

# **ELECTRONEURODIAGNOSTIC PROGRAM GRADUATE COMPETENCIES FOR PERFORMING INTRAOPERATIVE NEUROPHYSIOLOGICAL MONITORING PROCEDURES –ADD ON IONM**

The following graduate competencies for performing Intraoperative Neurophysiological Monitoring (IONM) are recommended as standards for the education of postsecondary students in Electroneurodiagnostic (END) programs with add on IONM. Employers can expect the graduates of CAAHEP-accredited END with add on IONM programs to be competent in the areas defined below with appropriate supervision consistent with the 1994 ACNS Guidelines for Intraoperative Monitoring of Sensory Evoked Potentials as well as any hospital credentialing and licensing requirements as may be required in the state where the surgery is occurring.

## **I. GENERAL COMPETENCIES FOR IONM**

### **A. The graduate observes operating room conduct by:**

1. Following standard 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. Passing sterile electrodes to the surgical personnel in an approved sterile manner;
4. Placing bloody or contaminated items in biohazard containers and sharps in a sharps container; and
5. Following hazardous material management guidelines;

### **B. The graduate observes electrical and general safety precautions in connecting the patient to equipment by:**

1. Using general safety precautions in handling of sharps, arranging cables and equipment to prevent injury;
2. Always making sure a ground electrode is appropriately placed; and
3. Assuring that equipment is maintained in good working order and maintenance checks are performed at least twice per year.

### **C. Before the patient enters the Operating Room and/or during intubation and prepping, the graduate:**

1. Discusses anesthetic recommendations for monitoring per established Lab 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. Refers potential conflict between the planned anesthesia and the monitoring to the appropriate personnel;
3. Documents all communications related to these discussions;
4. Confers with appropriate personnel regarding structures at risk and modalities to be monitored prior to surgery;
5. Confirms with the surgeon their understanding of what is involved with the surgery, relays any changes as appropriate, and documents conversation(s) prior to induction of the patient;
6. Collects patient history information (from patient, physician, OR staff and patient's chart as appropriate) prior to induction of the patient;
7. Verifies patient name, birth date, type and level of procedure prior to induction of patient;
8. Sets up equipment and performs calibration appropriate for equipment type prior to induction of the patient;
9. Applies electrodes (primary and backup) and secures placement;
10. Tests equipment and checks integrity of electrodes by checking and documenting impedances;
11. Arranges head box, cables and electrodes for minimization of artifacts, and to prevent electrodes from being dislodged, dried or contaminated with fluids;
12. Obtains baseline recordings prior to induction/intubation per established Lab protocols, and then again after induction of anesthesia and prior to skin incision;
13. Reports baseline findings;
14. Documents vital signs present at time of baseline; and
15. If remote monitoring is used, connects on-line to remote monitoring work station and assures computer dialog with appropriate personnel.

**D. During the procedure the graduate documents:**

1. Surgical maneuvers and events;
2. Levels of inhaled anesthetics, infusion rates of IV anesthetics, dosage of other IV medications administered, and use of muscle relaxants;
3. Blood pressure, temperature and other physiologic parameters as appropriate per Lab protocols;
4. ALL WARNINGS TO ATTENDING SURGEON, SURGEON REPLIES AND CORRECTIVE ACTION TAKEN;
5. Communications with appropriate personnel;
6. Critical communications with anesthesia team or other OR personnel;
7. All waveform tracings (printed and/or electronically archived - if "waterfall" display is used, each waveform must be fully visible);
8. Exact time, peak labels, latencies and amplitudes for all printed traces as dictated by lab or service policies; and
9. Technical summary of the monitoring according to Lab protocols.

**E. During the procedure the graduate reports and documents:**

1. Any findings and significant changes according to established Lab policy and procedures.  
**If it is not clear, or not yet clear, whether an IONM change is significant, or due to technical, anesthetic or benign cause, the graduate:**
  1. Informs the surgeon of the change and of the probability that it may be significant according to documented policy and procedure alarm criteria;
  2. Notifies the surgeon that monitoring is momentarily interrupted for technical reasons, (machine shutdowns, anesthetic levels too high, continuous use of electrocautery, artifact from C-arm, etc); and
  3. Obtains the input and assistance per established Lab protocols.

