Intraoperative Neurophysiologic Monitoring

Policy Number: 7.01.58
Origination: 10/1988
Last Review: 8/2018
Next Review: 5/2019

Policy
Blue Cross and Blue Shield of Kansas City (Blue KC) will provide coverage for intraoperative neurophysiologic monitoring when it is determined to be medically necessary because the criteria shown below are met.

Note: These policy statements refer only to use of these techniques as part of intraoperative monitoring. Other clinical applications of these techniques, such as visual-evoked potentials and EMG, are not considered in this policy.

When Policy Topic is covered
Intraoperative monitoring, which includes somatosensory-evoked potentials, motor-evoked potentials using transcranial electrical stimulation, brainstem auditory-evoked potentials, EMG of cranial nerves, EEG, and electrocorticography (ECoG), may be considered medically necessary during spinal, intracranial, or vascular procedures.

Intraoperative neurophysiologic monitoring of the recurrent laryngeal nerve may be considered medically necessary in patients undergoing:

- high risk thyroid or parathyroid surgery, including:
  - total thyroidectomy
  - repeat thyroid or parathyroid surgery
  - surgery for cancer
  - thyrotoxicosis
  - retrosternal or giant goiter
  - thyroiditis

- anterior cervical spine surgery associated with any of the following increased risk situations:
  - prior anterior cervical surgery, particularly revision anterior cervical disectomy and fusion, revision surgery through a scarred surgical field, reoperation for pseudarthrosis or revision for failed fusion
  - multilevel anterior cervical disectomy and fusion
  - time consuming anterior cervical disectomy and fusion (eg, tumor)
Intraoperative neurophysiologic monitoring of the recurrent laryngeal nerve during anterior cervical spine surgery not meeting the criteria above or during esophageal surgeries is considered **investigational**.

Intraoperative monitoring of visual-evoked potentials is considered **investigational**.

Due to the lack of FDA approval, intraoperative monitoring of motor-evoked potentials using transcranial magnetic stimulation is considered **investigational**.

The billing of 95999 (unlisted code) for train-of-four neurophysiologic testing is considered investigational.

Intraoperative EMG and nerve conduction velocity monitoring during surgery on the peripheral nerves is considered **not medically necessary**. (See Considerations section for further discussion)

Note: These policy statements refer only to use of these techniques as part of intraoperative monitoring. Other clinical applications of these techniques, such as visual-evoked potentials and EMG, are not considered in this policy.

**Considerations**

Intraoperative monitoring including somatosensory-evoked potentials and motor-evoked potentials using transcranial electrical stimulation, brainstem auditory-evoked potentials, electromyography of cranial nerves, electroencephalography, and electrocorticography has broad acceptance, particularly for spine surgery and open abdominal aorta aneurysm repairs. Therefore, this evidence review focuses on monitoring of the recurrent laryngeal nerve during neck surgeries and monitoring of peripheral nerves.

Intraoperative monitoring typically is done in the operating room by a technician, with a physician as a remote backup. In some operating rooms there is a central physician monitoring room, where a physician may simultaneously monitor several cases.

Intraoperative monitoring is considered reimbursable as a separate service only when a licensed physician, other than the operating surgeon, performs the monitoring while in attendance in the operating room throughout the procedure.

Constant communication between surgeon, neurophysiologist, and anesthetist are required for safe and effective intraoperative neurophysiologic monitoring.
Implementation of a local policy on this technology may also involve discussions about credentialing of those providing the intraoperative monitoring services, as well as on-site versus remote real-time review and interpretation. Coding for intraoperative monitoring uses time-based codes; they are not based on the number (single vs. multiple) of modalities used.

### Description of Procedure or Service

<table>
<thead>
<tr>
<th>Populations</th>
<th>Interventions</th>
<th>Comparators</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| **Individuals:**  
  - Who are undergoing thyroid or parathyroid surgery who are at high risk of injury to the recurrent laryngeal nerve  
| Interventions of interest are:  
  - Intraoperative neurophysiologic monitoring  
| Comparators of interest are:  
  - Surgery without neurophysiologic monitoring  
| Relevant outcomes include:  
  - Morbid events  
  - Functional outcomes  
  - Quality of life |
| **Individuals:**  
  - Who are undergoing anterior cervical spine surgery who are at high risk of injury to the recurrent laryngeal nerve  
| Interventions of interest are:  
  - Intraoperative neurophysiologic monitoring  
| Comparators of interest are:  
  - Surgery without neurophysiologic monitoring  
| Relevant outcomes include:  
  - Morbid events  
  - Functional outcomes  
  - Quality of life |
| **Individuals:**  
  - Who are undergoing esophageal surgery  
| Interventions of interest are:  
  - Intraoperative neurophysiologic monitoring  
| Comparators of interest are:  
  - Surgery without neurophysiologic monitoring  
| Relevant outcomes include:  
  - Morbid events  
  - Functional outcomes  
  - Quality of life |
| **Individuals:**  
  - Who are undergoing surgery in proximity to a peripheral nerve  
| Interventions of interest are:  
  - Intraoperative neurophysiologic monitoring  
| Comparators of interest are:  
  - Surgery without neurophysiologic monitoring  
| Relevant outcomes include:  
  - Morbid events  
  - Functional outcomes  
  - Quality of life |

Intraoperative neurophysiologic monitoring (IONM) describes a variety of procedures that have been used to monitor the integrity of neural pathways during high-risk neurosurgical, orthopedic, and vascular surgeries. It involves the detection of electrical signals produced by the nervous system in response to sensory or electrical stimuli to provide information about the functional integrity of neuronal structures.

For individuals who are undergoing thyroid or parathyroid surgery who are at high risk of injury to the recurrent laryngeal nerve (RLN) who receive IONM, the evidence includes a large randomized controlled trial (RCT) and systematic reviews. Relevant outcomes are morbid events, functional outcomes, and quality of life. The strongest evidence on neurophysiologic monitoring is from an RCT of 1000 patients undergoing thyroid surgery. This RCT found a significant reduction in RLN injury in patients at high risk for injury. High risk in this trial was defined as surgery for cancer, thyrotoxicosis, retrosternal or giant goiter, or thyroiditis. The
high-risk category may also include patients with prior thyroid or parathyroid surgery or total thyroidectomy. A low volume of surgeries may also contribute to a higher risk for recurrent laryngeal nerve injury. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who are undergoing anterior cervical spine surgery who are at high risk of injury to the recurrent laryngeal nerve who receive IONM, the evidence includes systematic reviews of case series and cohort studies. Relevant outcomes are morbid events, functional outcomes, and quality of life. A qualitative systematic review found moderate evidence that monitoring the endotracheal cuff pressure reduced the incidence of vocal cord palsy, but there was insufficient data to recommend the routine use of EMG. A 2016 meta-analysis found a high rate of RLN injury following revision anterior cervical disectomy and fusion, but the magnitude of the problem with current surgical procedures is uncertain. No studies were identified that evaluated whether IONM reduces RLN injury in anterior cervical spine surgeries. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are undergoing esophageal surgery who receive IONM, the evidence includes a nonrandomized comparative study. Relevant outcomes are morbid events, functional outcomes, and quality of life. One nonrandomized comparative study on surgery for esophageal cancer was identified. This study is confounded because only those patients who had visual identification of the nerve underwent neurophysiologic monitoring. There is insufficient evidence to evaluate whether neurophysiologic monitoring reduces RLN injury in patients undergoing surgery for esophageal cancer. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are undergoing surgery in proximity to a peripheral nerve who receive IONM, the evidence includes case series and a controlled cohort study. Relevant outcomes are morbid events, functional outcomes, and quality of life. Surgical guidance with peripheral IONM and the predictive ability of monitoring of peripheral nerves has been reported. No prospective comparative studies were identified that assessed whether outcomes are improved with neurophysiologic monitoring. The evidence is insufficient to determine the effects of the technology on health outcomes.

