Anthem

Clinical UM Guideline

Subject: Intraoperative Neurophysiological Monitoring
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Description

Intraoperative neurophysiological monitoring uses recordings of the nervous system's electrical response to the stimulation of specific neural pathways (e.g., visual, motor, auditory, general sensory evoked response studies) to obtain information on the functional integrity of pathways within the nervous system during an operative procedure. This information can assist in diagnosis of a pathological process, monitor response to therapies, identify anatomical distribution of a disease process or identify neurologic compromise. This document addresses the various types of evoked response studies and their use in intraoperative neurophysiological monitoring when the monitoring is not provided by a member of the operating team. The use of neural evoked response studies for purposes other than assistance during a surgical procedure is not addressed in this document.

Note: Please see the following related documents for additional information:

- CG-MED-24 Electromyography and Nerve Conduction Studies
- CG-MED-46 Electroencephalography and Video Electroencephalographic Monitoring
- CG-MED-50 Visual, Somatosensory and Motor Evoked Potentials

Clinical Indications

Medically Necessary:

Intraoperative neurophysiological monitoring is considered **medically necessary** when ALL of the following are met:

A. The specific testing is used to monitor neural integrity during a spinal, neurologic, cranial, or vascular procedure that may compromise neurologic function; **and**
B. The specific testing is tailored to the clinical circumstances of the surgery. The following tests may be medically necessary when the neural pathway measured by the test is likely to be affected by the surgical procedure:
    1. Somatosensory-evoked potentials (SSEP);
    2. Brainstem auditory-evoked potentials (BAEPs);
    3. Electromyogram (EMG);
    4. Electroencephalogram (EEG);
    5. Electrocorticography (ECoG);
    6. Direct cortical stimulation;
    7. Nerve conduction velocity testing;
    8. Motor evoked potentials (MEP); **and**
C. The monitoring is ordered by the operating surgeon; **and**
D. The monitoring is set up and performed in the operating room by an independent technologist present at the operating site whose sole function is monitoring and transmission of data for a single case. The technologist is in continuous attendance in the operating room; **and**
E. A qualified individual (that is, a neurologist or a MD or PhD-level neurophysiologist) who is NOT a member of the surgical team, whose sole function is interpreting monitored data, performs real time monitored data interpretation; **and**
F. The surgical team (surgeon, anesthesiologist) and the monitoring team (technician, physician) have a direct, real-time communication regarding the individual's status based on data interpretation; **and**
G. The monitoring physician may work from a remote site only when an independent technologist is in continuous attendance in the operating room and has the capability for real-time communication with the supervising monitoring physician; **and**
H. The number of individuals monitored by the physician at one time should not exceed the requirements to provide adequate attention to each individual (generally 3 or fewer simultaneous cases).

Not Medically Necessary:

The following services are considered **not medically necessary** in the following situations:

- The criteria above are not met; **or**
- Intraoperative neurophysiological monitoring of visual-evoked potentials; **or**
- Intraoperative neurophysiological vestibular evoked myogenic potential testing; **or**
- With the exception of EMG during pedicle screw stimulation, intraoperative neurophysiological monitoring used during routine spinal surgeries in the absence of myelopathy or other complicating conditions that would create significant potential risk of damage to the nerve root, plexus (for example, anterior spine access through the psoas muscle) or spinal cord.

Coding

The following codes for treatments and procedures applicable to this guideline are included below for informational purposes. Inclusion or exclusion of a procedure, diagnosis or device code(s) does not constitute or imply member coverage or provider reimbursement policy. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

When services may be Medically Necessary when criteria are met:

CPT	
95829	Electrocorticogram at surgery
95940	Continuous intraoperative neurophysiology monitoring in the operating room, one on one monitoring requiring personal attendance, each 15 minutes

95941	Continuous intraoperative neurophysiology monitoring, from outside the operating room (remote or nearby) or for monitoring of more than one case while in the operating room, per hour

HCPCS

G0453	Continuous intraoperative neurophysiology monitoring, from outside the operating room (remote or nearby), per patient, (attention directed exclusively to one patient) each 15 minutes

