Automated Point-of-Care Nerve Conduction Tests

DISCLAIMER

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POLICY

Automated point-of-care nerve conduction tests are considered investigational.

POLICY GUIDELINES

There is a specific CPT code for this testing:

95905: Motor and/or sensory nerve conduction, using preconfigured electrode array(s), amplitude and latency/velocity study, each limb, includes F-wave study when performed, with interpretation and report.

Automated nerve conduction testing using devices such as the Axon II, which does not have stimulus and recording electrodes on the same preconfigured electrode array, should be reported using the unlisted CPT code 95999 or HCPCS code G0255 - Current perception threshold/sensory nerve conduction test (SNCT), per limb.

BENEFIT APPLICATION

BLUECARD/NATIONAL ACCOUNT ISSUES

State or federal mandates (e.g., Federal Employee Program) may dictate that certain U.S. Food and Drug Administration–approved devices, drugs, or biologics may not be considered investigational, and thus these devices may be assessed only by their medical necessity.

BACKGROUND

ELECTRODIAGNOSTIC TESTING

Nerve conduction studies (NCSs) and needle electromyography (EMG), when properly performed by a trained practitioner, are considered the criterion standard of electro-diagnostic testing for the evaluation of focal and generalized disorders of peripheral nerves.

CARPAL TUNNEL SYNDROME

However, the need for specialized equipment and personnel may limit the availability of electro-diagnostic testing for some patients. One proposed use of automated nerve conduction devices is to assist in the diagnosis of carpal tunnel syndrome. Carpal tunnel syndrome is a pressure-induced...
entrapment neuropathy of the median nerve as it passes through the carpal tunnel, resulting in sensorimotor disturbances. This syndrome is defined by its characteristic clinical symptoms, which may include pain, subjective feelings of swelling, and nocturnal paresthesia. A variety of simple diagnostic tools are available, and a positive response to conservative management (steroid injection, splints, modification of activity) can confirm the clinical diagnosis.\textsuperscript{1} Electrodiagnostic studies may also be used to confirm the presence or absence of a median neuropathy at the wrist, assess the severity of the neuropathy, and assess associated diagnoses. Nerve conduction is typically assessed before the surgical release of the carpal tunnel, but the use of EMG in the diagnosis of carpal tunnel syndrome is controversial.

**LUMBOSACRAL RADICULOPATHY**

Electrodiagnostic studies are useful in the evaluation of lumbosacral radiculopathy in the presence of disabling symptoms of radiculopathy or neuromuscular weakness. These tests are most commonly considered in patients with persistent disabling symptoms when neuroimaging findings are inconsistent with clinical presentation. Comparisons of automated point-of-care (POC) NCSs with EMGs and standardized NCSs have been evaluated as alternative electrodiagnostic tools.

**PERIPHERAL NEUROPATHY**

POC nerve conduction testing has been proposed as an alternative to standard electrodiagnostic methods for the diagnosis of peripheral neuropathy and, in particular, for detecting neuropathy in patients with diabetes. Peripheral neuropathy is relatively common in patients with diabetes, and the diagnosis is often made clinically through the physical examination. Diabetic peripheral neuropathy can lead to morbidity including pain, foot deformity, and foot ulceration. Clinical practice guidelines have recommended using simple sensory tools such as the 10-g Semmes-Weinstein monofilament or the 128-Hz vibration tuning fork for diagnosis.\textsuperscript{2} These simple tests predict the presence of neuropathy defined by electrophysiologic criteria with a high level of accuracy. Electrophysiologic testing may be used in research studies and may be required in cases with an atypical presentation.

**REGULATORY STATUS**

Multiple devices have been cleared for POC neural conduction testing. For example, in 1986, Neurometer® CPT/C (Neurotron\textsuperscript{®}) was cleared for marketing by the U.S. Food and Drug Administration (FDA) through the 510(k) process (K853608). The device evaluates and documents sensory nerve impairments at cutaneous or mucosal sites. The evaluation detects and quantifies hyperesthesia in early stages of progressive neuropathy and hypoesthesia in more advanced conditions.