Clinical input and professional society guidelines support the use of intraoperative monitoring during spinal, intracranial, or vascular procedures. There was general agreement that intraoperative monitoring of visual-evoked potentials and motor-evoked potentials (MEPs) using transcranial magnetic stimulation is investigational. It should be noted that there is controversy about the utility of IONM in some surgical procedures. Most of the literature is from Europe and the United Kingdom, and, while many articles report the sensitivity and specificity of MEPs for predicting postsurgical neurologic deficits, few articles report intraoperative interventions undertaken in response to information from monitoring.
Clinical input was also supportive of intraoperative monitoring during high-risk thyroid or parathyroid surgery, and during anterior cervical spine surgery associated with any of the following increased risk situations:

- prior anterior cervical surgery, particularly revision anterior cervical discectomy and fusion, revision surgery through a scarred surgical field, reoperation for pseudarthrosis, or revision for failed fusion
- multilevel anterior cervical discectomy and fusion
- time-consuming anterior cervical discectomy and fusion (eg, tumor)
- preexisting recurrent laryngeal nerve pathology, when there is residual function of the recurrent laryngeal nerve.

Background

**INTRAOPERATIVE NEUROPHYSIOLOGIC MONITORING**

The principal goal of intraoperative monitoring is the identification of nervous system impairment in the hope that prompt intervention will prevent permanent deficits. Correctable factors at surgery include circulatory disturbance, excess compression from retraction, bony structures, or hematomas, or mechanical stretching. The technology is continuously evolving with refinements in equipment and analytic techniques including multimodal intraoperative monitoring in which more than one technique is used and recording in which several patients are monitored under the supervision of a physician who is outside the operating room.

The different methodologies of monitoring are described below:

**Sensory-evoked Potentials**

Sensory-evoked potential describes the responses of the sensory pathways to sensory or electrical stimuli. Intraoperative monitoring of sensory-evoked potentials is used to assess the functional integrity of central nervous system (CNS) pathways during operations that put the spinal cord or brain at risk for significant ischemia or traumatic injury. The basic principles of sensory-evoked potential monitoring involve identification of a neurological region at risk, selection and stimulation of a nerve that carries a signal through the at-risk region, and recording and interpretation of the signal at certain standardized points along the pathway. Monitoring of sensory-evoked potentials is commonly used during the following procedures: carotid endarterectomy, brain surgery involving vasculature, surgery with distraction compression or ischemia of the spinal cord and brainstem, and acoustic neuroma surgery. Sensory-evoked potentials can be further broken down into the following categories according to the type of simulation used:

- Somatosensory-evoked potentials (SSEPs) are electrical waves that are generated by the response of sensory neurons to stimulation. Peripheral nerves, such as the median, ulnar, or tibial nerves are typically stimulated, but in some situations the spinal cord may be stimulated directly. Recording is done either cortically or at the level of the spinal cord above the surgical procedure. Intraoperative monitoring of SSEPs is most commonly used during orthopedic or neurologic surgery to prompt intervention to reduce surgically induced
morbidity and/or to monitor the level of anesthesia. One of the most common indications for SSEP monitoring is in patients undergoing corrective surgery for scoliosis. In this setting, SSEP monitors the status of the posterior column pathways and thus does not reflect ischemia in the anterior (motor) pathways. Several different techniques are commonly used, including stimulation of a relevant peripheral nerve with monitoring from the scalp, from interspinous ligament needle electrodes, or from catheter electrodes in the epidural space.

- Brainstem auditory-evoked potentials (BAEPs) are generated in response to auditory clicks and can define the functional status of the auditory nerve. Surgical resection of a cerebellopontine angle tumor, such as an acoustic neuroma, places the auditory nerves at risk, and BAEPs have been extensively used to monitor auditory function during these procedures.
- Visual-evoked potentials (VEPs) are used to track visual signals from the retina to the occipital cortex light flashes. VEP monitoring has been used for surgery on lesions near the optic chiasm. However, VEPs are very difficult to interpret due to their sensitivity to anesthesia, temperature, and blood pressure.

Motor-Evoked Potential Monitoring
Motor-evoked potentials (MEPs) are recorded from muscles following direct or transcranial electrical stimulation of motor cortex or by pulsed magnetic stimulation provided by a coil placed over the head. Peripheral motor responses (muscle activity) are recorded by electrodes placed on the skin at prescribed points along the motor pathways. Motor evoked potentials, especially when induced by magnetic stimulation, can be affected by anesthesia. The Digitimer electrical cortical stimulator received U.S. Food and Drug Administration (FDA) premarket approval in 2002. Devices for transcranial magnetic stimulation have not yet received approval from the FDA for this use.

Multimodal IONM, in which more than one technique is used, most commonly with SSEPs and MEPs, has also been described.

EMG (Electromyogram) Monitoring and Nerve Conduction Velocity Measurements
Electromyogram 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 around the nerve roots and around 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 monitoring is done in the direction opposite that of sensory-evoked potentials, but the purpose is similar—to verify that the neural pathway is intact.

EEG (Electroencephalogram) Monitoring
Spontaneous EEG monitoring can also be recorded during surgery and can be subdivided as follows:
EEG monitoring has been widely used to monitor cerebral ischemia secondary to carotid cross clamping during a carotid endarterectomy. EEG monitoring may identify those patients who would benefit from the use of a vascular shunt during the procedure to restore adequate cerebral perfusion. Conversely, shunts, which have an associated risk of iatrogenic complications, may be avoided in those patients in whom the EEG is normal. Carotid endarterectomy may be done with the patient under local anesthesia so that monitoring of cortical function can be directly assessed.

Electrocorticography (ECoG) is the recording of the EEG directly from a surgically exposed cerebral cortex. CoG 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. In these applications, ECoG does not constitute monitoring, per se.

Intraoperative monitoring including SSEPs and MEPs using transcranial electrical stimulation, BAEPs, EMG of cranial nerves, EEG, and ECoG, has broad acceptance, particularly for spine surgery and open abdominal aorta aneurysm repairs. These indications have long been considered standard of care, as evidenced by numerous society guidelines, including those of the American Academy of Neurology, American Association of Neurological Surgeons, Congress of Neurologic Surgeons, the American Clinical Neurophysiology Society, and the American Association of Neuromuscular & Electrodiagnostic Medicine. Therefore, this evidence review focuses on monitoring of the recurrent laryngeal nerve during neck and esophageal surgeries and monitoring of peripheral nerves.

REGULATORY STATUS
A number of electroencephalography and electromyography monitors have been cleared for marketing by the U.S. Food and Drug Administration (FDA) through the 510(k) process. FDA product code: GWQ.

Intraoperative monitoring of motor-evoked potentials using transcranial magnetic stimulation does not have FDA approval.

Rationale
This evidence review was initially created in September 1997 and updated regularly with searches of the MEDLINE database. Early literature focused on intraoperative monitoring of cranial and spinal nerves. This evidence review focuses on more recently investigated techniques, including monitoring of the recurrent laryngeal nerve (RLN) and peripheral nerves. The most recent literature review was performed through October 11, 2016.

Assessment of efficacy for therapeutic intervention involves a determination of whether the intervention improves health outcomes. The optimal study design for this purpose is a randomized controlled trial (RCT) that includes clinically relevant measures of health outcomes. Nonrandomized comparative studies and uncontrolled studies can sometimes provide useful information on health outcomes, but are prone to biases such as noncomparability of treatment groups,
placebo effect, and variable natural history of the condition. Following is a summary of the key literature to date.

**NEUROPHYSIOLOGIC MONITORING OF THE RLN DURING THYROID AND PARATHYROID SURGERY**

In 2016, Pardal-Refoyo and Ochoa-Sangrador reported a meta-analysis of injury of the recurrent laryngeal nerve (RLN) in total thyroidectomy with or without intraoperative monitoring.\(^{(8)}\) Included were 1 large (n=1000) and 1 small (n=23) RCT and 52 case series (total N=30,922 patients) that estimated risk to the RLN. Twenty-nine studies used RLN monitoring and 25 did not. The prevalence of bilateral laryngeal paralysis in patients who had RLN monitoring was lower (2.43%; 95% confidence interval [CI], 1.55% to 3.5%) compared to series that did not use monitoring (5.18%; 95% CI 2.53 to 8.7%). The absolute risk reduction was 2.75%, with a number needed to treat of 364.13.