ICD-10 Procedure

4A1004G-4A10X4G	Monitoring of central nervous electrical activity, intraoperative [by approach; includes codes 4A1004G, 4A1034G, 4A1074G, 4A1084G, 4A10X4G]
4A1104G-4A11X4G	Monitoring of peripheral nervous electrical activity, intraoperative [by approach; includes codes 4A1104G, 4A1134G, 4A1174G, 4A1184G, 4A11X4G]

ICD-10 Diagnosis

	All diagnoses

When services are Not Medically Necessary:
For the procedure codes listed above when criteria are not met or for situations designated in the Clinical Indications section as not medically necessary.

Discussion/General Information

Evoked response studies, when used during surgical procedures, monitor the nerves that are located at or pass through operative sites. The functional integrity of neurologic pathways is monitored for compromise due to significant ischemia or injury that might put the tested nerves or spinal cord at risk. Real-time intraoperative neurophysiological monitoring (IONM) can be performed with the data transmitted to an off-site monitoring center where a physician (e.g. neurophysiologist) provides interpretation and alerts the surgical team if the individual's neurological status is compromised.

The American Academy of Neurology (AAN), in its *Principles of Coding for Intraoperative Neurophysiologic Monitoring (IOM) and Testing* document (last updated in July 2018) stated that the beneficial results of IOM are realized under the following conditions in a hospital setting:

- A well-trained, experienced technologist is present at the operating site recording and monitoring a single surgical case.
- A monitoring clinical neurophysiologist supervises the technologist.
- There should be preoperative anesthesia planning and continuous communication between the anesthesiologist and the monitoring staff.
- A specifically trained technologist or non-physician monitorist should be in continuous attendance in the operating room, with the capacity (physical or electronic) of real-time communication with the supervising physician.
- Monitoring may be performed from a remote site only when a specifically trained technologist or non-physician monitorist is in continuous attendance in the operating room and has either the physical or electronic ability for prompt real-time communication with the supervising monitoring physician.

Guidance on the number of cases monitored at a given time by a supervising physician is provided in the following section of the AAN principles of coding document:

> The number of cases monitored at any one time will vary, but should not exceed the requirements for providing adequate attention to each. For example, a 2010 AAN survey of IOM practitioners shows that on average 90% of monitoring hours are spent monitoring three (3) or fewer simultaneous cases and that practitioners rarely monitor more than six (6) cases simultaneously (2010 AAN Survey of IOM Practitioners – unpublished).

In January 2018, the American Association of Neurological Surgeons/Congress of Neurological Surgeons (AANS/CNS) Joint Section on Disorders of the Spine and Peripheral Nerves published a position statement on IOM, as follows:

> Intraoperative somatosensory evoked potential (SSEP) and motor evoked potential (MEP) monitoring are commonly referred to as intraoperative monitoring (IOM). There is Level I evidence that IOM is a reliable diagnostic tool for assessment of spinal cord integrity during surgery. MEPs have been shown to be superior to SSEPs in the assessment of spinal cord integrity during surgery. Intraoperative MEPs have been shown to predict recovery in traumatic cervical spinal cord injury.
>
> There is insufficient evidence (Level III) of a therapeutic benefit of IOM during spinal surgery. While IOM is generally regarded as integral to lateral spine surgery, there is insufficient evidence to support a therapeutic benefit….
>
> There is no published data to suggest that IOM results in alterations of procedures, abortion of procedures, increased procedure/anesthesia time, increased procedural difficulty, or increased risk of needle-sticks for the operative team.
>
> IOM should be performed in procedures when the operating surgeon feels that the diagnostic information is of value, such as deformity correction, spinal instability, spinal cord compression, intradural spinal cord lesions and when in proximity to peripheral nerves or roots. Spontaneous and evoked electromyography is recommended for minimally invasive lateral retroperitoneal transpsoas approaches to the lumbar spine, and may also be of utility during pedicle screw insertion.