In 1998 NC-stat\textsuperscript{®} (NeuroMetrix) was cleared by FDA through the 510(k) process (K982359). NC-stat\textsuperscript{®} is intended “to measure neuromuscular signals that are useful in diagnosing and evaluating systemic and entrapment neuropathies.” This version is no longer commercially available. It is the predicate device for the NC-stat DPNCheck\textsuperscript{®} (K041320), cleared in 2004, and the NeuroMetrix Advance (K070109), cleared in 2008. The NC-stat DPNCheck device measures the sural nerve conduction velocity and sensory nerve action potential amplitude. It is a handheld device with an infrared thermometer, noninvasive electrical stimulation probes, and a single-use biosensor for each test. NC-stat DPNCheck is designed specifically for NCS of the sural nerve in the assessment of diabetic peripheral neuropathy. The NeuroMetrix ADVANCE is a POC test that can be used to perform needle EMG in addition to surface electrodes for the performance of NCSs. If the needle EMG module is used, then the device is also intended to measure signals useful in evaluating disorders of muscles.

On January 23, 2017, Cadwell Sierra Summit, Cadwell Sierra Ascent (Cadwell Industries) was cleared for marketing by FDA through the 510K process (K162383). There is a portable laptop version and a desktop
application with a handheld device. The system is used for acquisition, display, storage, transmission, analysis, and reporting of electrophysiologic and environmental data including EMG, NCS, evoked potentials, and autonomic responses (RR interval variability). The Cadwell Sierra Summit is used to detect the physiologic function of the nervous system, and to support the diagnosis of neuromuscular diseases or conditions.

FDA product code: JXE.

Other examples of devices cleared for marketing by FDA through the 510(k) process are noted in Table 1.

### Table 1. Examples of FDA Cleared Devices for Neural Conduction Testing

<table>
<thead>
<tr>
<th>Device</th>
<th>Manufacturer</th>
<th>Date Cleared</th>
<th>510(k)</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axon II™</td>
<td>PainDX</td>
<td>1998</td>
<td>K980866</td>
<td>Part of a routine neurologic exam or screening procedure for detection of peripheral neuropathy, which may be caused by various pathologic conditions or exposures to toxic substances</td>
</tr>
<tr>
<td>Brevio®</td>
<td>Neurotron Medical</td>
<td>2001</td>
<td>K012069</td>
<td>To measure nerve response latency and amplitude in the diagnosis and monitoring of peripheral neuropathies</td>
</tr>
<tr>
<td>NC-stat®, NC-stat</td>
<td>NeuroMetrix</td>
<td>2004</td>
<td>K041320</td>
<td>To stimulate and measure neuromuscular signals in diagnosing and evaluating systemic and entrapment neuropathies. Added the sural biosensor for use in diagnosing neuropathies affecting the sural nerve.</td>
</tr>
<tr>
<td>DPN-Check</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC-stat®</td>
<td>NeuroMetrix</td>
<td>2006</td>
<td>K060584</td>
<td>Addition of the modified median motor-sensory biosensor to stimulate and measure neuromuscular signals useful in diagnosing and evaluating systemic and entrapment neuropathies</td>
</tr>
<tr>
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<tr>
<td>XLTEK NEUROPATH</td>
<td>Excel Tech</td>
<td>2006</td>
<td>K053058</td>
<td>To stimulate and measure neuromuscular signals useful in diagnosing and evaluating systemic and entrapment neuropathies</td>
</tr>
<tr>
<td>NeuroMetrix Advance™</td>
<td>NeuroMetrix</td>
<td>2008</td>
<td>K070109</td>
<td>To measure neuromuscular signals useful as an aid in diagnosing and evaluating patients suspected of having focal or systemic neuropathies. If the elective needle EMG module is used, then the device is also intended to measure signals useful as an aid in evaluating disorders of muscles.</td>
</tr>
</tbody>
</table>

EMG: electromyography; FDA: U.S. Food and Drug Administration.

