Electromyography and Nerve Conduction Studies

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Next Review: 10/2017

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

If the test or procedure is not listed in the member’s list of benefits, and Blue Cross and Blue Shield of Kansas City determines that it was done on an individual without specific symptoms of a condition or disease for which the test was done, it will be considered a non-covered screening test.

When Policy Topic is covered
Electrodiagnostic assessment, consisting of EMG, NCS, and related measures, may be considered medically necessary as an adjunct to history, physical exam (PE), and imaging studies when the following criteria are met:

- Signs and symptoms of peripheral neuropathy and/or myopathy are present; AND
- Definitive diagnosis cannot be made by PE and imaging studies alone; AND
- Work-up for 1 or more of the following categories of disease is indicated (see Policy Guidelines section):
  - Compressive neuropathies
  - Nerve root compression
  - Traumatic nerve injuries
  - Generalized and focal neuropathies/myopathies
  - Plexopathies
  - Motor neuron diseases
  - Neuromuscular junction disorders

A repeat electrodiagnostic assessment may be considered medically necessary when at least 1 of the following criteria have been met:

- Development of new symptoms or signs suggesting a second diagnosis in a patient who has received an initial diagnosis; OR
- Interim progression of disease following an initial test that was inconclusive, such that a repeat test is likely to elicit additional findings; OR
Unexpected change(s) in the course of disease or response to treatment, suggesting that the initial diagnosis may be incorrect and that reexamination is indicated.

**When Policy Topic is not covered**
Electrodiagnostic assessment, consisting of EMG, NCS, and related measures, is investigational when the above criteria are not met, including but not limited to, the following situations:
- Screening of asymptomatic individuals
- Serial assessments to evaluate progression of disease in a patient with a previously diagnosed neuropathy or myopathy
- Evaluation of treatment response in a patient with previously diagnosed neuropathy or myopathy
- Evaluation of severity of disease in a patient with previously diagnosed neuropathy or myopathy

**Considerations**
The following list gives specific diagnoses, according to categories of testing listed in the policy statement, for which EMG/NCS generally provides useful information in confirming or excluding the diagnosis, above that provided by clinical examination and imaging. It includes the most common diagnoses for testing, but it is not exhaustive. There may also be other less common disorders for which EMG/NCS provides useful diagnostic information.
- Compressive neuropathies
  - Carpal tunnel syndrome
  - Ulnar nerve entrapment
  - Thoracic outlet syndrome
  - Tarsal tunnel syndrome
  - Other peripheral nerve entrapments
- Nerve root compression (when PE and magnetic resonance imaging [MRI] are inconclusive)
  - Cervical nerve root compression
  - Thoracic nerve root compression
  - Lumbosacral nerve root compression
- Traumatic nerve injuries
- Generalized and focal polyneuropathies
  - Diabetic neuropathy
  - Uremic neuropathy
  - Alcohol-related neuropathy
  - Hereditary neuropathies
    - Charcot-Marie-Tooth
    - Other hereditary neuropathies
  - Demyelinating polyneuropathies
    - Guillain-Barré syndrome (acute)
    - Chronic idiopathic demyelinating polyneuropathy
- Generalized myopathies
  - Polymyositis
- Dermatomyositis
- Muscular dystrophies
- Plexopathies
  - Cervical plexopathy
  - Brachial plexopathy
  - Lumbosacral plexopathy
- Motor neuron diseases
  - Amyotrophic lateral sclerosis
  - Progressive muscular atrophy
  - Progressive bulbar palsy
  - Pseudobulbar palsy
  - Primary lateral sclerosis
- Neuromuscular junction disorders
  - Myasthenia gravis
  - Myasthenic syndrome
  - Lambert-Eaton syndrome

The following recommendations on the number of repeat services are reproduced from the AANEM Position Statement (1999). These numbers do not represent absolute maximums for all patients; they are defined by AANEM as being sufficient to make a diagnosis in at least 90% of patients with that particular diagnosis. Therefore, there may be a small percentage of cases that require a greater number of tests than specified in Table PG1.

**Table PG1. Recommended Maximum Number of Electrodiagnostic Studies for Specific Diagnoses**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Needle EMG</th>
<th>NCSs</th>
<th>Other Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Tests</td>
<td>Motor NCS (± F Wave)</td>
<td>Sensory NCS</td>
</tr>
<tr>
<td>Carpal tunnel syndrome (unilateral)</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Carpal tunnel syndrome (bilateral)</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Radiculopathy</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Mononeuropathy</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Polyneuropathy/mononeuropathy multiplex</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Myopathy</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Motor neuropathy (eg, ALS)</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Plexopathy</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Neuromuscular junction</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Tarsal tunnel syndrome (unilateral)</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Tarsal tunnel syndrome (bilateral)</td>
<td>2</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Weakness, fatigue, cramps, or twitching (focal)</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Weakness, fatigue, cramps, or twitching (general)</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Pain, numbness, or tingling (focal)</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Pain, numbness, or tingling (focal)</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

ALS: amyotrophic lateral sclerosis; EMG: electromyography; NCS: nerve conduction study; RNS: repetitive nerve stimulation.
The AANEM position statement (1999) also included minimum standards for a lab performing electrodiagnostic evaluation. These are:

- The tests should be medically indicated.
- The tests should be performed using equipment that provides assessment of all parameters of the recorded signals. Equipment designed for screening purposes is not acceptable.
- The NCS should be performed by a physician or by a trained technician under the direct supervision of a physician.
- A trained physician must perform the needle EMG exam.
- One physician should perform and supervise all components of the electrodiagnostic testing.

