

Although the use of a more procedurally specific type of matching would most likely lead to a decrease in statistical power within a given data set, selection bias with regard to surgical procedure cannot be properly controlled for without doing so.

In addition, variables that are known to be correlated with postoperative pneumonia need to be accounted for in the analysis to better elucidate the real impact of NMDR and neostigmine reversal on this outcome. These include patient functional status, smoking history, and presence of chronic obstructive pulmonary disease.<sup>3,6,7</sup> Although these variables were indirectly accounted for in this study through the American Society of Anesthesiologists classification, a previous investigation revealed that each of these aforementioned factors were still associated with postoperative pneumonia even after controlling for American Society of Anesthesiologists class.<sup>7</sup> Also, this analysis does not account for the beneficial effects of optimum postoperative analgesia, specifically epidural analgesia,<sup>9</sup> on the occurrence of postoperative pneumonia. Lastly, several references in this article are erroneous. In fact, all four citations in the second paragraph of page 649 do not confirm the ideas expressed in their respective sentences.

### Competing Interests

The authors declare no competing interests.

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### References

1. Bulka CM, Terekhov MA, Martin BJ, Dmochowski RR, Hayes RM, Ehrenfeld JM: Nondepolarizing neuromuscular blocking agents, reversal, and risk of postoperative pneumonia. *ANESTHESIOLOGY* 2016; 125:647–55
2. Murphy GS, Kopman AF: “To reverse or not to reverse?": The answer is clear! *ANESTHESIOLOGY* 2016; 125:611–4
3. Lynch JP III: Hospital-acquired pneumonia: Risk factors, microbiology, and treatment. *Chest* 2001; 119(2 suppl):373–84S
4. Grailey K, Markar SR, Karthikesalingam A, Aboud R, Ziprin P, Faiz O: Laparoscopic *versus* open colorectal resection in the elderly population. *Surg Endosc* 2013; 27:19–30
5. Whitson BA, Andrade RS, Boettcher A, Bardales R, Kratzke RA, Dahlberg PS, Maddaus MA: Video-assisted thoracoscopic surgery is more favorable than thoracotomy for resection of clinical stage I non-small cell lung cancer. *Ann Thorac Surg* 2007; 83:1965–70
6. Arozullah AM, Khuri SF, Henderson WG, Daley J; Participants in the National Veterans Affairs Surgical Quality Improvement Program: Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. *Ann Intern Med* 2001; 135:847–57
7. Gupta H, Gupta PK, Schuller D, Fang X, Miller WJ, Modrykamien A, Wichman TO, Morrow LE: Development and validation of a risk calculator for predicting postoperative pneumonia. *Mayo Clin Proc* 2013; 88:1241–9
8. Normand ST, Landrum MB, Guadagnoli E, Ayanian JZ, Ryan TJ, Cleary PD, McNeil BJ: Validating recommendations for coronary angiography following acute myocardial infarction in the elderly: A matched analysis using propensity scores. *J Clin Epidemiol* 2001; 54:387–98
9. Pöpping DM, Elia N, Marret E, Remy C, Tramèr MR: Protective effects of epidural analgesia on pulmonary complications after abdominal and thoracic surgery: A meta-analysis. *Arch Surg* 2008; 143:990–1000

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## Risk of Postoperative Pneumonia with Neuromuscular Blockade: Keep It Simple!

*To the Editor:*

We read with interest the article by Bulka *et al.*<sup>1</sup> regarding the relationship between the management of intraoperative neuromuscular blockade and postoperative pneumonia. The use of large databases to address rare outcomes has increased in recent years. The value in using these databases is the large number of patients who can be assessed. Such large numbers would be extremely challenging to achieve in a randomized controlled study. However, a major limitation and concern with database studies like this one is subsequent confusion between correlation and causation. With regard to residual paralysis, we believe that these challenges can be bypassed with one simple technique—the objective monitoring of the effects of a neuromuscular blocking agent. Although the incidence of residual neuromuscular blockade at extubation is significant,<sup>2</sup> currently, monitoring of neuromuscular blockade is still not an explicitly articulated American Society of Anesthesiologists basic monitoring standard.<sup>3</sup> Whereas many practitioners use such monitoring in their practice, others rely on clinical signs of strength or other outdated measures, such as the 5-s head lift or 50-Hz sustained tetanus to determine adequate recovery from neuromuscular blockade before extubation. Still others simply rely on time from reversal agents being given.<sup>4</sup>

