Kansas City
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Electromyography and Nerve Conduction Studies

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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 Considerations 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

Indication	Needle EMG	NCSs		Other Studies	
	No. of Tests	Motor NCS (± F Wave)	Sensory NCS	H-Reflex	RNS Testing
Carpal tunnel syndrome (unilateral)	1	3	4	0	0
Carpal tunnel syndrome (bilateral)	2	4	6	0	0
Radiculopathy	2	3	2	2	0
Mononeuropathy	1	3	3	2	0
Polyneuropathy/mononeuropathy multiplex	3	4	4	2	0
Myopathy	2	2	2	0	2
Motor neuropathy (eg, ALS)	4	4	2	0	2
Plexopathy	2	4	6	2	0
Neuromuscular junction	2	2	2	0	3
Tarsal tunnel syndrome (unilateral)	1	4	4	0	0
Tarsal tunnel syndrome (bilateral)	2	5	6	0	0
Weakness, fatigue, cramps, or twitching (focal)	2	3	4	0	2
Weakness, fatigue, cramps, or twitching (general)	4	4	4	0	2
Pain, numbness, or tingling (focal)	1	3	4	2	0
Pain, numbness, or tingling (focal)	2	4	6	2	0

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

Populations	Interventions	Comparators	Outcomes
Individuals: ▪ With suspected peripheral neuropathy or myopathy	Interventions of interest are: ▪ Electrodiagnostic testing including electromyography and nerve conduction studies	Comparators of interest are: ▪ Clinical diagnostic workup without electrodiagnostic testing	Relevant outcomes include: ▪ Test accuracy ▪ Symptoms ▪ Functional outcomes ▪ Quality of life

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.

For individual with suspected peripheral neuropathy or myopathy who receive electrodiagnostic assessment including electromyography and nerve conduction studies, the evidence includes scattered small studies on a few diagnoses, such as carpal tunnel syndrome, radiculopathy, and myopathy. Relevant outcomes are test accuracy, symptoms, functional outcomes, and quality of life. We have several challenges obtaining high-quality evidence on electrodiagnostic testing. Most prominently, electrodiagnostic assessment is considered 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, we cannot determine the sensitivity and specificity of particular EMG/NCS abnormalities for particular clinical disorders. In general, these tests are considered more specific than sensitive, and normal results do not rule out disease. For the available evidence on specific diagnoses, studies have reported a wide range of sensitivities, which are often less than 50%. The specificity is expected to be considerably higher, but the data insufficient to provide precise estimates of either sensitivity or specificity. The evidence is insufficient to determine the effects of the technology on health outcomes.

Based on the limitations of clinical exam, established practice patterns, and guidelines from specialty societies, it is likely that these electrodiagnostic tests

improve the ability to diagnose neuropathy and myopathy above that of clinical examination alone. Many disorders diagnosed have specific treatments available; therefore, the use of EMG/NCS is likely to improve outcomes by initiating effective or terminating ineffective treatments in patients correctly diagnosed. As a result, the use of EMG/NCS may be considered 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.[1] 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. EMG/NCS may be useful when there is no clear etiology when symptoms are severe or rapidly progressing, or when symptoms are atypical (eg, asymmetrical, acute onset, or appearing to be autonomic).

According to the American Association of Neuromuscular and Electrodiagnostic Medicine, electrodiagnostic assessment has the following goals[2]:

- 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 and 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 needle EMG, NCS, repetitive nerve stimulation study, somatosensory evoked potentials, and blink reflexes.

- 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.[2] 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.[3]

- 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.[2]
- 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.[3]
    - 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.[3] 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).[3] 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.[2] 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.[2]

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/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. A number of electromyographic devices have received marketing clearance by the U.S. Food and Drug Administration (FDA). Some are listed in Table 1.

