LETTERS

Neuromuscular Block Monitoring Has New Opportunities Coming
To the editor: I read the AANA Journal’s recent article “Residual Neuromuscular Blockade: Evidence-Based Recommendations to Improve Patient Outcomes” with keen interest, and the authors should be applauded for a comprehensive and informative review article. This is a timely and necessary emphasis on a subject we in anesthesia practice have long neglected. Considering that recommendations for quantitative neuromuscular monitoring have been continually made since the initial application of accelerometer in the measurement of neuromuscular block 30 years ago and consistent evidence that quantitative/subjective neuromuscular monitoring lowers the incidence of residual paralysis (defined as a train-of-four [TOF] ratio ≤0.9), it seems almost unfathomable that we have not yet embraced this better method of monitoring. The expressed reasons for poor incorporation of quantitative/subjective neuromuscular monitoring have included that it is difficult to use, is prone to artifact, is unreliable, and is cost-prohibitive. While it is true that impediment of thumb movement with accelerometer-type quantitative/subjective neuromuscular monitoring does occur and can cause inaccurate readings, our qualitative/subjective assessment of twitch counts, as the authors clearly describe, are more so unreliable. Whether we crawl under the drapes to find the patient’s thumb to hold or visualize, we are preparing the patient’s extremity for assessment. Why clinicians cannot do the same to ensure that the drapes, blankets, forced-air warming blankets, and even operating room personnel are not restricting free movement of the patient’s thumb with accelerometer or kinemyography devices is difficult to rationalize. The stated difficulties of use of quantitative/subjective neuromuscular monitoring are easily overcome and certainly are being overcome by those who regularly use typical qualitative/subjective peripheral nerve stimulators (PNSs).

If electromyography is considered the clinical gold standard, the TOF measurements obtained by kinemyography may deviate up to 10% and those obtained by accelerometer by 10% to 15%. Although there is good correlation between kinemyography and accelerometer, both tend to overestimate the TOF ratio (0.1-0.15). This deviation pales, however, when one considers the limitation of visual/tactile assessment of TOF fade with a typical PNS. The reliability of PNSs that require subjective assessment of fade allow up to 60% error. The threshold for reliable human detection of fade has been found to be 0.4 to 0.5. This means that a TOF ratio of 0.6, 0.7, 0.8, or 0.9 cannot be reliably detected by visual or tactile assessment. This reflects the significant limitation of typical qualitative/subjective assessment to determine the presence of residual paralysis.

Last, the cost of these devices, which range from approximately US $1,000 to US $2,000, may seem expensive but not in light of the sequelae of residual paralysis. Residual paralysis is associated with critical respiratory events including extended recovery room stay, extended hospital stay, increased care (by recovery room nurses, respiratory therapists, Certified Registered Nurse Anesthetists [CRNAs], and physicians), and even reintubation. All of these carry costs that lessen the cost argument against these better monitors of neuromuscular block.

Overwhelming evidence showing the benefit of quantitative/subjective neuromuscular monitoring to lower the incidence of residual paralysis and ultimately improve patient care and outcomes has not been enough to move us to change practice. Nor does it seem that risk management considerations have been examined. We now have numerous literature recommendations from clinical studies, expert opinions, consensus statements, and professional organizations worldwide that push for quantitative/subjective neuromuscular blockade monitoring:

APSF [Anesthesia Patient Safety Foundation]…believe that every patient receiving nondepolarizing neuromuscular blocking drugs (NMBDs) should have at least qualitative, and preferably quantitative monitoring of the intensity of neuromuscular blockade.4(p5)

[For gastrointestinal surgery:] When NMBA [neuromuscular blockade agents] are administered neuromuscular function should be monitored by using a peripheral nerve stimulator….A TOF ratio of 0.9 must be achieved [prior to extubation] to ensure adequate return of muscle function and thus [prevent associated] complications.10(p298,299)

Whenever a neuromuscular blocker is administered, neuromuscular function must be monitored by observing the evoked muscular response to peripheral nerve stimulation. Ideally, this should be done at the hand muscles (not the facial
muscles) with a quantitative (objective) monitor. Objective monitoring...is the only method of assuring...satisfactory recovery of [neuromuscular blockade and patient safety].\(^{11(p1)}\)

Subjective...tests of NMB are not predictive of adequate neuromuscular recovery and are not sensitive to the presence of residual neuromuscular weakness; their use should be abandoned in favor of objective monitoring.\(^{11(p1)}\)

