

# What We Know

## Precise Measurement Leads to Patient Comfort and Safety

THE literature is replete with information about perioperative use of neuromuscular blocking agents (NMBAs), and recent review articles<sup>1,2</sup> have summarized current knowledge. We know that residual neuromuscular weakness is common, despite advances in the pharmacology of NMBAs; we know that most clinicians believe clinically significant weakness is a rare event; that the use of acceleromyography allows measurement of the intraoperative train-of-four (TOF) ratio; that acceleromyography reduces the incidence of postoperative residual weakness in the postanesthesia care unit (PACU); that TOF less than 0.9 is associated with multiple respiratory events and complications, and with delays in PACU discharge; and that awake volunteers described significant discomfort from residual block, defined as TOF less than 0.90.

What we did not know (but perhaps suspected)<sup>3,4</sup> was whether intraoperative acceleromyography (objective) monitoring would result in less subjective weakness and associated symptoms of residual paresis. In this issue of the journal, Murphy *et al.*<sup>5</sup> report that objective acceleromyography monitoring reduces unpleasant symptoms of muscle weakness in the PACU and improves quality of patient recovery.

This study<sup>5</sup> is unique and important because precise measurement of TOF ratios in the PACU was followed by a standardized examination designed to evaluate patients for signs and symptoms of muscle weakness. Thus, objective criteria (a battery of 11 individual tests) of muscle strength were followed by subjective assessments of symptoms of residual block. These assessments included questions about the “ease” or “comfort” associated with performing the tests. In addition, patients rated five other symptoms of residual



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weakness: blurry or double vision, facial weakness or numbness, and generalized weakness.

This study also confirms another piece of information we already knew: that assessments based on clinical tests of muscle strength (*e.g.*, head lift for 5 s, grip strength) are not reliable predictors of neuromuscular function. The reader may also note that the authors used the accelerograph monitor without previous calibration or normalization. However, the authors did apply preload to the thumb by attaching a hand adapter. Application of a preload is expected to increase the TOF ratio precision, but it may increase the bias (in relation to mechanomyography) during late recovery.<sup>6</sup> One might then conclude that an acceleromyographic recovery to TOF ratio more than 0.9, when the “baseline” recovery in the PACU had TOF ratio values as high as 1.26 and 1.28, would be insufficient to exclude residual weakness in this context. That is, if the baseline TOF (due to absence of cali-

bration and normalization of the monitor) were considered to be 1.26, rather than the assumed 1.00, recovery to 90% of baseline would yield a TOF of 1.13 (not the TOF of 0.90, as considered by the authors). In such a case, TOF ratios more than 1.13 would have to be considered as indicative of adequate recovery. Even if that were true, however, the same bias would be present in both patient groups, and the relative differences in the TOF ratios would persist.

Another potential limitation in interpreting the results<sup>5</sup> is the fact that it is not entirely clear how or why acceleromyography objective monitoring resulted in better PACU outcome, because there were no differences in the duration of anesthesia, the total dose of rocuronium administered, or the dose of pharmacologic reversal (50 mcg/kg neostigmine) be-

Photograph: J. P. Rathmell.

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tween the control and acceleromyography patient groups. Despite the protocol similarities, however, when acceleromyography was used to ensure that a TOF ratio greater than 0.8 was reached before tracheal extubation, 55% of patients in the control group had a TOF count of 4 at the time of reversal, compared with 82% of patients in the acceleromyography group. Based on these data alone, one might conclude that the difference in outcome between the two patient groups should be expected. It is also entirely reasonable, however, to ascribe the differences to the “more rational and accurate titration of NMBAs during the last 45 or 60 min of an anesthetic” by the anesthesiologists who had access to the actual TOF ratio.<sup>5</sup> As is the case with all high-quality clinical studies, the current study raises more clinically relevant questions than it solves.