**RATIONALE**

This evidence review was created in February 2007 and has been updated regularly with searches of the MEDLINE database. The most recent literature update was performed through July 6, 2017.

Assessment of a diagnostic technology typically focuses on 3 categories of evidence: (1) technical performance; (2) diagnostic accuracy (sensitivity, specificity, positive and negative predictive value) in
appropriate populations of patients; and (3) demonstration that the diagnostic information can be used to improve patient outcomes. This evaluation focuses on the technical performance of NC-stat, the first automated nerve conduction test device to be marketed, and its reported performance in diagnosing patients (validity) with suspected deficits of neuronal transmission (eg, carpal tunnel syndrome [CTS], lumbosacral radiculopathy, diabetic neuropathy).

AUTOMATED POINT-OF-CARE NERVE CONDUCTION STUDIES

Technical Performance
This technical performance review applies to all clinical indications addressed in this evidence review.

The technical performance of a device is typically assessed with 2 types of studies: those that compare test measurements with a criterion standard and those that compare results taken with the same device on different occasions (test-retest reliability). The criterion standard for nerve conduction testing is the electrophysiologic nerve conduction study (NCS) combined with needle electromyography (EMG). Several studies have assessed the reliability and validity of NC-stat when used by personnel trained in electrophysiology. These studies, most of which are company-sponsored, are described next.

Comparison with the Criterion Standard
A 2006 study compared results for sensory nerve testing from NC-stat with the criterion standard in median and ulnar nerves of 60 patients referred to an EMG laboratory for neck and shoulder pain who also volunteered to undergo testing with NC-stat. Reported Pearson correlations between NC-stat and the reference standard were high (0.91 for median nerve distal sensory latency [DSL], 0.70 for ulnar DSL, 0.88 for the median-ulnar difference of the DSL). However, this final correlation was calculated only with the responses obtained for 81 (68%) of 120 possible nerve pairs. The authors reported systematic differences between the techniques and indicated that use of NC-stat would require applicable reference ranges.

A 2004 study of motor nerve function compared NC-stat with standard nerve conduction tests of the wrist in a small study of 17 subjects with diabetes who had clinical evidence of peripheral neuropathy in either the upper or lower extremity. Again, Pearson correlation coefficients were relatively high and ranged from 0.70 for ulnar distal motor latency (DML) to 0.96 for median nerve DML.

Another NeuroMetrix-sponsored trial (2007) compared NC-stat with standard EMG results for peroneal and posterior tibial nerve conduction in 60 patients referred to an EMG laboratory. The report indicated that all patients referred to the laboratory were offered the opportunity to participate but did not provide the total number of referrals. F-wave latency was found to have the highest correlation (Spearman $\rho=0.91, 0.90$), with moderate correlations for amplitude (Spearman $\rho=0.86, 0.73$) and DML (Spearman $\rho=0.70, 0.45$) for peroneal and posterior tibial nerves, respectively. The authors concluded that there was excellent criterion validity for the peroneal and posterior tibial F-wave latency and the peroneal amplitude; acceptable criterion validity for the peroneal DML and posterior tibial amplitude; but the validity of the posterior tibial DML could not be demonstrated. Although NC-stat results were significantly correlated with standard EMG tests in the study population as a whole, in subgroup analysis of the most abnormal half of responses, the correlation coefficient for amplitude of the peroneal response was 0.62, and the correlation coefficient for DML was only 0.32 for the posterior tibial nerve and 0.10 for the peroneal nerve. Thus, in this pathologic subgroup analysis, criterion validity was lost for the peroneal DML and decreased from “excellent” to “acceptable” for the other parameters. The authors noted that “this study did not address interpretations performed by physicians using NC-stat data, nor the validity of the reference ranges used or the way these were collected.”
In 2004, Rotman et al reported a Pearson correlation coefficient of 0.944 for DML in 46 patients with CTS who had an NCS at a different time (average difference, 28 days). Another study (2005) compared results from NC-stat with standard NCS in a previously diagnosed patient population. This study compared DML of the median nerve in 72 (of 400 treated) patients with established CTS before and after surgical intervention, finding a correlation coefficient of 0.88 for the median nerve DML. However, a scatter plot indicated poor correlation for longer latencies.

