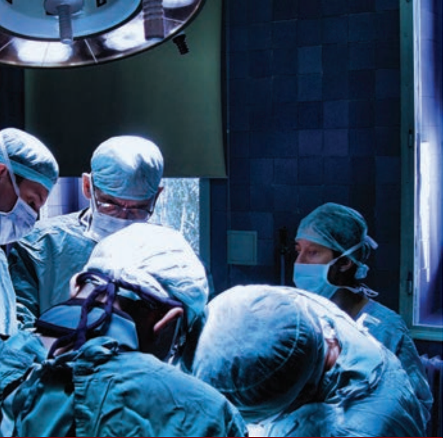

CANM
CANADIAN ASSOCIATION OF NEUROPHYSIOLOGICAL MONITORING

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Canadian IOM News

Official Newsletter of CANM

Message from the President

It is an enormous privilege to be the president of the Canadian Association of Neurophysiological Monitoring (CANM), and one I do not carry lightly. I was very sorry that personal circumstances prevented me from attending our annual meeting in Vancouver. I wish to thank Dr. Charles Dong and his organizing committee for putting on a superb meeting. Sadly, Charles has decided to resign from the CANM executive. Charles is exceptionally busy with his role in the International Society for Intraoperative Neurophysiology, in addition to his work in Vancouver. We will miss his insight on the executive, but I know that he will remain very influential in Canadian intraoperative neurophysiological monitoring (IOM).

One feature of my absence from the meeting in Vancouver is that I am able to pay tribute to our former president in print, in a way he wouldn't have tolerated in person. Dr. David Houlden is a giant of Canadian IOM. I have known Dave for many years, and he first mentioned his vision for CANM to me in a Montreal hotel over breakfast. Just a few months later, we were all invited to our first CANM meeting! He has worked to make CANM the organization it is today, and despite his official resignation from the executive, I am reassured that I will always able to call on Dave for advice.

As the new CANM president, I would like to take this opportunity to learn and stay connected with you through email, phone, or in person where possible (or even a letter!). This collegial spirit is a further strength of CANM and one that we should strive to enhance. Please contact me!

Jonathan Norton, PhD
President, CANM

Thank You for Making the 5th CANM IOM Symposium a Hugh Success!

The 5th CANM IOM Symposium was held in Vancouver, British Columbia, September 28–29, 2012. I would like to thank all guest speakers, case study authors, vendor sponsors, and attendees who came together and made it one of our best meetings yet!

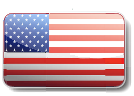
As many attendees commented, the case presentations at the beginning of the symposium were fun, interactive, and educational. So was the workshop given by Rebecca Clark-Bash, the renowned IOM educator. These case studies and the workshop discussed various practical aspects of IOM, which was not only beneficial to those new to the field but to veterans as well.

The much-anticipated Dr. MacDonald delivered an informative and elegant keynote speech on MEP warning criteria, which will surely have an impact on our daily practice. The lectures given by the surgeons were also well received. These professionals spoke not only about surgical procedures and how monitoring can help achieve optimal results, but also about the security and reduced anxiety that IOM provides. Needless to say, lectures by our clinical neurophysiologists that detailed applications of electrophysiological techniques in surgical monitoring were much enjoyed by the attendees. Many indicated that they would adopt some of the monitoring techniques learned at the meeting in their future practice, which is exactly what we want to hear!

The meeting went smoothly and effectively, thanks to the dedication and hard work of the organizing committee. During the Welcome Reception in the beautiful Coal Harbor Suite, people chatted with colleagues and met old and new friends over a cup of BC wine and tasty hors d'oeuvres.

The two days of the meeting passed by quickly, but the memory of the wonderful experience will last a long time. Once again, thank you to all who attended and made the Vancouver symposium a tremendous success. We look forward to seeing you again next year in Ottawa!

