Policies and Procedures of the Masters of Surgical Neurophysiology Program

Last Updated 3/01/2020

Here is an assortment of various policies and procedures created by the IONM program.
Policies on Advanced Placement

Master of Science in Surgical Neurophysiology

1. The program understands that employment opportunities may be offered to the students throughout the program by either neuromonitoring providers or in-house IONM entities. The employment under this circumstance does not disqualify students from participating and completing the program.

2. The employers promise the program that students are allowed to complete a minimum of 8 hours of Clinical Practicum each week during the academic semesters under the supervision of the mentors and the information regarding their case coverage will be provided to the Clinical Director of the program.

3. Students shall not be paid for the weekly 8 hours of Clinical Practicum. Receiving payments during these hours disqualify the students from continuation of their Clinical Practicum.

4. A fair interview process will be open to all the students. All students interested can apply to the program.

5. Once employed, the employer will take over the responsibilities of general and professional liabilities of the students along with assuring they are properly credentialed to enter any healthcare facility they are assigned to.

6. Students who are hired and their respective mentors need to continue to submit evaluation reports on the intervals requested by the Clinical Director of the program similar to other students that are not hired (as described in Policies and Procedures for Clinical Practicum).

7. Any corrective measure(s) that are recommended based on the students’ progress in the Clinical Practicum, need to be implemented and the evaluation of the students will be monitored by the Clinical Director of the program to assure student’s successful progression in the remainder of the program.
Criteria for Successful Completion of Each Segment of the Curriculum

Master of Science in Surgical Neurophysiology

University of Connecticut

The students in the Master of Science in Surgical Neurophysiology complete a condensed 1-year program that include four semesters: Summer Session I, Summer Session II, Fall and Spring. The criteria to pass each segment of the curriculum based on the semester is as follow:

**Summer Session I:**

Includes 3 core courses:

- PNB 5101 - Anatomy and Physiology for Intraoperative Neuromonitoring – 4 Credits
- PNB 5102 - Fundamentals of Intraoperative Neuromonitoring – 3 Credits
- PNB 5103 - Applied Intraoperative Neuromonitoring – 2 Credits

**Grading Scale:**

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<tr>
<th>Grade</th>
<th>Letter Grade</th>
<th>GPA</th>
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<td>A-</td>
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Students need to obtain a cumulative B or higher grade in the three courses (and at least B- or higher in each course individually) to be able to progress to the next semester.

**Summer Session I:**

Includes 1 core course:

- PNB 5104 - Clinical Practicum in Intraoperative Neuromonitoring (1) – 3 Credits

Students need to obtain a B or higher grade to continue in the program.
**Fall Semester:**

Includes 2 core courses:

- PNB 5104 - Clinical Practicum in Intraoperative Neuromonitoring (2) – 3 Credits
- PNB 5105 - Seminar in Intraoperative Neuromonitoring (1) – 2 Credits

And 1 or 2 of these elective courses:

- PNB 3251 - Biology of the Brain – 3 Credits
- PNB 4400 - Biology of Nervous System Diseases – 3 Credits
- PNB 5390 - Membrane Transport in Health and Disease – 3 Credits
- PNB 6418 - Integrative Neurobiology – 3 Credits

Students need to obtain a cumulative B or higher grade in the courses they take (and at least B- or higher in each course individually) to be able to progress to the next semester.

**Spring Semester:**

Includes 3 core courses:

- PNB 5104 - Clinical Practicum in Intraoperative Neuromonitoring (3) – 3 Credits
- PNB 5105 - Seminar in Intraoperative Neuromonitoring (2) – 2 Credits
- PNB 5106 - Advanced Modalities in Intraoperative Neuromonitoring – 4 Credits

And 0 or 1 of these elective courses:

- PNB 6426 - Molecular and Cellular Neurobiology – 3 Credits

Students need to obtain a cumulative B or higher grade in the courses they take (and at least B- or higher in each course individually) to be able to graduate. Total of 32 credits required for graduation.
Policies and Procedures for Clinical Practicum

Master of Science in Surgical Neurophysiology

1. All students enrolling in Clinical Practicum need to complete Criminal Background Screening, Immunizations, Drug Testing and Physical Exam as required by healthcare affiliated partners and be cleared before they can start their hospital visits.

2. If any student becomes non-compliant with the requirements mentioned at any time during the program, his/her Clinical Practicum will be halted until the requirement is satisfactory met.

3. Students need to follow any specific affiliate healthcare partners individual rules and regulations while on their facilities grounds.

4. Students must meet their assigned mentor for the day preferably one hour prior to the start of the procedure.

5. Each student is only allowed one missed clinical day each semester with prior notification to the Clinical Director of the program unless the student is ill and in that case the student with coordination with the Clinical Director will be taken out of the Clinical Practicum until the student has recovered from their illnesses.

6. Missing more than one clinical day without coordination with the Clinical Director of the program can result in failing the course and if it continues more than two clinical days, may result in disqualification from continuation of the Clinical Practicum for the semester and all the consecutive semester(s).