The largest RCT of RLN neuromonitoring for thyroid surgery was reported by Barczynski et al in 2009.\(^{(9)}\) RLN monitoring was performed with electrodes in the vocal muscles through the cricothyroid ligament, which may not be the method that is currently used in the United States. In 500 patients who had thyroidectomy with only visual RLN identification, there were 38 cases of transient RLN injuries and 12 cases of permanent RLN injuries. In the 500 patients who had visualization plus RLN monitoring, there were 19 transient injuries and 8 permanent RLN injuries. The absolute risk reduction with the addition of RLN monitoring was 2.3% for RLN injury (p=0.007) and 1.9% for RLN paresis (p=0.011), with no significant difference in the prevalence of permanent RLN palsy (0.4%, p=NS). However, in high-risk patients, defined as those undergoing surgery for cancer, thyrotoxicosis, retrosternal or giant goiter, or thyroiditis, the prevalence of transient RLN paresis was 2.9% lower in in patients who had RLN monitoring (p=0.011) compared to those with only visual identification. In low-risk patients there was no significant difference in RLN injury between monitoring and no monitoring. Notably, high-risk patients with prior thyroid or parathyroid surgery were excluded from this study. A benefit of RLN monitoring has also been shown in patients undergoing high-risk total thyroidectomy.\(^{(10)}\)

**Section Summary: Neurophysiologic Monitoring of the RLN During Thyroid and Parathyroid Surgery**

The evidence on IONM of the RLN includes a large RCT and systematic reviews on thyroid and parathyroid surgery. The strongest evidence is from an RCT of 1000 patients undergoing thyroid surgery. This RCT found minimal effect of neurophysiologic monitoring overall, but a significant reduction in RLN injury in patients at high risk for injury. High risk in this study was defined as surgery for cancer, thyrotoxicosis, retrosternal or giant goiter, or thyroiditis. The high-risk category may also include patients with prior thyroid or parathyroid surgery or total thyroidectomy.
NEUROPHYSIOLOGIC MONITORING OF THE RLN DURING CERVICAL SPINE SURGERY

For anterior cervical spine surgery, a qualitative systematic review by Tan et al (2014) identified potential mechanisms for RLN injury including direct pressure on the nerve by the endotracheal tube, pinching of the nerve by the surgical retractor, overstretching of the RLN, and division of the divisions of vagus nerve. The investigators reported that the major cause of vocal cord palsy was believed to be due direct pressure by the endotracheal tube, and there was moderate evidence that monitoring the cuff pressure reduced the incidence of vocal cord palsy, but there was a paucity of trial data to recommend the routine use of electromyography (EMG). Risk factors associated with a higher rate of RLN injury were surgery at more than 3 levels and reoperation. There was poor evidence that there is an increase with the level of incision and extent of surgery (single vs multilevel) and duration of surgery.

A 2016 meta-analysis (Erwood et al) included 3 prospective cohort studies and 5 retrospective series (total N=238 patients) on RLN injury following revision anterior cervical discectomy and fusion (ACDF). RLN injury was defined as hoarseness or dysphagia, based either on patient report or evaluation by independent evaluators. Meta-analysis indicated a rate of RLN injury of 14.1% overall (95% CI, 9.8% to 19.1%). Included in the meta-analysis was a cohort study with prospective evaluation and dysphagia as a primary outcome (Lee et al, 2007). In this study, the rate of hoarseness and dysphagia was as high as 62% at 6 mos and 27.7% at 24 months. A more recent prospective study that was included in the meta-analysis is by Chen et al 2013, who reported dysphagia in 7.9% of patients. However, dysphagia was not a primary outcome in this study. The meta-analysis found evidence of publication bias, suggesting that studies which found low rates of RLN damage may not have been reported.

The RLN is not observable during anterior cervical spine surgery, so that the method of stimulating the RLN and monitoring the EMG of the vocal cord muscles is not feasible. Dimopoulis et al (2009) measured spontaneous EMG activity with electrodes embedded in the wall of the endotracheal tube to evaluate whether this method could detect RLN injury. Out of 298 patients undergoing ACDF, 14.4% showed spontaneous intraoperative EMG activity. Postoperative RLN injury was observed in 2.3% of patients, all of whom showed spontaneous EMG activity during surgery. The sensitivity of IONM to predict RLN injury was 100%, and specificity was 87%. IONM had a positive predictive value of 16% and negative predictive value of 97%. Significantly increased EMG activity was reported for patients with previous surgical procedures, multi-level procedures, longer lasting surgery, and self-retained retractors. No studies have been identified that evaluated whether increased EMG activity would lead to interventions and reduce the incidence of RLN damage. Possible distraction of the surgeons with the spontaneous EMG activity was noted.
Section Summary: Neurophysiologic Monitoring of the RLN During Cervical Spine Surgery
The evidence on IONM of the RLN in cervical spinal surgery includes a qualitative systematic review from 2014 and a meta-analysis from 2016. The qualitative review found moderate evidence that monitoring the endotracheal cuff pressure reduced the incidence of vocal cord palsy, but there was insufficient data to recommend the routine use of EMG. The 2016 meta-analysis found a high rate of RLN injury following revision ACDF, although the magnitude of the problem with current surgical procedures is uncertain. No studies were identified that evaluated whether IONM reduces RLN injury in anterior cervical spine surgeries.

NEUROPHYSIOLOGIC MONITORING OF THE RLN DURING ESOPHAGEAL SURGERY
One 2014 comparative study from Asia was identified on RLN monitoring during surgery for esophageal cancer.(16) One hundred fifteen patients with esophageal cancer were enrolled in this prospective study. In 54 patients, the left RLN was found and underwent monitoring. In the remainder (n=61), the RLN was not found. No RLN injury was found during surgery in either group, but 6 of 61 patients who did not receive monitoring had notable RLN injury identified postoperatively. It is unclear whether the difference in outcomes is due to monitoring or to the inability to identify the RLN during surgery.

Section Summary: Neurophysiologic Monitoring of the RLN During Esophageal Surgery
One nonrandomized comparative study on surgery for esophageal cancer was identified. It is confounded because only the patients who had visual identification of the nerve underwent neurophysiologic monitoring. There is insufficient evidence to evaluate whether neurophysiologic monitoring reduces RLN injury in patients undergoing surgery for esophageal cancer.

NEUROPHYSIOLOGIC MONITORING OF PERIPHERAL NERVES
Intervention during surgery was addressed by Kneist et al (2013) in a case-control study with 30 patients.(17) In patients undergoing total mesorectal excision, impaired anorectal function was observed in 1 (7%) of 15 patients who had intraoperative monitoring compared with 6 (40%) of 15 without. Kneist et al (2013) also reported on erectile function following low anterior rectal resection in a pilot study with 17 patients.(18) In this study, the combined intraoperative measurement of bladder and internal anal sphincter innervation was a strong predictor of postoperative erectile function with a sensitivity of 90%, specificity of 86%, positive predictive value of 90%, and negative predictive value of 86%. The possibility of intervention during surgery was not addressed.

A 2011 report by Clarkson et al described the use of intraoperative nerve recording for suspected brachial plexus root avulsion.(19) Included in this retrospective review were 25 consecutive patients who underwent intraoperative nerve recording during surgery for unilateral brachial plexus injury. Of 55 roots thought to be avulsed preoperatively, 14 (25%) were found to be intact with intraoperative nerve recording. Eleven of these were then used for reconstruction,
of which 9 (82%) had a positive functional outcome. Electrophysiologic monitoring has also been reported to guide selective rhizotomy for glossopharyngeal neuralgia in a series of 8 patients. (20)

Neurophysiologic monitoring of peripheral nerves has also been reported in patients undergoing orthopedic procedures including tibial/fibular osteotomies, hip arthroscopy for femoroacetabular impingement, and shoulder arthroplasty. (21-23)

Section Summary: Neurophysiologic Monitoring of Peripheral Nerves
Surgical guidance with peripheral IONM has been reported in case series and 1 case-control study. Other case series have reported on the predictive ability of monitoring of peripheral nerves. No prospective comparative studies were identified that assessed whether outcomes are improved with neurophysiologic monitoring.