### Description of Procedure or Service

<table>
<thead>
<tr>
<th>Populations</th>
<th>Interventions</th>
<th>Comparators</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individuals:</strong></td>
<td></td>
<td><strong>Comparators of interest are:</strong></td>
<td>Relevant outcomes include:</td>
</tr>
<tr>
<td>With signs and/or</td>
<td>EMG and/or NCSs</td>
<td>Clinical diagnostic workup without EMG and/or NCS</td>
<td>Test accuracy</td>
</tr>
<tr>
<td>symptoms of</td>
<td></td>
<td></td>
<td>Symptoms</td>
</tr>
<tr>
<td>neuropathy or</td>
<td></td>
<td></td>
<td>Functional outcomes</td>
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<tr>
<td>myopathy, without</td>
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<tr>
<td>a definitive</td>
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<tr>
<td>diagnosis</td>
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<tr>
<td><strong>Individuals:</strong></td>
<td></td>
<td><strong>Comparators of interest are:</strong></td>
<td>Relevant outcomes include:</td>
</tr>
<tr>
<td>Who are asymptomatic</td>
<td>EMG and/or NCSs</td>
<td>Usual care</td>
<td>Test accuracy</td>
</tr>
<tr>
<td><strong>Individuals:</strong></td>
<td></td>
<td><strong>Comparators of interest are:</strong></td>
<td>Symptoms</td>
</tr>
<tr>
<td>With established</td>
<td>EMG and/or NCSs</td>
<td>Usual care</td>
<td>Functional outcomes</td>
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<tr>
<td>diagnosis of</td>
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<tr>
<td>neuropathy or</td>
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<tr>
<td>myopathy</td>
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</tbody>
</table>

EMG: electromyography; NCS: nerve conduction study.

Electromyography (EMG) and nerve conduction studies (NCS), also collectively known as electrodiagnostic assessment, are intended to evaluate the electrical functioning of muscles and peripheral nerves. These tests are used as diagnostic aids for the evaluation of myopathy and peripheral neuropathy by identifying, localizing, and characterizing electrical abnormalities in the skeletal muscles and peripheral nerves.

The evidence for the accuracy of electrodiagnostic assessment in patients with signs and symptoms of neuropathy or myopathy includes scattered small studies on a few diagnoses, such as carpal tunnel syndrome, radiculopathy, and myopathy. Relevant outcomes are the sensitivity, specificity, predictive values, and related measures of diagnostic accuracy. There are several challenges to obtaining high-quality evidence of this type. Most prominently, electrodiagnostic assessment is considered to be the criterion standard for evaluating the electrical function of peripheral nerves and muscles. Because of the lack of a true alternative reference standard, it is difficult to perform high-quality studies on diagnostic accuracy. As a result, the sensitivity and specificity of particular EMG/NCS abnormalities for particular clinical disorders cannot be determined. In general, these tests are considered to be more specific than sensitive, and normal results
do not rule out disease. For the available evidence on specific diagnoses, studies report a wide range of sensitivities, which are often less than 50%. The specificity is expected to be considerably higher, but the data are not sufficient to provide precise estimates of either sensitivity or specificity. Therefore, the evidence is insufficient to determine the effects of the technology on health outcomes.

Based on the limitations of clinical exam, established practice patterns, guidelines from specialty societies, and the results of clinical input, it is likely that these tests do improve the ability to diagnose neuropathy and myopathy above that of clinical examination alone. Many of the disorders diagnosed will have specific treatments available; therefore, the use of EMG/NCS is likely to improve outcomes by initiating effective treatment or terminating ineffective treatment in patients who are correctly diagnosed. As a result, the use of EMG/NCS may be considered to be medically necessary as a diagnostic aid in the evaluation of signs and symptoms suggestive of a peripheral neuropathy or myopathy. For other uses, such as monitoring disease progression and screening asymptomatic individuals, the use of EMG/NCS is considered investigational.

**Background**

Electromyography (EMG) and nerve conduction study (NCS) have been used for several decades as adjuncts to the clinical examination in the evaluation of myopathy and peripheral neuropathy. The intent of these tests is to evaluate the integrity and electrical function of muscles and peripheral nerves. They are performed when there is a clinical suspicion for a myopathic or neuropathic process and when clinical examination and standard laboratory testing is unable to make a definitive diagnosis.