Test-Retest
NeuroMetrix has reported on intraoperator reliability in 15 healthy subjects who underwent measurements 7 days apart. This 2006 report stated that “each upper- and lower-extremity nerve was tested twice by the same technician” and that 9 subjects participated in both upper- and lower-extremity studies. It is unclear from the report whether the upper and lower extremities were designed as separate studies, or if 12 (29%) of 42 measurements did not provide usable data. Of the data reported, the coefficient of variation ranged from 0.013 for F-wave latency to 0.298 for the compound muscle action potential amplitude of the peroneal nerve. A 2010 publication by NeuroMetrix reported test-retest reproducibility with the ADVANCE system in 30 subjects with symptoms suggestive of neuropathies; 29 subjects completed the study. Coefficients of variation ranged from 4.2% to 9.8% for tests measured 3 to 7 days apart. Between-session intraclass correlation coefficients (ICCs) ranged from 0.98 for F-wave latency to 0.77 for sural sensory conduction velocity.

Normative Values
In 2009, NeuroMetrix published reference ranges for key nerve conduction parameters in healthy subjects. Data analyzed were pooled from 5 studies, including from 92 to 848 healthy subjects with data on the median, ulnar, peroneal, tibial, and sural nerves. Subject age and height were found to affect the parameters. In addition to providing reference ranges for clinicians to use (providing that NCS techniques are consistent with those described in the article), the authors stated that clinicians could use the same method to develop their reference ranges. At this time, the proposed reference ranges have not been validated in a clinical patient population.

Due to the lack of uniform standards in nerve conduction testing in the United States, the American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) identified 7 criteria that would identify high quality NCS articles that would be appropriate for using as referent standards (2016). AANEM identified normative criteria for nerve conduction velocity tests based on a review of high-quality published studies (see Table 2). In March 2017, the American Academy of Neurology affirmed AANEM’s recommendations.

Table 2. Criteria for Evaluating Published Sources for Normative Standards

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year published</td>
<td>Published during or after 1990, written in or translated from other languages into English</td>
</tr>
<tr>
<td>Sample size</td>
<td>&gt;100 normal subjects</td>
</tr>
<tr>
<td>Subjects</td>
<td>Inclusion and exclusion criteria must be methodologically sound and reflect a true “normal” group of asymptomatic individuals</td>
</tr>
<tr>
<td>Testing factors</td>
<td>● Use of digital electromyographic equipment</td>
</tr>
<tr>
<td></td>
<td>● Methods of temperature control stated</td>
</tr>
<tr>
<td></td>
<td>● Testing techniques with electrode placement and distances between simulating and recording electrodes specified</td>
</tr>
<tr>
<td></td>
<td>● Filter settings specified</td>
</tr>
</tbody>
</table>
MP 2.01.77
Automated Point-of-Care Nerve Conduction Tests

- Screen display parameters (milliseconds per division, microvolts/millivolts per division) specified

<table>
<thead>
<tr>
<th>Age</th>
<th>Wide distribution of subject ages &gt;18 years with adequate sampling of the elderly</th>
</tr>
</thead>
</table>

| Statistical analyses | ● Data distribution should be described and appropriate statistical methods used to account for non-Gaussian distributions  
● Cutoff values expressed and derived as percentiles of the distribution (the preferred method)  
● Percentage of subjects who have an absent response should be reported |

| Data presentation | Reference values and cutoff points for NCS parameters clearly presented in a useful format |

NCS: nerve conduction study.

In 2016, Chen published reference values for upper and lower NCSs in adults, as a companion study to the Dillingham report (above), to address the need for greater standardization in the field of electrodiagnostic medicine.\(^\text{13}\) Using the consensus based criteria developed by AANEM a comprehensive literature search was conducted for 11 routinely performed sensory and motor NCS from 1990 to 2012. Over 7500 articles were found, but after review a single acceptable study meeting all criteria was identified for the 11 nerves. Reviewers determined there were multifactorial reasons that so few studies met the criteria. Large-scale normative studies are time intensive, requiring significant resources and cost. Data from many studies did not address the non-Gaussian distribution of NCS parameters and often derived cutoff values using the mean and standard deviations rather than percentiles.

