Routine neuromuscular monitoring before succinylcholine. Comment on *Br J Anaesth* 2020; 125: 629–36

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Keywords: neuromuscular block; neuromuscular monitoring; postoperative pulmonary complications; succinylcholine; TofScan; train-of-four ratio

Editor—We read with interest the recent article in the *British Journal of Anaesthesia* entitled 'Succinylcholine and postoperative pulmonary complications: a retrospective cohort study using registry data from two hospital networks'. Schaefer and colleagues[1] examined the association between succinylcholine and postoperative pulmonary complications (POPC) and they observed that of 244 850 adult, noncardiac surgical patients, 5.4% experienced POPC. Moreover, succinylcholine use was dose-dependently associated with increased risk of POPC: the higher the dose of succinylcholine, the higher the risk of POPC.[1] Considering the alarmingly high incidence of POPC observed in their study, Schaefer and colleagues recommended avoiding succinylcholine in patients undergoing procedures shorter than 2 h.

The observations made by Schaefer and colleagues strongly suggest residual paralysis as an underlying mechanism of POPC. At first glance this may be surprising as generations of anaesthesiologists used succinylcholine for its unique pharmacodynamic profile of rapid onset and short duration.[2,3] With this practice, they aimed to avoid residual paralysis and did not consider the need to use neuromuscular monitoring.[3] However, the pharmacodynamic profile of succinylcholine is characterised by high inter-individual variability that depends on the enzymatic activity of plasma butyrylcholinesterase (BChE) amongst others. Data from the Danish Cholinesterase Research Unit identified a deficit in BChE activity as a major risk factor for unexpected residual paralysis, respiratory complications, premature awakening, and distressing awareness during emergence after succinylcholine-induced neuromuscular block.[4,5] Moreover, lack of neuromuscular monitoring increases the risk of these adverse events significantly.[6] Thus, several lines of evidence suggest that residual paralysis also occurs after succinylcholine and may affect patient outcomes. Rather than repeating requiems for succinylcholine, we should, at least as a first step, encourage monitoring of neuromuscular transmission for whichever type of neuromuscular-blocking drug is used, even if succinylcholine alone has been administered.[7]

For decades, depolarising neuromuscular block could only be assessed with single twitch (ST) stimulation, a stimulation pattern with which most anaesthesiologists have limited experience.[8] As a consequence, succinylcholine-induced neuromuscular block was most often not monitored. However, the fact that residual paralysis is difficult to diagnose given the absence of fade during depolarising neuromuscular block is no longer acceptable as a pretext not to monitor recovery after succinylcholine.[3,9] Of interest in this context, a new parameter for monitoring of depolarising neuromuscular block has recently been presented.[10] This new parameter does not reference fade of the fourth twitch response to the height of the first twitch in a corresponding train-of-four (TOF) series (i.e. T4/T1), but references fade of the fourth response to a reference value taken before the neuromuscular blocking drug has been given (i.e. T4/Tref). As a result, the T4/Tref ratio is independent of fade in a TOF series. The T4/Tref ratio should facilitate and increase routine monitoring of recovery from succinylcholine.

Declarations of interest

TFB was associate editor of the *European Journal of Anaesthesiology* from 2011 to 2020 and he is chairman of the research committee of the European Society of Anaesthesiology. He has received funding from MSD to give international lectures and to chair CME meetings within the past 5 yr. DS has no conflicts of interest.

References

1. Schaefer MS, Hammer M, Santer P, et al. Succinylcholine and postoperative pulmonary complications: a retrospective cohort study using registry data from two hospital networks. *Br J Anaesth* 2020; **125**: 629–36
2. Brull SJ, Meistelman C. Pharmacology of neuromuscular-blocking drugs. In: Gropper MA, Eriksson L, Fleisher L, Wiener-Kronish J, Cohen KL, editors. *Miller's anesthesia*. 9th Edn. Philadelphia: Elsevier; 2020. p. 792–831
3. Blobner M, Hunter JM. Another nail in the coffin of succinylcholine? *Br J Anaesth* 2020; **125**: 423–5
4. Dell-Kuster S, Levano S, Burkhart CS, et al. Predictors of the variability in neuromuscular block duration following succinylcholine: a prospective observational study. *Eur J Anaesthesiol* 2015; **32**: 687–96
5. Thomsen JL, Nielsen CV, Eskildsen KZ, Demant MN, Gätke MR. Awarness during emergence from anaesthesia: significance of neuromuscular monitoring in patients with butyrylcholinesterase deficiency. *Br J Anaesth* 2015; **115**: 78–88

DOI of original article: 10.1016/j.bja.2020.05.059.