SUMMARY OF EVIDENCE
For individuals who are undergoing thyroid or parathyroid surgery who are at high risk of injury to the recurrent laryngeal nerve who receive IONM, the evidence includes a large RCT and systematic reviews. Relevant outcomes are morbid events, functional outcomes, and quality of life. The strongest evidence on neurophysiologic monitoring is from an RCT of 1000 patients undergoing thyroid surgery. This RCT found a significant reduction in RLN injury in patients at high risk for injury. High risk in this study was defined as surgery for cancer, thyrotoxicosis, retrosternal or giant goiter, or thyroiditis. The high risk category may also include patients with prior thyroid or parathyroid surgery or total thyroidectomy. A low volume of surgeries may also contribute to a higher risk for recurrent laryngeal nerve injury. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who are undergoing anterior cervical spine surgery who are at high risk of injury to the recurrent laryngeal nerve who receive IONM, the evidence includes systematic reviews of case series and cohort studies. Relevant outcomes are morbid events, functional outcomes, and quality of life. A qualitative systematic review found moderate evidence that monitoring the endotracheal cuff pressure reduced the incidence of vocal cord palsy, but there was insufficient data to recommend the routine use of EMG. A 2016 meta-analysis found a high rate of RLN injury following revision anterior cervical disectomy and fusion, but the magnitude of the problem with current surgical procedures is uncertain. No studies were identified that evaluated whether IONM reduces RLN injury in anterior cervical spine surgeries. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are undergoing esophageal surgery who are at high risk of injury to the recurrent laryngeal nerve who receive IONM, the evidence includes a non-randomized comparative study. Relevant outcomes are morbid events, functional outcomes, and quality of life. One non-randomized comparative study on surgery for esophageal cancer was identified. This study is confounded because only the patients who had visual identification of the nerve underwent
neurophysiologic monitoring. There is insufficient evidence to evaluate whether neurophysiologic monitoring reduces RLN injury in patients undergoing surgery for esophageal cancer. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are undergoing surgery in proximity to a peripheral nerve who receive IONM, the evidence includes case series and a controlled cohort study. Relevant outcomes are morbid events, functional outcomes, and quality of life. Surgical guidance with peripheral IONM and the predictive ability of monitoring of peripheral nerves has been reported. No prospective comparative studies were identified that assessed whether outcomes are improved with neurophysiologic monitoring. The evidence is insufficient to determine the effects of the technology on health outcomes.

**CLINICAL INPUT**

**OBJECTIVE**
In 2017, clinical input was sought for intraoperative neurophysiologic monitoring of the recurrent laryngeal nerve (RLN) to determine whether monitoring improves health outcomes when used during cervical spine surgery.

**RESPONDENTS**
Clinical input was provided by the following medical specialty societies (listed alphabetically):
- American Academy of Neurological Surgeons and Congress of Neurological Surgeons (AANS/CNS)
- American Academy of Orthopaedic Surgeons and North American Spine Society (AAOS/NASS combined response)
- American Academy of Otolaryngology—Head and Neck Surgery (AAO-HNS)

Clinical input provided by the specialty society at an aggregate level is attributed to the specialty society. Clinical input contribution provided by a physician member designated by the specialty society is attributed to the individual physician and not a statement from the specialty society. Specialty society and physician respondents participating in the Evidence Street clinical input process provide review, input, and feedback on topics being evaluated by Evidence Street. However, participation in the clinical input process does not imply an endorsement or explicit agreement with the Evidence Opinion published by BCBSA.
CLINICAL INPUT RESPONSES

<table>
<thead>
<tr>
<th>Clinical Indication</th>
<th>Respondent</th>
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<tr>
<td>Revision anterior cervical discectomy and fusion</td>
<td>AANS/CNS</td>
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<td>Revision surgery through a scarred surgical field</td>
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<td>Reoperation for pseudarthrosis or revision for failed fusion</td>
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<td>Prior anterior cervical surgery</td>
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<td>Multilevel anterior cervical discectomy and fusion</td>
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<td>Pre-existing recurrent laryngeal nerve pathology, when there is residual function of the recurrent laryngeal nerve.</td>
<td>AAO-HNS</td>
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<td>Lower-level cervical spine surgery</td>
<td>AAO-HNS</td>
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<td>Right-sided approach</td>
<td>AAO-HNS</td>
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Would use of intraoperative neurophysiologic monitoring of the recurrent laryngeal nerve be expected to improve health outcomes by reducing nerve injury and post-operative morbidity?

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<th>Yes or No</th>
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</table>

Is the use of intraoperative neurophysiologic monitoring of the recurrent laryngeal nerve be in accordance with generally accepted medical practice?

<table>
<thead>
<tr>
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Additional Comments

- “While there is little evidence to support the use of intraoperative monitoring of the recurrent laryngeal nerve during primary anterior cervical spine surgery, it has been well-studied in soft-tissue surgery of the neck, including thyroidectomy. Given the increased difficulty, scarring and aberrant anatomy sometimes associated with revision anterior cervical surgery, we extrapolate from the available literature that monitoring of the recurrent laryngeal nerve may increase patient safety in these revision situations. Thus, each case and use of monitoring would be up to the surgeons’ discretion.” (AAOS/NASS)

- “We feel that it is generally at the surgeon’s discretion whether neurophysiologic monitoring of the recurrent laryngeal nerve is indicated in patients undergoing cervical spine surgery. As referenced above, for monitoring of the recurrent laryngeal nerve, there are certain circumstances where this nerve is at much higher risk of injury, and perhaps monitoring of this nerve may play a role in preventing injuries to it.” (AANS/CNS)

- “If there is a pre-existing injury to the RLN and there is no nerve function it would seem that monitoring that side has no value. If the included definition of RLN pathology was partial and not complete there would be value in monitoring the affected nerve. However, if they are talking about the contralateral RLN that was currently working well, the answer should be high confidence and...”
monitored in every situation. Monitoring the contralateral RLN in the presence of ipsilateral pathology would be yes with high confidence. However, monitoring the already damaged RLN would not be valuable as described above.” (AAO-HNS)

**BCBSA INTERPRETATION OF CLINICAL INPUT**
Based on clinical input, for individuals undergoing cervical spine surgery the following patient factors and/or surgical factors may be expected to increase the risk of recurrent laryngeal nerve injury.

- prior anterior cervical surgery, particularly revision anterior cervical discectomy and fusion, revision surgery through a scarred surgical field, reoperation for pseudarthrosis or revision for failed fusion;
- multilevel anterior cervical discectomy and fusion;
- time consuming anterior cervical discectomy and fusion (eg, tumor); and
- preexisting recurrent laryngeal nerve pathology, when there is residual function of the recurrent laryngeal nerve.

Thus, the use of intraoperative neurophysiologic monitoring of the recurrent laryngeal nerve during such cases of cervical spine surgery may be expected to improve health outcomes with at least intermediate or higher confidence level and may be considered reasonable in clinical practice based on the surgeon’s discretion. Clinical input supports these uses.

**SUPPLEMENTAL INFORMATION**

**CLINICAL INPUT FROM PHYSICIAN SPECIALTY SOCIETIES AND ACADEMIC MEDICAL CENTERS**
While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.