The results of these tests do not generally provide a specific diagnosis. Rather, they provide additional information that assists the physician in characterizing a clinical syndrome. According to the American Association of Neuromuscular and Electrodieagnostic Medicine, electrodiagnostic assessment has the following goals:

- Identify normal and abnormal nerve, muscle, motor or sensory neuron, and neuromuscular junction (NMJ) functioning
- Localize region(s) of abnormal function
- Define the type of abnormal function
- Determine the distribution of abnormalities
- Determine the severity of abnormalities
- Estimate the date of a specific nerve injury
- Estimate the duration of the disease
- Determine the progression of abnormalities or of recovery from abnormal function
- Aid in diagnosis and prognosis of disease
- Aid in selecting treatment options
- Aid in following response to treatment by providing objective evidence of change in NM function
- Localize correct locations for injections of intramuscular agents
Components of the electrodiagnostic exam may include the following:

- **Needle EMG.** A needle electrode is inserted into selected muscles, chosen by the examining physician depending on the differential diagnosis and other information available at the time of exam. The response of the muscle to electrical stimulation is recorded. There are 3 components evaluated: observation at rest, action potential with minimal voluntary contraction, and action potential with maximum contraction.
  - Single fiber EMG. In this technique, a needle electrode records the response of a single muscle fiber. This test can evaluate “jitter,” which is defined as the variability in time between activation of the nerve and generation of the muscle action potential. Single fiber EMG can also be used to measure fiber density, which is defined as the mean number of muscle fibers for 1 motor unit.

- **NCS.** Both motor and sensory nerve conduction are assessed. For motor conduction, electrical stimuli are delivered along various points on the nerve and the electrical response is recorded from the appropriate muscle. For sensory conduction, electrical stimuli are delivered to 1 point on the nerve and the response recorded at a distal point on the nerve. Parameters recorded include velocity, amplitude, latency, and configuration.
  - Late wave responses. Late waves are a complement to the basic NCS study and evaluate the functioning of the proximal segment of peripheral nerves, such as the nerve root and the anterior horn cells. There are 2 types of late responses, the H-reflex and the F wave.
    - **H-reflex.** The H-reflex is elicited by stimulating the posterior tibial nerve and measuring the response in the gastrocnemius muscle. It is analogous to the ankle reflex and can be prolonged by a radiculopathy at S1 or by a peripheral neuropathy.
    - **F wave.** The F wave is assessed by supramaximal stimulation of the distal nerve and can be used to estimate the conduction velocity in the proximal portion of the nerve. This will provide information on the presence of proximal nerve abnormalities, such as radiculopathy or plexopathy.

- **Repetitive nerve stimulation (RNS) studies.** RNS studies are intended to evaluate the integrity and function of the NMJ. The test involves stimulating a nerve repetitively at variable rates and recording the response of the corresponding muscle(s). Disorders of the NMJ will show a diminished muscular response to repetitive stimulation.

- **Somatosensory evoked potentials (SEP).** SEPs evaluate nerve conduction in various sensory fibers of both the peripheral and central nervous system and are used to test the integrity and function of these nerve pathways. They are typically used to assess nerve conduction in the spinal cord and other central pathways that cannot be assessed by standard NCS.

- **Blink reflexes.** The blink reflexes, which are analogs of the corneal reflex, are evaluated by stimulating the orbicularis orbis muscle at the lower eyelid. They are used to localize lesions in the fifth or seventh cranial nerves.

The specific components of an individual test are not standardized. Rather, a differential diagnosis is developed by the treating physician, and/or the clinician...
performing the test, and the specific components of the exam are determined by the disorders that are being considered in the differential. In addition, the differential diagnosis may be modified during the exam to reflect initial findings, and this may also influence the specific components that are included in the final analysis.²

**Regulatory Status**

EMG and NCS measure nerve and muscle function and may be indicated when evaluating limb pain, weakness related to possible spinal nerve compression or other neurologic injury or disorder.

The EPAD™ by SafeOp Surgical is the most recent (2014) FDA-approved electromyographic device. The EPAD is specifically designed for peripheral nerve response (somatosensory evoked potential) and NMJ monitoring. The CERSR® Electromyography System by SpineMatrix is specifically designed for real-time recording from multiple locations by applying an array of surface electrodes over an anatomic region of interest. Other FDA-approved myographical devices include: Physical Monitoring Registration Unit-S (PMRU-S) by Oktx LLC, MyoVision 3G Wirefree™ System by Precision Biometrics, NuVasive® NV M5 System by NuVasive, Neuro Omega™ System by Alpha Omega Engineering, and the CareFusion Nicolet® EDX by CareFusion 209. FDA product code: IKN.

**Rationale**

This evidence review was created in August 2014 and updated periodically with searches of the MEDLINE database. The most recent update with literature review covers the period of July 1, 2014, through July 1, 2015.

