Canadian IONM News

Official Newsletter of CANM

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CANM
CANADIAN ASSOCIATION OF NEUROPHYSIOLOGICAL MONITORING

Message from the President

In my final newsletter message as president of CANM, I would like to take this opportunity to thank the team of hard-working members of this association who have served (and continue to serve) on the Executive Board and other important working groups and committees. CANM is a relatively small organization but what we lack in size, we make up for in might. CANM would not exist without the tireless dedication of a small core of talented individuals and I want to thank each one for volunteering enormous amounts of time and energy to CANM and for elevating the practice of IONM in Canada. It has been an honour to serve as leader of CANM's executive team over the past 2 years and I am excited to see what great heights CANM will achieve under the inspired and energetic leadership of our incoming president, Dr. Marshall Wilkinson. Marshall is a well-known and beloved Canadian leader in intraoperative neurophysiology and his term as CANM President will commence this fall.

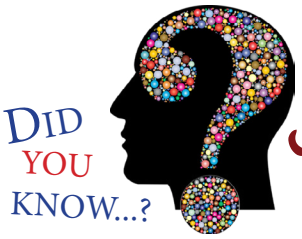
Also happening this fall is the graduation of the second cohort of students who have successfully completed the 2-year Michener Graduate Certificate in Intraoperative Neurophysiological Monitoring. This group of graduates marks the beginning of a regular infusion of young, well-educated and motivated entrants into our profession. The introduction of energetic and evolving talent into the IONM community in Canada is exciting because it represents a wealth of possibility for the growth and development of our profession. New practitioners will bring academic research experience, innovative ideas and approaches and I believe that the best way that CANM can help the IONM community capitalize on this emerging resource is to encourage active engagement in our association. CANM has an Associate Member category that is particularly suited to students and new practitioners who have not yet met the case volume required for Full Membership. I strongly encourage CANM membership and participation at the outset of a career in IONM because it is the best way to connect with Canadian colleagues and remain tuned into the rapidly changing face of our profession across the country.

CANM is at the leading edge of a movement in IONM in Canada that elevates the profession by demanding a level of discipline and excellence that is consistent with the 'expert in the room' model. Public interest and patient safety are the motivational drivers of CANM's ongoing campaign

to implement core competency requirements and benchmark achievements along a pathway leading to the designation of 'Certified Intraoperative Neurophysiology Practitioner' (CINP) – the proposed new gold standard for IONM practitioners in Canada. Over the past several years there has been an active dialogue among CANM members and IONM practitioners about the details of the proposed CINP pathway. The conversation and debate has heated up over the last year as we move closer to the CINP designation as a reality versus a concept for consideration. I strongly encourage IONM practitioners of all ages, educational backgrounds, clinical experience and stages of career to speak up and share their unique opinions and perspectives. CANM has worked hard to be inclusive and invite feedback from our membership and the IONM community at large about the proposed CINP pathway - we want to hear from everyone. CANM members will cast their vote on whether to accept the proposed CINP pathway soon and details about the voting process will be posted on the website and emailed to members in advance so please stay tuned. I encourage all eligible CANM members to cast a ballot and to encourage their junior colleagues to join the conversation leading up to the CINP pathway vote.

September and the 10th Anniversary CANM IONM Symposium are quickly approaching and it is time to start making your travel plans! This year's event will be extra special with our own Dr. David Houlden as the keynote speaker. David is the founding President of CANM and can always be counted on to give a superbly entertaining and inspired talk. We will come together to reflect and celebrate the incredible journey that CANM has led over the last 10 years and we will take a collective look toward a future that shines with tremendous promise for IONM in Canada. I look forward to seeing everyone in Toronto on September 15th and 16th and celebrating the launch of the next chapter of the CANM story under the skillful stewardship of Dr. Marshall Wilkinson and his new Executive Team. Our gatherings are the perfect size to support meaningful engagement and it is almost impossible to attend without learning at least one new clinical 'trick' or forging an important new professional connection.

Susan Morris, PhD Neurophysiologist
President, CANM Executive Board
IWK Children's Health Program
CDHA Division of Neurosurgery
Assistant Professor (Surgery),
Dalhousie University
Halifax, Nova Scotia



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Membership has its PRIVILEGES!

BECOME A MEMBER NOW!

Only FULL MEMBERS of CANM

will be eligible for grandfathering allowances related to the future credentialing pathway leading to the Certified Intraoperative Neurophysiology Practitioner (CINP) designation.

Grandfathering allowances are contingent upon maintenance of **RECURRING FULL MEMBERSHIP,** until certified, starting **JANUARY 2018.**

Eligible members will be EXEMPT from the following standard pre-requisites:

- Bachelor's Degree in Health-Related Sciences (*stream 1 & 2*)
- Michener Institute Graduate Certificate in IONM (*stream 1*)
- (future) CANM-sanctioned Internship (*stream 1 & 2*)

See **www.canm.ca** for more details on the CINP credentialing pathway 2017 **FULL MEMBERS of CANM** will have the privilege of **VOTING** on the finalized credentialing pathway at an upcoming Special Meeting of Members after a period of review. Watch your email for more information.

New CANM Members

Full Member
Rachel Cleary – Richmond, BC

Associate Member
Patricia Warf – Naperville, Illinois

2017 CANM Membership Fees

FULL MEMBER:
$165

ASSOCIATE MEMBER:
$130

INTERNATIONAL MEMBER:
$165

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to sign up today

Intraoperative Neurophysiological Monitoring Graduate Certificate Program

The Canadian Association of Neurophysiological Monitoring (CANM) and The Michener Institute of Education at UHN have partnered to introduce a one-of-a-kind Intraoperative Neurophysiological Monitoring (IONM) Graduate Certificate Program.

- Prepare for a career in IONM
- Be certification ready

The online program comprises six courses ranging from basic sciences to advanced topics in IONM.