Perhaps the reluctance to consistently monitor the effects of neuromuscular blocking agent and, most importantly, the adequacy of recovery before extubation, represents a peculiar psychologic phenomenon. The practice of anesthesiology is replete with situations in which parameters are monitored at baseline and for the effects of any intervention. In addition, many of our routine practices could be deemed unnecessary in the majority of patients, yet are performed to prevent devastating outcomes in the remaining small percentage of patients. Examples include preoxygenation before the induction of anesthesia, maintenance of blood pressure within certain parameters to prevent stroke or myocardial ischemia, and maintenance of normothermia to prevent wound infection and cardiovascular complications. These practices have become routine or standard because they protect patients from rare but serious complications. As Perrow<sup>5</sup> points out, Murphy's law is wrong: everything that can go wrong usually goes right, and then we draw the wrong conclusion. The ability to adequately ventilate 1,000 successive patients could

lead one to disregard the need for preoxygenation, but this would lead to the trap that Perrow<sup>5</sup> warns against. Similarly, we believe that the low frequency of complications from residual paralysis (reintubation, respiratory distress, and pneumonia) leads to a sense of complacency, because we either do not see or do not recognize these complications, especially if, as with pneumonia, they manifest later. Finally, when we see something rarely, it is easy to equate low risk with no risk, to the point that when the adverse outcome does occur, we are convinced it must be from some other cause. However, when common causes are ruled out, uncommon causes become very likely. Although twitch monitors are not without their own limitations, we believe the routine confirmation of adequate strength before extubation, using a quantitative train-of-four ratio greater than 0.9 or sustained 5-s tetanus at 100 Hz, can reduce the risk of adverse events from residual neuromuscular blockade and should become a standard of care.

### Competing Interests

The authors declare no competing interests.

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### References

1. Bulka CM, Terekhov MA, Martin BJ, Dmochowski RR, Hayes RM, Ehrenfeld JM: Nondepolarizing neuromuscular blocking agents, reversal, and risk of postoperative pneumonia. *ANESTHESIOLOGY* 2016; 125:647–55
2. Murphy GS, Szokol JW, Marymont JH, Franklin M, Avram MJ, Vender JS: Residual paralysis at the time of tracheal extubation. *Anesth Analg* 2005; 100:1840–5
3. American Society of Anesthesiologists. Standards for basic anesthetic monitoring. Available at: <https://www.asahq.org/>. Accessed November 30, 2016
4. Naguib M, Kopman AF, Lien CA, Hunter JM, Lopez A, Brull SJ: A survey of current management of neuromuscular block in the United States and Europe. *Anesth Analg* 2010; 111:110–9
5. Perrow C: *Normal Accidents*. Princeton, Princeton University Press, 1999.

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## Science or Fiction? Risk of Postoperative Pneumonia with Neuromuscular Blockade

*To the Editor:*

We read with interest the study by Bulka *et al.*,<sup>1</sup> which suggested a higher risk of postoperative pneumonia (POP) after the use of neuromuscular blocking agents (NMBAs). We believe that there are inconsistencies and calculation errors that significantly change the results of their study. In the NMBA analysis, there were 38 POP cases among 1,455 patients from the 10,594 patients who received an NMBA

during surgery, yielding a POP incidence rate of 2.6%. However, in the NMBA reversal analysis, these same 10,594 patients were split into two subgroups: 1,623 patients who did not receive reversal and 8,971 patients who were given neostigmine. To our surprise, the POP incidence rates are significantly higher in both subgroups, with 149 POP cases in the 1,320 patients (11.5%) who received NMBA without reversal and 70 POP cases in the 1,320 patients (5.3%) who received NMBA and were reversed with neostigmine. Because these two subgroups are from the same 10,594 patients in the NMBA group, we do not understand why the POP rates are so much higher in the two subgroups.

The authors are silent on this apparent discrepancy in POP incidences. We believe that this is due to calculation errors. In Table 2 of the article,<sup>1</sup> the POP incidence rates are presented as “Incidence per 10,000 person-days at risk” because each patient was followed for up to 30 days. There are four such values, 9.00, 5.22, 4.22, and 1.88, representing patients who received NMBA, those who did not receive any NMBA, those who received NMBA without reversal, and those who received NMBA with reversal, respectively. The last two numbers appear to be incorrect; we believe that they should be 42.2 (not 4.22) and 18.8 (not 1.88). Thus, the actual POP incidence rates are much higher in the two NMBA subgroups than that of the total NMBA group (42.2 and 18.8 compared with 9.00). These errors in data collection and calculation lead to invalid conclusions.

We also wonder about the study design, with its 30-day observation period. Although it has been suggested that many postoperative complications require a 30-day follow-up,<sup>2</sup> we do not think this applies to NMBA complications. Any postoperative residual neuromuscular blockade in these patients would be clinically insignificant in a matter of hours, and a POP related to that should easily be evident within 1 week. It would seem to be erroneous to attribute any POP cases that occurred several weeks after surgery to the use of NMBA.

### Competing Interests

The authors declare no competing interests.

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### References

1. Bulka CM, Terekhov MA, Martin BJ, Dmochowski RR, Hayes RM, Ehrenfeld JM: Nondepolarizing neuromuscular blocking agents, reversal, and risk of postoperative pneumonia. *ANESTHESIOLOGY* 2016; 125:647–55
2. Woodfield JC, Jamil W, Sagar PM: Incidence and significance of postoperative complications occurring between discharge and 30 days: a prospective cohort study. *J Surg Res* 2016; 206:77–82

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