The Association Between Intraoperative Objective Neuromuscular Monitoring and Rocuronium Consumption During Laparoscopic Abdominal Surgery: A Single-Center Retrospective Analysis

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Research Article

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Abstract

Background: Rocuronium consumption with or without intraoperative objective neuromuscular monitoring in clinical settings of unrestricted use of sugammadex and neuromuscular monitoring has not been reported. The aim of the study was to investigate the association between the use of intraoperative objective neuromuscular monitoring and rocuronium consumption in patients undergoing laparoscopic abdominal surgery.

Methods: Data were collected by reviewing electronic medical records of patients who received laparoscopic abdominal surgery under general anesthesia with rocuronium and reversal with sugammadex at Asahikawa Medical University Hospital between May 2017 and April 2018. Multiple linear regression model was developed to compare the amount of rocuronium consumption per weight per hour (mg/kg/h) between the group in which intraoperative objective neuromuscular monitoring was used (NM+ group) and the group in which intraoperative neuromuscular monitoring was not used (NM- group). Additionally, we performed an interaction test with reference to the results of the subgroup analysis.

Results: A total of 429 patients were evaluated, with 371 patients (86%) included in NM+ group and 58 patients (14%) in NM- group. In the NM+ group, 94% of the patients received additional rocuronium after reappearance of TOF response while 6% of the patients received additional rocuronium before reappearance of TOF in order to maintain post-tetanic count. Log-transformed rocuronium consumption between NM+ group and NM- group was not significantly different (back-transformed $\beta$-coefficients [95%CI]: 1.054 [0.946–1.174]; $P=0.34$). Male sex and body mass index (BMI) were independent factors associated with 15% (0.854 [0.789–0.925]; $P<0.001$) and 3% (for every 1 kg/m$^2$ increase in BMI) (0.970 [0.962–0.979]; $P<0.001$) decrease in intraoperative rocuronium consumption, respectively. A significant interaction was detected between the use of neuromuscular monitoring and age≥65 ($\beta$: 0.843 [0.759–0.936]; $P=0.001$).

Conclusions: This single center retrospective study demonstrated that although the use of intraoperative objective neuromuscular monitoring was not an individual factor influencing intraoperative rocuronium consumption, the use of intraoperative neuromuscular monitoring reduced rocuronium consumption by approximately 15% during laparoscopic abdominal surgery in elderly patients.

Background

The use of quantitative (objective) neuromuscular monitoring is recommended whenever neuromuscular blocking agents (NMBAs) and neuromuscular reversal agents are administered [1]. Intraoperative neuromuscular monitoring provides precise measurement of the depth of neuromuscular block as guidance for appropriate dosing of NMBAs and reversal agents. Since intraoperative neuromuscular monitoring was not a widespread practice in Japan, the Japanese Society of Anesthesiologists updated their practice guidelines in March 2019 to recommend the use of intraoperative neuromuscular
monitoring (whether objective or subjective was not specified) whenever NMBAs and neuromuscular reversal agents are administered. In our institution, acceleromyography (IntelliVue NMT Module, Philips Healthcare, Amsterdam, the Netherlands) became available in all operating rooms in 2014, and the objective train-of-four (TOF) responses are automatically recorded in the institutional electronic medical records (EMRs). As a result, we have previously reported that the use of intraoperative neuromuscular monitoring reduces the reversal dose of sugammadex in a single center retrospective study [2]. To the best of our knowledge, rocuronium consumption with or without intraoperative objective neuromuscular monitoring in clinical settings of unrestricted use of sugammadex and neuromuscular monitoring has not been reported. Since optimal depth of neuromuscular block differs among the types of surgery, we focused on laparoscopic surgery in which the use of NMBAs is recommended throughout the procedure [3]. In addition, it is reported that elderly patients are at greater risk of postoperative residual neuromuscular block and postoperative pulmonary complications [4]. We hypothesized that the use of intraoperative objective neuromuscular monitoring decreases rocuronium consumption and prevents overuse of rocuronium during laparoscopic surgery in elderly (age ≥ 65) patients. Therefore, in this retrospective study, we compared the rocuronium consumption in laparoscopic surgical cases in which intraoperative neuromuscular monitor was used, to cases in which intraoperative neuromuscular monitoring was not used.

