuronium ($p < 0.01$). No significant differences were identified in the baseline characteristics or secondary outcomes related to induction agent choice or ED length of stay. Conclusions: The results of this study further support that the use of rocuronium for RSI is associated with a significantly longer time to sedation and/or analgesia, making emergency medicine provider awareness essential for minimizing the risks associated with inadequate post-intubation sedation.

Keywords: awareness with paralysis; critical care; deep sedation; emergency medicine; neuromuscular blocking agents; rapid sequence intubation; pharmacists

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1. Introduction

Rapid sequence intubation (RSI) is the preferred method for quickly securing an airway in a critically ill patient [1]. Indications for RSI include risk of aspiration, impending airway loss, or impaired gas exchange requiring mechanical ventilation. RSI involves

nearly simultaneous administration of a rapid-acting induction agent, followed by a neuromuscular blocking agent (NMBA) to facilitate ideal intubation conditions [2]. The NMBAs that are most commonly used for RSI are succinylcholine and rocuronium. Succinylcholine is a depolarizing NMBA which binds to and activates acetylcholine (ACh) receptors on the motor endplate [3]. It has an onset of action of 30–60 s and a duration of action of 5–15 min. Rocuronium is a non-depolarizing NMBA which competitively blocks ACh receptors on the motor endplate [4]. It has an onset of action of 1–2 min, but a significantly longer duration of action of 45–70 min.

Awareness with paralysis can occur in patients who are given longer-acting NMBAs with delayed initiation of post-intubation sedation and/or insufficient sedation depth. In the ED-AWARENESS study, Pappal et al. (2021) were the first to prospectively study the concept of awareness with paralysis in the emergency department (ED) setting and found a prevalence of possible or definite awareness in 2.9% (10/345 patients) of patients with documented NMBA exposure [5]. This is a clinically important finding, as patients who experience awareness with paralysis may develop long-term psychological sequalae, including post-traumatic stress disorder, depression, and complex phobias.

The previous literature has associated the use of rocuronium with a significantly longer time to sedation and analgesia as paralyzed patients may not demonstrate movement or signs of distress for a prolonged period of time. Watt et al. (2013) found a mean time of 27 min between intubation and post-intubation sedation in the rocuronium group versus 15 min in the succinylcholine group ($p < 0.001$) in their retrospective cohort study which included 200 ED patients [6]. Similarly, Johnson et al. (2015) found a mean time to sedation or analgesia of 34 min in the rocuronium group versus 16 min in the succinylcholine group ($p = 0.002$) among their cohort of 106 ED patients [7]. In contrast to these results, a recent study by Carlson et al. (2023) found no difference in the median time to initiation of analgesia or sedation in a sample of 200 ED patients receiving succinylcholine vs. rocuronium for RSI (10 min vs. 8.5 min; $p = 0.82$) [8].

This study aimed to evaluate the association between paralytic agent choice and time to initiation of analgesia and/or sedation after RSI in the ED of a large tertiary care hospital.

2. Materials and Methods

This study was an IRB-approved, single-center, retrospective cohort evaluation of adult patients who received succinylcholine or rocuronium in the ED for RSI from 1 October 2021 through 30 September 2023. Patients were consecutively screened in reverse chronological order until 200 patients were included in each group. All data were extracted from the hospital's electronic medical record database. Patients were excluded if they were intubated prior to ED arrival, experienced cardiac arrest prior to or during their ED stay, or were administered NMBA for any reason other than RSI. Incomplete records were also excluded. Data collection included baseline characteristics as well as medication regimen details.

The primary outcome was the time to initiation of post-intubation analgesia and/or sedation after RSI. Time to initiation was defined as the difference in minutes between paralytic administration and first documented administration of continuous or intermittent post-intubation analgesia and/or sedation. Secondary outcomes included the median dose of induction and paralytic agents used and the length of ED stay. Induction agents included etomidate, ketamine, midazolam, propofol, and methohexital. Post-intubation analgesia and/or sedation was defined as the use of the following: dexmedetomidine, diazepam, fentanyl, hydromorphone, ketamine, lorazepam, midazolam, morphine, and propofol.