**F. At the end of the procedure the graduate:**

1. Discards disposable supplies, especially sharps and contaminated items in an approved manner;
2. cleans and disinfects equipment, cables, etc.; and
3. Checks patient for burns, skin breakdown under electrode site/tape, and documents incidents according to hospital policy and procedures.

**II. KNOWLEDGE BASE FOR PERFORMING IONM**

**A. The graduate performing intraoperative neurophysiologic monitoring understands:**

1. The need to have appropriate anesthetic for the modality being monitored and know that methods for resolving conflicts will be specified in departmental protocols;
2. The importance of effective communication among all involved personnel concerning what is involved in the surgery and what structures are at risk;
3. The importance of effective communication with appropriate personnel, per departmental protocols, and documenting not only verbal notification but also responses from the surgeon.
4. Blood pressure and other physiologic factors, and their potential effects upon the monitoring being performed;
5. The international system of electrode measurement and placement, and can demonstrate proficiency in this skill;
6. Effects of the filters and other parameters utilized during IONM;
7. The value of pre-operative (prior to day of surgery) testing EPs, EEG and EMG for these patients;
8. Surgical procedure being performed;
9. Structures at risk and times of greatest risk;
10. Unique spine instrumentation and the effect of their corrective force;
11. Critical periods during the surgery where monitoring is most crucial;
12. Anatomy and physiology of monitored pathways, including source of blood supply and generators of waveforms recorded from various electrode derivations;
13. Potential pre-operative deficits, intraoperative injuries and post-operative outcomes;
14. Waveform changes generated by:
  - a) Ischemia;
  - b) Changes in blood pressure;
  - c) Oxygen saturation;

- d) Temperature, core and limb;
- e) Artifacts; and
- f) Anesthesia;
- 15. Effects of changes in concentration of volatile agents (MAC) on patient and on monitoring;
- 16. Interactions between nitrous oxide and potent volatile anesthetics ;
- 17. Other unstable physiological factors such as changes in CO<sub>2</sub> and hematocrit;
- 18. 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;
- 19. The operating room environment:
  - a) Operating room etiquette;
  - b) The use of collodian, acetone or other flammable materials;
  - c) Potentially bio-hazardous material; and
  - d) Sharp electrodes;
- 20. 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);
- 21. Infection Control and Safety issues surrounding correct protocols for re-usable electrode/probe sterilization requirements;
- 22. Effects of other equipment (blood warmers, microscopes, etc.), on the quality of the intraoperative recording;
- 23. Troubleshooting;
- 24. Other knowledge as detailed in the ABRET Neurophysiologic Intraoperative Monitoring Practice Analysis; and
- 25. Understands general roles and responsibilities appropriate to his/her credentials.

**B. In addition, the graduate maintains and improves knowledge and skills by:**

- 1. Participating in hospital in-service programs, especially post-operative review of monitored surgical cases;
- 2. Reading books and journal articles related to IONM;
- 3. Attending professional meetings and seminars;
- 4. Obtaining required continuing education credits to maintain all related current credentials in the field;
- 5. Pursuing opportunities to participate in outcomes studies and/or other research activities; and
- 6. Pursuing opportunities to participate in professional organizations.

### **III. INTRAOPERATIVE ELECTROENCEPHALOGRAM (EEG) MONITORING**

**A. The graduate will obtain a technically satisfactory EEG recording by:**

- 1. Discussing anesthetic recommendations for monitoring per established Lab 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. Recognizing, documenting and correcting all artifacts;
- 4. Recognizing and documenting all EEG patterns that may be seen during the monitoring, and be able to explain their relevance to the performance of IONM;
- 5. Monitoring respiration, EKG, EMG and eye movements, if appropriate;
- 6. Establishing a preoperative, pre-anesthetic baseline;

7. Establishing a post-anesthetic baseline prior to incision and re-establishing that baseline if necessary due to anesthetic effects, prior to clamping as per lab protocols;
8. Documenting blood pressure at frequent intervals and whenever there is a significant event;
9. Documenting all stages of surgery; and
10. Performing other duties as detailed in Section I.