Methods

Ethical approval for this retrospective cohort study was provided by the Asahikawa Medical University Research Ethics Committee on March 31, 2020 (approval number: 18242-2). Informed consent was waived also by the Asahikawa Medical University Research Ethics Committee due to the retrospective design of the study. This study was conducted at Asahikawa Medical University Hospital in Asahikawa, Japan. Data were collected by using Vi-pros (DOWELL Co., Ltd., Tokyo, Japan) and reviewing the EMRs of patients who received laparoscopic abdominal surgery under general anesthesia maintained with rocuronium and reversed with sugammadex at Asahikawa Medical University Hospital operating rooms between May 1, 2017 and April 30, 2018. Patients with incomplete medical records were excluded. The collected data included the use of intraoperative neuromuscular monitoring and characteristics of patient, surgery and anesthesia.

Patient characteristics included age, sex, body mass index (BMI [kg/m²]), liver damage marker enzyme of alanine aminotransferase (ALT [IU/L]), and renal function as estimate glomerular filtration rate (eGFR [ml/min/1.73m²]). Surgical characteristics included type of surgery and surgical procedure time (minutes). Anesthesia characteristics included anesthesia-controlled time (minutes), type of anesthetic agent (inhaletal or intravenous), total dose of administered rocuronium (mg), and type of additional rocuronium administration (continuous infusion or intermittent bolus).

One of the main outcomes in this study was the difference in the total amount of rocuronium consumption (mg) per weight (kg) per surgical duration (hours) (mg/kg/h) between the group in which intraoperative quantitative neuromuscular monitoring was used (NM + group) and the group in which
intraoperative neuromuscular monitoring was not used (NM- group). In addition, we performed a subgroup analysis with interaction test which is the other main outcomes in this study.

**Statistical analysis**

Data are shown as % (number), median (25–75%, interquartile range [IQR]), or mean difference (95% confidence interval [CI]). For univariate comparisons, we used $\chi^2$ test for categorical variables and Student's $t$ test or Mann-Whitney $U$ test for continuous variables.

Multiple linear regression analysis was performed to compare the amount of intraoperative rocuronium consumption (mg/kg/h) between NM+ group and NM- group after adjusting for confounding factors. The primary independent variable was the use of intraoperative neuromuscular monitoring. Other independent variables were possible confounding factors previously reported to influence neuromuscular blocking effects: age [5], sex [6], BMI [7], liver function (we used liver damage marker enzyme of ALT) [8], renal function (eGFR) [9], type of anesthetic agent [10], and type of maintenance rocuronium administration (bolus vs. continuous infusion) [11]. A subject-to-variable ratio of 15:1 was maintained to avoid overfitting of independent variables. The dependent variable was the amount of intraoperative rocuronium consumption (mg/kg/h). All variables were decided prior to the analysis based on the aforementioned report and forced into the model. The assumptions of linearity, normality, homoscedasticity, and multicollinearity were tested using two-way scatter plots, normal quantile-quantile (QQ) plot, residuals vs. fitted plot, variance inflation factor. Adjusted R-squared was calculated to measure the model's goodness of fit.

Prior to the interaction test, a subgroup analysis was performed in predefined subgroups including age (< 65 or 65–75 or ≥ 75), sex (male or female), BMI (< 18.5 or 18.5–25 or ≥ 25), ALT (< 40 or 40≤), eGFR (< 60 or 60≤), and type of anesthetic agent (inhalational or intravenous) to investigate the trend in rocuronium consumption between NM+ group and NM- group. In reference to the forest plot of the subgroup analysis, potential effect variables were tested for interaction with the use of neuromuscular monitoring in the final multiple linear regression analysis.

All analyses were performed by R software (version 3.4.1) and considered statistically significant with $P < 0.05$.

**Results**

Among 459 patients who received laparoscopic abdominal surgery under general anesthesia maintained with rocuronium and reversed with sugammadex from May 2017 to April 2018, we excluded 30 patients who had incomplete medical records. A total of 429 patients were evaluated, with 371 patients (86%) included in NM+ group and 58 patients (14%) in NM- group (Fig. 1). Patient characteristics are shown in Table 1. There were no significant differences in age, sex, BMI, ALT, eGFR, type of surgery, and type of anesthetic agent between the two groups. NM+ group patients had longer surgery and anesthesia time.
and were more likely to receive additional rocuronium by intermittent bolus than NM- group patients. In the NM + group, 94% of the patients received additional rocuronium after reappearance of TOF response while 6% of the patients received additional rocuronium before reappearance of TOF in order to maintain post-tetanic count (PTC). NM- group patients received significantly larger reversal doses of sugammadex compared to NM + group (2.2 [2.1–2.9] vs 2.1 [2.0-2.5]).
Table 1
Patient characteristics