**2014 Input**
In response to requests, input was received from 5 physician specialty societies (7 responses) and 2 academic medical centers while this policy was under review in 2014. Input agreed that intraoperative monitoring with somatosensory-evoked potentials, motor-evoked potentials (MEPs) using transcranial electrical stimulation, brainstem auditory-evoked potentials, electromyography of cranial nerves, electroencephalography, or electrocorticography, may be medically necessary during spinal, intracranial, or vascular procedures. There was general agreement that intraoperative monitoring of visual-evoked potentials and MEPs using transcranial magnetic stimulation is investigational. Input was mixed on whether intraoperative neurophysiologic monitoring of peripheral nerves would be considered medically necessary. Some reviewers recommended monitoring of some peripheral nerves during spinal surgery (eg, nerve roots, percutaneous pedicle screw placement, lateral transpsoas approach to the lumbar spine). Other
reviewers suggested neurophysiologic monitoring for resection of peripheral nerve tumors or during surgery around the brachial plexus or facial/cranial nerves.

**PRACTICE GUIDELINES AND POSITION STATEMENTS**

**American Association of Neurological Surgeons and Congress of Neurological Surgeons**

A 2012 position statement on electrophysiologic monitoring during routine spinal surgery by the American Association of Neurological Surgeons (AANS) and Congress of Neurological Surgeons (CNS) stated that intraoperative electrophysiologic monitoring during spinal surgery may assist in diagnosing neurologic injury.\(^{5}\) However, AANS and CNS found no evidence that such monitoring either (1) reduces the incidence of neurologic injury or (2) mitigates the severity of it. The position offered by AANS and CNS is that routine use of intraoperative electrophysiologic monitoring is neither warranted nor recommended, although intraoperative electrophysiologic monitoring should be performed if the diagnostic information gained is of value, particularly in high-risk cases such as deformity, gross instability, navigation through or around peripheral nerves, or intramedullary procedures.

A 2014 guideline update from AANS and CNS found no evidence that would conflict with their previous recommendations for intraoperative monitoring for lumbar fusion.\(^{6,24}\) The societies found no evidence that intraoperative monitoring can prevent injury to the nerve roots. They found limited evidence that intraoperative monitoring can indicate a medial pedicle breach by a pedicle screw, but once a nerve root injury has taken place, changing the direction of the screw does not alter the outcome.

**American Association of Neuromuscular and Electrodiagnostic Medicine**

A 2013 position statement on somatosensory-evoked potentials (SSEPs) from the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) has indicated that intraoperative sensory-evoked potentials (SEPs) have demonstrated usefulness for monitoring of spinal cord, brainstem, and brain sensory tracts.\(^{7}\) AANEM stated that intraoperative SEP monitoring is indicated for selected spine surgeries in which there is a risk of additional nerve root or spinal cord injury. Indications for SEP monitoring may include, but are not limited to, complex, extensive, or lengthy procedures, and when mandated by hospital policy. However, intraoperative SEP monitoring may not be indicated for routine lumbar or cervical root decompression.

**American Clinical Neurophysiology Society**

In 2009 the American Clinical Neurophysiology Society (ACNS) published recommended standards for intraoperative neurophysiologic monitoring.\(^{4}\) Guideline 11A included the following statement:\(^{25}\):

“The monitoring team should be under the direct supervision of a physician with training and experience in NIOIOM [neurophysiologic intraoperative monitoring]. The monitoring physician should be licensed in the state and
privileged to interpret neurophysiologic testing in the hospital in which the surgery is being performed. He/she is responsible for real-time interpretation of NIOM data. The monitoring physician should be present in the operating room or have access to NIOM data in real-time from a remote location and be in communication with the staff in the operating room. There are many methods of remote monitoring, however any method used must conform to local and national protected health information guidelines. The monitoring physician must be available to be in the operating room, and the specifics of this availability (ie, types of surgeries) should be decided by the hospital credentialing committee. In order to devote the needed attention, it is recommended that the monitoring physician interpret no more than three cases concurrently.”

American Academy of Neurology
The American Academy of Neurology (AAN) published an assessment of IONM in 1990 with an evidence-based guideline update in 2012 by the AAN and ACNS.(1,2) The 1990 assessment indicated that monitoring requires a team approach with a well-trained physician-neurophysiologist to provide or supervise monitoring. Electroencephalography (EEG) monitoring is used during carotid endarterectomy or for other similar situations in which cerebral blood flow is at high risk. Electroencephalography from surgically exposed cortex can help to define the optimal limits of a surgical resection or identify regions of greatest impairment, while sensory cortex SSEPs can help to localize the central fissure and motor cortex. Auditory-evoked potentials, along with cranial nerve monitoring can be used during posterior fossa neurosurgical procedures. Spinal cord SSEPs are frequently used to monitor the spinal cord during orthopedic or neurosurgical procedures around the spinal cord, or cross-clamping of the thoracic aorta. EMG monitoring during procedures around the roots and peripheral nerves can be used to warn of excessive traction or other impairment of motor nerves. At the time of the 1990 assessment, motor-evoked potentials (MEPs) were considered investigational by many neurophysiologists. The 2012 update, which was endorsed by AANEM, concluded that the available evidence supports IONM using SSEPs or MEPs when conducted under the supervision of a clinical neurophysiologist experienced with IONM. Evidence was insufficient to evaluate IONM when conducted by technicians alone or by an automated device.

AAN published a model policy on principles of coding for IONM and testing in 2012.(26) The background section of this document has provided the following information on the value of IONM in averting neural injuries during surgery:

1. “Value of EEG Monitoring in Carotid Surgery. Carotid occlusion, incident to carotid endarterectomies, poses a high risk for cerebral hemispheric injury. EEG monitoring is capable of detecting cerebral ischemia, a serious prelude to injury. Studies of continuous monitoring established the ability of EEG to correctly predict risks of postoperative deficits after a deliberate, but necessary, carotid occlusion as part of the surgical procedure. The surgeon can respond to adverse EEG events by raising blood pressure, implanting a shunt, adjusting a poorly functioning shunt, or performing other interventions.
2. Multicenter Data in Spinal Surgeries. An extensive multicenter study conducted in 1995 demonstrated that IOM [intraoperative neurophysiologic monitoring] using SEP reduced the risk of paraplegia by 60% in spinal surgeries. The incidence of false negative cases, wherein an operative complication occurred without having been detected by the monitoring procedure, was small: 0.06%.

3. Technology Assessment of Monitoring in Spinal Surgeries. A technology assessment by the McGill University Health Center reviewed 11 studies and concluded that spinal IOM is capable of substantially reducing injury in surgeries that pose a risk to spinal cord integrity. It recommended combined SEP/MEP monitoring, under the presence or constant availability of a monitoring physician, for all cases of spinal surgery for which there is a risk of spinal cord injury.

4. Value of Combined Motor and Sensory Monitoring. Numerous studies of post-surgical paraparesis and quadriplegia have shown that both SEP and MEP monitoring had predicted adverse outcomes in a timely fashion. The timing of the predictions allowed the surgeons the opportunity to intervene and prevent adverse outcomes. The two different techniques (SEP and MEP) monitor different spinal cord tracts. Sometimes, one of the techniques cannot be used for practical purposes, for anesthetic reasons, or because of preoperative absence of signals in those pathways. Thus, the decision about which of these techniques to use needs to be tailored to the individual patient’s circumstances.

5. Protecting the Spinal Cord from Ischemia during Aortic Procedures. Studies have shown that IOM accurately predicts risks for spinal cord ischemia associated with clamping the aorta or ligating segmental spinal arteries. IOM can assess whether the spinal cord is tolerating the degree of relative ischemia in these procedures. The surgeon can then respond by raising blood pressure, implanting a shunt, re-implanting segmental vessels, draining spinal fluid, or through other interventions.

6. Value of EMG Monitoring. Selective posterior rhizotomy in cerebral palsy significantly reduces spasticity, increases range of motion, and improves functional skills. Electromyography during this procedure can assist in selecting specific dorsal roots to transect. EMG [electromyography] can also be used in peripheral nerve procedures that pose a risk of injuries to nerves.