Evoked response studies are categorized according to the type of stimulation used:

Somatosensory-evoked potentials (SSEPs)
SSEPs are electrical waves that are generated by the response of sensory neurons to stimulation. Peripheral nerves (i.e., the median, ulnar or tibial nerve) are typically stimulated, but in some situations, the spinal cord may be stimulated directly. By stimulating the skin in various dermatomal areas, an SEP may also be recorded. This is called a dermatomal SEP or DSEP. The American Association of Electrodiagnostic Medicine's (AAEM, 1999) published guidelines: *Somatosensory Evoked Potentials: Clinical Uses* stated that, in many medical centers, SSEP monitoring during spinal surgery is standard practice and it is most commonly used in surgery for scoliosis and following spinal trauma. However, they noted that "intraoperative somatosensory evoked potentials monitoring is not of proven benefit for routine lumbar or cervical laminectomy or fusion".

A 2005 position statement from the American Society of Neurophysiological Monitoring (ASNM) on SSEPs stated:

> On the basis of current clinical literature and clinical and scientific evidence, somatosensory evoked potentials

> (SSEPs) are an established intraoperative monitoring modality for either localizing the human sensorimotor cortex or assessing the function of the somatosensory pathways during surgical procedures in the spinal cord and cerebrum. (Class II and III evidence, Type A recommendation).

In 2012, Nuwer and colleagues published an evidence review for a guideline from the American Academy of Neurology (AAN) and the American Clinical Neurophysiology Society (ACNS). The authors conducted a literature search for studies on the impact of IOM using SSEPs and/or transcranial motor-evoked potentials (MEPs) in individuals undergoing spinal surgery. A total of 12 studies were included in the review; all were case series. The studies consistently found that paraparesis, paraplegia and quadriplegia events occurred in IOM surgeries when there were evoked potential (EP) changes and none of these events occurred in IOM surgeries without EP changes. The authors concluded that IOM is effective for predicting an increased risk of adverse outcomes (paraparesis, paraplegia and quadriplegia) in individuals undergoing spinal surgery.

There are several meta-analyses on the diagnostic accuracy of SSEP for specific types of surgery. A meta-analysis by Nwachuku and colleagues (2015) identified 15 cohort studies on the diagnostic value of SSEP changes during carotid endarterectomy (CAE) for individuals with symptomatic carotid stenosis (CS). In a pooled analysis, changes in SSEPs had a mean specificity of 91% and a mean sensitivity of 58%. Individuals later found to have perioperative neurological deficits were 14 times more likely to have had changes in SSEPs during surgery.

Thurmula and colleagues (2016) evaluated studies on the diagnostic accuracy of SSEP during cerebral aneurysm clipping surgery. The authors identified 13 relevant prospective and retrospective cohort studies. The pooled sensitivity of SSEP for predicting postoperative neurological outcomes was 56.8% (95% confidence interval [CI], 44.1-68.6%) and the pooled specificity was 84.5% (95% CI, 76.3-90.3%). There was a pooled diagnostic odds ratio (DOR) for SSEP of 7.7 (95% CI, 5.1-11.8) suggesting that the odds for detecting a change in SSEP was 7 times higher in individuals with a postoperative neurological deficit than in those without a deficit.

In 2018, Azad and colleagues published a meta-analysis on the diagnostic utility of IONM for intramedullary spinal cord tumors. The authors identified 8 studies on SSEP monitoring, all of which were retrospective cohort studies. The pooled sensitivity for identifying postoperative deficits was 85% (95% CI, 75-91%) and the pooled specificity was 72% (95% CI, 57-83%). The pooled DOR for SSEP was 14.3 (95% CI, 5.47-37.3) indicating that the odds of detecting a change in SSEP was significantly higher in individuals with neurological deficits than in those without neurological deficits.

Reddy and colleagues (2021) published a meta-analysis of studies examining SSEP during cervical spinal surgery. The authors identified 23 studies with a total of 7747 individuals that met their review criteria, which was a sample size of at least 20 adults who underwent elective cervical spinal surgery. In a pooled analysis, the combined sensitivity of intraoperative SSEP changes in predicting postoperative neurological deficits was 46% (95% CI, 34.5% to 57.8%) and the combined specificity was 96.7% (95% CI, 93.9% to 98.2%). The pooled DOR was 27.32 (95% CI, 13.45 to 55.50), indicating that individuals who developed a new postoperative neurologic deficit were 27 times more likely to have had a significant change in intraoperative SSEP than individuals who did not have a postoperative neurologic deficit.