Assessment of a diagnostic technology typically focuses on 3 categories of evidence: (1) technical performance (test-retest reliability or interrater reliability); (2) diagnostic accuracy (sensitivity, specificity, and positive and negative predictive value) in relevant populations of patients; and (3) demonstration that the diagnostic information can be used to improve patient outcomes. In addition, subsequent use of a technology outside of the investigational setting may also be evaluated. These categories of evidence, although not always evaluated in sequence, can be considered similar to the 4 phases of therapeutic studies.

**Technical Performance**

There was little recent published evidence on the technical performance of electromyography (EMG)/nerve conduction studies (NCS). Some research on test-test reliability and validity of specific EMG components in specific populations was identified.⁴⁻⁸ Two review articles by Lariviére et al summarized reliability and validity of measures of muscle strength and endurance.⁷,⁸ Correlations of EMG measures with strength and endurance varied by the specific measure examined, with $r$ values that ranged from 0.39 to 0.81. Test-test reliability was less variable and on average higher, with intraclass correlations ranging from 0.75 to 0.83. Other published studies examined methods for improving reliability, for example...
by attempting to establish better normalization values for asymptomatic individuals.\textsuperscript{4,5}

It is expected that the performance of the test is operator-dependent and that individuals with less skill and training will produce less reliable and valid results.\textsuperscript{1}

There was no evidence identified that examined the difference in results, reliability, or validity by degree of expertise.

**Suspected Peripheral Neuropathy or Myopathy**

**Diagnostic Accuracy**

There is little recent literature on the sensitivity and specificity of EMG/NCS for the diagnosis of specific neuropathic and myopathic disorders. In general, EMG and NCS are considered the criterion standard for establishing abnormalities of the electrical system of nerves and muscles, and the lack of a true reference standard makes research on diagnostic accuracy difficult.

Examples of some representative literature on diagnostic accuracy are reviewed next.

**Carpal Tunnel Syndrome**

A systematic review of the literature on the diagnosis of carpal tunnel syndrome (CTS) was performed by the American Academy of Orthopaedic Surgeons in support of their guideline development process.\textsuperscript{9} There were a total of 35 studies identified with useful data on diagnostic accuracy; however, there was a lack of high-quality evidence. There were no prospective studies identified that enrolled a population of patients similar to that seen in clinical practice. The following description of the evidence base was made:

The systematic literature review of primary studies indicated that published articles did not employ a consistent reference standard, few studies evaluated the same diagnostic test, and most studies enrolled only a few patients. In addition, the majority of primary studies used a case-control design, which is subject to spectrum bias, thus artificially inflating the sensitivity and specificity of the evaluated tests. Because of the diversity and suboptimal design of published studies, no one test could be identified as a "gold standard" for carpal tunnel syndrome diagnosis.

As a result of the poor quality of evidence, the review concluded that the sensitivity and specificity of electrodiagnostic assessment for CTS is unknown. Evidence-based recommendations could not be developed, and all recommendations were therefore rated at a level V, which is expert opinion.

Some of the individual studies are reviewed next, with emphasis on the larger, more recent, and methodologically stronger studies. In 2014, Fowler et al evaluated the diagnostic accuracy of neurodiagnostic studies and ultrasound for CTS, using validated clinical diagnostic criteria as the reference standard.\textsuperscript{10} Eighty-five consecutive patients with upper extremity symptoms were referred for
evaluation over a 3-month period at 1 clinic. All patients completed electrodiagnostic assessment, ultrasound examination, and a validated clinical diagnostic tool (CTS-6 score). The electrodiagnostic exam was considered positive when there was a distal motor latency of 4.2 ms or more or a distal sensory latency of 3.2 ms or more. There were 55 patients who were positive for CTS on the CTS-6 clinical score. Using the CTS-6 as the reference standard, the sensitivity of neurodiagnostic assessment was 89% and the sensitivity was 80%. That was compared with ultrasound, which had a reported sensitivity of 89% and a specificity of 90%. This study is limited by the imperfect nature of the reference standard, which is not a true criterion standard for diagnosis, and which may itself have suboptimal sensitivity.

Chang et al examined the sensitivity and specificity of various NCS parameters in 280 consecutive patients (360 hands) with suspected CTS, and 150 normal controls. In the 360 hands with suspected CTS, 328 (91.1%) had at least 1 electrodiagnostic abnormality and 8.9% had normal exams. For individual NCS measures, the sensitivity ranged from 72.5% to 87.2%, and the specificity ranged from 96.7% to 98.7%. The authors presented algorithms for serial testing to maximize the sensitivity of the exam.

Homan et al evaluated the agreement between clinical symptoms, physical exam, and electrodiagnostic studies in 824 individuals with suspected work-related CTS from 6 job facilities. The specific tests used were symptom surveys that included hand diagrams, physical exam results, and bilateral sensory NCS. The κ value was calculated to determine the degree of agreement above chance. There were 449 individuals with at least 1 positive finding on any exam. Of these, only 5% had positive findings on all 3 domains (symptoms, physical exam, NCS). Overall there was poor agreement between the 3 measures, with κ values ranging from 0 to 0.18.