1	Clinical Sciences for IONM	SEP 2017	4	IONM Modalities II	SEP 2017
2	Basic Principles of IONM	JAN 2018	5	Considerations for IONM	JAN 2018
3	IONM Modalities I	MAY 2018	6	Advanced Topics in IONM	MAY 2018

For program details and admission requirements visit **MICHENER.CA/CE/IONM**

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CANM CANADIAN ASSOCIATION OF NEUROPHYSIOLOGICAL MONITORING

Celebrating our 10th Anniversary!

Please join us to celebrate the 10th anniversary of CANM's annual symposium, to be held in the inaugural city of Toronto, Ontario on September 15-16, 2017. This year's symposium will be an opportunity to reflect on and commemorate the significant achievements we have made in advancing the intraoperative neuromonitoring profession over the last 10 years. To this end, it is only fitting to have CANM's founding president, Dr. David Houlden, provide the keynote address. Dr. Houlden has been instrumental in the development of IONM as a profession in Canada. He is our strongest advocate on the national and international stage and an inspirational mentor to many of us in the field. Through the years, he has shown a dogged dedication to advancing best practices in IONM by engaging in rigorous research and applying his innovative ideas and techniques in the OR. This will be evident by his lecture on some of his newer research involving the use of intraoperative visual evoked potentials.

Dr. Houlden is just the tip of the iceberg. This year's scientific program is replete with national and international experts in IONM providing their thought-provoking insights into topics ranging from spinal cord stimulator placements to subcortical mapping using ultrasonic aspirators. We have incorporated the best ideas from prior symposia in this year's program. Sessions include the ever-popular case presentations, interactive case conundrums, roundtable discussions and hot topics and current trends IONM. Our social event caps off the didactic component of the symposium providing an opportunity to exchange ideas with colleagues and friends, put faces to names, and make new contacts. Of course, the annual CANM symposium would not be successful without the support of our sponsors and exhibitors. There will be ample time for attendees to interact with our vendors and explore the newest technology.

This year's symposium is being held in Toronto, the largest city in Canada. Toronto is a vibrant, multicultural city recognized as the heart of Canada's arts, culture, and entertainment scene. The symposium's venue, Pantages Hotel, is in a prime downtown location within walking distance to the Eaton Centre, St. Lawrence Market, and the Hockey Hall of Fame. Access to the subway is minutes away to transport you to other main Toronto tourist attractions, such as the Rogers Center, Ripley's Aquarium, and the CN Tower.

The symposium is a University of Toronto accredited Continuing Medical Education (CME) event. For registration details, payment options and further information about the symposium please visit the CANM website.

Come help us celebrate this milestone in CANM's history! We look forward to seeing you in Toronto in September!

Jamie Johnston, Ph.D., CNIM
2017 CANM Symposium Organizing Committee

Announcing the next CANM *talks*

CANM is pleased to announce the next session in our interactive webinar series, CANM *talks*. This is a complimentary webinar series, however, due to limited availability priority access will be given to CANM members. One Category 1 Continuing Medical Education (CME) credit is awarded to each participant by the Royal College of Physicians and Surgeons of Canada in association with the University of Toronto.

How to Use Bulbocavernosus Reflex Testing During Thoracic and Lower Spine Surgery

Stanley Skinner, MD
Abbot Northwestern Hospital
Minneapolis, MN
Wednesday October 18, 2017
7:30pm EST

Objectives: **1) Review the use of bulbocavernosus reflex in thoracic and lower spine surgery**
2) Invite questions, comments, and discussion

TO REGISTER: **Send email with subject line "Register – October 18" to talks@canm.ca**

More CANM *talks* coming in 2018!

Did you know?
Members have access to all previous CANM *talks* webinars

Have an idea for a future webinar topic?
Send us your suggestion to info@canm.ca

CANM *talks* Webinars for 2017

Since 2014, CANM has hosted CANM *talks* – a series of easily accessible online educational IONM webinars. CANM *talks* is an hour-long webinar that is accredited by the Royal College of Physicians and Surgeons of Canada for Section 1 Credit and is complimentary for all registrants. This past year, we have hosted two CANM *talks* and will showcase the final 2017 webinar on October 18 at 7:30pm EST.

On May 17, Laura Holmes, on behalf of the CANM Executive and Education Committee, presented the **"Proposed Pathway for Certified Intraoperative Neurophysiology Practitioner (CINP) Accreditation"**. CANM has worked tirelessly over the last few years to develop an accreditation strategy with multiple streams leading to a national examination and achievement of the CINP designation. This professional designation is the first step in our quest to make IONM an independent, self-regulated and nationally recognized Allied Health Profession in Canada. This webinar was particularly important as it provided an opportunity for the CANM Executive and Education Committee to directly solicit feedback and address questions and concerns from the greater IONM community. The finalized CINP pathway proposal will be released soon and it will be put to a formal vote by Full CANM members after a period of review. To view the CINP pathway presentation and FAQs of the CINP Proposal, please visit **www.canm.ca**.

The second CANM *talks* guest speaker of the year was Rebecca Clark-Bash, President of Knowledge Plus, Inc. on June 21. In addition to being a well-known IONM educator and advocate, Rebecca occasionally consults in litigious medical cases. Her webinar on the **"Medical-Legal Implications of IONM"** provided great insight and knowledge into what we as IONM professionals can do to better protect ourselves in our daily job performance and ultimately ensure consistent and high-quality patient care. Rebecca highlighted areas of concern such as proper documentation (what should be included), effective communication between all surgical parties in the OR, and certifying that the IONM machine is regularly checked and maintained.

Please join us for the last CANM *talks* of the year on **October 18 at 7:30pm EST**. Our guest speaker will be Dr. Stanley Skinner, presenting the use and effectiveness of the Bulbocavernosus Reflex, an often-overlooked method of monitoring the sacral nerves.

