



Original contribution

# Rocuronium is associated with an increased risk of reintubation in patients with soft tissue infections<sup>☆</sup>



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## Abstract

**Study Objective:** To determine risk factors associated with reintubations in adult patients with soft tissue infections.  
**Design:** A retrospective case-control design.

**Setting:** Operating room and postoperative recovery area.

**Patients:** There were 39 patients who presented for surgical intervention of their soft tissue infection and 222 controls having general surgery who were matched for age, sex, and body mass index. All patients were older than the age of 18 years and mostly American Society of Anesthesiologists physical status of III to IV and presented to our level 1 trauma center.

**Interventions:** Reintubation within 2 hours after planned extubation.

**Measurements:** The following data were collected: reintubation rates, train of four ratio, reversal agents, age, sex, creatinine, smoking history, transfusion requirements, Sequential Organ Failure Assessment score, hemoglobin, and lactate.

**Main Results:** The use of rocuronium was independently associated with increased odds of reintubation. Patients with a higher train of four ratio were more likely to be reintubated and less likely to be reversed as compared to those with a lower train of four ratio.

**Conclusions:** Soft tissue patients who have received rocuronium are at increased risk for reintubation, particularly those with renal failure. In addition, this article supports the use of neuromuscular blockade reversals, even in patients with a strong train of four ratio.

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## 1. Introduction

Reintubation after planned extubation in either the operating room or postanesthesia care unit (PACU) is an uncommon event; however, it may have a significant impact on morbidity, mortality, and cost. The incidence of reintubation rates in the PACU has been reported to be approximately 0.19% [1,2]

which is lower than the failed extubation rate reported in intensive care units [3,4]. Despite the relatively rare occurrence of this event, reintubation poses a significant risk to patient safety and remains an important focus for quality improvement initiatives [5].

There are limited data regarding the risk factors for reintubation in the PACU. One case-control study identified head and neck surgery, cardiothoracic surgery, airway surgery, and operative time more than 3 hours as surgically related independent risk factors for reintubation, whereas American Society of Anesthesiologists (ASA) physical status III and administration of aminosteroid neuromuscular blockade drugs (NMBD) were found to be independent anesthetic risk factors for reintubation [6]. In a Taiwanese study, the majority of reintubations occurred within 10 minutes of extubation and was more common in patients with chronic obstructive pulmonary disease, pneumonia, ascites, or systemic inflammatory response syndrome [7].

Reintubation has been shown to be an independent risk factor for morbidity and mortality [8–13]. It is associated with the development of ventilator-associated pneumonia, need for tracheostomy, and increased hospital costs and may be associated with a risk of mortality more than 40% [8–13]. Furthermore, patients requiring reintubation are often at greater risk for having a difficult airway. In a previous study by Pronovost et al [14], for every 6 failed extubations prevented, 1 death was avoided. In the same study, the marginal cost of hospital care for a failed extubation was \$10,000 per incident [14].

There are currently no well-defined risk factors associated with reintubation after planned extubation for patients in need of surgery for severe soft tissue infections. As a primary statewide referral center for patients requiring evaluation and treatment of soft tissue infections, our institution has significant experience with this distinct patient population. The primary objective of this work was to determine factors associated with reintubation in adult patients with soft tissue infections, most commonly necrotizing fasciitis of the perineum. We hypothesized that use of rocuronium in patients with soft tissue infections is an independent risk factor for extubation failure.

## 2. Methods

### 2.1. Study population, design, and outcome of interest

After expedited approval by the institutional review board of the University of Maryland School of Medicine, a retrospective case-control design was devised to investigate the outcome of interest. The study was completed at a single level 1 trauma center that accepts more than 8000 direct patient admissions annually. The study population was composed of cases and controls, age 18 years or older and admitted to the trauma center from January 1, 2008, to May 21, 2015. Cases were identified using a preexisting database maintained at the institution to track patients admitted with soft tissue

infections in addition to a quality assurance database maintained in the Division of Trauma Anesthesiology used to identify cases of reintubation. Controls were selected as patients with nonnecrotizing soft tissue infections and matched to cases using similar distributions of the following independent variables: sex (3:1 male to female ratio), age ( $\pm 15$  years), and body mass index ( $\pm 10$ ). The primary outcome of interest for this work was the requirement for reintubation.

### 2.2. Anesthetic management

Patients in this study were induced with propofol at 1 to 1.5 mg/kg and subsequently maintained under general anesthesia at a minimum alveolar concentration of 1 of either isoflurane or sevoflurane. Muscle relaxation was provided by either rocuronium at an intubating dose of 0.6 mg/kg or vecuronium at an intubating dose of 0.1 mg/kg based on the discretion of the provider. In the case group, 23 patients received rocuronium, and 16 patients received vecuronium. In the control group, 154 patients received rocuronium, and 63 received vecuronium. The train of four (TOF) monitoring was analyzed by Life-tech MiniStim monitor. Before extubation, the TOF was monitored at either the orbicularis oculi muscle or the adductor pollicis muscle. The site was not recorded, but it is common at our institution to monitor the orbicularis oculi muscle as the adductor pollicis muscle is often inaccessible due to arm position.

### 2.3. Statistical analysis

Student *t* tests or Wilcoxon rank sum tests were used for comparison of normally and nonnormally distributed continuous variables, and the  $\chi^2$  or Fisher exact test was used for comparison of end points expressed as percentages. All tests were done with a 2-sided significance of 0.05. To analyze independent variables associated with the outcome of interest (reintubation), a fixed-effect logit for panel data analysis (conditional logistic regression) was used for the matched case-control groups to determine any association with the use of rocuronium and reintubation.

To further investigate relationships between measured variables and latent constructs, a structural equation modeling (SEM) approach was used. SEM is a comprehensive statistical approach to test hypotheses about relations among observed (measured) and unobserved (latent) variables [15–17]. SEM is a highly flexible multivariate technique that can help with understanding the patterns of correlation among a set of variables [17,18]. In SEM, model specification involves formulating statements about a set of variables. A pictorial representation of a model is transformed into a set of equations, and the equations are solved to test model fit and estimate parameters [17]. Relationships between independent and dependent variables can be assessed with SEM. A large direct effect is indicated by a standardized path coefficient with an absolute value greater than 0.50 [17,19].

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