7. The University shall withdraw any Student from the Facility at the Facility’s request, if the Facility determines that due to health, performance, or other reasons, such Student's continued participation in the Program is detrimental to the Student, the Facility, and/or the Facility’s patients or personnel.

8. Students would need to adhere to all the recommendations provided to them by the Clinical Director of the program based on the feedback from mentors and show improvement in the deficient areas.

9. All the tasks assigned out of the Operating Room including case presentations, paper presentations, etc. need to be completed on the deadlines provided.

10. All students shall complete the program evaluation forms on a frequency recommended by the program’s Clinical Director.

11. All mentors shall complete the program evaluation forms on a frequency recommended by the program’s Clinical Director.
12. The students must not disclose any confidential material or information connected with the Facility or any of its patients, except as required by federal or State law, including the Connecticut Freedom of Information Act (FOIA). Students are required to comply with the Facility’s policy on confidentiality.

13. The students must keep all the proprietary information of the neuromonitoring providers they may be exposed to while with the mentors in the Operating Room environment confidential.

14. The students must also abide with any specific requests by the neuromonitoring providers as it relates to their activity while training under the supervision of assigned mentors by these providers.

15. In case of any needle stick incident, the students shall immediately notify the Circulating Nurse in the operating room and the program Clinical Director so appropriate follow-ups can be completed.

16. Any case of misconduct, harassment, violence, etc. occurring while on the healthcare facilities shall be reported immediately to the Clinical Director of the Program, for HR or any other UConn appropriate bodies be informed and for follow-up measures to be put in place appropriately.
Policy on Credits for Experiential Learning

Master of Science in Surgical Neurophysiology

1. The Clinical Practicum is offered over a period of 3 consecutive semesters (Summer Session II, Fall and Spring) to the students. Each semester includes 3 credits over its course.

2. Students will complete close to 250 clinical hours during these three Clinical Practicums.

3. In addition to these clinical hours, the students need to complete a variety of tasks and assignments:
   a. Participation in roundtable format Question and Answer (Q & A) sessions regarding their experience in the first few weeks of starting their clinical practicums (Summer Session II).
   b. Presenting their monitored cases to the class and responding to questions about them (Fall Semester).
   c. Presenting research articles in the field of IONM and a follow up discussion about the points made by the author(s) (Spring Semester).

4. Each student must submit an evaluation report on a weekly basis (or other intervals recommended by the Clinical Director of the program) to report their experience with their clinical training and emphasize on areas in need of improvement (either by them or by their mentors).

5. A comprehensive exam is conducted at the end of each semester that the Clinical practicum is offered. The exam not only tests the students understanding of the concepts related to IONM, but also includes testing the students’ abilities in writing protocols appropriate for modalities tested, placement of electrodes on the mannequin models and offer monitoring plans suited for different types of surgical procedures. The content of the exam will be more expansive towards the end of the program corresponding to students’ progress in the program.

6. Final grading and awarding the credits in each semester is based on successful completion of the assigned tasks, continuous participation in covering assigned surgical cases (no more than one missed day per semester with prior coordination with the Clinical Director of the program), meeting certain competency level evaluated by the mentors and successful completion of the end of the semester exam.
GRADUATE COMPETENCIES FOR PERFORMING INTRAOPERATIVE NEUROPHYSIOLOGIC MONITORING (IONM)

The Master of Science in Surgical Neurophysiology Program at the University of Connecticut Department of Physiology and Neurobiology has adopted all the guidelines set forth by the Committee on Accreditation for Education in Neurodiagnostic Technology (CoA-NDT) in Intraoperative Neurophysiological Monitoring (IONM). All the competencies recommended by the committee has been implemented in different program’s courses and students are trained throughout the program to meet the level of competencies expected.

I. GENERAL COMPETENCIES FOR IONM

A. Upon completion of the program, the graduate will have observed operating room conduct by:

1. Following standard (Universal) precautions and transmission-based precautions, observing hospital policies surrounding clothing, caps, shoe covers and masks;
2. Avoiding contamination of sterile drapes, personnel, instruments, etc. and having an understanding of the sterile field;
3. Following patient confidentiality standards as set by the Health Insurance Portability and Accountability Act (HIPAA);
4. Passing sterile electrodes to the surgical personnel in an approved sterile manner;
5. Placing bloody or contaminated items in biohazard containers and sharps in a sharps container;
6. Following hazardous material management guidelines; and
7. Complying with operating room protocols for emergency and disaster situations.