CANM *talks* webinars are open to all interested parties, however priority registration is given to CANM members. Become a CANM member today and you'll also get access to videos of past CANM *talks* on the Intraoperative Neurophysiology Discussion Board at: **http://canm.proboards.com/**

Sincerely,

Nancy Lu, BSc., CNIM
Treasurer, CANM Executive Board
Toronto Western Hospital,
University Health Network
Toronto, Ontario

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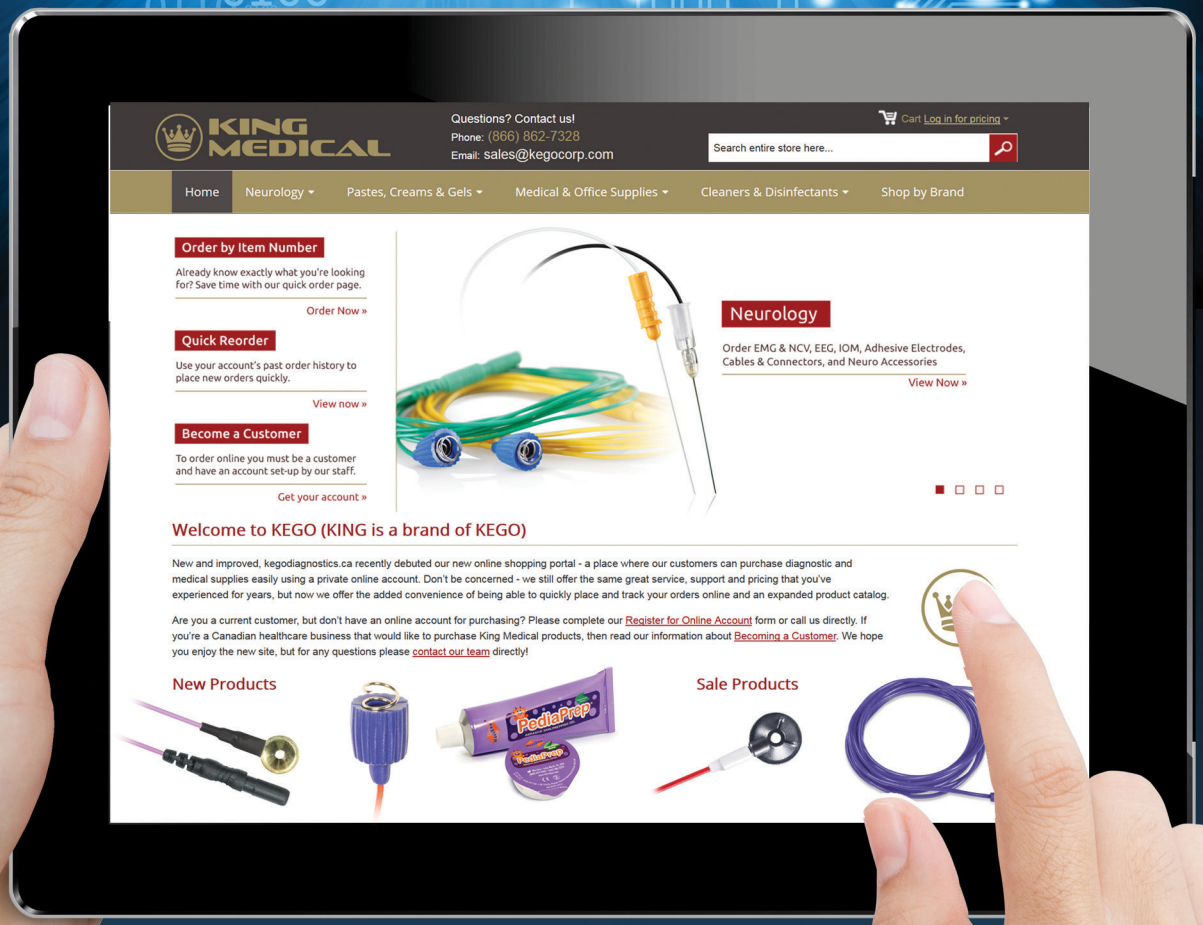

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Update:
CERTIFIED INTRAOPERATIVE NEUROPHYSIOLOGY PRACTITIONER (CINP)

The CINP designation is the culmination of a comprehensive educational, training, and clinical experience background, and exhaustive credentialing process. It marks the first proposed Canadian board-certification in IONM and is designed to signal professional competency in the practice of IONM.

CLICK HERE TO REVIEW THE PROPOSAL

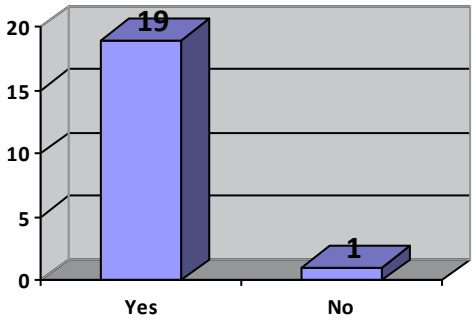
The CINP proposal was first unveiled at the 2016 CANM Symposium, and was featured in the April 2017 issue of Canadian IONM News. Over the past several months, feedback on the proposal has been collected from the Canadian IONM community in a variety of formats, including an anonymous survey. The results of this survey combined with comments received during the Town Hall session of CANM *talks*, via email, and through direct correspondence with Canadian IONM professionals will form the basis for the review of the proposal by the CANM Education and Credentialing Committee.

Given the implications of this credential on the Canadian IONM community, the Executive Board of CANM together with the Education and Credentialing Committee needs to carefully examine the strengths of the current proposal and opportunities for improvement before moving forward. A considerate review of this nature takes time, which is why we have chosen to defer the vote on the finalized pathway that was originally scheduled to take place at the Annual General Meeting of Members on September 16, 2017. The finalized pathway to CINP designation will be released in the next few months and the Canadian IONM community will be asked to offer commentary prior to the Special Meeting of Members (date TBA) when the vote will occur.