**Lumbar Radiculopathy**

The North American Spine Society published evidence-based guidelines on the diagnosis and treatment of lumbar radiculopathy in 2012. A systematic review of the literature was performed to identify studies of diagnostic accuracy, 1 of which was electrodiagnostic testing. For the diagnosis of lumbar radiculopathy, the guidelines reviewed 5 studies on diagnostic accuracy, 2 of which also included a control group of normal individuals. Sensitivities for various EMG and NCS parameters ranged from 17% to 65%. In the 2 studies that included a normal control group, specificity for EMG abnormalities was 100% and 87%.

Subsequent to the NASS publication, Mondelli et al published a study in 2013 that evaluated electrodiagnostic findings in patients with lumbosacral radiculopathy and herniated disc. The diagnosis of radiculopathy due to herniated disc was made by a combination of clinical symptoms and magnetic resonance imaging (MRI) results. A total of 108 consecutive patients with monoradiculopathy at L4, L5, or S1 were enrolled from 4 electrodiagnostic laboratories. There was at least 1 EMG abnormality recorded in 42% of patients, with the most common abnormality being a delay in the F wave minimum latency. EMG abnormalities could be
predicted on multivariate regression by the presence of clinical symptoms, including muscle weakness, abnormal reflexes, and the presence of paresthesias.

**Peroneal Neuropathy**
AENEM published an evidence review in support of practice parameters on the utility of electrodiagnostic testing for patients with suspected peroneal neuropathy. The authors performed a systematic review of the literature for publications that provided information on the utility of EMG/NCS. A total of 11 studies met their inclusion criteria, 4 of which were prospective. Eight studies described use of motor NCS, 8 described use of sensory NCS, and 5 described use of needle EMG. The strongest study design (n=4) used a cohort of patients with clinically diagnosed peroneal neuropathy and reported the sensitivity of EMG/NCS. The sensitivity of EMG/NCS varied widely by the type of measure and the specific area tested, ranging from 19% to 91%. Specificity was not reported. The authors concluded that certain NCS parameters were useful for diagnosing peroneal neuropathy and proposed a specific testing strategy to maximize sensitivity. EMG was not felt to be useful for confirming the diagnosis of peroneal neuropathy, but may be helpful in excluding alternate diagnoses.

**Pediatric Myopathy**
Some research has evaluated the accuracy of EMG/NCS compared with muscle biopsy in children with suspected myopathy. The intent of this line of research is to evaluate whether the diagnosis can be made with certainty by clinical exam and EMG/NCS, without the need for muscle biopsy.

Rabie et al evaluated the diagnostic accuracy of EMG compared with muscle biopsy in children with neuropathies or myopathies. The authors retrospectively identified 27 children between the ages of 6 days to 16 years who had EMG studies, a muscle biopsy, and a final diagnosis assigned by the treating physician(s). Final diagnoses were congenital myopathy (5 patients), nonspecific myopathy (6 patients), congenital myasthenic syndrome (3 patients), juvenile myasthenia gravis (1 patient), arthrogryposis multiplex congenital (2 patients), hereditary motor and sensory neuropathy (1 patient), bilateral peroneal neuropathies (1 patient), and normal (8 patients). In general, the sensitivity of EMG for detecting abnormalities implied by the final diagnosis was low. For example, the sensitivity of EMG for detecting myopathic motor unit potentials in any myopathy was 47% (7/15), and the sensitivity for congenital myopathies was 40% (2/5). The sensitivity was especially low for patients younger than 2 years of age compared with older children, but this comparison is limited by very low numbers of patients in each group.

Ghosh et al performed a retrospective chart review of 227 patients who received EMG studies between the years of 2009-2013. There were 72 patients (32%) who also received muscle biopsy, and these 72 patients constituted the study group. The criterion standard was myopathy confirmed either by muscle biopsy or genetic testing. The overall sensitivity of EMG was 91%, with the most commonly missed diagnosis being metabolic myopathy. The overall specificity was 67%. This low specificity, which is lower than most other reports of specificity, raises the
question of whether the sensitivity of muscle biopsy is lower than expected, thus resulting in EMG results that are true positives being classified as false positives.

**Section Summary: Suspected Peripheral Neuropathy or Myopathy**
EMG/NCS is generally considered to be a specific, but not a sensitive test. However, the evidence on diagnostic accuracy of EMG/NCS is poor, in part because of the lack of a true reference standard. In the scattered evidence that was identified, sensitivity was often less than 50%, and specificity was most commonly in the range of 80% to 100%. Because of the small quantity and poor quality of the evidence, precise estimates of sensitivity and specificity for specific disorders cannot be made.