Table 1. Electromyographic Devices Approved by FDA

Device	Manufacturer	FDA Clearance	510(k) No.	FDA Product Code
NuVasive® NVM5 System	NuVasive	2011	K112718	ETN
CERSR® Electromyography System	SpineMatrix	2011	K110048	IKN
CareFusion Nicolet® EDX	CareFusion 209	2012	K120979	GWF
Physical Monitoring Registration Unit-S (PMRU-S)	Oktx	2013	K123902	IKN
MyoVision 3G Wirefree™ System	Precision Biometrics	2013	K123399	IKN
Neuro Omega™ System	Alpha Omega Engineering	2013	K123796	GZL
EPAD™	SafeOp Surgical	2014	K132616	GWF
Sierra Summit, Sierra Ascent	Cadwell Industries	2017	K162383	IKN, GWF

FDA: Food and Drug Administration.

Rationale

This evidence review was created in August 2014 and has been updated regularly with searches of the MEDLINE database. The most recent literature update was performed through April 9, 2018.

Evidence reviews assess whether a medical test is clinically useful. A useful test provides information to make a clinical management decision that improves the net health outcome. That is, the balance of benefits and harms is better when the test is used to manage the condition than when another test or no test is used to manage the condition.

The first step in assessing a medical test is to formulate the clinical context and purpose of the test. The test must be technically reliable, clinically valid, and clinically useful for that purpose. Evidence reviews assess the evidence on whether a test is clinically valid and clinically useful. Technical reliability is outside the scope of these reviews, and credible information on technical reliability is available from other sources.

Suspected Peripheral Neuropathy or Myopathy

Clinical Context and Test Purpose

The purpose of electrodiagnostic testing in patients who have suspected peripheral neuropathy or myopathy is to aid in the diagnosis of disease and to guide treatment.

The question addressed in this evidence review is: Does electrodiagnostic testing improve health outcomes in patients who have suspected peripheral neuropathy or myopathy but no definitive diagnosis based on history, physical exam, and imaging studies?

The following PICOTS were used to select literature to inform this review.

Patients
The relevant population of interest is individuals who have suspected peripheral neuropathy or myopathy. The population falls into the broad categories of compressive neuropathies, nerve root compression, traumatic nerve injuries, generalized and focal neuropathies and myopathies, plexopathy, motor neuron disease, and neuromuscular junction disorders.

Interventions
The relevant intervention of interest is electrodiagnostic assessment, consisting of electromyography (EMG), nerve conduction studies (NCS), and related measures, to evaluate the integrity and electrical function of muscles and peripheral nerves.

Comparators
The relevant comparators of interest are standard clinical diagnostic tools and practices currently being used to inform decisions on the diagnosis of suspected peripheral neuropathy or myopathy: history, physical exam, and imaging studies when appropriate.

Outcomes
The clinical utility would be supported by a reduction in pain or other symptoms and improvement in functional measures and quality of life measures specific to the condition. Alternatively, evidence of clinical utility may be derived from a chain of evidence linking improvement in diagnostic accuracy with improvements in treatment guided by a correct diagnosis.

Beneficial outcomes include aiding in the diagnosis of disease and guiding treatment that results in a reductionin symptoms such as pain, numbness, or tingling, and improvements in functional outcomes of muscle strength and quality of life measures.

If patients are diagnosed with peripheral neuropathies or myopathies based on inaccurate EMG or NCS results, unnecessary treatment may be initiated when watchful waiting may be the more appropriate management approach.

Timing
Electrodiagnostic tests are typically performed following clinical evaluation, to confirm a diagnosis or provide additional information for a differential diagnosis.

Setting
The tests should be performed in a dedicated electrodiagnostic laboratory using equipment that provides an assessment of all parameters of the recorded signals.

An EMS and NCS should be performed by a physician or by a trained technician under the direct supervision of a physician.

Technically Reliable
Assessment of technical reliability focuses on specific tests and operators and requires review of unpublished and often proprietary information. Review of specific tests, operators, and unpublished data are outside the scope of this evidence review, and alternative sources exist. This evidence review focuses on the clinical validity and clinical utility.

Clinically Valid
A test must detect the presence or absence of a condition, the risk of developing a condition in the future, or treatment response (beneficial or adverse).

In general, EMG and NCS are considered the criterion standards for establishing abnormalities of the electrical system of nerves and muscles, and hence there is a lack of a true reference standard.

Below are examples of representative literature on clinical validity.