<table>
<thead>
<tr>
<th></th>
<th>Group NM+ n = 371</th>
<th>Group NM- n = 58</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>65 (49–72)</td>
<td>63 (46–72)</td>
<td>.45</td>
</tr>
<tr>
<td>Male sex</td>
<td>54.2% (201)</td>
<td>41.4% (24)</td>
<td>.26</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>22.7 (20.6–25.6)</td>
<td>22.2 (19.9–25.4)</td>
<td>.40</td>
</tr>
<tr>
<td>ALT (U/L)</td>
<td>17 (12–24)</td>
<td>17 (14–23)</td>
<td>.80</td>
</tr>
<tr>
<td>eGFR (mL/min/1.73m(^2))</td>
<td>78 (64–93)</td>
<td>81 (67–99)</td>
<td>.178</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
<td></td>
<td>.24</td>
</tr>
<tr>
<td>Gastroenterology</td>
<td>56.6% (210)</td>
<td>44.8% (26)</td>
<td></td>
</tr>
<tr>
<td>Gynecology</td>
<td>20.8% (77)</td>
<td>27.6% (16)</td>
<td></td>
</tr>
<tr>
<td>Urology</td>
<td>22.6% (84)</td>
<td>27.6% (16)</td>
<td></td>
</tr>
<tr>
<td>Surgical procedure time (min)</td>
<td>202 (128–296)</td>
<td>138 (110–246)</td>
<td>.019</td>
</tr>
<tr>
<td>Anesthesia-controlled time (min)</td>
<td>279 (195–374)</td>
<td>215 (173–313)</td>
<td>.007</td>
</tr>
<tr>
<td>Anesthetic agent</td>
<td></td>
<td></td>
<td>.26</td>
</tr>
<tr>
<td>Inhalational</td>
<td>63.9% (237)</td>
<td>55.2% (32)</td>
<td></td>
</tr>
<tr>
<td>Intravenous</td>
<td>36.1% (134)</td>
<td>44.8% (26)</td>
<td></td>
</tr>
<tr>
<td>Additional rocuronium administration</td>
<td></td>
<td></td>
<td>.013</td>
</tr>
<tr>
<td>Intermittent bolus administration</td>
<td>97.3% (361)</td>
<td>89.7% (52)</td>
<td></td>
</tr>
<tr>
<td>Continuous infusion</td>
<td>2.7% (10)</td>
<td>10.3% (6)</td>
<td></td>
</tr>
<tr>
<td>Dose of sugammadex (mg/kg)</td>
<td>2.1 (2.0-2.5)</td>
<td>2.2 (2.0-2.9)</td>
<td>.010</td>
</tr>
</tbody>
</table>

Data are expressed as % (n), or median (25–75%, interquartile range [IQR]).

Abbreviations

NM+: with intraoperative objective neuromuscular monitoring

NM-: without neuromuscular monitoring

BMI: body mass index

ALT: alanine aminotransferase

eGFR: estimate glomerular filtration rate
Table 2 illustrates the multiple linear regression model developed to compare intraoperative rocuronium consumption (mg/kg/h) between the groups. Dependent variables were logarithmically transformed since the distribution of the residuals were positively skewed in the normal QQ plot, thereby generating a normal distribution. The resulting $\beta$-coefficients from the log-transformed outcome were back-transformed. The back-transformed $\beta$-coefficients were then interpreted as percentage increase or decrease. The F-value and p-value of the model were 22.62 and < 0.001, respectively, indicating that the model was statistically significant at 95% CI. The model's adjusted R-squared was 0.33, indicating that 33% of the variance could be explained by the model. Rocuronium consumption between NM + group and NM- group was not significantly different ($\beta$-coefficients [95%CI]: 1.054 [0.946–1.174]; P = 0.34). Male sex was independently associated with decreased rocuronium consumption by approximately 15% ($\beta$: 0.854 [0.789–0.925]; P < 0.001). BMI was also an independent factor associated with a 3% decrease in rocuronium consumption for every 1 kg/m$^2$ increase in BMI ($\beta$: 0.970 [0.962–0.979]; P < 0.001). Rocuronium consumption tended to decrease with age, decrease in ALT, increase in eGFR, intravenous anesthesia (vs. inhalational), and bolus administration of rocuronium (vs. continuous infusion), although statistical significance was not achieved.
Table 2
Multiple linear regression model developed for estimating the dose of rocuronium consumption (mg) per weight (kg) per hour (mg/kg/h).