Motor-Evoked Potential Monitoring (MEP)
MEP evaluates motor pathways located in the anterolateral spinal tracts perfused by the anterior spinal artery. MEP utilizes electric or magnetic stimulation of the motor neural pathways in the brain or spinal cord. Electrical stimulation is accomplished by placement of surface or needle electrodes on the sites that innervate areas at risk during surgery. Magnetic stimulation utilizes a magnetic coil placed on the head over the motor cortex. The electromagnetic energy induces an electrical current within the brain, which in turn can stimulate the motor neurons.

The ASNM published a position statement on intraoperative MEP (MacDonald, 2013). The document included a summary recommendation that intraoperative MEPs are an established option when done by appropriately qualified personnel for:

> …localizing motor cortex, judging subcortical proximity to corticospinal tract fibers and monitoring motor pathways during surgical procedures that risk motor system injury in the brain, brainstem, spinal cord or facial nerve…

The evidence level for the recommendation was based on Class II (non-randomized studies such as cohort studies and case series) and Class III (expert opinion, historical controls and case reports) evidence.

Several meta-analyses evaluating literature on the diagnostic accuracy of MEPs for specific indications have been published. A 2016 meta-analysis (Tanaka, 2016) identified 19 studies on MEP monitoring during thoracic or thoracoabdominal aortic aneurysm (TAA/TAAA) surgery. The authors found that MEP monitoring performed well for detecting postoperative paraplegia (pooled sensitivity: 89.1%, pooled specificity, 99.3%).

In 2017, Thirumala reviewed studies on diagnostic accuracy of transcranial MEPs for detecting neurological deficits during idiopathic scoliosis correction surgery. The authors identified 12 studies, 4 prospective cohort studies and 8 retrospective cohort studies. The pooled mean specificity for detecting a neurological deficit was 91% (95% CI, 34-100%) and the pooled mean specificity was 96% (95% CI, 92-98%). The pooled DOR was 250 (95% CI, 11-5767). This indicated a large increase in the odds of observing new motor deficits in individuals with significant changes in transcranial MEP changes during idiopathic scoliosis correction surgery compared to those without significant transcranial MEP changes.

A meta-analysis published by Azad and colleagues in 2018 addressed the diagnostic utility of IONM for intramedullary spinal cord tumors. The authors identified 12 retrospective cohort studies and 1 case-control study on MEPs for monitoring intramedullary spinal cord tumors. In a pooled analysis of data from these studies, the mean sensitivity for detecting postoperative deficits was 90% (95% CI, 84-94%) and a mean specificity of 82% (95% CI, 70-90%). The pooled DOR for MEP was 55.7 (95% CI, 26.3-119.1), which indicated a substantial increase in the odds of detecting neurological deficits in individuals with a change in MEP during spinal cord surgery compared to those without MEP changes.

In 2023, Reddy and colleagues published a meta-analysis of studies on transcranial MEPs in cervical spine decompression surgery. The authors identified 19 studies that had a total of 4,608 participants. There were 119 (2.58%) postoperative neurological deficits. Overall, transcranial MEP changes had a sensitivity of 94% and a specificity of 56% for predicting neurological deficit. The pooled DOR for MEP was 19.26 (95% CI, 10.56 to 36.31).

Brainstem auditory-evoked potentials (BAEPs)
BAEPs, also known as auditory brainstem evoked responses (ABR) are generated in response to auditory clicks and can define the functional status of the auditory nerve, pons and lower midbrain.

In 2008, the ASNM published a position statement on intraoperative monitoring of auditory evoked potentials (Martin, 2008). Based on Class III evidence (see above section on MEPs), the guideline panel stated that ABR recordings are of value during surgical procedures involving the brainstem and in assessing the function of the eighth nerve during select surgical procedures in the cerebellopontine angle.