7. Value of Spinal Monitoring using SSEP and MEPs. According to a recent review of spinal monitoring using SSEP and MEPs by the Therapeutics and Technology Assessment Subcommittee of AAN and ACNS, IOM is established as effective to predict an increased risk of the adverse outcomes of paraparesis, paraplegia, and quadriplegia in spinal surgery (4 Class I and 7 Class II studies). Surgeons and other members of the operating team should be alerted to the increased risk of severe adverse neurologic outcomes in patients with important IOM changes (Level A).”

**Limitations on Coverage**

“To derive optimal benefits from this technology, it is incumbent on the IOM team to understand the limits of the technology, listed below.

1. Use of Qualified Personnel. IOM must be furnished by qualified personnel. For instance, the beneficial results of monitoring with SSEPs demonstrated by the
1995 multicenter study (Nuwer et al, 1995) showed fewer neurologic deficits with experienced monitoring teams. While false-positive events were significant in only 1% of cases, the negative predictive value for this technique was over 99%. Thus, absence of events during monitoring signifies and assures safety of the procedure. In general, it is recommended that the monitoring team strive to optimize recording and interpreting conditions such that:

- A well-trained, experienced technologist, present at the operating site, is recording and monitoring a single surgical case; and
- A monitoring clinical neurophysiologist supervises the technologist.

2. Effects of the Depth of Anesthesia and Muscle Relaxation. The level of anesthesia may also significantly impact on the ability to interpret intraoperative studies; therefore, preoperative planning and continuous communication between the anesthesiologist and the monitoring team is expected.

3. Recording Conditions. It is also expected that a specifically trained technologist or nonphysician monitorist, preferably with credentials from the American Board of Neurophysiologic Monitoring or the American Board of Registration of Electrodiagnostic Technologists (ABRET), will be in continuous attendance in the operating room, with either the physical or electronic capability for real-time communication with the supervising physician.

4. Monitoring Necessity. Intraoperative monitoring is not medically necessary in situations where historical data and current practices reveal no potential for damage to neural integrity during surgery. Monitoring under these circumstances will exceed the patient’s medical need (Social Security Act (Title XVIII); Medicare Benefit Policy Manual).

5. Communications. Monitoring may be performed from a remote site, as long as a well-trained technologist (see detail previous discussion) is in continuous attendance in the operating room, with either the physical or electronic ability for prompt real-time communication with the supervising monitoring physician.

6. Supervision Requirements. Different levels of physician supervision apply to different kinds of IOM procedures. Code 95940 supervision require continuous physician monitoring in the operating room (OR). Code 95941 supervision require continuous physician monitoring which can be provided online or in the operating room (OR).”

**American Society of Neurophysiological Monitoring**

In 2013, the American Society of Neurophysiological Monitoring (ASNM) provided practice guidelines for the supervising professional on IONM. The ASNM 2013 position statement on intraoperative MEP monitoring included the statement that MEPs are an established practice option for cortical and subcortical mapping and for monitoring during surgeries risking motor injury in the brain, brainstem, spinal cord or facial nerve.

**National Institute for Health and Care Excellence**

The 2008 guidance from the U.K.’s National Institute for Health and Care Excellence on intraoperative nerve monitoring during thyroid surgery found no major safety concerns. In terms of efficacy, IONM may be helpful in performing more complex operations such as reoperative surgery and operations
on large thyroid glands. Therefore, it may be used with normal arrangements for consent, audit and clinical governance.

U.S. PREVENTIVE SERVICES TASK FORCE RECOMMENDATIONS
Not applicable.

MEDICARE NATIONAL COVERAGE
EEG monitoring "may be covered routinely in carotid endarterectomies and in other neurological procedures where cerebral perfusion could be reduced. Such other procedures might include aneurysm surgery where hypotensive anesthesia is used or other cerebral vascular procedures where cerebral blood flow may be interrupted."(31) Coverage determinations for other modalities were not identified.

In 2013, the Centers for Medicare and Medicaid Services (CMS) Physician Fee Schedule Final Rule discussed payment of neurophysiologic monitoring. The rule states that CPT code 95940, which is reported when a physician monitors a patient directly, is payable by Medicare. CPT code 95941, which is used for remote monitoring, was made invalid for submission to Medicare.

In the Final Rule, CMS established a HCPCS G code (see Considerations) for reporting physician monitoring performed from outside of the operating room (nearby or remotely). HCPCS code G0453 may be billed only for undivided attention by the monitoring physician to a single beneficiary (1:1 technologist:oversight physician billing), and not for simultaneous attention by the monitoring physician to more than 1 patient.(32)

ONGOING AND UNPUBLISHED CLINICAL TRIALS
Some currently unpublished trials that might influence this review are listed in Table 1.

Table 1. Summary of Key Trials

<table>
<thead>
<tr>
<th>NCT No.</th>
<th>Trial Name</th>
<th>Planned Enrollment</th>
<th>Completion Date</th>
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<tr>
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<tr>
<td>NCT02395146</td>
<td>Intra-operative Monitoring of the External Branch of the Superior Laryngeal Nerve (EBSLN) During Thyroid Surgery: Does it Improve Voice Preservation?</td>
<td>60</td>
<td>Aug 2017</td>
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<td>NCT01585727</td>
<td>Continuous Intraoperative Monitoring of the Pelvic Autonomic Nerves During Total Mesorectal Excision (TME) for the Prevention of Urogenital and Anorectal Dysfunction in Patients With Rectal Cancer (NEUROS)</td>
<td>188</td>
<td>Dec 2017</td>
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<tr>
<td>NCT01630785</td>
<td>Observation of Neurosurgical Interventions With Intraoperative Neurophysiological Monitoring IONM</td>
<td>5000</td>
<td>Dec 2023</td>
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<tr>
<td>Unpublished</td>
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<tr>
<td>NCT02187653a</td>
<td>Spine Registry Exposure for Lumbar and Cervical Surgery Utilizing IOM</td>
<td>10,000</td>
<td>Dec 2016 (unknown)</td>
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</table>

NCT: national clinical trial.
a Denotes industry-sponsored or cosponsored trial.

References:


**Billing Coding/Physician Documentation Information**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>92585</td>
<td>Auditory evoked potentials for evoked response audiometry and/or testing of the central nervous system; comprehensive</td>
</tr>
<tr>
<td>95822</td>
<td>Electroencephalogram (EEG); recording in coma or sleep only</td>
</tr>
<tr>
<td>95829</td>
<td>Electroencephogram at surgery (separate procedure)</td>
</tr>
<tr>
<td>95860</td>
<td>Needle electromyography; 1 extremity with or without related paraspinal areas</td>
</tr>
<tr>
<td>95861</td>
<td>Needle electromyography; 2 extremities with or without related paraspinal areas</td>
</tr>
<tr>
<td>95863</td>
<td>Needle electromyography; 3 extremities with or without related paraspinal areas</td>
</tr>
<tr>
<td>95864</td>
<td>Needle electromyography; 4 extremities with or without related paraspinal areas</td>
</tr>
<tr>
<td>95865</td>
<td>Needle electromyography; larynx</td>
</tr>
<tr>
<td>95866</td>
<td>Needle electromyography; hemidiaphragm</td>
</tr>
<tr>
<td>95867</td>
<td>Needle electromyography; cranial nerve supplied muscle(s), unilateral</td>
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<td>95868</td>
<td>Needle electromyography; cranial nerve supplied muscles, bilateral</td>
</tr>
<tr>
<td>95869</td>
<td>Needle electromyography; thoracic paraspinal muscles (excluding T1 or T12)</td>
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<tr>
<td>95870</td>
<td>Needle electromyography; limited study of muscles in 1 extremity or non-limb (axial) muscles (unilateral or bilateral), other than thoracic paraspinal, cranial nerve supplied muscles, or sphincters</td>
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<tr>
<td>95907</td>
<td>Nerve conduction studies; 1-2 studies</td>
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<tr>
<td>95908</td>
<td>Nerve conduction studies; 3-4 studies</td>
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<td>95909</td>
<td>Nerve conduction studies; 5-6 studies</td>
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<td>Nerve conduction studies; 11-12 studies</td>
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<tr>
<td>95913</td>
<td>Nerve conduction studies; 13 or more studies</td>
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<td>95925</td>
<td>Short-latency somatosensory evoked potential study, stimulation of any/all peripheral nerves or skin sites, recording from the central nervous system; in upper limbs</td>
</tr>
<tr>
<td>95926</td>
<td>Short-latency somatosensory evoked potential study, stimulation of any/all peripheral nerves or skin sites, recording from the central nervous system; in lower limbs</td>
</tr>
<tr>
<td>95927</td>
<td>Short-latency somatosensory evoked potential study, stimulation of any/all peripheral nerves or skin sites, recording from the central nervous system; in the trunk or head</td>
</tr>
<tr>
<td>95928</td>
<td>Central motor evoked potential study (transcranial motor stimulation); upper limbs</td>
</tr>
<tr>
<td>95929</td>
<td>Central motor evoked potential study (transcranial motor stimulation); lower limbs</td>
</tr>
<tr>
<td>95930</td>
<td>Visual evoked potential (VEP) testing central nervous system, checkerboard or flash</td>
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</tbody>
</table>
95933  Orbicularis oculi (blink) reflex, by electrodiagnostic testing
95937  Neuromuscular junction testing (repetitive stimulation, paired stimuli), each nerve, any 1 method
95938  Short-latency somatosensory evoked potential study, stimulation of any/all peripheral nerves or skin sites, recording from the central nervous system; in upper and lower limbs
95939  Central motor evoked potential study (transcranial motor stimulation); in upper and lower limbs
95940  Continuous intraoperative neurophysiology monitoring in the operating room, one on one monitoring requiring personal attendance, each 15 minutes (List separately in addition to code for primary procedure)
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 (List separately in addition to code for primary procedure)
95955  Electroencephalograph during non-cranial surgery (e.g. carotid surgery)
95999  Unlisted neurologic or neuromuscular diagnostic procedure
G0453  Continuous intraoperative neurophysiology monitoring, from outside the operating room (remote or nearby), per patient, (attention directed exclusively to one patient) each 15 minutes (list in addition to primary procedure)