<table>
<thead>
<tr>
<th>Variables</th>
<th>β Coefficients (95%CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of intraoperative neuromuscular monitor</td>
<td>1.054 (0.946–1.174)</td>
<td>.34</td>
</tr>
<tr>
<td>Age</td>
<td>0.997 (0.993–1.000)</td>
<td>.072</td>
</tr>
<tr>
<td>Male sex</td>
<td>0.854 (0.789–0.925)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>BMI</td>
<td>0.970 (0.962–0.979)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>ALT</td>
<td>1.000 (0.999–1.000)</td>
<td>.24</td>
</tr>
<tr>
<td>eGFR</td>
<td>1.001 (0.999–1.002)</td>
<td>.42</td>
</tr>
<tr>
<td>Intravenous anesthesia (vs. inhalational)</td>
<td>1.041 (0.951–1.141)</td>
<td>.38</td>
</tr>
<tr>
<td>Bolus administration (vs. continuous)</td>
<td>1.045 (0.877–1.141)</td>
<td>.62</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of intraoperative neuromuscular monitoring and Age ≥ 65</td>
<td>0.843 (0.759–0.936)</td>
<td>.001</td>
</tr>
</tbody>
</table>

Multiple R-squared: 0.33. The β-coefficients and 95% confidence intervals are back-transformed coefficients from multiple linear regression models using log-transformed dependent variables.

Abbreviations

CI: confidence interval
BMI: body mass index
ALT: alanine aminotransferase
eGFR: estimate glomerular filtration rate

Among predefined subgroups in the subgroup analysis, statistically significant mean difference in rocuronium consumption between NM + group and NM- group was found only in the BMI < 18.5 subgroup (mean difference [95%CI]: 0.27 [0.03–0.51]) (Fig. 2). In reference to forest plot, potential inter-subgroup differences of rocuronium consumption (that is, potential interaction) were predicted at categories of age (< 65 or ≥ 65), sex (male or female), BMI (< 18.5 or ≥ 18.5), ALT (< 40 or ≥ 40), eGFR (< 60 or ≥ 60), and type of anesthetic agent (inhalational or intravenous). All these predicted variables were tested for interaction with the use of neuromuscular monitoring in the final multiple linear regression analysis (Table 2). A significant interaction was detected between the use of neuromuscular monitoring and age ≥ 65 (β: 0.843 [0.759–0.936]; P = 0.001).

Discussion
In this single-center retrospective study, although the use of intraoperative neuromuscular monitoring was not an individual factor influencing intraoperative rocuronium consumption, we found that the use of intraoperative neuromuscular monitoring reduced rocuronium consumption by approximately 15% during laparoscopic surgery in elderly patients (age ≥ 65). In other words, without intraoperative neuromuscular monitoring, there is a risk of overusing rocuronium in elderly patients. It is known that elderly patients have a longer duration of action of rocuronium compared to younger patients [5, 12]. One prospective study showed that means ± standard deviation (SD) of duration of action (minutes) after 0.6 mg/kg rocuronium administration in elderly and younger controls were 42.4 ± 14.5 and 27.5 ± 7.1, respectively [5]. Moreover, elderly patients have greater variability in the duration of action of rocuronium compared to younger patients [13]. One prospective study reported that the range of duration of action after 0.6 mg/kg rocuronium administration under sevoflurane anesthesia in elderly patients was 33–119 minutes [13]. The mechanism of this prolongation and increased variability in the duration of action of rocuronium in elderly patients are attributed to decreased plasma clearance of rocuronium due to age-related reduction in liver size [14], decrease in hepatic and renal blood flow [14], and decrease in rocuronium's distribution volume [5]. The lower rocuronium consumption in elderly patients who underwent quantitative monitoring vs. those who did not undergo such monitoring (and were managed with subjective evaluation) indicates that quantitative monitoring facilitates administration of lower total doses of rocuronium. This may indicate patient safety implications, since the elderly are at higher risk for residual neuromuscular block and attendant complications [4].

According to previous reports, age [5], female sex [6], obesity [7], liver dysfunction [8], renal dysfunction [9], use of inhalational anesthesia [10], and continuous infusion of rocuronium [11] are the factors which decrease intraoperative rocuronium consumption. In our study’s multiple linear regression analysis, BMI and male sex were the independent factors associated with significant decrease in intraoperative rocuronium consumption per body weight. Although statistical difference was not found (p = 0.072), there was a trend that intraoperative rocuronium consumption decreased with age. Therefore, factors other than male sex, which decreased rocuronium consumption in our study, were consistent to previous reports. One prospective study showed that women required approximately 30% less rocuronium than men to maintain the same degree of neuromuscular block [6]. The etiology of the high sensitivity to NMBAs in female sex was reported as more fat, less muscle, and lower distribution volume compared to men [6]. In contrast, male sex had a decrease in rocuronium consumption by 15% in our study. The reason for the apparent contradiction is unknown; however, we speculate that higher age group (median age of approximately 65 years old) in our study compared to previous study (mean age of approximately 30 years old) may have affected the different sensitivity to NMBAs between sex.