B. Upon completion of the program, the graduate will have provided a safe recording environment by:

1. Verifying identity of patient according to the National Patient Safety Standards of The Joint Commission;
2. Obtain sterile electrodes before procedure and clean or dispose of electrodes after each procedure;
3. Attending to patient needs appropriately;
4. Recognizing/responding to life-threatening situations;
5. Being certified to perform CPR;
6. Following and documenting operating room (OR) protocols for sedation;
7. Maintaining instrument/equipment in good working order;
8. Taking appropriate precautions to ensure electrical safety;
9. Understanding the underlying disease and formulating a recording strategy based on the patient’s needs during his/her responsibilities, in conjunction with a supervisor;
10. Having all equipment checked for safety annually or more frequently as indicated by written policy;
11. Maintaining individual equipment logs (safety checks, break downs, repairs, and such) as required;
12. Using general safety precautions in arranging cables and equipment to prevent injury; and
13. Always making sure a ground electrode is appropriately placed.
C. Upon completion of the program, the graduate will have prepared a basic patient information sheet that includes critical thinking regarding:

1. Patient information (name, age, ID number, doctor, etc.);
2. The name of the surgical procedure that is being performed;
3. Recording time, date, and graduate’s name or initials;
4. Noting current pertinent patient history and familial medical history; and clinical findings specific to the modality studied and/or surgical procedure;
5. Listing current medications/sedation and time of last dosage especially prior to and during surgical procedure;
6. Noting contraindications to recording modalities specifying the patient’s mental, behavioral, and consciousness states;
7. Diagramming skull defects or physical anomalies, if any, as related to stimulating for motor cortex and/or scalp;
8. Identifying any modifications in electrode placement during OR procedure;
9. Results of relevant studies i.e. in patient history; and
10. Communicating possible contra-indications to monitoring to the surgical team.

D. Upon completion of the program, the graduate will have demonstrated the following (conducted before the patient enters the Operating Room and/or during intubation and prepping):

1. Collecting patient history information (from patient, surgeon, or patient's chart as appropriate) prior to induction of the patient;
2. Establishing a monitoring plan based upon history and exam documentation and understanding patient’s conditions that may affect monitoring;
3. Following protocol based on surgical procedure and maintaining respect and patient confidentiality according to Health Information Portability and Accountability Act (HIPAA);
4. Verifying ID bracelet, patient name, birth date, type and level of procedure prior to induction of patient;
5. Accommodating monitoring techniques for disabilities and/or special needs;
6. Discussing anesthetic recommendations for monitoring per established department protocols, in a cordial manner, with anesthesia staff (this should include a discussion of the effects different types of anesthetics have on the planned monitoring);
7. Referring potential conflict between the planned anesthesia and the monitoring to the appropriate personnel;
8. Documenting all communications related to these discussions;
9. Confirming with surgeon and appropriate personnel which structures are at risk and modalities to be monitored prior to surgery;
10. Confirming with the surgeon his/her understanding of what is involved with the surgery, relaying any changes as appropriate, and documenting conversation(s) prior to induction of the patient;
11. Explaining all IONM test procedures and explains electrode application if patient is awake and signing consent per hospital policy;
12. Setting up equipment and performing calibration appropriate for equipment type prior to induction of the patient;
13. Testing equipment and checking integrity of electrodes by checking and documenting impedances;
14. Arranging head box, cables and electrodes for minimization of artifacts, and to prevent electrodes from being dislodged, dried or contaminated with fluids;
15. Recognizing and correcting malfunctions seen in calibrations;
16. Applying electrodes according to standards in E. below;
17. Discussing the need for soft padding to be placed in the mouth to prevent injury from stimulation and reaching an agreement about who will be responsible for this (graduate or anesthesiologist) per department protocols;
18. Double checking bite block prior to obtaining baselines and intermittently throughout procedure as appropriate per established department protocols;
19. Obtaining baseline recordings after induction and prior to intubation and/or positioning, and then again after positioning of the patient and/or prior to skin incision per established department protocols;  
20. Reporting baseline findings;  
21. Documenting vital signs present at time of baseline; and  
22. Assuring there is reliable communication with the supervising neurophysiologist and when remote monitoring is used, connects on-line to remote monitoring work station and assures computer dialog with appropriate personnel.

E. Upon completion of the program, the graduate will have demonstrated an electrode application method that includes:

1. measuring, marking and applying electrodes according to commonly accepted national and international standards;  
2. Cleaning and prepping patient’s skin prior to electrode application;  
3. Applying electrodes (primary and backup) and securing placement, and cleaning or disposing properly after each use;  
4. Using appropriate electrodes based on stimulus or recording sites;  
5. Adjusting electrode placement for anatomical defects or anomalies, documenting changes as appropriate for the recording or stimulation of neurophysiological data; and  
6. Applying electrodes with a method appropriate to type, site and purpose and verifying electrode impedances within the range of normal.

F. Upon completion of the program, the graduate will have reported and documented the following during the procedure:

1. Appropriate bite blocks are in place following positioning;  
2. Montage, filters, paper speed, & sensitivity setting changes;  
3. Surgical maneuvers and events;  
4. Levels of inhaled anesthetics, infusion rates of IV anesthetics, dosage of other IV medications administered, and use of muscle relaxants;  
5. Blood pressure, temperature and other physiologic parameters as appropriate per department protocols;  
6. Surgical events which may impact the results;  
7. Any special stimulation or assessment procedures;  
8. Routine communications with appropriate personnel;  
9. Changes in the monitored signals and communicates with the surgeon and supervising neurophysiologist regarding the changes, according to documented policy and procedure alarm criteria;  
10. Unexpected interruptions of monitoring for technical reasons (machine shutdowns, anesthetic levels too high, continuous use of electrocautery, artifact from C-arm, etc);  
11. All changes noted in the records including information related to the cause (technical, anesthetic, physiological, etc);  
12. ALL WARNINGS TO ATTENDING SURGEON, SURGEON REPLIES, AND CORRECTIVE ACTION TAKEN;  
13. Critical communications with anesthesia team or other OR personnel;  
14. All waveform tracings (printed and/or electronically archived - if “waterfall” display is used, each waveform must be fully visible);  
15. exact time, peak labels, latencies and amplitudes for all printed traces as dictated by department or service policies;  
16. Technical details of the monitoring according to department protocols; and  
17. Input and assistance of others, per established department protocols.