Charles Dong, PhD
Chair, CANM 2012 Symposium Organizing Committee
Director, CANM Executive Committee

Intraoperative Monitoring in Canada versus the United States: A Canadian Perspective

The basic tenets of IOM are the same in Canada and the United States. We use the same spectrum of modalities to guide surgeons and provide comprehensive neuroprotection for an almost identical array of surgical procedures. Both countries have progressive IOM programs that are an essential component of large hospitals, many of which are university based. Both countries also have national professional societies with mandates to promote IOM and improve upon existing standards of education and practice. CANM was formed in 2008 and has quickly become a guiding force for the profession on this side of the border. In the United States, there are numerous national groups, but the clear leaders are the American Society of Neurophysiological Monitoring (ASNM) and the American Board of Registration of Electro-encephalographic and Evoked Potential Technologists (ABRET).

The differences that do exist between Canada and the United States relate to how IOM can be delivered within our different models of health care. In Canada, we have a government-funded universal health care system that is administered by our provincial and territorial governments. Health care is a right of the individual citizen, and there is universal access regardless of health status or economic circumstance. In the United States, the health care system is largely controlled by private entities such as health maintenance organizations (HMOs) and private insurance companies. Government-funded health care delivery programs do exist, but they are limited to specific groups, such as Medicaid for the elderly and Medicare for the poor. Most Americans rely on health care that is administered through private insurers that are associated with and subsidized by their employer. The American medical system is, by its very nature, entrepreneurial, and this spirit can extend to the delivery of IOM. Private IOM companies are very common in the United States, and they operate in a way that is not easily sustainable in Canada. The concept of IOM as a business is where Canadian and American practitioners tend to diverge in both practical and ideological senses.

Private IOM companies exist throughout the United States and typically contract their services to individual hospitals or surgeon groups. There are different models of payment, but the costs are generally borne by the hospital, the patient's insurance provider, or both. The level of compensation that individual IOM companies receive for services rendered varies from region to region, but fees are generally based on the parameters set by current procedural terminology (CPT) codes. CPT codes are an important tool in the US medical system because they define the services for which medical practitioners can bill and receive compensation. For IOM-related services, the CPT codes are comprehensive and facilitate the billing of almost every IOM modality imaginable. The existence of IOM-related CPT codes creates the opportunity and framework for IOM to be a tremendously profitable endeavour – essentially because the modalities monitored equal money made.

It is important to point out that the vast majority of private IOM companies in the United States engage in the profession for the right reasons and have a healthy focus on patient care. There are also many that stand shoulder to shoulder with the very best university- or hospital-based programs in the country. However, the sad reality is that some unscrupulous private practitioners also exist, and they do not necessarily engage in IOM with the purest of motives. The capitalist bent of the American health care system means that greed has an opportunity to take root, and it can infect the quality of IOM delivered. Because there is a great monetary incentive to monitor as many surgical procedures as possible and with as many modalities as possible, a small minority inevitably take advantage and practise the volume approach. This modus operandi sullies the spirit of IOM because it treats it as a mercenary tool – nothing more and nothing less. Some of these operators go so far as to rank profit over patient care, parking inexperienced or unqualified personnel in front of IOM equipment, which become tantamount to cash machines. This misguided model is further fuelled by the current lack of standardized IOM educational programs in North America. Things have come a long way, but it is still possible to walk into an operating room with little more than a few weeks of on-the-job training and a dog-eared "how to" manual.

We are fortunate in Canada because the existence of our government-funded universal health care system has prevented what is possible in the United States, that is, the opportunity for an unscrupulous few to tarnish the reputation of what is, by and large, an excellent IOM system. The Canadian system of IOM delivery evolved under almost pristine conditions because it had the "advantage" of being constrained by a tightly controlled and cash-strapped public system. However, it is a good bet that if Canadian health care ever adopted the American entrepreneurial model, our IOM system would inevitably reflect this change – we would begin to see a small minority of opportunists taking advantage and engaging in IOM for the wrong reasons.

Overall, IOM in Canada and the United States shares far more similarities than differences. Both countries have reason to be proud of the high quality and strong international reputation of our respective programs. It will be important for the key professional organizations in both countries to keep working toward standardization of practices and the development of educational programs leading to a professional designation in IOM. It is in this way that we will ensure the continued growth and maturation of IOM on both sides of the border.