Carpal Tunnel Syndrome

Systematic Reviews
A 2004 systematic review of the literature on the diagnosis of carpal tunnel syndrome (CTS) was performed by the American Academy of Orthopaedic Surgeons (AAOS) in support of its guideline development process.[4] No prospective studies were identified that enrolled a population of patients similar to that seen in clinical practice. AAOS offered the following appraisal of the evidence base:

> "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, AAOS concluded that the sensitivity and specificity of electrodiagnostic assessment for CTS were unknown. Evidence-based recommendations could not be developed, and all recommendations were therefore rated at a level V (expert opinion).

Observational Studies
Two studies identified calculated the sensitivity and specificity of EMG and NCS.[5,6] One study used Carpal Tunnel Syndrome–6 (CTS-6) test results as a comparator[5] and the other used mean values of normal controls as comparators.[6]

Fowler et al (2014) evaluated the diagnostic accuracy of electrodiagnostic testing and ultrasound for diagnosing CTS, using validated clinical diagnostic criteria as the reference standard (see Table 2).[5] The reference standard was 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. Sensitivity, specificity, positive predictive value, and negative predictive values were calculated (see Table 3). This study was limited by the imperfect nature of the reference standard (CTS-6 is not a true criterion standard for diagnosis) and suboptimal sensitivity.

Chang et al (2006) examined the sensitivity and specificity of various motor and sensory NCS parameters in 280 consecutive patients (360 hands) with suspected CTS and 150 normal controls (see Table 2).[6] In the 360 hands with suspected CTS, 328 (91%) had at least 1 electrodiagnostic abnormality and 9% had normal exams. For individual NCS measures, the sensitivity ranged from 73% to 87% and the specificity ranged from 97% to 99% (see Table 3). Among the 150 controls, NCS readings were mostly within the normal range, with a few sensory and motor findings falling in the abnormal range.

Table 2. Summary of Nonrandomized Study Characteristics for Carpal Tunnel Syndrome

Study	Study Type	Country	Dates	Participants	Blinding	Testing
Fowler et al (2014)[5]	Cross-sectional	U.S.	NR	• Consecutive patients referred to an upper-extremity practice for EMG testing • CTS-6 positive: 55 • CTS-6 negative: 30	EMG technician blinded to CTS-6 results	All patients underwent: (1) CTS-6, (2) ultrasound, and (3) electrodiagnostic testing
Chang et al (2006)[6]	Cross-sectional	Taiwan	NR	• Consecutive patients presenting with ≥1 of the following: numbness, paresthesia, nocturnal awakening, weakness, or pain • CTS patients: 280 • Volunteer controls: 150	EMG technicians blinded to clinical information and diagnosis	All patients underwent the following EMG/NCS testing: motor DL, W-P MCV, sensory DL (D1), sensory DL (D2), sensory DL (D4), W-P SCV (D2), W-P SCT (D2), M-R and M-U

CTS-6: Carpal Tunnel Syndrome–6; D1: thumb; D2: index finger; D4: ring finger; DL: distal latency; EMG: elecyromyography; M-R: median-radial sensory latency difference; M-U: median-ulnar sensory latency difference; NCS: nerve conduction studies; NR: not reported; W-P MCV: wrist-palm motor conduction velocity; W-P SCT: wrist-palm sensory conduction time; W-P SCV: wrist-palm sensory conduction velocity.

Table 3. Summary of Nonrandomized Study Results for Carpal Tunnel Syndrome

Study	Sensitivity (95% CI), %		Specificity (95% CI), %		PPV (95% CI), %		NPV (95% CI), %	
	US[a]	EMG[a]	US[a]	EMG[a]	US[a]	EMG[a]	US[a]	EMG[a]
Fowler et al (2014)[5]	89 (77 to 95)	89 (77 to 95)	90 (72 to 97)	80 (61 to 92)	94 (83 to 98)	89 (71 to 95)	82 (64 to 92)	80 (61 to 92)
Chang et al (2006)[6]								
Motor DL[b]	65.0		99.3		NR		NR	
SDL (D1)[b]	80.3		98.7		NR		NR	
SDL (D2)[b]	72.5		99.3		NR		NR	
SDL (D4)[b]	76.7		100		NR		NR	
W-P MCV[b]	81.7		100		NR		NR	
W-P SCV[b]	73.6		100		NR		NR	
W-P SCT[b]	80.8		100		NR		NR	
M-R[b]	86.7		98.7		NR		NR	
M-U[b]	87.2		96.7		NR		NR	

