EDITORIAL

Intraoperative neuromonitoring: gold standard or fool's gold?

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ZUCCARO et al. report their institution's experience with the use of intraoperative neuromonitoring (IONM), focusing on the strengths of transcranial electric motor evoked potential (TceMEP) monitoring.⁸ The authors choose an alert threshold parameter of a 50% decrease in baseline TceMEP amplitude. With this cut-off, they report a sensitivity of 100% and a specificity of 93%–100%.

Other authors have also reported that TceMEP monitoring has 100% sensitivity and 100% specificity, or near 100%, for predicting neurological deficits after surgery,^{1,2,5} but this is unrealistic, disingenuous, confusing, and misleading. Although it is mathematically possible to achieve this, in reality and in clinical practice there is no diagnostic test that has 100% sensitivity and 100% specificity. As sensitivity increases, specificity must be compromised as described by receiver operator curve (ROC) analysis. Studies that report implausibly high sensitivity and specificity for IONM may suffer from disease spectrum bias, a form of sampling bias. That is, the prevalence of spinal cord injury after spine surgery is so small in a given population that it falsely and artificially affects positive and negative predictive values, positive and negative likelihood ratios, and sensitivity and specificity, if analyzing a single-center experience only.⁴

The gold standard for evaluating a diagnostic test is ROC analysis, plotting 1 minus specificity on the x axis versus sensitivity on the y axis. The authors could have used this statistical tool to plot sensitivity/specificity pairings for various alert thresholds as a ROC. The optimal threshold is then defined as the shortest distance between the coordinate (0, 1) and any point on the ROC. As written, however, the authors anecdotally state that they used a 50% decrease in MEP amplitude. What is the authors' justification for or scientific/mathematical evidence that this threshold for TceMEPs is the optimal cutoff?

Furthermore, the authors are too aggressive in suggest-

ing that IONM is “standard of care”; it implies that spine surgeons who do not use IONM are committing malpractice. The present study was not designed to answer the question: Is IONM a surgical adjunct that makes neurosurgery or spine surgery safer as an “early warning system” by preventing injury, as the authors suggest? Does IONM improve outcomes? Or does it simply indicate that neural injury has already occurred and add to cost of care without any value added?³ A standard of care is based on Level I evidence derived from a prospective randomized study. At this point, it is doubtful that a randomized study examining the safety and efficacy of IONM could be completed. Surgeons who routinely utilize IONM in complex spine surgery are unlikely to submit their patients to randomization. Therefore, without strength of evidence, IONM cannot be classified as standard of care. The jury is still out on this designation.

Most importantly, though, the authors have shown that spine surgery, neurosurgery, and the practice of surgery in general are a “team sport.” For successful outcomes to occur and complications to be mitigated, surgery depends on the skill, knowledge, and expertise of all members of the team—surgeons, nurses, surgical technicians, anesthesiologist, electrophysiologists, electrophysiology technicians, and many more. But success also relies heavily on communication among team members. It is clear that at the authors' institution, high reliability has been fostered through the implementation of standard work—for example, the critical events checklist for loss of TceMEPs, clinical pathways, and crew resource management, all pillars of quality improvement. The authors should be applauded for this accomplishment.^{6,7}

Crew resource management is a system of communication developed by NASA, after the collision of two Boeing 747s on a foggy runway in the Canary Islands in 1977, to address stressful and at times emergency situations that may arise in the cockpit. An investigation of

this deadliest disaster in aviation history found that miscommunication between the control tower and the pilots, and among the flight crew themselves within the military-like hierarchical confines of the cockpit, was the most significant factor in the accident. Crew resource management is based on a flattened authority structure where all members of the team are encouraged to speak up if they identify a dangerous situation;⁶ in addition, team members are encouraged to use standard terminology. This is readily applicable to the operating room and ensuring patient safety. Perhaps, this is the key message from the present study.

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Disclosures

The author reports no conflict of interest.