#### **IV. INTRAOPERATIVE EVOKED POTENTIAL (EP) MONITORING**

##### **A. The graduate will obtain a technically satisfactory EP recording by:**

1. Discussing anesthetic recommendations for monitoring per established Lab 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 between the monitoring team and anesthesia, surgical staff, and the surgeon;
3. Ensuring that the averager and stimulators are correctly synchronized;
4. Ensuring that all stimulators are correctly delivering expected stimuli to the selected side;
5. Choosing the appropriate stimulus rate and adjust as needed to reduce time-locked artifacts;
6. Establishing and documenting that stimulating parameters are within safe limits as per established lab protocols;
7. Recognizing, documenting and correcting all artifacts;
8. Establishing baseline values prior to induction of anesthesia and positioning of the patient, if appropriate (as in cases of unstable cervical spine);
9. Reestablishing baselines per established Lab protocols;
10. Monitoring continuously throughout the procedure - documenting evoked potential tracings at frequent intervals as directed by policy and procedure manuals; and
11. Performing other duties as detailed in Section I.

##### **B. The graduate records technically adequate SEP data by:**

1. Maintaining stimulating electrode impedance equal and below 5000 Ohms to assure proper stimulation and to decrease stimulus artifact;
2. 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 lab protocols;
3. Recording from electrodes overlying the scalp surface, peripheral sites and from electrodes placed in the spinous process or epidural spaces, as per Lab protocols;
4. Marking waveforms and calculating the absolute latencies, amplitudes and inter-peak intervals at baseline and throughout the monitoring procedure as per Lab protocols;
5. Recording from additional electrode derivations in case of technical problems in order to allow continuous recording as per Lab protocols; and
6. Delivering unilateral alternating stimulation of left and right-sided nerves or on special occasions from bilateral stimulation (e.g., infants) per established protocols.

##### **C. The graduate assists with specialized training in the localization of "sensorimotor" cortex by:**

1. Discussing anesthetic recommendations for monitoring per established Lab 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. Obtaining relevant patient history;
4. Obtaining a pre-incision baseline with surface electrodes to confirm function of the somatosensory pathway and approximate latency of the N20 peak;
5. Selecting appropriate time-base, sensitivity and band pass settings per lab protocols;
6. Selecting the appropriate stimulation site (normally, contra-lateral median nerve);
7. Recording from cotton wick, stainless steel, platinum or carbon ball electrodes or stainless steel or platinum electrodes embedded in inert Teflon or silicone sheet placed by the surgeon;
8. Preparing stimulus site to reduce stimulating electrode impedance;
9. Monitoring sub-cortical peripheral nerve site to verify stimulus effect;

10. Using a monopolar montage that records direct cortical responses and produces a "phase reversal";
11. Obtaining adequate resolution of the obligate components;
12. Recording from multiple cortical sites in order to obtain adequate localization;
13. Printing out a hard copy of simultaneous or sequentially recorded SEPs for the purpose of studying the amplitude gradient and polarity of the responses in relation to the location of the gyri; and
14. Performing other duties as detailed in Section I.