CI: confidence interval; D1: thumb; D2: index finger; D4: ring finger; DL: distal latency; EMG: electromyography; M-R: median-radial sensory latency difference; M-U: median-ulnar sensory latency difference; NPV: negative predictive value; NR: not reported; PPV: positive predictive value; SDL: sensory distal latency; US: ultrasound; W-P MCV: wrist-palm motor conduction velocity; W-P SCT: wrist-palm sensory conduction time; W-P SCV: wrist-palm sensory conduction velocity.

[a] Compared with Carpal Tunnel Syndrome–6 test results

[b] Compared with mean values of normal controls ± 2.5 standard deviations.

Two studies calculated correlations between EMG and NCS with other measures rather than calculating sensitivity and sensitivity.[7,8] Homan et al (1999) evaluated the association among clinical symptoms, physical exam, and electrodiagnostic studies in 824 individuals with suspected work-related CTS from 6 job facilities.[7] A total of 449 individuals had at least 1 positive finding on any exam. Of these, only 3% had positive findings on all 3 domains (symptoms, physical exam, NCS). Overall, there was poor agreement across the 3 measures (κ range, 0-0.18). Tulipan et al (2017) retrospectively studied 50 patients presenting for CTS treatment.[8] Patients completed the Disabilities of the Arm, Shoulder, and Hand questionnaire and the 12-Item Short-Form Health Survey. There were no significant correlations between Disabilities of the Arm, Shoulder, and Hand questionnaire and the 12-Item Short-Form Health Survey scores with median motor or sensory latency measures.

Lumbar Radiculopathy

The North American Spine Society published evidence-based guidelines on the diagnosis and treatment of lumbar radiculopathy in 2012.[9] These guidelines were based on a systematic review of the literature identifying studies of diagnostic techniques. Five studies on the diagnostic accuracy of electrophysiologic tests were discussed—2 case-control studies and 3 case series. 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%, respectively.

After the North American Spine Society publication, Mondelli et al (2013) evaluated EMG findings in patients with lumbosacral radiculopathy and herniated disc. The diagnosis of radiculopathy due to herniated disc was based on a combination of clinical symptoms and magnetic resonance imaging results.[10] A total of 108 consecutive patients with monoradiculopathy at L4, L5, or S1 were enrolled from 4 electrodiagnostic laboratories. At least 1 EMG abnormality was recorded in 42% of patients, with the most common 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

The Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) published an evidence review (2005) in support of practice parameters on the utility of electrodiagnostic testing for patients with suspected peroneal neuropathy.[11] Reviewers performed a systematic review of the literature through July 2003 on the utility of EMG/NCS. Eleven studies met inclusion criteria, four of which were prospective. Eight studies described the use of motor NCS, 8 described the use of sensory NCS, and 5 described the use of needle EMG. Strength of evidence assessments considered the studies to be class III or IV level of evidence. The strongest study design (n=4 studies) used a cohort of patients with clinically diagnosed peroneal neuropathy and reported the sensitivity of EMG/NCS. Sensitivity rates for EMG/NCS varied widely by the type of measure, and the specific area tested, ranging from 19% to 91%. Specificity was not reported. Reviewers concluded that certain NCS parameters were useful for diagnosing peroneal neuropathy and proposed a specific testing strategy to maximize sensitivity. EMG was not found to be useful for confirming the diagnosis of peroneal neuropathy but was helpful in excluding alternative diagnoses.

Pediatric Myopathy

Evidence was identified comparing the accuracy of EMG and NCS with muscle biopsy in children with suspected myopathy. The intent of this line of research is to evaluate whether a diagnosis can be made with certainty using clinical exam plus EMG or NCS, thereby avoiding muscle biopsy.

Rabie et al (2007) compared the diagnostic accuracy of EMG with muscle biopsy in children who had neuropathies or myopathies.[12] 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 was limited by small numbers of patients in each group.