**Evaluation of Current Clinical Practice Guidelines**
The lack of high-quality evidence on the clinical utility of EMG/NCS is reflected by the lack of evidence-based guidelines. Most existing guidelines rely on expert consensus. This section will review some of the available guidelines, with a focus on the degree to which they are evidence-based and whether the recommendations are consistent across different guideline bodies. Guidelines from 3 organizations will be examined here, focusing on the methods of the development process, and the rigor of evidence review. The 3 organizations are the American Association of Neuromuscular and Neurodiagnostic Medicine (AANEM), American Academy of Neurology (AAN), and American Academy of Orthopaedic Surgeons (AAOS) (CTS only). The subsequent section on “Practice Guidelines and Position Statements” summarizes the recommendations of the guidelines.

AANEM published a document titled “Recommended Policy for Electrodiagnostic Medicine” in 1999. This document is a Position Statement based on consensus of experts in the field. A consensus conference was held in which 43 experts in the field of electrodiagnostic medicine were invited. No information was given regarding the selection process for these individuals, but it was noted that they were either neurologists or physiatrists who represented a diversity of practice types and locations. Members of AANEM who participated included the board of directors, professional practice committee members, other committee chairs. Physicians from both academic medical centers and from private practice were included. Further details about the process of literature review, and/or the process for group decision making, was not provided.

AAOS published clinical practice guidelines on the diagnosis and treatment of CTS in 2007. The following statement was made regarding the methodology of these guidelines:

The AAOS Carpal Tunnel Syndrome (CTS) Guideline Work Group systematically reviewed the available literature, evaluated the level of evidence found in that literature, and subsequently wrote the following recommendations based on a rigorous, standardized consensus process.
Multiple iterations of written review were conducted by the participating Work Group, AAOS Guidelines Oversight Committee, AAOS Evidence-based Practice Committee, and the AAOS Council on Research, Quality Assessment, and Technology prior to final approval by the AAOS Board of Directors.

Voting and reaching consensus on guideline recommendations was conducted using a modification of the nominal group technique. In this modification each Work Group member ranked a recommendation or performance measure on a scale ranging from 1 (extremely appropriate) to 9 (extremely inappropriate). Consensus was obtained; 6 of 7 Work Group members ranked the recommendation or measure as a 7, 8, or 9. If at least 2 work group members did not assign a rank of 7, 8, or 9, an iterative process was used to resolve disagreements. If disagreements were not resolved after several rounds of discussion, no recommendation was adopted.

AAN published a position statement on electrodiagnostic assessment in 2004. According to AAN, “A position statement is a concise explanation of AAN’s position on a certain issue that includes background information and the rationale behind the Academy’s position. The position statement, generally not exceeding 1,000 words, is in-depth and must reference all supporting evidence.” The AAN document on EMG did not contain any description of literature review, nor were there references accompanying the recommendations.

**Section Summary: Clinical Practice Guidelines**
The existing guidelines from these major specialty societies consist primarily of expert consensus. For guidelines in which an evidence review was performed, such as the AAOS guidelines, the evidence was not sufficient to make evidence-based recommendations. All 3 of these societies make general recommendations as to the utility of electrodiagnostic testing as an adjunct to diagnosis for myopathic and neuropathic disorders. None of the guidelines offer detailed indications for patient testing by diagnosis.

**Ongoing and Unpublished Clinical Trials**
A search of ClinicalTrials.gov in June 2015 did not identify any ongoing or unpublished trials that would likely influence this review.

**Summary of Evidence**
The evidence for the accuracy of electrodiagnostic assessment in patients with signs and symptoms of neuropathy or myopathy includes scattered small studies on a few diagnoses, such as carpal tunnel syndrome, radiculopathy, and myopathy. Relevant outcomes are the sensitivity, specificity, predictive values, and related measures of diagnostic accuracy. There are several challenges to obtaining high-quality evidence of this type. Most prominently, electrodiagnostic assessment is considered to be the criterion standard for evaluating the electrical function of peripheral nerves and muscles. Because of the lack of a true alternative reference standard, it is difficult to perform high-quality studies on diagnostic accuracy. As a result, the sensitivity and specificity of particular electromyography (EMG) and nerve conduction studies (NCS) abnormalities for particular clinical
disorders cannot be determined. In general, these tests are considered to be more specific than sensitive, and normal results do not rule out disease. For the available evidence on specific diagnoses, studies report a wide range of sensitivities, which are often less than 50%. The specificity is expected to be considerably higher, but the data are not sufficient to provide precise estimates of either sensitivity or specificity. Therefore, the evidence is insufficient to determine the effects of the technology on health outcomes.

**Practice Guidelines and Position Statements**
The American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) published 2 position statements on recommended coverage policy for EMG/NCS. The first, titled “Recommended policy for electrodiagnostic medicine”, was initially published in 1999 with the latest update performed in 2004.