**Section Summary: Technical Performance**

Six studies have evaluated the technical performance of the NC-stat test in upper and lower extremities when used by electrophysiology personnel. The total population studied was 567 patients ranging from cohorts of 15 to 400. Weaknesses in the studies included lack of applicable or valid reference ranges for testing and variable test results. Three reviews addressed the lack of normative values or reference ranges to validate or confirm pathology.

**Diagnostic Accuracy**

Diagnostic performance is evaluated based on the ability of a test to diagnose a clinical condition accurately compared with a criterion standard. The sensitivity of a test is the ability to detect a disease when the condition is present (true positive), while specificity indicates the ability to detect patients who are suspected of disease but who do not have the condition (true negative). Evaluation of diagnostic performance, therefore, requires independent assessment by 2 methods in a population of patients who are suspected of disease but who do not all have the disease. Studies that do not meet these criteria (broad patient population and comparison of point-of-care [POC] use with the standard laboratory EMG) may be considered relevant to the technical performance of the device but are inadequate for evaluation of its diagnostic performance.

For diagnostic accuracy, we considered NeuroPath Comparative Validation Study Plan (NCT00393549). This phase 3 clinical trial was terminated by the manufacturer without further documentation. The intent of the trial was to compare the performance of the NeuroPath automated nerve conduction test with the standard of care manual test in the diagnosis of entrapment neuropathies. Planned study outcomes were the diagnostic validity and accuracy of the XL Tech NeuroPath.

There is no documentation that the results of NC-stat studies obtained by minimally trained personnel (≈1 day device-specific training) compared with specialists trained in EMG and electrophysiology have been validated by 2 methods.
Section Summary: Diagnostic Accuracy
Criterion standards are necessary to evaluate diagnostic performance. There are diagnostic accuracy limitations related to the lack of studies evaluating validation of the performance of automated nerve conduction test with the standard of care manual tests and validation of minimally trained electrophysiology personnel performance.

ENTRAPMENT NEUROPATHY: CARPAL TUNNEL SYNDROME

Clinical Context and Test Purpose
The following PICOTS were used to select literature to inform this review.

Patients
The relevant populations of interest are individuals with CTS.

Interventions
The relevant intervention of interest is automated POC nerve conduction testing.

Comparators
The comparators of interest are a standard clinical examination, and electrophysiologic NCS combined with needle EMG.

Outcomes
The primary outcomes of interest relate to diagnostic accuracy (i.e., test accuracy and validity) and health outcomes (i.e., symptoms, functional outcomes).

Timing
Diagnostic accuracy is a short-term outcome. Symptoms and functional outcomes would be measured over the long term after patients have been diagnosed and treated.

Setting
Patients would be tested in the primary care or specialty care setting (e.g., neurology or orthopedics).

Technical Performance
See the Technical Performance section above.

Diagnostic Accuracy
In an early report of NC-stat technology using DML to diagnose CTS, Leffler et al (2000) reported that in 248 symptomatic hands (apparently a combination of an initial and validation group), compared with conventional diagnosis, testing using this device had a sensitivity of 86% and specificity of 90%. In the 2004 report by Rotman et al, the NC-stat DML had a sensitivity of 89% “at the predetermined specificity of 95%” for the diagnosis of CTS for “70 hands” that met the standardized CTS case definition. However, in a 2006 POC study evaluating industrial workers for possible CTS using DML, many patients who were identified with prolonged DML by NC-stat fell within the normal range (using a 95% cutoff point) as defined by this study population.