Mann–Whitney U was used to analyze continuous data and the Chi Square test or Fisher's Exact test were used to analyze categorical data where appropriate. A p-value of <0.05 was considered to be statistically significant. An inter-rater blinded to the study

performed an audit of the primary outcome for 10% of a randomly selected sample. An inter-rater agreement level of 90% or greater was accepted.

3. Results

A total of 1215 charts were screened, and 400 patients were included in the analysis. Study subjects were mostly male with a median age of 67 years in both groups. No statistically significant differences in the baseline characteristics were detected between groups (Table 1). Etomidate was the most frequently used induction agent, regardless of paralytic choice, and all patients in this study received continuous post-intubation sedation. Additional details regarding RSI and post-RSI sedation and analgesia can be found in Table 2. The median time to initiation of post-intubation sedation and/or analgesia was significantly longer in the rocuronium group compared to the succinylcholine group (14 min vs. 9 min, respectively; $p < 0.01$) (Table 3). The actual inter-rater agreement level for the primary outcome was 97.5% and therefore accepted. The median dose of etomidate that was administered was 0.3 mg/kg in both groups, and the median doses of rocuronium and succinylcholine were 1 mg/kg and 1.4 mg/kg, respectively. The ED length of stay was similar between groups, with a median duration of 265 min with succinylcholine administration and 244 min with rocuronium administration ($p = 0.81$).

Table 1. Baseline characteristics.

	Rocuronium (n = 200)	Succinylcholine (n = 200)	*p*-Value
Age (years)	67 (56–75)	67 (52–77)	0.82
Female sex, n (%)	90 (45)	91 (45.5)	0.92
Weight (kg)	78 (66–98)	84 (66–100)	0.47
GCS at presentation	13 (8–15)	13 (8–15)	0.33

Expressed as median (IQR) unless otherwise noted. GCS: Glasgow Coma Scale; IQR: interquartile range.

Table 2. Rapid sequence intubation and post-intubation sedation.

	Rocuronium (n = 200)	Succinylcholine (n = 200)	*p*-Value
Pre-medication used			
Lidocaine	0 (0)	2 (1)	0.50
Induction agent used			
Etomidate	189 (94.5)	187 (93.5)	0.67
Other	11 (5.5)	13 (6.5)	-
Continuous analgosedation	200 (100)	200 (100)	1.00
Sedative + analgesic	98 (49)	145 (72.5)	<0.01
Sedative only	79 (39.5)	47 (23.5)	<0.01
Analgesic only	23 (11.5)	8 (4)	<0.01
Intermittent analgosedation	13 (6.5)	29 (14.5)	<0.01
Midazolam	9/13 (69)	20/29 (69)	1.00
Ketamine	2/13 (15)	8/29 (28)	0.47
Lorazepam	1/13 (8)	1/29 (3)	0.53
Fentanyl	1/13 (8)	0/29 (0)	0.31

Expressed as n (%) unless otherwise noted.

Table 3. Outcomes.

	Rocuronium (n = 200)	Succinylcholine (n = 200)	*p*-Value
Time to initiation of sedation and/or analgesia (minutes)	14 (7–28)	9 (5–16)	<0.01
Induction agent dose (mg/kg)			
Etomidate	0.29 (0.23–0.32)	0.26 (0.21–0.30)	<0.01
Other	-	-	-

Table 3. *Cont.*

	Rocuronium (n = 200)	Succinylcholine (n = 200)	*p*-Value
Paralytic agent dose (mg/kg)	1.03 (0.95–1.30)	1.40 (1.13–1.61)	-
Length of ED stay (minutes)	244 (182–314)	265 (176–356)	0.33

Expressed as median (IQR) unless otherwise noted.

4. Discussion

This is the largest study to date assessing the difference in time to post-intubation sedation in patients given rocuronium or succinylcholine for RSI in the ED. This study reports a median time to post-intubation analgesia and/or sedation use of 14 min in the rocuronium group, which is longer than the approximately 5 min duration of action of the most commonly used induction agent, etomidate [9]. With over 90% of patients receiving etomidate for induction in RSI, this leaves a sizeable portion of patients who are at risk for awareness with paralysis.