G. Upon completion of the program, the graduate will have obtained an IONM recording that includes:

1. A pre-incision anesthetized baseline;  
2. Additional baselines as may be necessary related to positioning or preintubation;
3. Continuous monitoring during the surgical procedure;
4. Periodic checks of electrode impedance;
5. Reliably interpretable waveforms which are relatively artifact free and exhibit good replication;
6. Use of appropriate recording and stimulus parameters; and
7. Obligate EP waveforms displayed according to recommended standard or policy.

H. Upon completion of the program, the graduate will have identified and eliminated/reduced artifacts contaminating the waveforms by:

1. Checking the quality of the raw signal regularly or whenever needed;
2. Understanding the meaning and significance of artifact rejection;
3. Understanding and enhancing the relationship of signal to noise ratio by various means including but not limited to increasing the number of sweeps, changing the repetition rate etc;
4. Recognizing whether the artifact is physiologic or non-physiologic;
5. Identifying source of the artifact (poor electrode application, malfunctioning stimulator, or positioning of cables) and correcting it accordingly;
6. Calculating frequency in Hz of rhythmic artifacts and understanding the effects of aliasing;
7. Proper grounding of the patient and equipment; and
8. Identifying and documents extraphysiological artifacts, ie. recording of EMG activity during IONM procedure if required.

I. Upon completion of the program, the graduate will have demonstrated customization of the recording procedure by:

1. Evaluating initial observed waveforms to assess any protocol modifications required;
2. Additional electrode derivations and other techniques as needed to enhance or clarify the waveforms as a result of changes occurring during the recording process;
3. Selecting montages appropriate for abnormalities seen and/or expected;
4. Selecting appropriate instrument settings; and
5. Applying additional electrodes to localize abnormal amplitude and frequency of activity.

J. Upon completion of the program, the graduate will have demonstrated the following at the end of the procedure:

1. Discarding disposable supplies, especially sharps and contaminated items, in an approved manner;
2. Cleaning and disinfecting equipment, cables, etc.;
3. Checking patient for burns, skin breakdown under electrode site/tape, and documenting incidents according to hospital policy and procedures;
4. Appropriately cleaning patient’s scalp, hair, and skin to remove paste or materials left from the procedure;
5. Completing the detailed test data worksheet that may include, but is not limited to:
   a. Montage;
   b. Time and voltage calibration scales;
   c. Filter settings;
   d. Side stimulated;
   e. Stimulus parameters-type, (polarity, rate, duration, delay, and, intensity);
   f. Number of trials averaged;
   g. Polarity convention;
h. Other modality-specific relevant information such as hearing thresholds, limb length and height;
i. Sedation/anesthesia and dosage; and
j. Obligate peaks with latencies and amplitudes.
6. Preparing hard copy of the waveforms if required by lab policy; and
7. Storing information on electronic media according to department policy.

II. KNOWLEDGE BASE FOR PERFORMING IONM

A. Upon completion of the program, the graduate will have explained:

1. Functional anatomy and physiology as pertains to the underlying disease process and surgical procedure being performed;
2. Medication effects on the IONM background and waveforms;
3. Medical terminology and appropriate abbreviations;
4. Signs, symptoms, and IONM correlates for common medical and surgical disorders;
5. Signs, symptoms, and IONM correlates for intraoperative neurological complications;
6. Seizure manifestations, classifications, and IONM correlates;
7. Psychiatric and psychological disorders; and
8. The availability of standards and guidelines of the ACNS, AAN or other pertinent professional organization.

B. Upon completion of the program, the graduate performing intraoperative neurophysiologic monitoring will have explained:

1. The optimal anesthetics for the modalities being monitored and preferences to be communicated effectively to the anesthesiologist documenting all communications related to these discussions;
2. The importance of effective communication among all involved personnel concerning what is involved in the surgery, what structures are at risk and documenting and appropriate communication with the supervising neurophysiologist;
3. Vital signs and other physiologic factors, and their potential effects upon the monitoring being performed;
4. The international system of electrode measurement and placement, and can demonstrate proficiency in this skill;
5. The value of preoperative testing EPs, EEG and EMG for these patients;
6. Surgical procedure being performed;
7. Critical periods during the surgery where monitoring is most crucial;
8. Structures at risk and times of greatest risk;
9. Unique surgical instrumentation and implants and their potential effects;
10. Impact of preoperative deficits and intraoperative injuries on post-operative outcomes;
11. Waveform changes generated by:
   a) Ischemia;
   b) Changes in blood pressure;
   c) Oxygen saturation;
   d) Temperature, core and limb;
   e) Technical factors and artifacts; and
   f) Anesthesia.
12. The principles of modern anesthetic techniques:
   a) How specific anesthetic agents affect central and peripheral nerve functioning;
   b) How muscle relaxants change responses, and how to monitor the level of neuromuscular blockade using a "train of four" technique;
c) How specific anesthetics change ongoing EEG;
d) How specific anesthetics change the latencies and amplitudes of evoked potentials; and
e) How the method of delivering anesthetics (inhalation, infusion, bolus injection, low flow inhalation) affects EEG and evoked potentials.