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Using Raw and Processed EEG to Monitor Level of Consciousness, Prevent Delayed Emergence, and Prevent False Positives

The use of a total intravenous anaesthetic (TIVA) is the optimal choice for IOM. There has been ample data to show the suppressive effects of nitrous oxide and halogenated agents on cortical somatosensory and motor evoked potentials (SEPs and MEPs). Volatile agents produce a dose-dependent reduction in SEP and MEP amplitudes.[5,6,10,11,14] MEPs have been shown to become variable and unstable at isoflurane levels below 0.5%.[10] When compared with other inhalational agents at equipotent concentrations, nitrous oxide produces the most profound SEP amplitude changes.[2,18,20] Unfortunately, the dependency of TIVA for IOM has introduced unwanted issues from an anaesthesiology perspective. Over the years, one of the most frequent concerns expressed to me by our anaesthesia colleagues is the lack of an MAC reading, and thus the possibility of raising the incidence of awareness. MAC is defined as the concentration of vapour that prevents movement to a standard surgical stimulus in 50% of subjects. MAC is accepted as a valid measure of potency of inhalational general anaesthetics and, as such, can give the anaesthesiologist a gauge of a patient's level of consciousness (LOC).

The incidence of awareness under anaesthesia has been reported to be approximately 0.1–0.2%.[16,17,19] The incidence of awareness in the pediatric population is less well documented, but is thought to be significantly higher, at around 0.8%. Engelhardt et al.[9] conducted a survey of members of the British and French pediatric anaesthesia societies regarding awareness during general anaesthesia. The vast majority of respondents stated that they rely almost exclusively on clinical signs, such as blood pressure and heart rate, and end-tidal anaesthetic concentrations. Bispectral Index (BIS) monitoring is routinely used by approximately 10% of surveyed members. The BIS, as well as other commercially available products, assigns a numerical value to the probability of consciousness using a complex electroencephalography (EEG) derivative. These devices attempt to demonstrate a dose-response relationship with hypnotic intravenous and inhalational agents independent of the agents being used.

There have been numerous studies that attempt to validate the usefulness of the BIS monitor; however, there remains a variety of conditions that could result in the BIS monitor indicating an incorrect hypnotic state.[7] Some of these conditions include paradoxical changes with anaesthetics, the effect of electromyogram (EMG) activity and muscle relaxants, electrical device interference, and abnormal EEG patterns such as low-voltage EEG and postictal EEG. The EEG with relation to age can also hinder the accuracy of the BIS. Several studies have found that the BIS value at 1 MAC of sevoflurane or desflurane steadily falls from late infancy.[21,23] With infants, there is strong evidence to suggest that commercial devices have substantially different performances, and they should be used very cautiously in this age group.[1,8,12,22]

Monitoring LOC, or depth of anaesthesia, can be accomplished by using raw EEG waveforms if there is a basic understanding of the changes that typically occur at different anaesthetic states. EEG activity is derived from the cerebral cortex and measures a combination of various electrical frequencies. The strength, or amplitude, of this activity can range from 50 to 300 µv. In awake patients with eyes closed, there is a predominance of alpha (8–12 Hz) and beta waves (13–30 Hz). With deepening anaesthesia, delta (1–3 Hz) and theta (4–7 Hz) slow-wave activities increase, with a decrease in alpha and beta. As deepening progresses, the patient reaches burst-suppression activity and finally isoelectricity. This process is reversed with the return of consciousness (Figure 1A–C). The use of the EEG to monitor LOC can keep the patient adequately anaesthetized. If the patient does not become too light, then it is safe to say that the chances of awareness are diminished.