Highlights of the CINP Survey

FIND FULL RESULTS HERE

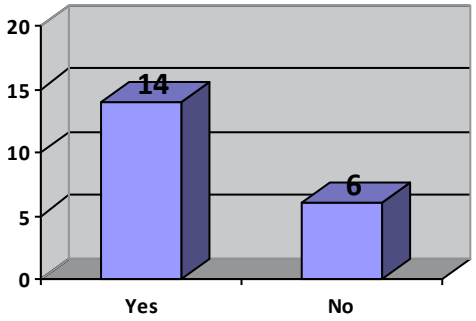
In principle, do you support the concept of a Canadian IONM accreditation initiative?



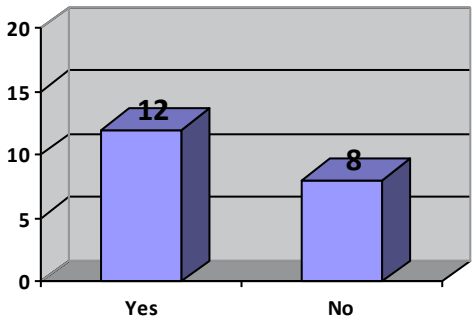
Update:

CERTIFIED INTRAOPERATIVE NEUROPHYSIOLOGY PRACTITIONER (CINP) Proposal

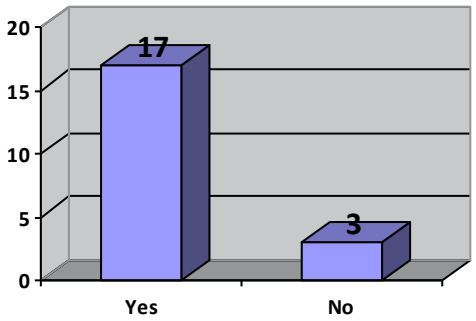
Do you support the CINP accreditation pathway and credentialing examination, as proposed (even if you will choose not to challenge it)?



Will you challenge the CINP examination?



Will you encourage new entrants into the IONM field to follow the CINP accreditation pathway and credentialing examination process?



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Value of a Team

The "Spine Team" Experience at BC's Children's Hospital

Cassie McFarlane, R.E.T., R.EP T., R.NCS.T., CNIM

In recent years the "Team Approach" has been growing in popularity in the operating room. This is a summary of a short talk titled "Value of a Team" that I presented at the 2016 CANM Annual Symposium in Halifax. It is based on our experience at BC's Children's Hospital with the creation of the "Spine Team" headed by Dr. Firoz Miyanji, who is one of three paediatric orthopedic surgeons specializing in spine procedures at our hospital. Dr. Miyanji was inspired by the growing number of studies, both hospital-based and involving other professions involved in complex, high-risk procedures (i.e. NASA, Swiss Re White Book), that showed increased positive outcomes for groups working in high-pressure situations. These studies showed that teams who had trained together and worked towards a common goal could increase efficiency and workplace satisfaction. More importantly, a standardized system and a cohesive team works together to minimise errors and poor outcomes, thereby improving overall safety. Management of paediatric spinal disorders is complex and the complication risks can be catastrophic. Towards this end, Dr. Miyanji led the creation of our "Spine Team" in 2012.

Our Spine team was made up of a homogenous staff group: a single spine surgeon, the IONM team and a smaller, consistent group of anaesthesiologists and nurses. The goal was for all staff to be very familiar with the type of operative procedure taking place as well as to be aware of the requirements and goals of the other team members for that surgery.

- In order to evaluate the theory behind the institutional pediatric spine surgery team approach (PSST) a retrospective, consecutive case-controlled study was designed. The quality and safety improvement of pediatric spine surgery would be evaluated comparing Pre- and Post-Implementation PSST. Each study period contained patient statistics over a 24 month period.

- Among both groups (pre and post PSST), the vast majority of cases involved treatment for idiopathic scoliosis, with neuromuscular cases the second most common.

The outcomes of the formal study were overwhelmingly positive. There was a statistically significant decline in the following areas: surgical site infection, operative time, length of stay, unplanned surgical procedures, and transfusion rates. Mean estimated blood loss did decline, but not significantly. The conclusion was that in addition to quality and safety, other potential benefits related to efficiency of care and decreased hospital costs.

We have noted other positive, though less measurable findings, amongst the team that may be contributing to good patient outcome. By limiting the members of the team staff is consistent and familiar with each other. Patient setup and cleanup amongst the team members is smooth and

Value of a Team

The "Spine Team" Experience at BC's Children's Hospital

Cassie McFarlane, R.E.T., R.EP T., R.NCS.T., CNIM

efficient because we are aware of each other's timing and requirements. We have changed our style of communication within the team: the focus is on plain language, common/standard terminology and relevant information only when communicating results or changes. When appropriate, though, casual conversation is encouraged to help strengthen rapport. Several times each year "Spine Dinners" are hosted, for a social opportunity outside of work that also include an educational component where team members take turns presenting relevant topics. From my perspective in the IONM corner, I find the more collegial atmosphere has led to improved discussion during the case: for example anaesthesiologists have been more approachable and encourage conversation when we are starting to have deteriorating responses, potentially avoiding raising an unnecessary alarm.

The prospective creation of the team itself re-focused staff on the overall goal of "best patient care" for each patient, each day. The initial study has concluded but we on the Spine Team continue to benefit from its effects. It has been a positive experience and one I'm happy to promote.

Dr. Miyanji has presented the data from this study at several national and international conferences but is not yet formally in print. A summary of the data can be found at the following link:

https://spinalnewsinternational.com/team-based-approach-significantly-improves-surgical-outcomes/

SPOTLIGHT:

Jeremy Spence

My name is Jeremy Spence, age 35, from St. John's, NL. I completed a BScH from Memorial University of Newfoundland and a few years later, the Electroneurophysiology program at the British Columbia Institute of Technology (BCIT). I'm currently working at the Health Sciences Center in Winnipeg as a full-time neurosurgical monitorist while completing the Michener Institute program in IONM. I'm currently a R. EEG T. and am in the process of obtaining my CNIM credential as well.