Ghosh and Sorenson (2014) performed a retrospective chart review of 227 patients who received EMG studies between the 2009 and 2013.[13] Seventy-two (32%) patients also received muscle biopsy, and these 72 patients constituted the study group. The criterion standard was myopathy confirmed by muscle biopsy or by genetic testing. The overall sensitivity of EMG was 91%, with the most commonly missed diagnosis being metabolic myopathy. The overall specificity was 67%, which is lower than most other reports of specificity, raises concern 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: Clinically Valid

EMG/NCS testing is generally considered to be specific, but not sensitive. However, the evidence on diagnostic accuracy of EMG and NCS is poor, in part because of the lack of a true reference standard. In the scattered evidence 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.

Clinically Useful

A test is clinically useful if the use of the results informs management decisions that improve the net health outcome of care. The net health outcome can be improved if patients receive correct therapy, or more effective therapy, or avoid unnecessary therapy, or avoid unnecessary testing.

To determine the clinical utility of EMG and NCS, studies need to evaluate the use of EMG and NCS testing to guide treatment decisions and then report health outcomes following the treatments. No studies of this type were identified.

Chain of Evidence

Indirect evidence on clinical utility rests on clinical validity. If the evidence is insufficient to demonstrate test performance, no inferences can be made about clinical utility.

The lack of high-quality evidence on the clinical utility of EMG and NCS is reflected by the lack of evidence-based guidelines. Most existing guidelines rely on expert consensus. This section reviews guidelines from 3 organizations, focusing on the methods of the development process, and the rigor of evidence review. The 3 organizations are AANEM, AAOS (CTS only), and the American Academy of Neurology (AAN). The Practice Guidelines and Position Statements discussion in the Supplemental Information section summarizes the recommendations of the guidelines.

In 1999, AANEM made recommendations on electrodiagnostic medicine based on the consensus of 43 experts in the field of electrodiagnostic medicine.[2] AANEM

provided no information on the selection process for these individuals but noted that they were neurologists or physiatrists representing diverse practice types and locations.

AAOS published practice guidelines on the diagnosis and treatment of CTS in 2007.[14] AAOS made the following statement on its guideline methodology:

> "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."

Consensus on guideline recommendations was reached using a modification of the nominal group technique.

AAN published a position statement on electrodiagnostic assessment in 2004.[15] 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 provide a literature review or references to accompany recommendations.

Section Summary: Clinically Useful

No studies were identified that evaluated clinical utility. Existing guidelines from prominent major specialty societies in electrodiagnostic medicine consist primarily of expert consensus. For guidelines based on an evidence review, such as the AAOS guidelines, the evidence was not sufficient to make evidence-based recommendations. All 3 societies have included general recommendations on the utility of electrodiagnostic testing as an adjunct to clinical diagnosis for myopathic and neuropathic disorders. Guidelines supporting these recommendations do not offer detailed indications for patient testing by diagnosis.

Summary of Evidence

For individuals with suspected peripheral neuropathy or myopathy who receive electrodiagnostic assessment including EMG and NCS, the evidence includes small observational studies on a few diagnoses, such as CTS, radiculopathy, and myopathy. Relevant outcomes are test accuracy, symptoms, functional outcomes, and quality of life. Because electrodiagnostic assessment is considered the criterion standard for evaluating the electrical function of peripheral nerves and muscles, there is no true alternative reference standard against which the sensitivity and specificity of particular EMG/NCS abnormalities for particular clinical disorders can be calculated. Different studies have used different reference

standards, such as EMG/NCS measures of healthy individuals or clinical examination results. In general, these tests are considered more specific than sensitive, and normal results do not rule out the disease. The limited evidence has shown a wide range of sensitivities, which are often less than 50%. The specificity is expected to be considerably higher, but the data are insufficient to provide precise estimates of either sensitivity or specificity. The evidence is insufficient to determine the effects of the technology on health outcomes.

