



# ARTICLE OF THE MONTH

## **Reversible Intraoperative Neurophysiologic Monitoring Alerts in Patients Undergoing Arthrodesis for Adolescent Idiopathic Scoliosis: What Are the Outcomes of Surgery?**

Amer F. Samdani, MD; James T. Bennett, MD; Robert J. Ames, MD; Jahangir K. Asghar, MD; Giuseppe Orlando, MD; Joshua M. Pahys, MD; Burt Yaszay, MD; Firoz Miyajni, MD; Baron S. Lonner, MD; Ronald A. Lehman Jr., MD; Peter O. Newton, MD; Patrick J. Cahill, MD; Randal R. Betz, MD

Welcome to the October 2016 installment of the SNACC Article of the Month! The featured article by Samdani *et al.* looks at intraoperative neurophysiologic monitoring (IONM) alerts in patients undergoing arthrodesis for adolescent idiopathic scoliosis and their impact on the outcome for these patients. Multimodality IONM using somatosensory evoked potentials (SSEPs) and transcranial motor evoked potentials (tcMEPs) is used routinely in scoliosis surgery in order to improve the sensitivity and specificity of neurophysiological monitoring. The neurophysiologist alerts the medical team of changes in neuromonitoring signals, allowing for the appropriate interventions to be deployed to restore baseline. This month we have Jeremy Lieberman, MD, sharing his thoughts on this article. Dr. Lieberman is Professor of Anesthesiology and Chief of Spine Anesthesia Division at UCSF, one of the few dedicated subspecialty services in the country. He is an active SNACC member and a recognized authority in the realm of neurophysiologic monitoring. His research addresses the use of neuromonitoring in spine surgery with a focus on motor evoked potentials, anesthetic and hemodynamic factors affecting the quality of these signals as well as ways to make neuromonitoring less subjective and therefore more reliable.

We encourage all of our readers to tell us what they think by joining us on [SNACC LinkedIn feed](#) the [Twitter feed](#), or the [Facebook page](#).

~ Oana Maties, MD and John F. Bebawy, MD

### **Commentary**

**Jeremy A. Lieberman, MD**

Professor

Chief, Division of Spine Anesthesia

Department of Anesthesia & Perioperative Care, University of California, San Francisco

Intraoperative neurophysiologic monitoring is an important tool used to detect spinal cord injury during complex spine surgery. Somatosensory Evoked Potentials (SSEPs) and transcranial Motor Evoked Potentials (MEPs) have proven to be highly sensitive; when used together as part of a multimodal technique, they can reliably detect

surgical manipulation nor are predictive of neural deficits are common. These “false-positive” alerts disrupt the flow of surgery, lead to unnecessary surgical interventions, and cause the surgeon to lose faith in the value of monitoring. These changes are often associated with anesthetic or physiologic changes, thus, the anesthesiologist needs to be closely involved with the surgeon and neurophysiologist in addressing alerts due to evoked potential changes.

Samdani *et al.* report the results of a multicenter prospective study of 676 patients that examined intraoperative monitoring alerts occurring during surgical correction of adolescent idiopathic scoliosis. They defined alert criteria as a decrease in SSEP or MEP response amplitude of >50% from baseline values. 36 patients (5.3%) were noted to have an alert. An alert was more likely to occur in patients with greater degrees of deformity, longer surgical duration, and higher amounts of intraoperative hemorrhage. Interventions in response to an alert included augmenting blood pressure, reducing anesthetics and/or doing a wake-up test, or undoing of the surgical correction. Thirty-four of 36 subjects had restoration of SSEP and MEP responses and completed their surgery. All awoke without neural deficits. Two cases were aborted. In one case, the intraoperative signals recovered and the patient was neurologically intact. In the other case, evoked potential amplitude remained poor and the patient awoke with lower extremity weakness that fortunately resolved several days later.

There are many valuable lessons to learn from this study. In this patient cohort, the majority of alerts were resolved by augmenting blood pressure, implying the decreases to evoked responses were not surgically induced, e.g., they were false-positive changes. Our ability to properly respond to alerts can be enhanced by our awareness of the preceding events occurring in the operation. If major surgical instrumentation or manipulation of the spine has just occurred, one is more likely to suspect this as prompting the alert. Physiologic or anesthetic changes prior to an alert tend to suggest false-positive etiologies, where anesthetic interventions such as increasing blood pressure, are more likely to be effective. (Skinner, *J Clin Neurophysiol* 2014; 31:118–126) In this study, the author's did look at inciting events prior to alerts. They noted alerts occurred in longer and bloodier cases, supporting their finding that physiologic interventions were so effective. Hemorrhage has been shown to produce reversible decreases in MEP responses, mainly by its effect of lowering cardiac output. (Lieberman, *Anesthesiology* 2013; 119:1109-19) Further, studies have shown that both hemorrhage and lower cardiac output cause rapid and profound increases in serum propofol levels, which may be a mechanism for the reduction of evoked potential amplitude. (Kurita, *Anesthesiology* 2002; 96:1498-503; Johnson, *Anesthesiology* 2004; 101:647-59)

Intraoperative alerts are common, especially in complex spine surgery. The criteria chosen by the neurophysiologist as to when to alert the surgical team to a significant change is variable. It is generally accepted that a 50% or greater decrease in SSEP amplitude may predict neural injury and merits a warning. Defining a serious decrease in MEP responses is far more controversial. Most neuromonitors choose a large decline in amplitude, say >50 to >80% from baseline. However, some will only sound an alert for complete loss of responses, e.g., an “all-or-none” occurrence. Others may ignore amplitude and declare an alert only if the stimulating energy needed to generate any response increases by a specific degree. It is essential for the anesthesiologist to be aware of the alert criteria being used, as this impacts on the accuracy of these modalities to detect surgical injury as well as how sensitive the alert criteria are to anesthetic or hemodynamic changes.

This and other studies suggest that outcomes for those patients experiencing alerts are not compromised if interventions during the procedure restore the reduced evoked potential responses. Wake-up tests were performed in 28% of the subjects. The data presented here and from other studies argue against the need to do a wake-up test if SSEP and MEP responses are recovered with interventions. (Padberg *et al.*, *Spine* 1998; 23:1392-400) It is likely that the high use of wake-up tests here reflect the time frame of these cases (2006-2012), when reliability of evoked potential monitoring was less evident.

Anesthesiologist awareness of the operative course is essential in focusing our suspicion as to the cause of the alert as well as the best initial interventions. Better understanding of the intraoperative factors that affect anesthetic depth and propofol pharmacokinetics may further enable us to reduce the incidence of false-positive alerts and restore signals after alerts occur.