13. Inhaled anesthetic volatility and related Minimal Alveolar Concentration (MAC) values;
14. Effects of changes in concentration of volatile agents (MAC) on patient and on monitoring;
15. Interactions between nitrous oxide and other volatile anesthetics;
16. Any unstable physiological factors such as changes in CO2 and hematocrit;
17. The operating room environment:
a) Operating room etiquette;
b) The use of collodion, acetone or other flammable materials;
c) Potentially biohazardous material; and
d) Sharp electrodes.
18. Electrical safety issues related to:
a) Types of recording and stimulating electrodes;
b) Cautery units and return grounding pads;
c) Other instruments that are connected to the patient;
d) Multiple grounds; and
e) Use of new equipment in the OR (bio-med checks at individual hospitals).
19. Infection Control and Safety issues surrounding correct protocols for reusable electrode/probe sterilization requirements;
20. Effects of other equipment (blood warmers, OR table, patient warmers, electrocautery units, microscopes, etc.), on the quality of the intraoperative recording;
21. Troubleshooting; and
22. Understands general roles, responsibilities and limitations appropriate to his/her credentials.

C. Upon completion of the program, the graduate will have demonstrated an understanding of how knowledge and skills are maintained and improved by:

1. Participating in hospital in-service programs, especially post-operative review of monitored surgical cases;
2. Reviewing IONM tracings with interpreting neurophysiologist on a regular basis;
3. Reading books and journal articles related to the field of IONM;
4. Attending professional meetings and seminars;
5. Attending continuing education courses in electroneurodiagnostics and intraoperative monitoring;
6. Obtaining required continuing education credits to maintain all related current credentials in the field;
7. Pursuing opportunities to participate in outcomes studies and/or other research activities; and
8. Pursuing opportunities to participate in professional organizations.

D. Upon completion of the program, the graduate will have demonstrated a basic historic knowledge of analog NDT technology including:

1. Differential amplifier input concepts;
2. Understanding the “grid” concept with respect to anode and cathode designation; and
3. Applying positive/negative and near/far field potentials to the grid concept.
E. Upon completion of the program, the graduate will have demonstrated application of the current digital principles of electronics and mathematics to a recording by:

1. Knowing how differential amplifiers work;
2. Determining the amplitude, latency and frequency of waveforms;
3. Calculating the duration of waveforms;
4. Understanding the polarity of the waveforms;
5. Understanding impedance; and
6. Understanding analog to digital conversion and the effects of the sampling rate theory.

F. Upon completion of the program, the graduate will have recognized that digital IONM systems have preset acquisition templates and therefore will have verified the integrity of the recording system by:

1. Verifying amplifier function;
2. Verifying appropriate filter settings;
3. Verifying sensitivity settings; and
4. Correcting or reporting malfunctions or deviations as appropriate.

G. Upon completion of the program, the graduate will have stated how waveform displays are affected by:

1. Amplifier and preamplifier integrity;
2. Filter settings;
3. Amplifier gain/display gain;
4. Referential and bipolar montages;
5. Digital filters;
6. Electrode types and electrode material composition; and
7. Malfunctioning equipment.

H. Upon completion of the program, the graduate will have demonstrated recognition of:

1. Normal, abnormal and unobtainable waveforms as related to clinical symptoms and/or diagnosis;
2. Variations of waveforms specific for each age range;
3. IONM patterns for levels of consciousness; and
4. Subclinical seizure patterns.

I. Upon completion of the program, the graduate will have demonstrated the following core competencies of allied health professionalism:

1. Patient care that is compassionate, appropriate, and effective for the treatment and promotion of health;
2. Principles of professionalism as manifested through a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to patients of diverse backgrounds;
3. Interpersonal and communication skills that result in the effective exchange of information and collaboration with patients, their families, and other health professionals; and
4. Systems-based practice as manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care, including relevant state and carrier regulations, medical regulatory terminology, malpractice risks, statutory scopes of practice, The Joint Commission requirements, and legal restrictions on health care practice.
III. PERFORMANCE OF NEURODIAGNOSTIC (NDT) IONM

A. Upon completion of the program, the graduate will have stated the requirements for monitoring any surgical case based upon details obtained in Section One above.

B. Upon completion of the program, the graduate will have stated and followed technical criteria:

1. Recognizing, documenting and correcting all artifacts;
2. Recommending criteria for assessing IONM abnormalities and maturation of components;
3. Concerning the aspects, electrical hazards, & recording techniques unique to hostile environments (OR, interventional neuroradiology suites);
4. Properly grounding the patient and equipment;
5. Including IONM normative data; and
6. Including other knowledge as detailed in the ABRET NDT Technology Practice Analyses.