The use of monitors and the ability to determine the actual TOF ratio resulted in a higher TOF ratio in the PACU, and decreased the proportion of patients with residual neuromuscular block (both TOF less than 0.70 and TOF less than 0.90). In these patients, the median weakness score (0–10 scale) was 4, which decreased to 2 after 1 h in the PACU. In contrast, in the group of patients in whom anesthesiologists did not have access to quantitative TOF ratios intraoperatively, the median weakness score was 6, which only decreased to 4 after 1 h in the PACU. Similarly, the mean number of symptoms of weakness in the acceleromyography-measured TOF ratio patient group was smaller (two symptoms decreasing to 0 after 1 h in the PACU) than in the subjective assessment patient group (five symptoms decreasing to 1 after 1 h in the PACU).

In a medical era in which patient participation in health-care decisions is encouraged, and in which reimbursement may well depend, at least in part, on patient satisfaction and absence of “never events” (*i.e.*, pay-for-performance criteria),<sup>7</sup> it is interesting to note that patients themselves are likely to provide the information that we are not always willing to ascertain: residual weakness associated with the use of NMBAs continues to occur. The authors found that the patients’ symptoms (minimum of five) of muscle weakness at PACU admission had both good sensitivity (0.87) and specificity (0.82), resulting in a receiver operating characteristic curve area of 0.913.<sup>5</sup> Patients can thus tell us when the TOF ratio is likely to be less than 0.90!

It is quite a conundrum that on the one hand, we have made considerable progress with regard to many outcome measures.<sup>8</sup> On the other hand, we have known for decades that patients continue to exhibit postoperative residual muscle weakness after administration of NMBAs, regardless of the drugs’ class or duration of action.<sup>9</sup> Yet, we are no closer now to avoiding this avoidable complication than we were 30 yr ago.<sup>1</sup> Although we may not know the exact reasons for this failure, it is reasonable to suggest that it may be a combina-

tion of factors. Major respiratory events are rare (*e.g.*, reintubation rate is 0.05%),<sup>10</sup> and they occur mostly outside the operating suite. When these events do occur, in the PACU, we are perhaps more likely to attribute respiratory failure to hypercapnia and acidosis, to the use of postoperative opioids (administered by PACU nurses), to hypothermia, or antibiotic administration, rather than attribute the complication to our own failure to ensure objective monitoring and appropriate pharmacologic reversal. We, as clinicians, are also more likely to rely on our vast and unfaltering (in our own view) clinical experience when we visually or tactilely deem the patient “adequately reversed.” After all, most of us are (we think) “well above average” in our skills!<sup>11</sup> Finally, it is difficult, if not impossible, not to succumb to the production pressure of rapid emergence and turnover of cases, which is unlikely to subside any time soon.

It is thus perhaps not surprising that we continue to disregard obvious findings that for decades have shown us repeatedly that residual postoperative weakness from the use of NMBAs is a real patient safety issue.<sup>12</sup> Because we can in most instances “get away” with our clinical assessment and intuition about the state of reversal of our patients, we have little incentive to spend extra resources on purchasing monitors (not to be confused with nerve stimulators) or expend additional time applying the somewhat unwieldy electrodes and wires of the nerve stimulators.

However, we must ask ourselves whether we are really doing the best for our patients when we cut corners. The occurrence of residual weakness is not debatable; serious respiratory events such as airway loss and need for tracheal reintubation, although rare (0.05%), may involve a significant number of patients, given the 20–30 million surgical cases involving general anesthesia in the United States‡; that objective measurement using an available, although admittedly not perfect, monitor (the accelerograph) leads to less residual paralysis and fewer subjective symptoms of weakness is also not debatable, thanks to Murphy *et al.*<sup>5</sup> Why, then, do we continue to ignore the obvious? Are we content to wait until external agencies issue practice alerts about residual weakness?<sup>13</sup> Or is it preferable to have the complications of residual weakness considered “never-events”<sup>7</sup> or “pay-for-performance” criteria for reimbursement before we implement changes in our practice? Does this mean that our safety culture—the attitudes, beliefs, perceptions, and values that we, anesthesiologists, share in relation to patient safety—should consider alternative safety performance indicators? These authors do not have the answers to these questions, but the clinicians will decide the practice that will ultimately answer them.

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‡ National Health Statistics Reports. Ambulatory Surgery in the United States, 2006. <http://www.cdc.gov/nchs/data/nhsr/nhsr011.pdf>. Accessed August 5, 2011.

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