Monitoring the level of anaesthesia using raw EEG, as opposed to commercial devices, allows for immediate identification of depth without acquisition delay. It also permits quick identification of electrocautery, EMG, or any other contaminating artifact that might otherwise pollute BIS readings. If recording SEPs, the same electrodes can be used to monitor EEG, which allows for multichannel or bilateral hemisphere recordings, if needed. As well, no proprietary electrodes or special equipment is required. Many EP devices can also convert the raw data into a frequency plot as a function of power. This algorithm is known as a fast Fourier transform (FFT) and creates a power spectrum (see Figure 1D–F). The FFT screen shots in Figure 1 display the corresponding power spectrum for the same 5-second sweep of raw EEG for each propofol infusion rate. An FFT can also be processed throughout the procedure to create a compressed spectral array (CSA) illustrating a trend of depth over time (Figure 2).

Another concern with the prolonged use of propofol under a TIVA is that it will result in a delayed emergence[13] as a result of anaesthetic deepening and accumulation. During propofol/remifentanil anaesthesia, it has been noted (personal observation) that an FFT power ratio of approximately 50% 1–7 Hz (delta and theta) and 50% 8–15 Hz (alpha and beta) (see Figure 2B) enables a rapid emergence from anaesthesia. This is useful if a wake-up test is required during a spine procedure, or if a quick emergence is preferable at the conclusion of a case for neurological assessment. Typically, the propofol and remifentanil infusion rates that produce an optimal power ratio during the initial stages of the surgical procedure tend to cause an EEG shift toward the lower frequencies, or deeper end, and may develop into burst suppression as the surgery proceeds. This anaesthetic deepening may be one of the causes of the "anaesthetic fade" phenomenon[15] and is more than likely due to the accumulation of propofol in body tissue. The infusion rates can be adjusted accordingly to maintain a 50:50 power ratio and facilitate a prompt emergence if necessary.

Finally, prolonged exposure to anaesthetic agents can necessitate higher stimulating thresholds to elicit MEP responses separate from the dose-dependent effect.[15] Anaesthetic deepening and accumulation result in motor neuron suppression and can lead to false alerts. Using EEG permits the maintenance of an adequate depth of anaesthesia while avoiding the patient becoming too deep. This helps reduce false positives due to the fade effect.

Interpreting EEG for the depth of anaesthesia is a skill that requires just a handful of cases before one is comfortable with it. Recent studies have shown after an extremely brief teaching session, anaesthesiologists were able to categorize EEGs as awake, sedated, or anaesthetized with comparable accuracy to the BIS and entropy monitors.[3,4] Raw EEG, alongside FFT recordings, can be used in place of a commercial device and may be more predictive in the pediatric population.

Raw and processed EEG should be one of the modalities in your IOM arsenal for every case. The use of TIVA remains a critical component of monitoring effectively without clouding clinical interpretation. We rely on the anaesthesiologists to provide TIVA and, in turn, we can assist them by providing important information on the LOC of the patient. EEG can also allow for quick emergence from anaesthesia if necessary, and it can prevent false positives due to anaesthetic fade. Having a collegial working relationship with the anesthesiologist is vital when in the operating room. I have found that one of the greatest measures of success in the field of IOM is having a mutually respectful relationship with both the anaesthesiologist and the surgeon. This earned respect is a great indicator that your work in the operating room is valued and appreciated.

Samuel Strantzas, MSc, D.ABNM, CNIM
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References