Supplemental Information

Practice Guidelines and Position Statements

American Association of Neuromuscular & Electrodiagnostic Medicine

The American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) has published several position statements on recommended coverage policy for electromyography (EMG) and nerve conduction study (NCS). The first, initially published in 1999, was updated in 2004. The second was published in 2010.[16] Needle EMG and NCS testing was recommended for the following indications:

1. "Focal neuropathies, entrapment neuropathies, or compressive lesions/syndromes such as carpal tunnel syndrome, ulnar neuropathies, or root lesions, for localization
2. Traumatic nerve lesions, for diagnosis and prognosis
3. Diagnosis or confirmation of suspected generalized neuropathies, such as diabetic, uremic, metabolic, or immune
4. Repetitive nerve stimulation in diagnosis of neuromuscular junction disorders such as myasthenia gravis, myasthenic syndrome
5. 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
6. Radiculopathy-cervical, lumbosacral
7. Polyneuropathy-metabolic, degenerative, hereditary
8. Plexopathy-idiopathic, trauma, infiltration
9. Myopathy-including polymyositis and dermatomyositis, myotonic, and congenital myopathies
10. Precise muscle location for injections such as botulinum toxin, phenol, etc."

This document also listed situations where electrodiagnostic assessment is considered investigational.

AANEM published practice parameters on the utility of EMG/NCS for the diagnosis of peroneal neuropathy in 2005.[11] This evidence-based review focused on whether EMG/NCS are useful in diagnosing peroneal neuropathy and/or in determining prognosis. Table 4 lists recommendations AANEM deemed "possibly useful, to make or confirm" a diagnosis.

Table 4. Guidelines on Diagnosis of Peroneal Neuropathy

Recommendation	LOR	COE
Motor NCSs of the peroneal nerve recording from the AT and EDB muscles	C	III
Orthodromic and antidromic superficial peroneal sensory NCS	C	III
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 **However, abnormalities on needle examination outside of the distribution of the peroneal nerve should suggest alternative diagnoses**	U	IV Expert
In patients with confirmed peroneal neuropathy, EDX studies are possibly useful in providing prognostic information, with regards to recovery of function	C	III/IV

AT: anterior tibialis; COE: class of evidence; EDB: extensor digitorum brevis; EDX: electrodiagnostic; EMG: electromyography; LOR: level of recommendation; NCS: nerve conduction study.

A 2003 consensus statement on diagnosing multifocal motor neuropathy from AANEM[17] has stated:

> "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."

A 2004 AANEM approved a position statement, endorsed by the American Academy of Neurology and the American Academy of Physical Medicine & Rehabilitation, on diagnostic electromyography included the following[15]:

- "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."

AANEM (2018) published a policy statement on the use of EMG for distal symmetric polyneuropathy.[18] The statement described 5 situations in which EMG would be beneficial for patients with distal symmetric polyneuropathy: "1) determining primary and alternative diagnoses; 2) determining severity, duration,

and prognosis of disease; 3) evaluating risk of associated problems; 4) determining the effect of medications; and 5) evaluating the effect of toxic exposures."

American Academy of Orthopaedic Surgeons

The American Academy of Orthopaedic Surgeons (2007) issued guidelines on the diagnosis of carpel tunnel syndrome.[14] Table 5 lists recommendations made.

Table 5. Guidelines on Diagnosis of Carpal Tunnel Syndrome

No.	Recommendation	LOR	GOE
3.1a	"The physician may obtain electrodiagnostic tests to differentiate among diagnoses."	V	C
3.1b	"The physician may obtain electrodiagnostic tests in the presence of thenar atrophy and/or persistent numbness."	V	C
3.1c	"The physician should obtain electrodiagnostic tests if clinical and/or provocative tests are positive and surgical management is being considered."	II/III	B
3.2	"If the physician orders electrodiagnostic tests, the testing protocol should follow the AAN/AANEM/AAPMR guidelines for diagnosis of CTS."	IV/V	C

AANEM: American Association of Neuromuscular & Electrodiagnostic Medicine; AAOS: American Academy of Orthopaedic Surgeons; AAPM&R: American Academy of Physical Medicine and Rehabilitation; CTS: carpal tunnel syndrome; GOE: grade of evidence; LOR: level of recommendation (II/III: "fair evidence"; IV/V: "poor quality evidence; V: "expert consensus").

North American Spine Society

The North American Spine Society published guidelines on the diagnosis and treatment of lumbar disc herniation in 2012.[9] 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)"

U.S. Preventive Services Task Force Recommendations

Not applicable.