Several factors may delay the initiation of analgesia and sedation in patients who receive rocuronium for RSI. Healthcare providers may have a false perception of adequate sedation in patients given long-acting paralytics, as they may not show signs of discomfort, even after the sedative used for RSI has worn off. Time to sedation can be influenced by logistical factors such as the availability of staff, time needed to retrieve medications, and programming medication pumps. Additionally, patient-specific characteristics may decrease the likelihood of receiving sedation. Lembersky et al. (2019) performed a retrospective analysis of data from the National Emergency Airway Registry with the goal of identifying patient populations that may be at risk for omission of post-intubation sedation [10]. The investigators found that the use of short-acting paralytics (i.e., succinylcholine) was associated with increased odds of receiving post-intubation sedation compared to long-acting NMBA (i.e., rocuronium and vecuronium) (1.89; 1.68–2.12). Other factors associated with significantly lower odds of receiving post-intubation sedation were pre- and post-intubation hypotension and cardiac or traumatic arrest. Our study excluded patients that experienced cardiac arrest prior to or during their ED stay but did not control for other potential confounders that would likely affect the primary outcome, such as provider experience, illness severity, and ED pharmacist involvement.

The studies by Watt and Johnson [6,7] included younger patients (30–40 s): the majority of which presented as trauma alerts. These patients likely had less comorbidities at the baseline but may have been a more tenuous population due to their need for intubation being traumatic in nature. The present study tended to exclude trauma patients, as medication administration documentation is recorded in a trauma alert form rather than the medication administration record used to identify the study population. The exclusion of this population may have reduced the magnitude of the effect between groups; however, a statistically significant difference was found, suggesting that the association is still present with the majority being a non-trauma, older patient population.

Watt was the only study that required etomidate as the induction agent for inclusion; however, in the other three studies, it was the most common induction agent administered (75–95%). Johnson required the use of continuous sedation to meet the primary outcome; all other studies included use of intermittent sedation as well, which better represents real-world practice. It is possible that this may have affected their primary outcome, if patients received adequate intermittent sedation but were not immediately started on continuous sedation. Watt used the time from etomidate administration, rather than paralytic administration, to sedation as their primary outcome. In RSI, these should be given nearly simultaneously and therefore would not be expected to significantly affect the primary outcome.

Post-intubation, all patients in this study received continuous sedation and/or analgesia; however, there were significant differences in the regimens selected. Patients who received rocuronium were less likely to be placed on a regimen with both a sedative and an analgesic, compared to the succinylcholine group (49% vs. 72.5%; $p < 0.01$). Additionally, patients who received succinylcholine were more likely to have intermittent sedation and/or analgesia administered in addition to the continuous sedation and/or analgesia (14.5% vs. 6.5%; $p < 0.01$). Similarly, Carlson et al. (2023) observed differences in post-intubation analgosedation practices, with fewer patients receiving both a sedative and analgesic regimen in the rocuronium group compared to the succinylcholine group [8]. They also found that at 60 min post-intubation, patients in the succinylcholine group were receiving significantly higher doses of fentanyl and propofol. This variability suggests a difference in the post-intubation management quality or strategy between the two, where patients given succinylcholine for intubation tend to receive more aggressive and complete post-intubation care. While the present study excluded pediatric patients and therefore cannot be generalized to that population, previous studies conducted on this population have shown similar results. In their study of 84 pediatric patients intubated with etomidate and rocuronium or vecuronium, Kendrick et al. (2009) found a mean time from etomidate to the administration of additional sedation of 46 min, and only 23.8% of patients received additional sedation within 15 min of initial etomidate administration [11].

Johnson and colleagues assessed the impact of ED pharmacist presence and found that time to sedation or analgesia was significantly shorter when an ED pharmacist was present. In their study, the presence of an ED pharmacist reduced the time to sedation or analgesia from 49 $\pm$ 45 min to 20 $\pm$ 21 min ($p < 0.001$). At the study institution, ED pharmacist coverage is not available at all times. This factor may have affected the primary outcome; however, the impact of the ED pharmacist was not assessed in the present study.