How did you hear about the Michener Institute Graduate Certificate in IONM and why did you enroll?

I heard about the program during my job interview process, actually. They were looking for someone with more experience in IONM (and who isn't?) but were willing to train a semi-qualified individual like myself also. As part of that training, when I'm not in the OR I'm doing Michener course work.

Why would you recommend the Michener Institute Graduate Certificate in IONM?

The modules are an amazing resource with a wealth of great information that could probably benefit even the more seasoned IONM professional. I was fortunate because the program at BCIT was extremely comprehensive and provided a great foundation, and I'm also working with, and learning from, some amazing IONM professionals here in Winnipeg. However, the Michener program is specific to IONM and has modules from other IONM pioneers and leaders across the country, so it's almost like getting to work with and learn from all of them.

How did you find out about the profession of IONM and what interested you in this career path?

That's a tough question really. I sort of stumbled into Electroneurophysiology while looking for something to do with my university degree. After that, IONM was touched-on during my studies and practicums so I had gotten a little exposure to it. The career path interested me because of the autonomy and the direct impact it has on patient care. While it can be very stressful, I appreciate how working in the OR, what we say and do really matters; we can help prevent or ameliorate some devastating patient outcomes which is immensely rewarding.

What has surprised you about the field of IONM?

I guess I'd have to say how small the field is, and how young it seems. I believe there are only four of us working in IONM in the whole province of MB, which seems unreal since IONM is considered the standard of care for spine surgeries such as scoliosis corrections, for example. I'm also a very analytically-minded person, so I appreciate when research literature shows clear black-and-white answers, but there is still a lot of grey.

What is your overall impression of CANM's plan to develop a credential in IONM?

I think it will be a huge step for advancing the field as a whole, and it should be our number one priority right now. I believe it is clear, especially to anyone working in the field, that having an expert in the room is the only IONM model that puts patients' welfare first. Toward that end, best practices need to be established and there needs to be clear credentialing and/or licensure. Not only will this ensure that we have qualified individuals in the OR, with the education and experience necessary, but it will also help in establishing the peer-to-peer relationships and trust between the IONM professionals and the surgeons and anesthesiologists that is required for effective neuromonitoring. Additionally, credentialing as a practitioner would hopefully help all professionals in the field get remuneration that is commensurate with the responsibility (and stress) of the position.

SPOTLIGHT:

Kristine Pederson

My name is Kristine Pederson and I am 26 years old. I grew up on a grain farm outside a tiny town called Archerwill, Saskatchewan. I graduated from the University of Saskatchewan with a Bachelor of Science in Physiology & Pharmacology in 2014. I then moved to Vancouver to study Electroneurophysiology at the British Columbia Institute of Technology (BCIT). Upon graduating from BCIT in 2016, I began my career in IONM at Health Sciences Centre in Winnipeg, Manitoba. I enrolled in the Michener Institute Graduate Certificate in IONM when I began working at HSC in

How did you hear about the Michener Institute Graduate Certificate in IONM and why did you enroll?

I was introduced to the Michener program by my employer when I started working at Health Sciences Centre. I had a very brief intro to IONM while I was at BCIT, but the Michener Institute Graduate Certificate in IONM is much more comprehensive and I thought it would be a great resource to aid in my on-the-job training as well as helping me to prepare for registration exams.

Why would you recommend the Michener Institute Graduate Certificate in IONM?

The Michener Institute Graduate Certificate in IONM is really the only comprehensive program available in Canada for people interested in starting a career in IONM. Furthermore, the quality of the courses is fantastic and the tutors have all been incredibly helpful. This program is a great way for those who are new to the field to learn about IONM, as well as a great resource for practicing professionals.

How did you find out about the profession of IONM and what interested you in this career path?

The Electroneurophysiology program at BCIT covers many modalities, including Evoked Potentials, EMG, Nerve Conduction Studies, and IONM, but the main focus is on EEG. It was there that I learned about IONM as a profession. I was interested in IONM as a way to combine and interpret all the modalities I'd learned about in a real-time setting.

What has surprised you about the field of IONM?

I was surprised at how few practicing IONM professionals there are in Canada! However, with new IONM educational opportunities available, I hope that this number will grow in the future.

What is your overall impression of CANM's plan to develop a credential in IONM?

I feel that Canada could greatly benefit from a more thorough and regulated credentialing exam. Although there is a lot of work to be done before it's ready to put into practice, I believe that the CINP accreditation has the potential to ensure a more competent IONM practitioner in the operating room, especially for newcomers to the field.

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Ontario's Provincial Guidelines for Epilepsy

Recently the Ontario Provincial Guidelines for Epilepsy Surgery Centres of Excellence were released. The guidelines were established in an effort to standardize the way patients are cared for when being surgically treated for epilepsy. About 30% of people with epilepsy have medically refractory, or drug resistant epilepsy[16]. In those patients, surgery and other nonconventional treatment are required.

Surgical treatment for epilepsy can result in far better outcomes with respect to seizure freedom, improved quality of life, and reduction of the psychosocial comorbidities that accompany drug resistant epilepsy than continued medical treatment.

Once an adult or child is referred to an epilepsy centre, it must be determined if there is an identifiable brain region from whence the seizures arise, and if the epileptogenic zone can be surgically removed with resultant seizure freedom. The epileptogenic zone may be defined as the region of epileptogenic cerebral cortex whose removal will result in a seizure-free state. A successful outcome from epilepsy surgery may be defined as a seizure-free state with no imposition of neurologic deficit[40].