Consistent to our previous report [2], we found that the use of intraoperative neuromuscular monitoring significantly reduced the reversal dose of sugammadex in patients undergoing laparoscopic abdominal surgery. In our previous study [2], we compared the reversal dose of sugammadex between NM+ and NM- regardless of the type of surgery. We believe that the result of the present analysis of laparoscopic abdominal surgical patients supports our previous conclusion of the use of intraoperative neuromuscular monitoring reducing the reversal dose of sugammadex.
During laparoscopic surgery, it is recommended to maintain a deeper neuromuscular block to improve the quality of surgical field and to reduce the risk of intraoperative adverse events [15]. However, a remaining question is, how deep should the neuromuscular block be during laparoscopic surgery? A recent systematic review concluded that the use of deep neuromuscular block (defined as PTC 1–2) may improve laparoscopic surgical conditions compared with moderate neuromuscular block (TOF count 1–2) [16]. Moreover, a randomized double-blind controlled study reported that deep neuromuscular block improved not only surgical conditions but also postoperative pain in laparoscopic bariatric surgery [17]. In NM + group in our study, 94% of the patients were maintained with moderate neuromuscular block during the surgery. As a first limitation of this study, if all patients were maintained with deep neuromuscular block in NM + group in our study, the difference in intraoperative rocuronium consumption between NM + group and NM- group may have been less.

This study has several other limitations. First, as our study was a single center study, our data may not be applicable to other institutions. However, the present results will be an example of an institution in which routine practice includes unrestricted use of sugammadex and the widespread availability of quantitative neuromuscular monitors in every operating room. Second, in NM- group, additional rocuronium was administered according to the attending anesthesiologist’s subjective evaluation. Subjective evaluation is likely based on each individual’s clinical experience which can be affected by institutional factors and educational background. Given that there was no statistical difference in rocuronium consumption between NM + group and NM- group among young patients (age ≥65), we anticipate that excessively high or low doses of rocuronium were not administered even without the use of intraoperative neuromuscular monitoring in our study. Third, due to the relatively high usage (86%) of intraoperative neuromuscular monitoring in this study, the number of patients in NM- group was small. Finally, as with any observational studies, the observed associations may be confounded by unmeasured factors such as patient severity. However, the association of interest remained significant after accounting for previously reported confounding factors.

Conclusions

In conclusion, this single center retrospective study demonstrated that although the use of intraoperative objective neuromuscular monitoring was not an individual factor influencing intraoperative rocuronium consumption, the use of intraoperative neuromuscular monitoring reduced rocuronium consumption by approximately 15% during laparoscopic abdominal surgery in elderly patients. Our findings should facilitate further research in objective intraoperative neuromuscular monitoring to maintain appropriate depth of neuromuscular block and optimize the consumption of NMBAs to prevent overuse of NMBAs and further, reversal agents as well.

Abbreviations

NMBAs: neuromuscular blocking agents
Declarations

Ethics approval and consent to participate

This study was approved by Asahikawa Medical University Research Ethics Committee (approved date: March 31, 2020, approval number: 18242-2). Informed consent was waived by Asahikawa Medical University Research Ethics Committee due the retrospective design of the study. The study protocol was in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

Hajime Iwasaki has received speaker fees from MSD, Inc, Japan. Kenichi Takahoko, Takashi Matsuno, Risako Matsuno, Sarah Kyuragi Luthe, and Hirotsugu Kanda have no competing interests.

Funding
Author’s contributions

Study design: KT, HI, SLK, and HK, Data collection: KT, HI, TM, and RM, Data analysis: KT and HI, Manuscript preparation: KT, HI, TM, and RM, Editing the manuscript: SLK and HK

All authors read and approved the final manuscript.

Acknowledgments

Kenichi Takahoko and Hajime Iwasaki are equally contributing first authors of this article.