This study was limited by its retrospective nature, as it relied heavily on the accuracy of documentation in the medical record and only associations, not causal relationships, can be drawn. Consecutive sampling in reverse chronological order was utilized, which could introduce selection bias through the inclusion of patients over differing time frames within the overall study period. Additionally, information on post-intubation vital signs and adequacy of sedation were not collected; therefore, conclusions cannot be made about the optimization of care after intubation and the possible incidence of awareness with paralysis in this study population.

5. Conclusions

The use of rocuronium for RSI was associated with a longer time to post-intubation sedation and/or analgesia compared with succinylcholine in the ED setting. These results add to the existing literature suggesting that paralytic choice for RSI has implications for post-intubation management. Emergency medicine provider awareness is essential for optimizing post-intubation sedation practices and minimizing the risks associated with inadequate sedation.

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Abbreviations

The following abbreviations are used in this manuscript:

ACh	Acetylcholine
ED	Emergency department
GCS	Glasgow Coma Scale
IQR	Interquartile range
IRB	Institutional review board
NMBA	Neuromuscular blocking agent
RSI	Rapid sequence intubation

References

1. Stollings, J.L.; Diedrich, D.A.; Oyen, L.J.; Brown, D.R. Rapid-sequence intubation: A review of the process and considerations when choosing medications. *Ann. Pharmacother.* **2014**, *48*, 62–76. [CrossRef] [PubMed]
2. Hampton, J.P.; Hommer, K.; Musselman, M.; Bilhimer, M. Rapid sequence intubation and the role of the emergency medicine pharmacist: 2022 update. *Am. J. Health-Syst. Pharm.* **2023**, *80*, 182–195. [CrossRef] [PubMed]
3. Hikma Pharmaceuticals USA Inc. *Succinylcholine [Package Insert]*; Hikma Pharmaceuticals USA Inc.: Berkeley Heights, NJ, USA, 2021.
4. Teva Pharmaceutical Ind. Ltd. *Rocuronium [Package Insert]*; Teva Pharmaceutical Ind. Ltd.: Irvine, CA, USA, 2008.
5. Pappal, R.D.; Roberts, B.W.; Mohr, N.M.; Ablordeppey, E.; Wessman, B.T.; Drewry, A.M.; Winkler, W.; Yan, Y.; Kollef, M.H.; Avidan, M.S.; et al. The ED-AWARENESS Study: A Prospective, Observational Cohort Study of Awareness with Paralysis in Mechanically Ventilated Patients Admitted from the Emergency Department. *Ann. Emerg. Med.* **2021**, *77*, 532–544. [CrossRef] [PubMed]
6. Watt, J.M.; Amini, A.; Traylor, B.R.; Amini, R.; Sakles, J.C.; E Patanwala, A. Effect of paralytic type on time to post-intubation sedative use in the emergency department. *Emerg. Med. J.* **2013**, *30*, 893–895. [CrossRef] [PubMed]
7. Johnson, E.G.; Meier, A.; Shirakbari, A.; Weant, K.; Justice, S.B. Impact of Rocuronium and Succinylcholine on Sedation Initiation After Rapid Sequence Intubation. *J. Emerg. Med.* **2015**, *49*, 43–49. [CrossRef] [PubMed]
8. Carlson, R.T.; Shah, S.; Wells, E.; Fertel, B.S.; Campbell, M.J. Post-intubation analgesia and sedation following succinylcholine vs. rocuronium in the emergency department. *Am. J. Emerg. Med.* **2023**, *71*, 99–103. [CrossRef] [PubMed]
9. Hospira, Inc. *Etomidate [Package Insert]*; Hospira, Inc.: Lake Forest, IL, USA, 2017.
10. Lembersky, O.; Golz, D.; Kramer, C.; Fantegrossi, A.; Carlson, J.N.; Walls, R.M.; Brown, C.A. Factors associated with post-intubation sedation after emergency department intubation: A Report from The National Emergency Airway Registry. *Am. J. Emerg. Med.* **2020**, *38*, 466–470. [CrossRef] [PubMed]
11. Kendrick, D.B.; Monroe, K.W.; Bernard, D.W.; Tofil, N.M.M. Sedation after intubation using etomidate and a long-acting neuromuscular blocker. *Pediatr. Emerg. Care* **2009**, *25*, 393–396. [CrossRef] [PubMed]

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