**D. The graduate obtains a technically adequate TCeMEP by:**

1. Checking for pre-existing medical conditions (i.e., indwelling devices such as pace-makers and stimulators, seizure disorder, stroke, significant head injury, intra-cranial 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 Lab protocols;
2. Discussing anesthetic recommendations for monitoring per established Lab 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);
3. Discussing the need for soft padding to be placed in the mouth to prevent injury from TCeMEP stimulation and reaching an agreement about who will be responsible for this (graduate or anesthesiologist) per lab protocols;
4. Padding mouth adequately to prevent injury and double checking prior to obtaining baselines and intermittently throughout procedure as appropriate per established Lab protocols;
5. Documenting all communications related to these discussions;
6. Choosing the appropriate stimulation sites by measuring the head using the international 10/20 system of electrode placement and placing electrodes specified per Lab protocols;
7. Applying stimulating electrodes that are below 5 K ohms and balanced;
8. Choosing the appropriate muscles to be monitored based on the surgical procedure being performed, per established lab protocols;
9. Securely applying recording electrodes that are below 5 K ohms and balanced to ensure proper recording of the muscle activity;
10. Choosing the appropriate stimulation parameters including, intensity, duration and frequency of stimulation delivery within ranges specified in approved policy and procedure manual; and
11. Performing other duties as detailed in Section I.

**E. The graduate obtains a technically adequate EMG, Evoked EMG/CMAP or Peripheral NAP by:**

1. Discussing anesthetic recommendations for monitoring per established Lab 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. 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 Lab protocols:
  - a) 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;
4. 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;
5. Choosing the appropriate muscles/nerves to be monitored based on the surgical procedure being performed per lab protocols;
6. Securely applying recording electrodes that are below 5 K ohms and balanced to ensure proper recording of the muscle activity ;
7. Choosing the appropriate stimulation parameters including, intensity, duration and frequency of stimulation delivery per Lab protocols;
8. Monitoring the ongoing EMG through a loud speaker which provides continuous auditory feedback to the surgical team per lab protocols;
9. Recognizing appropriate alarm criterion and reporting and documenting alerts per lab protocols;
10. Verifying the level of neuromuscular blockade through ""TOF"" monitoring throughout monitored portion of the procedure per lab protocols;
11. Recognizing pedicle screw stimulation thresholds and reporting them per Lab protocols; and

12. Performing other duties as detailed in Section I.

**F. The graduate records technically adequate BAEP data by:**

1. Discussing anesthetic recommendations for monitoring per established Lab 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. Documenting any existing hearing loss or condition of ear structures;
4. Using molded ear speakers or insert transducers to avoid contamination of the surgical field;
5. Requesting warm irrigation be utilized during procedure;
6. Using waterproof adhesive tape, Tegaderm and/or bone wax to protect the ear speaker and ear canal from blood or fluids;
7. Choosing the appropriate montage, time-base, number of stimuli, sensitivity and band pass settings per Lab protocols;
8. Using alternating click polarity to minimize stimulus artifact, or rarefaction or condensation clicks to obtain best response as appropriate;
9. Using an appropriate stimulus intensity per Lab protocols;
10. Using an appropriate stimulus rate to resolve the most important BAEP components and maintaining the same rate throughout;
11. Obtaining adequate resolution of obligate component(s) waves I, III and V;
12. Measuring and calculating the absolute latencies, amplitudes and inter-peak intervals of obligate peaks at base-line and throughout monitoring and adjusting the base-lines as necessary due to anesthetic and other physiologic changes;
13. Masking the contra-lateral ear with appropriate intensity, when applicable;
14. Continuously monitoring the ear ipsi-lateral to surgical intervention (contra-lateral ear monitoring is also appropriate for large posterior fossa tumors, or as a control); and
15. Performing other duties as detailed in Section I.

**G. The graduate understands 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 surgeon with a sterile direct nerve electrode for placement on the exposed 8th nerve;
2. Using the same auditory clicks to stimulate the ipsi-lateral 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 ipsi-lateral ear;
4. Selecting appropriate time base and recording sensitivity to record these high amplitude responses according to Lab protocols; and
5. Performing other duties as detailed in Section I.

**H. The graduate obtains 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 not employed during monitoring;
3. Monitoring the ongoing EMG through a loud speaker which provides continuous auditory feedback to the surgical team per lab protocols;
4. Providing a sterile stimulating probe of monopolar or bipolar concentric type per lab 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 lab protocols;
6. Recording spontaneous free-running EMG and evoked CMAPs; and
7. Performing other duties as detailed in Section I.