C. Upon graduation, the graduate will have applied the principles and concepts of NDT instrumentation to the recording by:

1. Signal averaging and noise reduction;
2. Analog to digital conversion including amplitude resolution, sampling rate, analysis time, sampling interval (dwell time), and Nyquist frequency;
3. The function of differential amplifiers including input impedance, common mode rejection, polarity convention, and gain;
4. Effects of stimulus & recording parameters on IONM waveforms;
5. The meaning and significance of artifact rejection;
6. Electrode impedance and its importance; and
7. Basic electricity and electronics concepts and electrical safety.

D. Upon graduation, the graduate will have obtained technically satisfactory recordings in each modality by:

1. Discussing anesthetic recommendations for monitoring per established department protocols, in a definitive but cordial manner, with anesthesia staff (this should include a discussion of the effects different types of anesthetics have on the planned monitoring);
2. Documenting all communications related to these discussions;
3. Understanding anatomy of IONM systems and generators of IONM components;
4. Understanding IONM correlates of certain clinical conditions such as neurologic, orthopedic, neurosurgical, and audiologic disorders;
5. Understanding pathologic and non-pathologic factors affecting IONMs;
6. Understanding the principles of stimulation and accurate placement of recording electrodes;
7. Ensuring that the averager and stimulators are correctly synchronized;
8. Establishing and documenting that stimulating parameters are within safe limits as per established department protocols;
9. Ensuring that all stimulators are correctly delivering expected stimuli to the selected side;
10. Choosing the appropriate stimulus rate and adjust as needed to reduce time-locked artifacts;
11. Obtaining clearly resolved IONM waveforms and obligate components according to recommended standard or department policy;
12. Recording at least two replications demonstrating consistency of latency and amplitude measurements;
13. Recognizing, documenting, identifying the source of, and correcting all artifacts;
14. Recognizing whether the artifact is physiologic or non-physiologic;
15. Calculating frequency in Hz of rhythmic artifacts and understanding the effects of aliasing;
16. Enhancing the signal to noise ratio by increasing the number of sweeps;
17. Applies additional electrode derivations and other techniques as needed to enhance or clarify abnormalities;
18. Checks the quality of the raw signal regularly or whenever needed;
19. Establishing baseline values prior to induction of anesthesia and positioning of the patient, if appropriate (as in cases of unstable cervical spine) and according to department protocols;
20. Monitoring continuously throughout the procedure - documenting evoked potential tracings at frequent intervals as directed by policy and procedure manuals; and
21. Performing other duties as detailed in Section One, General Competencies for IONM.

E. Upon completion of the program, the graduate will have differentiated artifacts from NDT waveforms by:

1. Recognizing possible artifactual waveforms;
2. Documenting (on the recording) patient movements;
3. Applying/recording leads for eye potentials or other physiological potentials (ie. respiration, EMG); applying/recording leads for ECG;
4. Replacing electrodes exhibiting questionable activity or contact; and
5. Troubleshooting for possible electrical interference;

F. Upon completion of the program, the graduate will have obtained a technically adequate IONM EEG by:

1. Recognizing and documenting all EEG patterns that may be seen during the monitoring, and being able to explain their relevance to the performance of IONM;
2. Establishing a preoperative, pre-anesthetic baseline if needed per department protocol;
3. Establishing a post-anesthetic baseline prior to incision and reestablishing that baseline if necessary due to anesthetic effects, prior to clamping as per department protocols;
4. Documenting blood pressure at frequent intervals and whenever there is a significant event;
5. Documenting all stages of surgery;
6. The graduate understands and follows technical criteria for:
   a. Recording neonatal and pediatric IONM EEG;
   b. Procedures associated with cardiovascular surgery; and
   c. Procedures associated with sonography.
7. Establishing electrocorticography (EcoG) and subdural/depth electrode placement/recording by:
   a. Understanding placement of electrodes and sterile method of transfer of connector cables from surgeon or to scrub nurse or coordinator;
   b. Connecting cables and creating or identifying montages to record field;
   c. Adjusting sensitivity parameters appropriately;
   d. Identifying and troubleshooting artifacts encountered during the recording;
   e. Recognizing and describing EEG waveforms consistent with epileptogenic foci in surgical field;
   f. Explaining cortical stimulation procedures;
   g. Correlating epileptogenic foci with neuroanatomy and clinical behaviors; and
   h. Completing procedure/paperwork and following infection control standards for electrode connector cables and other IONM equipment.
8. Completing Wada test and other radiographic/EEG procedures:
   a. Preparing equipment and supplies needed for recording in the special procedure;
b. Applying electrodes using the International 10/20 System of electrode placement based on ACNS guidelines;
c. Running a 10-minute baseline with appropriate montage and filter settings;
d. Understanding angiographic procedures prior to beginning Wada test;
e. Understanding need for prior placement of EEG scalp electrodes before procedure;
f. Understanding anesthetic injection and CNS reaction on EEG brainwaves;
g. Describing brainwave changes as neurologist or other qualified professional establishes clinical behaviors associated with memory, speech, and other neurological testing procedures;
h. Documenting clinical behaviors on EEG recording during Wada testing of left and right hemispheres;
i. Establishing baseline recordings post-Wada procedure; and
j. Completing procedure/paperwork and removing electrodes.