In order to achieve these twin goals three fundamental questions need to be answered:

1. **Can the epileptogenic zone be lateralized to one side of the brain?**
2. **Can the precise localization of the epileptogenic zone be determined in the involved hemisphere?**
3. **What brain function, i.e. motor, sensory, language, and memory function might be damaged if the epileptogenic zone is surgically removed?**

The Guidelines put forth a measure to answer these questions through a series of presurgical diagnostic measures to select those adults and children who have the best chance of achieving a successful outcome from epilepsy surgery. These tests require a multidisciplinary approach and involve but are not limited to; neurosurgery, neuropsychology, psychosocial, neuroimaging, and neurophysiology. Once the decision has been made to proceed with surgery, it is imperative that the epileptogenic zone be safely removed.

This summary describes in detail the neurophysiology component, and specifically, the guidelines for intraoperative functional mapping and monitoring during epilepsy surgery. The technical components for each test protocol are described in detail, along with anesthetic and safety considerations. Further information and complete guidelines can be found at **http://braininstitute.ca/resources/guidelines-and-toolkits/provincial-guidelines-for-epilepsy**

Samuel Strantzas, MSc., D.ABNM
Assoc. Clinical Neurophysiologist
Intraoperative Neuromonitoring
Hospital for Sick Children
Toronto, Ontario

Ontario's Provincial Guidelines for Epilepsy

Test Protocols

1. Functional Cortical Mapping

Functional mapping of eloquent cortex is executed in the operating room prior to insertion of the subdural grid. The goals are; 1) to identify the central sulcus by recording phase reversal SEPs, and 2) to identify the primary motor cortex by stimulating the brain directly and recording compound muscle action potentials (CMAP). This information is used for preservation of motor and sensory function during cortical resection.

a. Phase reversals

Phase reversal SEPs are utilized as an intraoperative monitoring tool to identify the sensory portion of the sensorimotor cortex (central sulcus identification)[2,7,12,29,49]

Stimulation montage[28,29]:

- median n. or ulnar n. at the wrist contralateral to tested hemisphere
- anode placed 2-3 cm distal to the cathode
- intensity is supra-maximal at 15-20 mA producing an observable twitch
- rate is 4-5 Hz and can be lowered to 1-3 Hz for children under 3 years of age
- pulse duration is 200-300 μs

Recording montage[28,29]:

- Channel 1: C-spine
- Channel 2-5: 1 x 4 strip electrode
- Channels 1-5 referenced to Fz
- Filter settings at 30-500 Hz. (Reduce high frequency filter to eliminate high frequency artifact)
- Strip electrode positioned with long axis in an anterior-posterior orientation placed over the presumed central sulcus, or previously mapped magnetoencephalography (MEG) somatosensory evoked field (SEF)
- Time base 50 ms
- 100 trials or until waveforms are clearly identifiable
- Test must be reproducible

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Interpretation of Phase Reversals[28,29,38,49]

- Maximal amplitude of the major negative peak at about 20 ms (N20) generated from the postcentral gyrus
- Phase reversal of the same 20 ms potential (P20) across the central sulcus with a 1-2 ms increased latency arising from the motor cortex
- The latency of the principal negative peak can vary with patient height, age and gender
- If no phase reversal is observed the strip electrode should be repositioned over a different area of the exposed cortex and stimulation re-attempted
- The strip electrode, on occasion, may have to be rotated and positioned in a more superior-inferior direction

b. Direct Cortical Stimulation (DCS)

Two methods of DCS have evolved. The 60 Hz technique applies stimuli with a 50 or 60 Hz frequency over a period of many seconds. This has been described by Penfield in the 1930s[31]. It requires a much higher number of pulses and, as a result, imparts a greater total charge to the brain than the high frequency train-of-five (HF-TOF) technique.

A literature review found stimulation associated seizures is reported in 1.2% with the HF-TOF technique and significantly more frequently in 9.5% with the 60 Hz technique[44]. The incidence of stimulation associated seizures with the 60 Hz technique has been reported as high as 24%[34,50]. It has also been shown that there is no increased risk of the occurrence of stimulation-associated seizures during surgery for patients with symptomatic epilepsy compared with those patients without[44].

The 60 Hz technique may be less sensitive in pediatric patients due to the relative inexcitability of the motor cortex[33].

Another advantage of the HF-TOF technique is that, as stimulation intensity is increased in a stepwise manner, you are able to selectively activate a small portion of fibres and record CMAPs, as opposed to observing gross motor movements. This improves mapping sensitivity[46] and allows specific regions of the motor homunculus to be identified across much of the entire body[13,25].

It is for these reasons that there has been a shift from the 60 Hz technique to the high frequency HF-TOF technique over the years. Stimulation and recording parameters for the HF-TOF technique is described below.

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Stimulation montage:

- Monopolar, 3 mm, ball-tipped probe for mapping
- Monopolar probe plugged into anode (red, positive)
- Anodal stimulation produces responses from contralateral muscle groups
- Needle electrode plugged into cathode (black, negative) 2 cm lateral to Cz on contralateral side of head
- Constant voltage[13,25] intensity 25-100 V
- Constant current intensity[7,38] 3-20 mA
- rate is 500-900 Hz (interstimulus interval = 1.1 ms - 2.5 ms)
- number of pulses 5 - 7
- 50 µs square wave pulse for constant voltage
- 200 - 500 µs square wave pulse for constant current

Recording montage[25]:

- Subdermal needle electrodes in contralateral muscles
- Orbicularis oris
- Deltoid
- Extensor digitorum communis
- First dorsal interosseuos
- Rectus femoris
- Tibialis anterior
- Abductor hallucis
- Time Base 20 -100 ms
- Filters 100 - 3000 Hz

Technical notes:

- Stimulation intensity is increased in a stepwise manner in 5 V, or 3 mA increments until a reproducible CMAP is obtained
- The lowest stimulation thresholds are recorded for each muscle group or combination of muscle groups[25]
- Constant voltage stimulators produce a more rapid charge delivery and require a lower total charge for equivalent stimulation, as compared to constant current[9]
- The extensor digitorum communis has been found to have the highest recorded rate and requires lowest stimulation intensity vs. other muscle groups[25]
- Mapping is more consistent in upper limbs compared to lower limbs and facial muscles[25]
- Patients with cortical dysplasia/tuberous sclerosis have higher stimulation thresholds[25]
- Higher stimulation thresholds are required in children compared to adults, and reliable CMAP responses may not be obtainable in children younger than 6 years[17].
- **Cold irrigation must be available and ready to use in the event of an induced seizure**

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2. Cortical Monitoring

Cortical monitoring is executed intra-operatively prior to, during, and after the resection of the epileptogenic zone. The goal is to reduce the risk of iatrogenic injury during the resection by preserving motor and sensory function. The monitoring modalities used are SEPs, tceMEPs, DCS using recurrent high frequency HF-TOF stimulation, and, if needed, subcortical stimulation of white matter.

a. Somatosensory Evoked Potentials

SEPs are utilized as an intraoperative monitoring tool to assess the functional status of the somatosensory pathway and reduce the risk of iatrogenic injury during resection. A comprehensive review of the underlying neuroanatomy and physiology, as well as a detailed review of the stimulation and recording settings in the neurosurgical setting is readily available in the literature1,[19,24,27-29,47]. A brief overview of the technical components is listed below.

Stimulation montage:

- median n. or ulnar n. at the wrist contralateral to tested hemisphere
- posterior tibial nerve at the medial malleolus
- anode placed 2-3 cm distal to the cathode
- intensity is supra-maximal at 15-20 mA for the upper extremities and 30-40 mA for the lower extremities with observable twitch
- rate is 4-5 Hz and can be lowered to 1-3 Hz for children under 3 years of age
- pulse duration is 200-300 μs

Recording montage:

- Channel 1: Cspine-Fz
- Channel 2: Cp3-Fz
- Channel 3: Cp3-Cp4
- Channel 4: Cp4-Fz
- Channel 5: Cp4-Cp3
- Filter settings at 30-500 Hz. (Reduce HFF to eliminate high frequency artifact)
- Time base 50 ms – 100 ms
- 100 trials or until waveforms are clearly identifiable
- Test must be reproducible

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Interpretation of Changes

- At present there is no definite criterion for when to consider SEP changes significant with regard to impending neural impairment.
- Generally a 50% drop in amplitude and a 10% increase in latency have been considered as alarm criterion.
- Normal fluctuations, technical conditions, the influence of systemic factors such as anaesthesia and blood pressure, temperature, and interindividual differences must be taken into consideration when interpreting SEP changes.
- Some of the variability in SEP fluctuations may be reduced by obtaining a post-induction baseline, and using a total-intravenous anaesthesia (TIVA).
- Baseline values may also be updated after the craniotomy is complete and just prior to cortical resection.
- **SEP changes that exceed the alert criterion must be reported to the surgeon after all technical and systemic causes have been ruled out.**

b. Trans Cranial Electric Motor Evoked Potentials

TceMEPs are utilized as an intraoperative monitoring tool to assess the functional status of the corticospinal pathway and reduce the risk of iatrogenic injury during the resection. TceMEP allows ongoing assessment of motor tract function during the complete operative procedure. TceMEP is utilized when direct cortical stimulation using recurrent HF-TOF stimulation is not available, including the exposure and closure of the surgical site.

A comprehensive review of the underlying neuroanatomy and physiology, as well as a detailed review of the stimulation and recording settings in the neurosurgical setting is readily available in the literature [10,21,22,46,50]. The technical components are similar to direct cortical stimulation (see above) with the following modifications;

Stimulation montage:

- Needle or cork screw electrodes inserted 2-3 cm on each side of Cz (C1-C2) and slightly anterior
- Anodal stimulation produces responses from contralateral muscle groups
- Constant voltage intensity 200-500 V.

Recording montage:

- Similar to DCS (see above).

Technical notes:

- Stimulation intensity is increased in a stepwise manner until reproducible MEPs are obtained from all muscle groups.
- Stimulating electrode position on side of surgery may need to be modified due to the incision site.

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- Excessive stimulation artifact may contaminate muscle groups such as orbicularis oris.

Interpretation of Changes

- Inter-trial variability makes the interpretation of tceMEPs somewhat more complicated than the interpretation of SEPs.
- Unlike spinal cord monitoring, the all-or-none criterion cannot be used during supratentorial surgery[23,43].
- Irreversible MEP deterioration without loss and reversible changes could be associated with new paresis[23,43].
- Normal fluctuations, technical conditions, the influence of systemic factors such as anaesthesia and blood pressure, temperature, and inter-individual differences must be taken into consideration when interpreting MEP changes.
- Some of the variability in tceMEP fluctuations may be reduced by obtaining a post induction baseline, and using a TIVA.
- **Any change, particularly amplitude or morphology, unexplained by systemic or anaesthetic effects exceeding the baseline variability, should be reported to the surgeon.**

c. Recurrent HF-TOF Stimulation and Subcortical Stimulation

Continuous monitoring of the motor pathways should be employed using recurrent HF- TOF stimulation once cortical mapping is complete just prior to the onset of the resection. The stimulus and recording parameters are similar to the DCS mapping parameters (see above), with the following modifications;

Stimulation montage[25,38,41]:

- Anodal stimulation is applied through the same 1x4 subdural strip electrode used to obtain phase reversal SPEs.
- The strip electrode is placed over region which produced the lowest stimulation thresholds during DCS mapping.
- Stimulation can be applied through 1 or up to all 4 contacts if needed, resulting in a wider coverage of the motor homunculus.
- **Stimulation is applied through each contact every 2-5 seconds.**
- Stimulation through each contact should be increased in a stepwise manner until clearly identifiable and reproducible responses are obtained from facial, upper, and lower extremity muscles.