**ICD10 Codes**

C41.2  Malignant neoplasm of vertebral column
C71.0-  Malignant neoplasm of brain; code range
C71.9
C72.0  Malignant neoplasm of spinal cord
C73  Malignant neoplasm of thyroid gland
C75.0  Malignant neoplasm of parathyroid gland
C79.31- Secondary malignant neoplasm of brain and cerebral meninges; code range
C79.32
D33.0-  Benign neoplasm of brain and other parts of central nervous system; code range
D33.9
D34  Benign neoplasm of thyroid gland
D35.1  Benign neoplasm of parathyroid gland
D43.0-  Neoplasm of uncertain behavior of brain and central nervous system; code range
D43.9
D44.0  Neoplasm of uncertain behavior of thyroid gland
D44.2  Neoplasm of uncertain behavior of parathyroid gland
D49.6  Neoplasm of unspecified behavior of brain
E04.0-  Other nontoxic goiter code range
E04.9
E05.00- Thyrotoxicosis code range
E05.91
E06.0-  Thyroiditis code range
E06.9
E21.0-  Hyperparathyroidism code range (E21.0 is primary hyperparathyroidism)
E2.15
I71.00-I71.9 Aortic aneurysm and dissection; code range
M50.00-M50.93 Cervical disc disorders; code range
M48.00-M48.08 Spinal stenosis; code range
M40.00-M40.57 Kyphosis and lordosis; code range
M41.00-M41.9 Scoliosis; code range
I65.01-I65.9 Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction; code range

Codes 95940 and 95941 would be reported in conjunction with the code(s) for the testing performed i.e., 92585, 95822, 95860-95870, 95907-95913, and 95925-95939.

Additional Policy Key Words
N/A

Policy Implementation/Update Information
10/1/88 New policy.
5/1/00 No policy statement changes.
5/1/01 Policy statement revised to include monitoring of motor evoked potentials within the brain and visual-evoked potentials as investigational. Monitoring of peripheral nerves during surgery is considered part of the total procedure.
5/1/02 No policy statement changes.
5/1/03 No policy statement changes.
5/1/04 No policy statement changes.
5/1/05 No policy statement changes.
5/1/06 No policy statement changes.
5/1/07 No policy statement changes.
5/1/08 No policy statement changes.
5/1/09 No policy statement changes.
5/1/10 No policy statement changes.
5/1/11 No policy statement changes.
9/1/11 Policy statements changed to indicate motor-evoked potentials using transcranial electrical stimulation may be considered medically necessary and motor-evoked potential using transcranial magnetic stimulation is investigational, other policy statements unchanged.
5/1/12 No policy statement changes.
5/1/13 No policy statement changes.
5/1/14 Added a statement in the Policy Guidelines about the associated nerve testing codes that would be reported with codes 95940 and 95941.
5/1/15 No policy statement changes.
7/1/15 No policy statement changes.
5/1/16  No policy statement changes.
5/1/17  No policy statement changes.
7/1/17  New clinical input obtained in 2017 is added regarding cervical spine surgery. Intraoperative monitoring is considered medically necessary for high risk thyroid and anterior cervical spine surgeries. Title changed to “Intraoperative Neurophysiologic Monitoring.”
5/1/18  No policy statement changes.
8/1/18  Added Investigational Statement regarding train of four neurophysiologic testing.

State and Federal mandates and health plan contract language, including specific provisions/exclusions, take precedence over Medical Policy and must be considered first in determining eligibility for coverage. The medical policies contained herein are for informational purposes. The medical policies do not constitute medical advice or medical care. Treating health care providers are independent contractors and are neither employees nor agents Blue KC and are solely responsible for diagnosis, treatment and medical advice. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, photocopying, or otherwise, without permission from Blue KC.

APPENDIX 1: CLINICAL INPUT

Appendix Table 1. Respondent Profile

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Organization / Congress of</th>
<th>Clinical Specialty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>American Academy of Neurological Surgeons / Congress of Neurological Surgeons</td>
<td>Neurosurgery</td>
</tr>
<tr>
<td>2</td>
<td>American Academy of Otolaryngology-Head and Neck Surgery</td>
<td>Otolaryngology, Head and Neck Surgery</td>
</tr>
<tr>
<td>3</td>
<td>American Academy of Orthopaedic Surgeons / North American Spine Society</td>
<td>Orthopaedic Surgery, Spine Disorders</td>
</tr>
</tbody>
</table>

Appendix Table 2. Respondent Conflict of Interest Disclosure

<table>
<thead>
<tr>
<th>No.</th>
<th>1. Research support related to the topic where clinical input is being sought</th>
<th>2. Positions, paid or unpaid, related to the topic where clinical input is being sought</th>
<th>3. Reportable, more than $1000, health care–related assets or sources of income for myself, my spouse, or my dependent children related to the topic where clinical input is being sought</th>
<th>4. Reportable, more than $350, gifts or travel reimbursements for myself, my spouse, or my dependent children related to the topic where clinical input is being sought</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>3 No</td>
<td>1 Yes = Triological Society Career Development Award recipient. Topic of research is the study of laryngeal motor neuropathy through the evaluation of transcranial magnetic stimulation-evoked myogenic potentials.</td>
<td>4 No</td>
<td>1 NR</td>
</tr>
<tr>
<td>3</td>
<td>No</td>
<td>No</td>
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</table>

No. 3  The North American Spine Society (NASS) employs rigorous checks and balances to ensure that its comments and recommendations on payors’ coverage policies/clinical evidence reports are scientifically sound and unbiased. These checks and balances include requiring all individuals involved in drafting, reviewing, revising and approving the comments to disclose any conflicts of interest he or she may have. Using an evidence-based approach when possible, the multi-disciplinary team works together to develop the comments which requires multiple levels of review. The individuals who provide the final reviews and approvals are further required to divest themselves of most financial interests in any medical industry-related concerns. For more information on NASS’ Level 1 disclosure policy, please visit NASS website.
APPENDIX 2: CLINICAL INPUT RESPONSES

Objective
Clinical input is sought for intraoperative neurophysiologic monitoring of the recurrent laryngeal nerve to determine whether monitoring improves health outcomes when used during cervical spine surgeries.