The second AANEM document regarding coverage policy, titled “Model Policy for Needle Electromyography and Nerve Conduction Studies,” was published in 2010. This document made the following specific recommendations for testing:

- Focal neuropathies, entrapment neuropathies, or compressive lesions/syndromes such as carpal tunnel syndrome, ulnar neuropathies, or root lesions, for localization
- Traumatic nerve lesions, for diagnosis and prognosis
- Diagnosis or confirmation of suspected generalized neuropathies, such as diabetic, uremic, metabolic, or immune
- Repetitive nerve stimulation in diagnosis of neuromuscular junction disorders such as myasthenia gravis, myasthenic syndrome
- Symptom-based presentations such as “pain in limb,” weakness, disturbance in skin sensation or “paresthesia” when appropriate pretest evaluations are inconclusive and the clinical assessment unequivocally supports the need for the study
- Radiculopathy-cervical, lumbosacral
- Polyneuropathy-metabolic, degenerative, hereditary
- Plexopathy-idiopathic, trauma, infiltration
- Myopathy-including polymyositis and dermatomyositis, myotonic, and congenital myopathies
- Precise muscle location for injections such as botulinum toxin, phenol, etc.

This document also listed situations that were considered investigational, these were:

- EDX [electrodiagnostic] testing with automated, noninvasive nerve conduction testing devices
- Screening testing for polyneuropathy of diabetes or end-stage renal disease (ESRD)
- Testing for the sole purpose of monitoring disease intensity or treatment efficacy in these two conditions also is not covered.
- Psychophysical measurements (current, vibration, thermal perceptions), even though they may involve delivery of a stimulus, are not covered.
Current Perception Threshold/Sensory Nerve Conduction Threshold Test (sNCT)

Examination using portable hand-held devices, which are incapable of real-time wave-form display and analysis

AANEM published practice parameters on the utility of EMG/NCS for the diagnosis of peroneal neuropathy. This was an evidence-based review, focusing on the questions of whether EMG/NCS are useful in diagnosing peroneal neuropathy, and/or in determining prognosis. The following recommendations were made:

In patients with suspected peroneal neuropathy, the following electrodiagnostic studies are possibly useful, to make or confirm the diagnosis:

- Motor NCSs of the peroneal nerve recording from the AT and EDB muscles (Level C recommendation, class III evidence)
- Orthodromic and antidromic superficial peroneal sensory NCS (Level C recommendation, class III evidence)
- At least one additional normal motor and sensory NCS in the same limb, to assure that the peroneal neuropathy is isolated, and not part of a more widespread local or systemic neuropathy.
- Data are insufficient to determine the role of needle EMG in making the diagnosis of peroneal neuropathy. (Level U recommendation, class IV evidence). However, abnormalities on needle examination outside of the distribution of the peroneal nerve should suggest alternative diagnoses (Expert opinion).
- In patients with confirmed peroneal neuropathy, EDX studies are possibly useful in providing prognostic information, with regards to recovery of function (Level C recommendation, class III and IV evidence).

The American Academy of Orthopaedic Surgeons (AAOS) issued a 2007 clinical guideline on the diagnosis of carpel tunnel syndrome. The guideline makes the following recommendations:

- **Recommendation 3.1a.** The physician may obtain electrodiagnostic tests to differentiate among diagnoses. (Level V, Grade C)
- **Recommendation 3.1b.** The physician may obtain electrodiagnostic tests in the presence of thenar atrophy and/or persistent numbness (Level V, Grade C).
- **Recommendation 3.1c.** The physician should obtain electrodiagnostic tests if clinical and/or provocative tests are positive and surgical management is being considered (Level II and III, Grade B)
- **Recommendation 3.2.** If the physician orders electrodiagnostic tests, the testing protocol should follow the AAN/AANEM/AAPMR guidelines for diagnosis of CTS (Level IV and V, Grade C).

An American Academy of Neurology (AAN) position statement on diagnostic electromyography in the practice of medicine, 2004 states the following:

- Clinical needle electromyography (EMG) is an invasive medical procedure during which the physician inserts an electrode into a patient's muscles to diagnose the cause of muscle weakness. Needle EMG allows physicians to
distinguish a wide range of conditions, from carpal tunnel syndrome to ALS (Lou Gehrig disease).

- Needle EMG is also an integral component of the neurological examination that cannot be separated from the physician’s evaluation of the patient. The test is dynamic and depends upon the visual, tactile, and audio observations of the examiner. There is no way for physicians to independently verify the accuracy of reports performed by non-physicians.
- Misdiagnosis can mean delayed or inappropriate treatment (including surgery) and diminished quality of life. Because needle EMG is strictly diagnostic, the procedure clearly and exclusively falls within the practice of medicine.
- The AAN supports working through regulatory and legislative channels to define this procedure as the practice of medicine. Such definition would help ensure the highest standards patient care, patient safety and cost-effectiveness in the performance of diagnostic EMG.