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References


**Figures**
Patients who received laparoscopic abdominal surgery under general anesthesia with rocuronium and sugammadex from May 2017 to April 2018 (n=459)

Excluded
Incomplete medical records (n=30)

Finally included
(n=429)

NM+ group
(n=371)

NM- group
(n=58)

Figure 1
Flow chart of patient selection and exclusion. Abbreviations NM+: with intraoperative objective neuromuscular monitoring NM-: without neuromuscular monitoring
Figure 2

Forest plot of mean difference in the amount of rocuronium consumption per kg weight per hour (mg/kg/h) according to predefined subgroups. Abbreviations NM+: with intraoperative objective neuromuscular monitoring NM-: without neuromuscular monitoring MD: mean difference SD: standard deviation BMI: body mass index ALT: alanine aminotransferase eGFR: estimate glomerular filtration rate

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>NM+ n</th>
<th>Mean (SD)</th>
<th>NM- n</th>
<th>Mean (SD)</th>
<th>Mean difference</th>
<th>MD 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age&lt;65</td>
<td>182</td>
<td>0.68 (0.34)</td>
<td>34</td>
<td>0.62 (0.23)</td>
<td>0.06 [0.04; 0.15]</td>
<td></td>
</tr>
<tr>
<td>Age65–75</td>
<td>123</td>
<td>0.47 (0.18)</td>
<td>13</td>
<td>0.53 (0.17)</td>
<td>-0.06 [-0.16; 0.04]</td>
<td></td>
</tr>
<tr>
<td>Age75≤</td>
<td>66</td>
<td>0.46 (0.20)</td>
<td>11</td>
<td>0.58 (0.20)</td>
<td>-0.11 [-0.24; 0.02]</td>
<td></td>
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<tr>
<td>Male</td>
<td>201</td>
<td>0.48 (0.21)</td>
<td>24</td>
<td>0.55 (0.20)</td>
<td>-0.06 [-0.15; 0.02]</td>
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<tr>
<td>Female</td>
<td>170</td>
<td>0.67 (0.34)</td>
<td>34</td>
<td>0.62 (0.22)</td>
<td>0.05 [-0.04; 0.14]</td>
<td></td>
</tr>
<tr>
<td>BMI&lt;18.5</td>
<td>26</td>
<td>0.89 (0.60)</td>
<td>5</td>
<td>0.62 (0.09)</td>
<td>0.27 [0.03; 0.51]</td>
<td></td>
</tr>
<tr>
<td>BMI18.5–25</td>
<td>238</td>
<td>0.58 (0.24)</td>
<td>36</td>
<td>0.63 (0.23)</td>
<td>-0.05 [-0.13; 0.03]</td>
<td></td>
</tr>
<tr>
<td>BMI25≤</td>
<td>107</td>
<td>0.46 (0.17)</td>
<td>17</td>
<td>0.51 (0.20)</td>
<td>-0.05 [-0.15; 0.05]</td>
<td></td>
</tr>
<tr>
<td>ALT&lt;40</td>
<td>344</td>
<td>0.57 (0.27)</td>
<td>54</td>
<td>0.60 (0.21)</td>
<td>-0.03 [-0.09; 0.03]</td>
<td></td>
</tr>
<tr>
<td>ALT40≤</td>
<td>27</td>
<td>0.59 (0.49)</td>
<td>4</td>
<td>0.51 (0.21)</td>
<td>0.08 [-0.19; 0.36]</td>
<td></td>
</tr>
<tr>
<td>eGFR&lt;60</td>
<td>70</td>
<td>0.47 (0.19)</td>
<td>9</td>
<td>0.54 (0.21)</td>
<td>-0.07 [-0.21; 0.08]</td>
<td></td>
</tr>
<tr>
<td>eGFR60≤</td>
<td>301</td>
<td>0.59 (0.31)</td>
<td>49</td>
<td>0.60 (0.21)</td>
<td>-0.01 [-0.08; 0.08]</td>
<td></td>
</tr>
<tr>
<td>Inhalational anesth</td>
<td>237</td>
<td>0.50 (0.23)</td>
<td>32</td>
<td>0.57 (0.21)</td>
<td>-0.08 [-0.15; 0.00]</td>
<td></td>
</tr>
<tr>
<td>Intravenous anesth</td>
<td>134</td>
<td>0.70 (0.35)</td>
<td>26</td>
<td>0.61 (0.22)</td>
<td>0.08 [-0.02; 0.19]</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.02 [-0.05; 0.01]</td>
<td></td>
</tr>
</tbody>
</table>

**Overall:**

- Increase in NM+ vs NM-: -0.02 [-0.05; 0.01]