6. Thomsen JL, Nielsen CV, Palmqvist DF, Gätke MR. Premature awakening and underuse of neuromuscular monitoring in registry of patients with butyrylcholinesterase deficiency. *Br J Anaesth* 2015; **115**: i89–94
7. Claudius C, Fuchs-Buder T. Neuromuscular monitoring. In: Gropper MA, Eriksson L, Fleisher L, Wiener-Kronish J, Cohen KL, editors. *Miller's Anaesthesia*. 9th Edn. Philadelphia: Elsevier; 2020. p. 1354–72
8. Kopman AF, Zhaku B, Lai KS. The "intubating dose" of succinylcholine. *Anesthesiology* 2003; **99**: 1050–4
9. Kopman AF, Brull SJ. Not another requiem for succinylcholine. *Comment Br J Anaesth* 2020; **125**: e349–50
10. Schmartz D, Chénard L, Baumann C, Fuchs-Buder T. A modified train-of-four ratio to assess recovery from depolarising neuromuscular blockade after succinylcholine, a prospective observational study. *J Clin Monit Comput* July 20 2020. https://doi.org/10.1007/s10877-020-00560-5

doi: 10.1016/j.bja.2020.12.022
Advance Access Publication Date: 19 January 2021

Reproducibility and transparency in anaesthesiology research. Comment on Br J Anaesth 2020; 125: 835–42

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Keywords: evidence-based medicine; methodology; reproducibility; research design; statistics

Editor—We commend Okonya and colleagues[1] for undertaking the important work of examining reproducibility and transparency in medical research. As the authors state in their paper, the availability of key study components, including data and analysis scripts, enable replication and reproducibility. Unfortunately, there are aspects of their own study that render it irreproducible.

First, the authors provide their bibliographic search strategy, raw data arising from that search, details of the devised data extraction tool, and data extracted from the selected papers. However, they did not provide the analysis code for the statistics performed on these data to arrive at the reported results. They used functions from within Microsoft Excel™ to conduct the statistical analysis for their study, and did not provide the spreadsheet where they conducted the analysis to the reader. Microsoft Excel (Microsoft Corp., Redmond, WA, USA) is well-known to introduce errors into scientific analysis, and cannot be considered a safe component for a reproducible scientific analysis.[2] We are unable to verify whether the functions used were the correct ones, or whether they were applied correctly, for the statistics reported. Coding errors within Excel spreadsheets can be easily missed and difficult to debug, and there are no records of the chronology of actions taken within an Excel spreadsheet and no guarantee that if other researchers were to open the spreadsheet on a different computer, it would show the exact same data. Indeed, Excel has recently been responsible for forcing an entire branch of science to change naming conventions, as data in this field were routinely modified on entry without alerting the researcher entering the data.[3]

Second, the authors state that they randomly sampled 450 papers from the more than 28 000 that were found using their search strategy. They did not state how the random sampling was conducted, and another researcher with the same raw bibliographic data would thus not be able to replicate their sampling procedure without this information. If a script was used to generate a random numerical sequence for selecting their sample, providing the random seed and the details of the computing environment used for random selection would be needed for independent researchers to replicate the pseudo-random number generation process.

Within the published protocol of their study on the Open Science Framework repository, they stated that they intended to perform the statistical analyses using STATA™, which would have likely addressed the above two issues as a STATA (StataCorp LLC, College Station, TX, USA) script file could have been published alongside their publication.

It is ironic that a study purporting to examine reproducibility and transparency has itself not met minimum basic standards to achieve either goal. We call on the authors and other anaesthesia researchers to adopt the approaches advocated by the Turing Way, a collaborative resource and community built around making research open and reproducible, focusing particularly on researchers working in the data science sphere.[4] We feel that sharing and publishing data and code alongside research outputs using the methods advocated

DOI of original article: 10.1016/j.bja.2020.03.035.