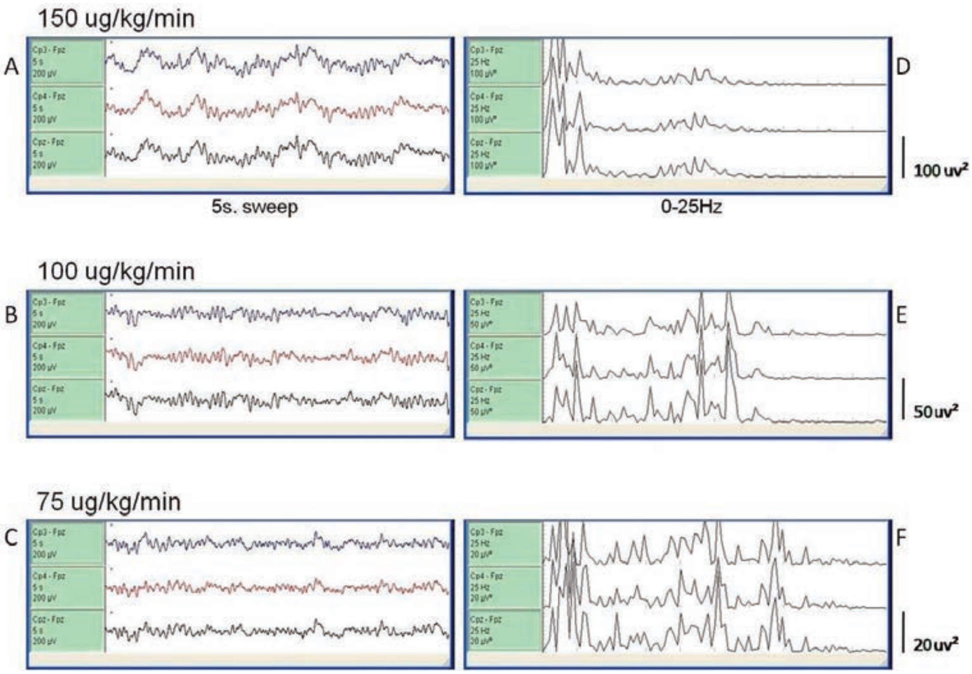

Figure 1. EEG and associated fast Fourier transforms (FFTs) at differing propofol infusion rates in conjunction with an infusion of 0.1 μg/kg/min remifentanil. Top recordings (A) are maintained at 150 μg/kg/min propofol and are shown to be anesthetically deep based on the low-frequency, large-amplitude waves of the EEG and corresponding FFT (D), which plots the majority of frequency power in the delta/theta range. The middle trace (B) shows the patient lightening when maintained on 100 μg/kg/min propofol based on the increased frequency and decreased amplitude of the EEG waves and a shift of the frequency power into the alpha range on the FFT (E). The bottom trace (C) indicates the patient to be anesthetically light when maintained on 75 μg/kg/min propofol based on the increased frequency and decreased amplitude of the EEG waves and a shift of the majority of frequency power into the alpha and beta range on the FFT (E). These images are taken from a 16-year-old patient undergoing posterior spinal fusion for the correction of idiopathic scoliosis. The raw EEG is recorded from Cp3-Fpz (*blue trace*), Cp4-Fpz (*red trace*), and Cpz-Fpz (*black trace*), and the filter settings are 0.5 Hz LFF and 35 Hz HFF.