G. Upon completion of the program, the graduate will have recognized that Visual Evoked Potentials are not normally recorded in the operating room and obtained a technically adequate VEP if needed by:

1. Obtaining relevant ophthalmologic and neurologic history;
2. Using a montage that records responses from both hemispheres;
3. Assessing the patient’s ERG;
4. Using LED googgle stimuli in selected patients as may be appropriate;
5. Explaining the limitations of use of flash and LED stimuli; and
6. Performing other duties as detailed in Section One, General Competencies for IONM.

H. Upon completion of the program, the graduate has recorded technically adequate BAEPs by:

1. Obtaining relevant audiologic, neurologic, and/or neurosurgical history, hearing loss, ear infections, dizziness, tinnitus, etc.;
2. Assessing the patient’s ear canals;
3. Noting the results of prior hearing evaluations;
4. Documenting any existing hearing loss or condition of ear structures;
5. Using molded ear speakers or insert transducers to avoid contamination of the surgical field;
6. Using waterproof adhesive tape and/or bone wax to protect the ear speaker and ear canal from blood or fluids;
7. Choosing the appropriate montage, timebase, number of stimuli, sensitivity and band pass settings per department protocols;
8. Choosing the appropriate click polarity, rate and intensity;
9. Establishing hearing thresholds;
10. Correlating elevations in thresholds with any existing hearing loss or conditions of ear structures;
11. Expressing click intensity measures in equivalent units of dBSL, dBHL or dBSPL;
12. Using techniques to enhance wave I resolution such as an ear to ear montage derivation or using an ear canal electrode or increasing stimulus intensity;
13. Using alternating click polarity to minimize stimulus artifact, or rarefaction or condensation clicks to obtain best response as appropriate;
14. Using an appropriate stimulus intensity per department protocols;
15. Using an appropriate stimulus rate to resolve the most important BAEP components and maintaining the same rate throughout;
16. Obtaining adequate resolution of obligate waves I, III and V;
17. Measuring and calculating the absolute latencies, amplitudes, and interpeak intervals of obligate peaks at baseline.
and throughout monitoring and adjusting the baselines as necessary due to anesthetic and other physiologic changes;
18. Masking the contralateral ear with appropriate intensity, when applicable;
19. Continuously monitoring the ear ipsilateral to surgical intervention (contralateral ear monitoring is also appropriate for large posterior fossa tumors, or as a control); and
20. Performing a latency intensity series for auditory assessment in infants & other patients whenever indicated.

I. Upon completion of the program, the graduate has demonstrated an understanding of how to record direct nerve action potentials from the 8th cranial nerve simultaneously with the BAEPs during certain posterior fossa procedures by:

1. Providing the scrub nurse or coordinator for the surgeon with a sterile direct nerve electrode for placement on the exposed 8th nerve;
2. Using the same auditory clicks to stimulate the ipsilateral ear at the same intensity and stimulus rate as that used with the BAEPs;
3. Using a montage referencing the direct nerve electrode to the ipsilateral ear; and
4. Selecting appropriate time base and recording sensitivity to record these high amplitude responses according to department protocols.

J. Upon completion of the program, the graduate has recorded technically adequate SEP data by:

1. Obtaining relevant neurologic, orthopedic, and/or neurosurgical history or any other relevant pathway specific information such as the presence of peripheral neuropathy;
2. Selecting appropriate timebase, sensitivity and bandpass settings;
3. Maintaining stimulating electrode impedance equal and below 5000 ohms to assure proper stimulation and to decrease stimulus artifact;
4. Selecting current of sufficient intensity and duration to elicit a motor twitch from the appropriate areas of stimulation;
5. Using a montage that records obligate peak responses from peripheral nerve, spinal cord, sub-cortical structures and the cerebral cortex as appropriate (for example, sub-cortical responses can be used for monitoring spinal cord function, but cortical responses would be required in monitoring an aneurysm clipping) as per department protocols;
6. Recording from electrodes overlying the scalp surface, peripheral sites and from electrodes placed in the spinous process or epidural spaces, as per department protocols;
7. Calculating peripheral nerve conduction velocity;
8. Marking waveforms and calculating the absolute latencies, amplitudes and interpeak intervals at baseline and throughout the monitoring procedure as per department protocols;
9. Recording from additional electrode derivations in case of technical problems in order to allow continuous recording as per department protocols; and
10. Delivering unilateral alternating stimulation of left and right-sided nerves or on special occasions from bilateral stimulation (e.g., infants) per established protocols.