A consensus statement on diagnosing multifocal motor neuropathy from AANEM\(^{20}\) states:

Multifocal motor neuropathy is a diagnosis that is based on recognition of a characteristic pattern of clinical symptoms, clinical signs, and electrodiagnostic findings. The fundamental electrodiagnostic finding is partial conduction block of motor axons.

An online information page on electrodiagnostic testing from AAOS, OrthoInfo, 2007\(^{21}\) provides the following information:

An EMG records and analyzes the electrical activity in your muscles. It is used to learn more about the functioning of nerves in the arms and legs. When a normal muscle is at rest, it is electrically silent.

NCS are often done along with the EMG to determine if a nerve is functioning normally. The doctor conducting the test will tape wires (electrodes) to the skin in various places along the nerve pathway. Then the doctor stimulates the nerve with an electric current. As the current travels down the nerve pathway, the electrodes placed along the way capture the signal and time how fast the signal is traveling. In healthy nerves, electrical signals can travel at up to 120 miles per hour. If the nerve is damaged, however, the signal will be slower and weaker. By stimulating the nerve at various places, the doctor can determine the specific site of the injury. Nerve conduction studies also may be used during treatment to test the progress being made.

The accuracy of electrodiagnostic tests depends on the skill of the person conducting the test and the precision of the equipment used. Generally, these tests can accurately determine injuries to the nerves or nerve roots as well as diseases of the nerves and muscles. In some conditions, however, it may take several weeks for changes to become apparent. Additionally, the tests cannot determine the existence or extent of pain. A person may still feel pain or exhibit symptoms even though electrodiagnostic tests show that
the nerves are functioning normally. In these cases, your orthopaedist will recommend a course of treatment for you.

The North American Spine Society published guidelines on the diagnosis and treatment of lumbar disc herniation in 2012. This document made the following statement about the use of EMG/NCS for diagnosis of lumbar disc herniation:

Electromyography, nerve conduction studies and F-waves are suggested to have limited utility in the diagnosis of lumbar disc herniation with radiculopathy. H-reflexes can be helpful in the diagnosis of an S1 radiculopathy, though are not specific to the diagnosis of lumbar disc herniation. (Grade of Recommendation: B)

The Institute for Clinical Systems Improvement published guidelines on the assessment and management of chronic pain in 2013. These guidelines made the following statement about the use of EMG/NCS:

Electromyography and nerve conduction studies are of use in patients suspected of having lower motor neuron dysfunction, nerve or nerve root pathology, or myopathy [Low Quality Evidence].

**U.S. Preventive Services Task Force Recommendations**
Not applicable.

**Medicare National Coverage**
Sensory Nerve Conduction Threshold Tests (sNCTs) (160.23). This procedure is different and distinct from assessment of nerve conduction velocity, amplitude and latency. It is also different from short-latency somatosensory evoked potentials.

Effective October 1, 2002, CMS initially concluded that there was insufficient scientific or clinical evidence to consider the sNCT test and the device used in performing this test reasonable and necessary within the meaning of section 1862(a)(1)(A) of the law. Therefore, sNCT was noncovered.

Effective April 1, 2004, based on a reconsideration of current Medicare policy for sNCT, CMS concludes that the use of any type of sNCT device (eg, “current output” type device used to perform current perception threshold [CPT], pain perception threshold [PPT], or pain tolerance threshold [PTT] testing or “voltage input” type device used for voltage-nerve conduction threshold (v-NCT) testing) to diagnose sensory neuropathies or radiculopathies in Medicare beneficiaries is not reasonable and necessary.

**References**
# Billing Coding/Physician Documentation Information

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<tr>
<th>Code</th>
<th>Description</th>
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<tr>
<td>95860</td>
<td>Needle electromyography; 1 extremity with or without related paraspinal areas</td>
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<td>95861</td>
<td>Needle electromyography; 2 extremities with or without related paraspinal areas</td>
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<tr>
<td>95863</td>
<td>Needle electromyography; 3 extremities with or without related paraspinal areas</td>
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<td>95867</td>
<td>Needle electromyography; cranial nerve supplied muscle(s), unilateral</td>
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<td>Needle electromyography; cranial nerve supplied muscles, bilateral</td>
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<td>95869</td>
<td>Needle electromyography; thoracic paraspinal muscles (excluding T1 or T12)</td>
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<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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<td>95886</td>
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**IDCD**

**E10.40**

Type 1 diabetes mellitus with neurological complications code range
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<td>Nerve root and plexus disorders code range</td>
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<td>Injury of nerves at ankle and foot level code range</td>
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**Additional Policy Key Words**
N/A

**Policy Implementation/Update Information**
10/1/15  Policy Created. May be considered medically necessary as an adjunct to clinical examination for the diagnosis of peripheral neuropathies and Electromyography and Nerve Conduction Studies 2.01.95
Electromyography and Nerve Conduction Studies 2.01.95

myopathies when criteria are met.
10/1/16  No policy statement changes.

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.