Responses

1. For patients undergoing cervical spine surgery, are there patient factors and/or surgical factors that would increase the risk of recurrent laryngeal nerve injury?

<table>
<thead>
<tr>
<th>No.</th>
<th>Yes/No</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>A meta-analysis by Erwood from 2016 was performed to determine the rate of recurrent laryngeal nerve (RLN) injuries after recurrent ACDF’s. They report a rate of RLN injury after reoperative ACDF of 14.1% (95% confidence interval [CI] 9.8%-19.1%). This number is much greater than what is reported for routine ACDF’s, and as such we must take into account that monitoring of the RLN may be indicated in patients undergoing revision ACDF procedures. Tan et al (2014 Spine J) also confirm that there is significant evidence that revision ACDF increase the risk of laryngeal palsy. An article from Dimopoulos (2009) reviewed the role of laryngeal intraoperative electromyography (IEMG) in predicting the development of postoperative recurrent laryngeal nerve (RLN) palsy in patients undergoing anterior cervical discectomy and fusion (ACDF). They found significantly increased IEMG activity in patients with previous surgical intervention, patients undergoing multilevel procedures, long-lasting procedures, and cases in which self-retained retractors were used. They therefore conclude that IEMG can provide real-time information and can potentially minimize the risk of operative RLN injury.</td>
</tr>
</tbody>
</table>

2. For each situation you described in Question 1:

a. Please fill in the first column of the table below with each indication you reported.
b. Please respond YES or NO whether the use of intraoperative neurophysiologic monitoring would be expected to improve health outcomes by reducing nerve injury and postoperative morbidity.
c. Please use the 1 to 5 scale outlined below to indicate your level of confidence that there is adequate evidence that supports your conclusions.
3. For each situation you described in Question 1:
   a. Please fill in the first column of the table below with each indication you reported.
   b. Please respond YES or NO whether this clinical use is in accordance with generally accepted medical practice.
   c. Please use the 1 to 5 scale outlined below to indicate your level of confidence that this clinical use is in accordance with generally accepted medical practice.

<table>
<thead>
<tr>
<th>No.</th>
<th>Fill in the blanks below with each indication you reported in Question 1</th>
<th>Yes/No</th>
<th>Low Confidence</th>
<th>Intermediate Confidence</th>
<th>High Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Revision anterior cervical discectomy and fusion</td>
<td>Yes</td>
<td>1</td>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td>1</td>
<td>Multilevel anterior cervical discectomy and fusion</td>
<td>Yes</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Time consuming anterior cervical discectomy and fusion (eg, tumor)</td>
<td>Yes</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Revision surgery through a scarred surgical field</td>
<td>Yes</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Preexisting recurrent laryngeal nerve pathology</td>
<td>Yes</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lower level cervical spine surgery</td>
<td>Yes</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Right-sided approach</td>
<td>Yes</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Prior anterior cervical surgery</td>
<td>Yes</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Reoperation for pseudarthrosis or revision for failed fusion</td>
<td>Yes</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

4. Additional comments and/or any citations supporting your clinical input on the clinical use of intraoperative neurophysiologic monitoring in patients undergoing cervical spine surgery.

<table>
<thead>
<tr>
<th>No.</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>We feel that it is generally at the surgeon's discretion whether neurophysiologic monitoring of the recurrent laryngeal nerve is indicated in patients undergoing cervical spine surgery. As referenced above, for monitoring of the recurrent laryngeal nerve, there are certain circumstances where this nerve is at much higher risk of injury, and perhaps monitoring of this nerve may play a role in preventing injuries to it.</td>
</tr>
<tr>
<td></td>
<td>On the broader topic of general intraoperative neurophysiologic monitoring in patients undergoing cervical spine surgery, the AANS has made guidelines as follows:</td>
</tr>
<tr>
<td></td>
<td>Multimodality intraoperative monitoring (IOM), including somatosensory evoked potentials (SSEP) and motor evoked potentials (MEP) recording during spinal cord/spinal column surgery is a reliable and valid diagnostic adjunct to assess spinal cord integrity and is recommended if utilized for this purpose.</td>
</tr>
<tr>
<td></td>
<td>Motor evoked potential recordings are superior to SSEP recordings during spinal cord/spinal column surgery as diagnostic adjuncts for assessment of spinal cord integrity and are recommended if utilized for this purpose.</td>
</tr>
<tr>
<td></td>
<td>SSEP recordings during spinal cord/spinal column surgery are reliable and valid diagnostic adjuncts to describe spinal cord integrity and are recommended if utilized for this purpose.</td>
</tr>
<tr>
<td>2</td>
<td>1. Revision surgery through a scarred surgical field</td>
</tr>
<tr>
<td></td>
<td>5. Preexisting recurrent laryngeal nerve pathology</td>
</tr>
</tbody>
</table>


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Preexisting recurrent laryngeal nerve pathology:
If there is a pre-existing injury to the RLN and there is no nerve function it would seem that monitoring that side has no value. If the included definition of RLN pathology was partial and not complete there would be value in monitoring the affected nerve. However, if they are talking about the contralateral RLN that was currently working normally, monitoring the already damaged RLN would not be valuable as described above.

Monitoring the contralateral RLN in the presence of ipsilateral pathology would be yes with high confidence. However, monitoring the already damaged RLN would not be valuable as described above.

5. Is there any evidence missing from the attached draft review of evidence?

<table>
<thead>
<tr>
<th>N o.</th>
<th>Yes/ No</th>
<th>Citations of Missing Evidence</th>
</tr>
</thead>
</table>
| 1    | Yes     | In 2010 Fehlings et al offered a systematic review of the literature on IOM recordings during spinal surgery. They screened 103 articles and reviewed 32 that met rigid inclusion criteria. The authors concluded that “high level” medical evidence supports the use of IOM as a sensitive and specific means to monitor spinal cord function and integrity and to detect intraoperative neurological injury during spinal surgery. (Fehlings MG, Brodie DS, Norvell DC, et al. The evidence for intraoperative neurophysiological monitoring in spine surgery: does it make a difference? Spine (Phila Pa 1976). 2010 Apr 20; 35(9 Suppl):S37-46. PMID: 20407350)


Case series of SSEP monitoring in 191 cervical spine procedures (24 for trauma). Broad spectrum of cervical pathology, I SSEP changes were noted in 33 cases while 10 patients had new neurological deficits post-surgery. Sensitivity was 99% but specificity low, 27%. False positives exceeded true positives 3:1.


Retrospective review of 427 cervical spine procedures for broad-spectrum pathology monitored with SSEP and TcMEP, comparing both modalities to neurological outcome. I TcMEP sensitivity and specificity were 100%. SSEP was 100% specific but only 25% sensitive. TcMEPs superior to SSEPs to detect motor tract deficits.


Prospective series of 246 patients undergoing cervical spine surgery with multimodal IOM. I Multimodal IOM sensitivity and specificity were 83% and 95%. Only 7 cases were performed for fracture/ instability.


Prospective series of 1055 cervical spine procedures performed with multimodal intraoperative monitoring (IOM). I/II SSEP (n=1055) was 52% sensitive and 100% specific while TcMEP (n=26) was 100% sensitive and 96% specific in predicting new post-op deficits. True comparison of monitoring modalities not offered.


Retrospective series of 52 consecutive patients undergoing surgery for cervical myelopathy with SSEP and TcMEP monitoring. I/II TcMEP sensitivity and specificity were 100% and 90% vs. 0% and 100% for SSEP. TcMEP positive predictive value was 17% (ie, five of six alerts were false positive).

Class I: TcMEPs superior to SSEP.
Class II: Limited to small CSM population.


Paniello RC, Martin-Bredahl KJ, Henkener LJ, et al. Preoperative laryngeal nerve screening for revision anterior cervical...