K. Upon completion of the program, the graduate has recorded technically adequate MEP data by:

1. Obtaining relevant neurologic, orthopedic, and/or neurosurgical history or any other relevant pathway specific information such as the presence of myelopathy;
2. Selecting appropriate timebase, sensitivity and bandpass settings;
3. Placing electrodes appropriately on the scalp and maintaining stimulating electrode impedance equal and below 5000
ohms to assure proper stimulation and to decrease stimulus artifact;
4. Selecting current of sufficient intensity and duration to elicit a compound muscle action potential from relevant muscle groups;
5. Adjusting stimulus parameters such as train, interstimulus interval, voltage and/or current to obtain best possible responses;
6. Using a montage that records responses from selected muscle groups appropriate for the operative levels per department protocols;
7. Marking waveforms at baseline, documenting latency and/or amplitude of response per department protocols; and
8. Marking waveforms throughout the monitoring procedure as per department protocols.

L. Upon completion of the program, the graduate has assisted with specialized training in the localization of "sensorimotor" cortex by:

1. Obtaining a pre-incision baseline with surface electrodes to confirm function of the somatosensory pathway and approximate latency of the N20 peak;
2. Selecting appropriate timebase, sensitivity and band pass settings per department protocols;
3. Selecting the appropriate stimulation site (normally, contralateral median nerve);
4. Recording from appropriate strip or grid electrodes as placed by the surgeon;
5. Preparing stimulus site to reduce stimulating electrode impedance;
6. Monitoring sub-cortical peripheral nerve site to verify stimulus effect;
7. Using a referential montage that records direct cortical responses and produces a physiologic “phase reversal”;
8. Obtaining adequate resolution of the obligate components;
9. Recording from multiple cortical sites in order to obtain adequate localization;
10. Printing out a hard copy of simultaneous or sequentially recorded responses for the purpose of studying the amplitude gradient and polarity of the responses in relation to the location of the gyri; and
11. Performing other duties as detailed in Section I.

M. Upon completion of the program, the graduate has obtained a technically adequate EMG, Evoked EMG/CMAP or Peripheral NAP by:

1. Measuring waveforms and distances used in routine nerve conduction studies;
2. Choosing the appropriate stimulator type (and recording electrode type) to be used in the sterile field if Evoked EMG/NAP responses will be utilized, based upon established department protocols: for direct peripheral nerve action potentials, this includes the use of a tripolar (+ - +) stimulating electrode, with a single ground between the tripolar stimulator and a (bipolar) recording electrode;
3. Correctly passing sterile stimulator (and reference electrode if needed) and/or recording electrodes onto field at the beginning of the procedure, and connecting it/them correctly to the monitoring equipment;
4. Choosing the appropriate muscles/nerves to be monitored based on the surgical procedure being performed per department protocols;
5. Securely applying recording electrodes that have low and balanced impedance to ensure proper recording of the muscle activity;
6. Choosing the appropriate stimulation parameters including intensity, duration, and frequency of stimulation delivery per department protocols;
7. Monitoring the ongoing EMG through a loud speaker that provides continuous auditory feedback to the surgical team per department protocols;
8. Recognizing appropriate alarm criterion and reporting and documenting alerts per department protocols;
9. Verifying the level of neuromuscular blockade through ""TOF"" monitoring throughout monitored portion of the
procedure per department protocols;
10. Recognizing pedicle screw stimulation thresholds and reporting them per department protocols; and
11. Ensuring the neuromuscular blockade is used in a limited manner consistent with policies and procedures.

N. Upon completion of the program, the graduate has obtained a technically adequate Motor Cranial Nerve recording by:

1. Applying needle, sticky pads or hook wire recording electrodes to the appropriate muscles to record spontaneous and evoked EMG responses from the specific nerves. Impedance and recording function must be tested prior to prepping and draping;
2. Ensuring the neuromuscular blockade is used in a limited manner consistent with policies and procedures;
3. Monitoring the ongoing EMG through a loud speaker that provides continuous auditory feedback to the surgical team per department protocols;
4. Providing a sterile stimulating probe of monopolar or bipolar concentric type per department protocols, when needed;
5. selecting appropriate current intensity and duration to produce a moderate muscle twitch of the muscles from the cranial nerve being stimulated being cognizant of patient safety issues, and following established department protocols; and
6. recording spontaneous free-running EMG and evoked CMAPs.

O. Upon completion of the program, the graduate has obtained technically adequate waveforms by:

1. Checking for pre-existing experiences medical conditions (i.e., indwelling devices such as pacemakers and stimulators, seizure disorder, stroke, significant head injury, intracranial metal objects such as aneurysm clips and metal plating devices, previous spinal instrumentation and motor deficits) and notifying appropriate individuals prior to obtaining baselines when these risk factors are present, per established department protocols;
2. Choosing the appropriate stimulation sites by measuring the head using the international 10/20 system of electrode placement and placing electrodes specified per department protocols;
3. Choosing the appropriate muscles to be monitored based on the surgical procedure being performed, per established department protocols;
4. Securely applying stimulating and recording electrodes that are below 5000 ohms and balanced to ensure proper recording of the muscle activity;
5. Choosing the appropriate stimulation parameters including, intensity, duration and frequency of stimulation delivery within ranges specified in approved policy and procedure manual; and
6. Ensuring the neuromuscular blockade is used in a limited manner consistent with policies and procedures.