Exploratory analysis of POPULAR data: learning to improve. Comment on *Br J Anaesth* 2020; 124: 63–72

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Editor—The prospective observational European multicentre cohort study (POst-operative PULmonary Complications After Use of Muscle Relaxants in Europe [POPULAR]) showed that the use of neuromuscular blocking agents in general anaesthesia is associated with an increased risk of postoperative pulmonary complications.[1] Surprisingly, the neuromuscular monitoring and the administration of reversal agents were not found to be associated with a decreased risk of postoperative pulmonary complications.[1] Blobner and colleagues[2] revised the POPULAR data. A *post hoc* analysis of patients who received quantitative monitoring of neuromuscular function showed that tracheal extubation in patients with a train-of-four ratio (TOFR) >0.95, rather than >0.9, reduced the adjusted risk of postoperative pulmonary complications by 3.5% from that reported in POPULAR (11.3%).[2] This finding is a confirmation of the need for adequate reversal from neuromuscular block before tracheal extubation. However, the study by Blobner and colleagues[2] deserves some consideration concerning the potential effect of reversal strategies in the population of patients considered.

After propensity score matching, comparing the TOFR >0.90 sub-cohort with the TOFR >0.95 sub-cohort, no difference was observed in the median dose (31 μg kg^{-1}) of neostigmine. However, this dose of neostigmine was slightly underdosed[3] for the median TOFR value of 0.19 measured at the time of reversal administration in the TOFR >0.90 sub-cohort, compared with the TOFR >0.95 sub-cohort that had a median TOFR value of 0.40 at the time of reversal.[2] In adult patients with a TOFR <0.4, neostigmine 50–70 μg kg^{-1} was suggested to achieve a maximal effect, reserving the dose of 20–30 μg kg^{-1} for patients with TOFR=0.4–0.9.[3] Interestingly, approximately 52% of the patients in the study were considered older (60 yr or older).[2] Comparing the dose–response curves for neostigmine in younger and older individuals, neostigmine appeared to be less effective.[4] A larger dose of neostigmine is required to antagonise moderate neuromuscular block in older patients compared with younger patients. This is supported by the finding that, after administration of neostigmine 50 μg kg^{-1} to antagonise moderate rocuronium-induced block (TOF count of at least 3), the incidence of residual neuromuscular block was significantly higher in older patients than in younger patients (57.7% *vs* 30.0%, respectively; $P<0.001$).[5] Furthermore, the TOFR in the PACU was significantly lower in older patients than in younger patients (median: 0.86 *vs* 0.93, respectively). Consequently, more frequent hypoxaemic events, airway obstruction, and postoperative pulmonary complications were observed in older patients.[5]

Conversely, differences between the groups were reported for sugammadex. First, sugammadex was slightly underdosed in the TOFR >0.90 sub-cohort compared with that in the TOFR >0.95 sub-cohort (median: 1.9 *vs* 2.2 mg kg^{-1}, respectively; $P=0.0006$).[2] Sugammadex 2 mg kg^{-1} is the recommended dosage for reversal of moderate rocuronium-induced neuromuscular block.[3] Lowering the dose of sugammadex under that recommended will progressively increase the risk of ineffectiveness.[6] Even if complete reversal from neuromuscular block may occur,[7] an off-label dose of sugammadex (<2 mg kg^{-1}) requires postoperative monitoring, particularly in high-risk patients.[6,7] Reappearance of paralysis or weakness after low-dose sugammadex administration occurred more frequently in elderly patients than in non-elderly patients (35% *vs* 5%; $P=0.044$).[8] Second, the lowest average dose of sugammadex was observed in the TOFR >0.90 sub-cohort of patients who showed a significantly lower level of TOFR at reversal compared with that in the TOFR >0.95 sub-cohort (median: 0.19 *vs* 0.40; $P<0.0001$).[2] Thus, the hypothesis that a better recovery from neuromuscular block after sugammadex than neostigmine in the TOFR >0.95 sub-cohort, particularly in high-risk patients, such as the older patients, cannot be reasonably excluded. In an RCT, Abd-Elfattah[9] showed that postoperative critical respiratory events were greater amongst older patients receiving neostigmine 50 μg kg^{-1} than among those receiving sugammadex 2 mg kg^{-1} after abdominal surgery (14.1% *vs* 4.2%, respectively; $P<0.05$).[9] In a retrospective evaluation, postoperative hypoxaemia (Spo_2 <95%) up to 24 h after operation occurred significantly less frequently in older patients receiving sugammadex 2 mg kg^{-1} than in those receiving neostigmine 50 μg kg^{-1} (23% *vs* 43%; $P=0.010$).[10] After robotic prostatectomy in older patients, the median normalised TOFR was higher in patients receiving sugammadex than receiving neostigmine (0.98 *vs* 0.85, respectively; $P=0.008$). Two patients received sugammadex after reversal of neuromuscular block with neostigmine because of residual weakness.[11] In a randomised trial, the occurrence of postoperative pulmonary complications in older adults undergoing surgery was lower for the sugammadex (2 mg kg^{-1}) group than the neostigmine (70 μg kg^{-1}) group (33% *vs* 40%; odds ratio=0.74; $P=0.30$).[12]

The study by Blobner and colleagues[2] provided two key messages that need to be translated to daily clinical practice for better outcomes. First, quantitative monitoring of neuromuscular function should be routinely used in clinical practice to assess full reversal from neuromuscular block.[13] Train-of-four ratio before tracheal extubation should be ≥0.95,[2]

aiming for a TOFR of 1.0.[13,14] Train-of-four ratio should be normalised by baseline values when calibrated acceleromyography is used.[13] Second, the dosage of the reversal drug should be titrated according to the level of neuromuscular block, following recommendations and avoiding underdosage.[3]

Declarations of interest

MC has received payments for lectures from Merck Sharp & Dohme, Rome, Italy. The other authors declare no conflicts of interest.

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Examining the correlation between Altmetric score and citation count in the anaesthesiology literature

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Editor—Traditional measures of impact of scientific research focus on article citation numbers and journal impact factor (IF).[1] With the increase of digital technology and use of social media platforms to discuss research, impact for these channels can also be assessed. Alternative-level metrics (altmetrics) are a new measure of the attention,