Medicare National Coverage

Sensory nerve conduction threshold tests are distinct from "assessment of nerve conduction velocity, amplitude and latency" and from "short-latency somatosensory evoked potentials."

In 2004, the Centers for Medicare & Medicaid affirmed its 2002 noncoverage policy, concluding: "that the use of any type of sNCT device (e.g., '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."[19]

Ongoing and Unpublished Clinical Trials

A search of ClinicalTrials.gov in April 2018 did not identify any ongoing or unpublished trials that would likely influence this review.

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Billing Coding/Physician Documentation Information

95860	Needle electromyography; 1 extremity with or without related paraspinal areas
95861	Needle electromyography; 2 extremities with or without related paraspinal areas
95863	Needle electromyography; 3 extremities with or without related paraspinal areas
95864	Needle electromyography; 4 extremities with or without related paraspinal areas
95865	Needle electromyography; larynx
95866	Needle electromyography; hemidiaphragm
95867	Needle electromyography; cranial nerve supplied muscle(s), unilateral
95868	Needle electromyography; cranial nerve supplied muscles, bilateral
95869	Needle electromyography; thoracic paraspinal muscles (excluding T1 or T12)
95870	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
95872	Needle electromyography using single fiber electrode, with quantitative measurement of jitter, blocking and/or fiber density, any/all sites of each muscle studied
95885	Needle electromyography, each extremity, with related paraspinal areas, when performed, done with nerve conduction, amplitude and latency/velocity study; limited (List separately in addition to code for primary procedure)
95886	Needle electromyography, each extremity, with related paraspinal areas, when performed, done with nerve conduction, amplitude and latency/velocity study; complete, five or more muscles studied, innervated by three or more nerves or four or more spinal levels (List separately in addition to code for primary procedure)
95887	Needle electromyography, non-extremity (cranial nerve supplied or axial) muscle(s) done with nerve conduction, amplitude and latency/velocity study (List separately in addition to code for primary procedure)
95907	Nerve conduction studies; 1-2 studies
95908	Nerve conduction studies; 3-4 studies
95909	Nerve conduction studies; 5-6 studies
95910	Nerve conduction studies; 7-8 studies
95911	Nerve conduction studies; 9-10 studies
95912	Nerve conduction studies; 11-12 studies
95913	Nerve conduction studies; 13 or more studies

	IDCD-10
E10.40-E10.49	Type 1 diabetes mellitus with neurological complications code range
G12.20-G12.9	Motor neuron disease code range
G54.0-G54.9	Nerve root and plexus disorders code range
G55	Nerve root and plexus compressions in diseases classified elsewhere
G56.00-G56.92	Mononeuropathies of upper limb code range
G57.00-G57.92	Mononeuropathies of lower limb code range
G60.0-G60.9	Hereditary and idiopathic neuropathy code range
G61.0-G61.9	Inflammatory polyneuropathy code range
G70.00-G70.9	Myasthenia gravis and other myoneural disorders code range
G71.0-G71.9	Primary disorders of muscles (includes muscular dystrophy)
M33.00-M33.99	Dermatopolymyositis code range
M54.10-M54.18	Radiculopathy code range
M54.30-M54.32	Sciatica code range
M54.40-M54.42	Lumbago with Sciatica code range
S14.12a-S14.9xs	Injury to nerves of the neck code range
S24.2xa-S24.9xs	Injury to nerves of the thorax code range
S34.21a-S34.9xs	Injury to nerves of the abdomen, lower back and pelvis level code range
S44.00a-S44.92s	Injury of nerves at shoulder and upper arm level code range
S54.00a-S54.92s	Injury of nerves at forearm level code range
S64.00a-S64.92s	Injury of nerves at wrist and hand level code range
S74.00a-S74.92s	Injury of nerves at hip and thigh level code range
S84.00a-S84.92s	Injury of nerves at lower leg level code range
S94.00a-S94.92s	Injury of nerves at ankle and foot level code range

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 myopathies when criteria are met.
10/1/16 No policy statement changes.
10/1/17 No policy statement changes.
10/1/18 No policy statement changes.