Professional organizations should develop practice standards and guidelines detailing how best to monitor and manage perioperative administration.\(^{11(p2)}\)

A peripheral nerve stimulator must be used whenever neuromuscular blocking drugs are given. A quantitative peripheral nerve stimulator is recommended.\(^{12(p2)}\)

Quantitative (objective) evaluation of the blockade depth and recovery is recommended. In the clinical setting, an accelerometric evaluation of the response of the thenar muscles to ulnar nerve stimulation appears to be the most appropriate method at present time. Achieving TOF-ratio above 0.9 is considered an adequate sign of recovery from the effect of non-depolarizing muscle relaxants.\(^{13(p1-2)}\)

Instrumental [objective] monitoring is the main means for assessment...The presence of four responses to TOF stimulation is not a sufficient criterion of full reversal.\(^{14(p32)}\)

Currently, AANA is evaluating and revising its practice standards and improvements to our current standard 5e are expected: “When neuromuscular blocking agents are administered, monitor neuromuscular response to assess depth of blockade and degree of recovery.”\(^{15(p2)}\) If consistent evidence-supported instructions are largely ignored, perhaps enticement with new quantitative/objective neuromuscular monitoring devices that address some of the current complaints may succeed in practice incorporation and ultimately improved patient outcomes. Currently available quantitative/objective neuromuscular monitoring devices are General Electric’s NMT system (Little Chalfont, United Kingdom),\(^{16}\) which is incorporated into anesthesia monitoring workstations. This system includes both kinemography-based (mechanosensor) and electromyography-based (electrosensor) devices.

Accelerometry devices available include the TOFscan\(^{17}\) and IntelliVue NMT\(^ {18}\) (Philips Andover, Massachusetts, United States) and the Stimpod NMS450 (XAvant, South Africa),\(^ {19}\) which uses a threedimensional accelerometer that better addresses the complaints of past systems like the TOF Watch (no longer manufactured). The TOF Watch used a single-axis (dimension) accelerometer, which limited its detection ability and was prone to errors from repositioning, off-axis movement, and restriction of movement. Newer accelerometry devices capture movement in all 3 dimensions and do not necessitate calibration. After placement of 2 ulnar nerve electrodes and a thumb band that contains the accelerometer transducer, one must merely push start. These devices are automated to provide continuous TOF counts and ratios, which makes it extremely useful and necessary, particularly during emergence for the determination of extubatability and adequacy of recovery, which is clearly described for the reader as a TOF ratio of ≥0.9.\(^ {20}\)

Ultimately, we will likely find the most clinically useful systems will be electromyography. Electromyography measures the actual amplitude of depolarization of the muscle membrane as opposed to the subsequent muscle-contraction-induced movement of the thumb. By focusing more specifically on the site of action of neuromuscular blocking agents, electromyography eliminates a cause of artifact and impediment to measurement. Restriction of thumb movement with electromyography systems does not matter because movement is not the measurement but rather the electrical amplitude of depolarization. Thus, hand positioning or coverings should not affect measurements. The GE NMT system (electrosensor) uses 5 individual electrodes placed along the ulnar nerve and around the thumb. This system requires proper positioning of electrodes in a specific order that takes a few moments during case setup. This system has been used successfully to lower the incidence of residual neuromuscular block.\(^ {21}\)

Two new additional electromyo- graphy systems are expected to be commercially marketed in the near future: Twitch View (Blink Device Co, Seattle, United States)\(^ {22}\) and Tetragraph (Senzime, Uppsala, Sweden).\(^ {23}\) These 2 new systems offer the ease of a single-strip electrode placement setup. Much like the bispectral array sensors that are incorporated into one adhesive strip, these systems use electrodes that also are embedded in a single adhesive strip. It appears that setup will require only the placement of one adhesive strip along the ulnar nerve and hand. Automated TOF counts and ratios are measured and recorded.

It is expected that these new systems will integrate into electronic medical records for automatic patient record keeping. If these 2 new systems fully integrate into the electronic medical record, are easy to set up, and are automated, several barriers to use may be overcome. For now, continued instruction and encouragement regarding improved neuromuscular block and the incidence and outcomes associated with residual paralysis are paramount. This review and continuing education course are an excellent example of the emphasis needed. Thank you to the authors for an informative, timely, and pertinent review.

REFERENCES

4. Stoelting RK. Monitoring of neuromuscular blockade: what would you expect if you were the patient? APSF Newsletter.


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