Electromyogram (EMG) Monitoring and Nerve Conduction Velocity Measurements
EMG monitoring and nerve conduction velocity measurements can be performed in the operating room and may be used to assess the status of the peripheral nerves, e.g., to identify the extent of nerve damage prior to nerve grafting or during resection of tumors. In addition, these techniques may be used during procedures adjacent to spinal nerve roots (including dorsal rhizotomy) and peripheral nerves to assess the presence of excessive traction or other impairment. Surgery in the region of cranial nerves can be monitored by electrically stimulating the proximal (brain) end of the nerve and recording via EMG in the facial or neck muscles. Thus, the monitoring is done in the direction opposite to that of sensory-evoked potentials, but the purpose is similar – to verify that the neural pathway is intact.

Placement of pedicle screws is common during spinal surgery to provide stabilization. Triggered EMG (t-EMG) can used to detect misplacement of pedicle screws that might cause neural damage. A 2015 meta-analysis by Lee and colleagues identified 11 studies on the diagnostic accuracy of t-EMG in pedicle screw placement in the lumbar and thoracic spine. Overall, studies found high specificity (low false-positive [FP] rate) and low sensitivity of t-EMG for monitoring pedicle screw placement. For surgeries in the lumbar spine, t-EMG predicted misplaced pedicle screw placement with a pooled sensitivity of 0.55 (95% CI, 0.32-0.76) and a FP rate of 0.03 (95% CI, 0.01-0.09). In the thoracic spine, the pooled sensitivity was 0.41 (95% CI, 0.14-0.74) and the FP rate was 0.05 (95% CI, 0.02-0.09).

A guideline from the ASNM on IOM of segmental spinal nerve root function addressed electronically-triggered EMG monitoring of pedicle screw placement (Leppanen, 2005). The guideline included the following recommendation on electrical stimulation:

> The use of electrical stimulation to help determine correct placement of spinal pedicle screws is a practice guideline that is of value for determining appropriate screw placement (Type C recommendation)

A Type C recommendation was defined as a positive recommendation based on strong consensus and evidence provided by expert opinion, case reports and/or non-randomized comparative studies with historical controls.

Electroencephalogram (EEG) Monitoring
EEG monitoring has been widely used to monitor cerebral ischemia secondary to carotid cross clamping during a carotid endarterectomy. EEG monitoring may identify those individuals who would benefit from the use of a vascular shunt during the procedure in order to restore adequate cerebral perfusion. Conversely, shunts, which have an associated risk of iatrogenic complications, may be avoided in those individuals in whom the EEG is normal. Similarly, EEG is used in aneurysm clipping and other procedures where cerebral ischemia is a foreseeable risk. In cases with MEP stimulation, EEG is sometimes used to monitor for complications such as seizures due to the electrical brain stimulation.

Electrocorticography (ECoG) and Direct Cortical Stimulation
ECoG and direct cortical stimulation are used to define the area of surgical resection. ECoG is a recording of the EEG directly from a surgically exposed cerebral cortex. ECoG is typically used to define the sensory cortex and to map the critical limits of a surgical resection. ECoG recordings have been most frequently used to identify epileptogenic regions for resection. Direct cortical stimulation is used in craniotomies to help identify the functional cortex, most commonly for language and motor cortex or subcortical structures. Stimulation is delivered to each area to define where the cortical function is disrupted so that key functional areas are avoided during resection.

A systematic review by Warsi and colleagues (2023) identified seven studies comparing ECoG-guided surgery and lesionectomy in individuals with medically refractory epilepsy that was associated with low-grade supratentorial intra-axial neoplasia. All studies had at least 12 months of follow-up data. In a pooled analysis of study findings, ECoG-guided surgery was associated with significantly greater postoperative seizure freedom (OR 3.95; 95% CI 2.32 to 6.72, P < .0001) than lesionectomy. A total of 85% in the ECoG-guided surgery group and 56% in the lesionectomy group were seizure-free at follow-up.

Visual-evoked potentials (VEPs)
VEPs are used to track visual signals from the retina to the occipital cortex. VEP monitoring has been used for surgery on lesions near the optic chiasm. However, VEPs are very difficult to interpret during surgery due to their sensitivity to anesthesia, temperature and blood pressure. A 2001 publication from the American Academy of Ophthalmology (AAO) stated that, in most cases VEPs are of limited clinical usefulness; use in surgery was not mentioned as one of the useful situations.