Recording montage:

- Similar to DCS (see above).

Interpretation of Changes

- Similar to tceMEPs (see above).
- The stimulating strip should be checked to make sure it has not shifted

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- **Any changes in amplitude or waveform morphology coinciding with the use of the bipolar cautery or CUSA should be paid special attention to. These changes could be due to a transfer of heat or ultrasonic energy indicating close proximity to the corticospinal tracts.**
- **Once all technical, systemic, and changes due to normal trial-to-trial variation have been ruled out, subcortical stimulation may be performed in the resection cavity where changes occurred.**
- Subcortical stimulation uses similar monopolar stimulation[45] and recording parameters as DCS mapping (see above). Subcortical stimulation with a monopolar probe and a multipulse stimulation is most efficient for the purpose of identifying the corticospinal tract[45].
- Triggering CMAPs during subcortical stimulation with thresholds > 3 mA are not associated with a significant new motor deficits[26,32,37].
- It has been shown that for each 1 mA of stimulation required to elicit a CMAP the proximity of the corticospinal tracts to the monopolar stimulator increases by 1 mm[32,37]. Therefore a positive CMAP response with a stimulation intensity of 1mA indicates the corticospinal tract is 1 mm away, and so on.

Anaesthetic Considerations

- **The use of TIVA is the optimal choice for monitoring purposes.** The most common combination of intravenous agents are opioids and propofol, in conjunction with a benzodiazepine.
- Propofol causes unconsciousness by producing corticocortical inhibition, possibly by GABA mediated inhibitory interneuron activity within the cerebral cortex[3] with minimal depression of the spinal alpha motor neurons[11].
- The minimal effect of propofol on MEPs has been shown to be overcome with the use of multiple pulse stimulation[6,20,30,48]. Propofol is metabolized rapidly and has become the drug of choice during TIVA. It is an excellent drug for a tightly controlled anaesthesia.
- Combined propofol and fentanyl anesthesia has been used effectively in obtaining myogenic MEPs in infants as young as 8 to 12 months[42].
- All volatile agents produce a dose-dependant reduction in cortical SEP and MEP amplitudes and an increased in response latency[4,8,15,35].
- Anaesthetic agents alter neuronal excitability by slowing axonal conduction or impeding synaptic function[39] in the spinal cord gray matter and brain. Inhaled anaesthetics cause structural changes of the receptor or ion channels.
- It has been shown that nitrous oxide and volatile agents increase the stimulation threshold during MEP acquisition by depressing sodium currents at the nodes of Ranvier of corticospinal axons, not the neurons themselves[5].

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Safety Considerations

- Associated risks and hazards may be introduced with the repetitive application of electrically elicited transcranial or direct cortical stimulation during a surgical procedure. Some of these associated risks include tongue lacerations, scalp burns at the electrode site, movement related injuries, and intraoperative seizures.
- There has a been a total of 3 published and 26 unpublished occurrences of tongue lacerations from a total of 15000 cases (0.19%)[18]. **A soft bite block must be used to prevent these injuries from occurring.**
- Repetitive tceMEP stimulation does not appear to be associated with lowered seizure thresholds, elevated risk of cardiac arrhythmia or brain neuronal damage[36]. The series of 18,862 consecutive patients included patients with cardiac pacemakers, titanium craniotomy plates and screws, documented cardiac disease, and history of epilepsy, brain tumors, cerebral aneurysms, spinal cord tumors and tethered spinal cords, among other pathologies.
- There is a risk of twitching causing injury during neurosurgical procedures[6,14] although no injuries have been reported.
- Kindling, which refers to the induction of self perpetuating epileptic foci that has been induced by repeated electrical stimulation, can occur in certain situations, however, this is rare.
- As previously mentioned, stimulation associated seizures are reported in 1.2% with the HF TOF technique and significantly more frequently in 9.5% with the 60-Hz, Penfield technique ($p=0.001$)[44].
- Intraoperative seizures associated with transient DCS occurred in 1.6% of patients presenting with symptomatic epilepsy, and in 1.5% of patients without symptomatic epilepsy. There is no increased risk of the occurrence of stimulation-associated seizures during surgery for patients with symptomatic epilepsy compared with those patients without[44].

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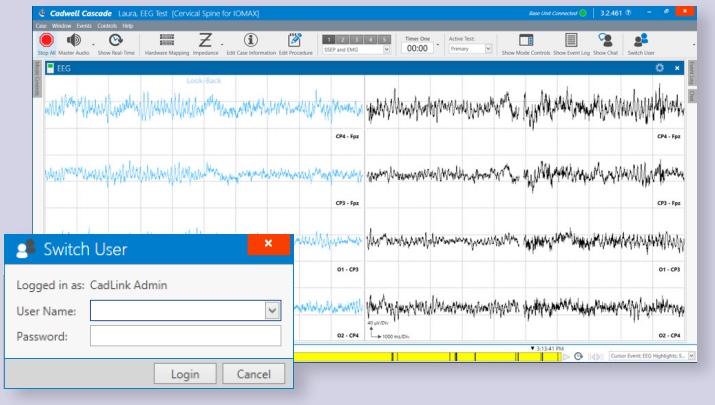

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Executive Board Elections will be held during our Annual General Meeting on Saturday, September 16th 2017 at 17:00 EDT - Pantages Hotel, Toronto, ON.

Candidates nominated for the position of President-Elect include:

- Srinivas Bulusu
- Jamie Johnston

Candidates nominated for the positions of Director (4 Positions) are:

- Peter Heyboer
- Laura Holmes
- David Houlden
- Jamie Johnston
- Susan Morris
- Francois Roy

FULL members unable to attend in person are entitled to vote by proxy. Information will be sent via email.

We encourage everyone to attend the AGM and hear more about the exciting things that have gone on in CANM over the past year and future directions.

Thank you for your support,
CANM Executive Board

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