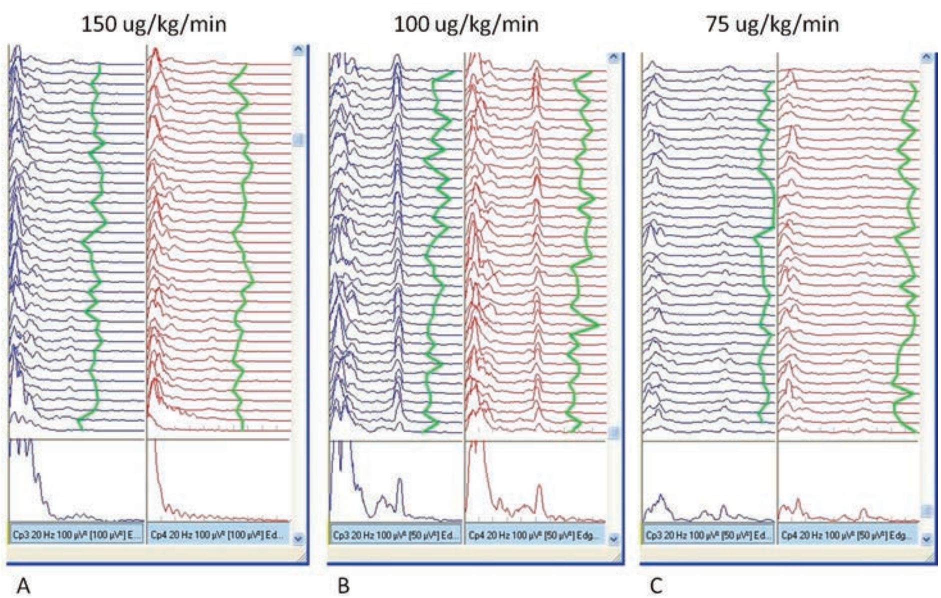

Figure 2. Compressed spectral array (CSA) demonstrating the maintenance of a 50:50 ratio in a patient under propofol/remifentanil anesthesia. The fast Fourier transform (FFT), derived from the raw EEG, is processed, and the power of the frequency and amplitude is displayed graphically as a CSA. The first peak demonstrates the power in the range of 1–7 Hz (delta and theta), and the second peak shows power in the range of 8–15 Hz (alpha and beta). When approximately 50% of the power is distributed to each range, shown by equal amplitude of peaks, a rapid emergence from anesthesia can be facilitated. Blue traces represent recordings from the left side of the cortex, whereas red traces indicate right-side recordings. The green line represents the 95% spectral edge frequency, and as the patient lightens, this shifts to the right. An adequate SEF falls in the 12–14 Hz range.


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Did You Know…?

IOM AND THE SURGICAL SAFETY CHECKLIST

In 2009, the World Health Organization (WHO) established the Surgical Safety Checklist in an effort to improve communication among surgical team members (www.who.int/patientsafety/safesurgery/ss_checklist/en/). The fundamental objective of the checklist is to ensure that surgical teams follow critical safety steps, thereby minimizing avoidable risks common to the operating room. Since the publication of the WHO pilot study by Gawande et al.,[1] evidence supporting the effectiveness of the checklist has continued to grow and many hospitals worldwide have now mandated its use in the operating room. WHO guidelines suggest that every organization adapt the checklist to its own circumstances and that the entire surgical team should participate (i.e., surgeons, anaesthesia professionals, nurses, technicians, and other operating room personnel).

In following with these recommendations, IOM, an established field of allied health care, should be represented in the checklist when applicable. IOM practitioners are a valuable members of the surgical team and can take part in the checklist by introducing themselves and confirming IOM related information such as the following:

- Neurophysiological tests performed
- Anaesthetic protocols required
- Potential intraoperative neurological deficits

The WHO Surgical Safety Checklist is enhanced and team coordination improved when IOM practitioners are included; nevertheless, some hospitals have been slow to integrate IOM into their checklist. At Toronto Western Hospital, the checklist includes surgeons, anaesthesiologists, and nurses but regrettably lacks the participation of IOM practitioners or other allied health care professionals. Recognized as a vital component to the neurosurgical team, Toronto Western Hospital's IOM practitioners have long been neglected from the checklist. Currently, a graduate studies project is under way with Queen's University to enhance the checklist at Toronto Western Hospital. The aim of this quality improvement initiative is to integrate one allied health care field, IOM, into the checklist at this hospital. This initiative would allow Toronto Western Hospital to be more closely aligned with the WHO Surgical Safety Checklist manual that recommends the inclusion of all operating room personnel. Hopefully this project will serve as a precursor for the amalgamation of additional allied health care professions into the checklist at Toronto Western Hospital.

Has your hospital incorporated IOM practitioners into the Surgical Safety Checklist?

Gina Bastaldo, HBSc, CNIM
Communications Director, CANM
Editor-in-Chief, *Canadian IOM News*

Reference

1. Gawande AB, Lapitan MCM, Merry AF, et al; Safe Surgery Saves Lives Study Group. A surgical safety checklist to reduce morbidity and mortality in a global population. N Engl J Med 2009;360:491–9.

Quick Poll

Does your IOM department participate in the Surgical Safety Checklist at your hospital?

a. Yes
b. No
c. Occasionally (not consistent)

Click Here!

Take the Quick Poll & View Results

Results from the Fall Issue's Quick Poll

Do you believe your IOM documentation practices need improvement?

a.	Significant changes are required.	20%
b.	**Moderate adjustments are necessary.**	**40%**
c.	I am not sure if modifications are necessary.	20%
d.	No amendments are required. I am satisfied with my current documentation practices.	20%