In 2021, Jashek-Amed and colleagues published a systematic review of studies evaluating VEP monitoring in individuals undergoing transsphenoidal surgery for pituitary adenoma. A total of 11 relevant studies were identified; 10 were case series and one was a cohort study comparing individuals who did and did not have VEP monitoring. The authors did not pool study findings. The sensitivity of VEPs in predicting visual function outcome, reported for 3 studies, was 25%, 88% and 100%, respectively. Specificity, reported in 7 studies, ranged from 85% to 100%. No operative complications related to intraoperative VEP monitoring were identified in the studies.

Vestibular Evoked Myogenic Potential (VEMP)
VEMP is described by Zhou and Cox (2006) as a biphasic response elicited by loud clicks or tone bursts recorded from the tonically contracted sternocleidomastoid muscle. This suggests that the VEMP is a vestibulocollic reflex whose afferent limb arises from acoustically sensitive cells in the saccule with signals conducted via the inferior vestibular nerve.

In 2017, the AAN published a practice guideline on cervical and ocular vestibular evoked myogenic potential testing (Fife, 2017). The guideline was based on a review of the literature. No RCTs were identified, and the review included nine controlled non-randomized studies. The guideline panel stated that cervical or ocular VEMP is possibly useful for distinguishing individuals with superior canal dehiscence syndrome (SCDS) from controls, that evidence is insufficient to determine whether VEMP is useful for diagnosing vestibular neuritis or Ménière disease and that it not been demonstrated that VEMP is useful for diagnosing or managing vestibular migraine. There were no recommendations related to intraoperative use of VEMP.

Definitions

Auditory evoked potential: Evoked potentials generated in the central nervous system by sound.

Brainstem auditory evoked potentials (BAEPs): Evoked potentials measured in the brainstem in response to sound.

Electrocorticography (ECoG): Direct measurement of the electrical activity of the brain using electrodes placed on the cortex.

Electroencephalogram (EEG): Measurement of the electrical activity of the brain.

Electromyogram (EMG): Measurement of electrical activity in muscle that has been electrically or neurologically stimulated.

Evoked potentials: Electrical activity evoked in one part of the nervous system through stimulation of another part of the nervous system.

Direct cortical stimulation: Application of stimulation directly to a surgically-exposed cortex.

Intraoperative: Occurring or performed during a surgical operation.

Motor evoked potentials (MEP): Electrical activity measurable in muscle in response to stimulation of the motor cortex area corresponding to that muscle.

Nerve conduction velocity test: Measurement of the speed at which a nerve impulse travels along a nerve following stimulation.

Somatosensory-evoked potentials (SSEP): Evoked potentials generated in the central nervous system by stimulation of peripheral sensory nerves.

Vestibular evoked myogenic potential (VEMP): Electrical activity in muscle (sternocleidomastoid for the cervical VEMP; inferior oblique for the ocular VEMP) generated in response to stimulation of the inner ear by sound.

Visual evoked potential (VEP): Evoked potentials generated in the central nervous system in response to light stimulus.

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Government Agency, Medical Society, and Other Authoritative Publications:

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The use of specific product names is illustrative only. It is not intended to be a recommendation of one product over another, and is not intended to represent a complete listing of all products available.

History

Status	Date	Action
Reviewed	02/15/2024	Medical Policy & Technology Assessment Committee (MPTAC) review. Updated Discussion/General Information and References sections.
Reviewed	02/16/2023	MPTAC review. Updated Rationale and References sections.
Reviewed	02/17/2022	MPTAC review. Updated Rationale and References sections.
Reviewed	02/11/2021	MPTAC review. Updated Rationale and References sections. Reformatted Coding section.
Revised	02/20/2020	MPTAC review. In bullet point E. of medically necessary statement, changed language related to qualifications of individual performing real time monitored data interpretation. Updated Rationale and References sections.
New	11/07/2019	MPTAC review. Initial document development.