A 2008 report assessed the diagnostic performance of NC-stat against the criterion standard NCS in patients who had been referred for electrodiagnostic testing at one of the several academic medical centers. Of 47 patients invited to participate in the study, 12 declined to participate, and records from 1 patient were missing, resulting in data analysis of 33 patients. The goal of the study was to compare the diagnostic performance of both testing methods as they would be used in standard practice; thus,
patients were not excluded by the particular diagnosis for which they were referred. The diagnosis being tested was CTS in 25 (76%) patients, with the remaining 8 patients having other potential diagnoses. NC-stat testing was independently performed by assistants (medical students, physical therapy assistants, occupational therapy assistants) who were trained to operate the device following the manufacturer’s recommendations. NC-stat results could not be obtained for 2 patients for median nerve motor studies and 3 (15%) patients for median nerve sensory studies. Based on the manufacturer’s suggested cutoff for abnormal nerve conduction, sensitivity was 100% for both the motor and sensory median-ulnar difference; specificity was 62% to 69% for the motor median-ulnar difference and 41% to 47% for the sensory median-ulnar difference. Pearson correlation coefficients ranged from 0.40 for the ulnar nerve to 0.91 for the median dorsal motor nerve. The ICCs had generally lower values than the Pearson coefficients, reflecting systematic bias due to methodologic differences in the 2 methods of NCS. The authors concluded that the recommended cutoff values for NC-stat might need to be adjusted, although specific study results were limited by the small sample size. Also, the authors noted that the study did not evaluate how well physicians can assign clinical relevance to the results and that, while the device may be suited for research studies or screening of symptomatic patients, “in many clinical situations referral to a specialist for a more comprehensive evaluation would be prudent.”

Section Summary: Diagnostic Accuracy for Carpal Tunnel Syndrome
There are no randomized controlled trials. Several uncontrolled nonrandomized studies have reported on the diagnostic accuracy of NC-stat to evaluate symptoms suggestive of CTS. There were no clinical comparators. There was high sensitivity but low specificity using manufacturer reference standards. Specificity results were also inconsistent across the trials. No reference ranges were validated, and normative values were not defined in these studies. No validation of testing by trained medical assistants vs trained specialist was reported in the studies.

Clinical Utility
In 2011, Bourke et al reported on a nonrandomized comparison of clinic-based NC-stat with referral to standard electrodiagnostic testing to evaluate the efficiency of work up and costs. The study included 142 patients being considered for decompression surgery for CTS at a hand clinic. Seventy-one patients who accepted NCSs in a nurse-led clinic were compared with 71 historical controls who had been sent for NCSs at the regional neurophysiologic unit. Patients with known or suspected complex neurologic conditions were excluded from the study. Outcome measures were time from presentation to carpal tunnel decompression, the cost of each pathway, and the practicalities of using the device in the clinic. In the NC-stat group, 43 (61%) patients had a diagnosis of CTS confirmed by NC-stat and underwent decompression surgery, and 28 (39%) patients had normal or inconclusive tests. Of these 28 patients, 12 were referred for electrodiagnostic testing, and 2 of them were recommended for decompression surgery (3% false negative). In the referred group, 44 (62%) patients had confirmation of CTS and underwent decompression surgery. Use of NC-stat in the clinic reduced the time from presentation to surgery from 198 days to 102 days. Cost saving for NC-stat was reduced by the need to refer nearly 20% of patients for standard electrophysiologic testing but still favored the clinic-based approach. Health outcomes for both approaches were not assessed.

The NeuroMetrix data registry was analyzed in 2007 for all NC-stat studies performed by a primary care provider and coded for CTS over a period of 10 days. The initial data set consisted of studies on 1190 patients performed by 613 different physician practices; studies that met CTS testing guidelines (82% met strict guidelines, 93% met less restrictive guidelines) were further analyzed. Thus, in nearly 1 (18.4%) of 5 patients, the studies did not meet strict CTS testing guidelines. From the limited patient set, 31% were identified as normal, 53% exhibited CTS, 5% demonstrated an ulnar neuropathy, and 11%
showed a nonspecific neuropathy. No comparison was made with standard nerve conduction testing nor was an assessment made of the impact of this testing on relevant clinical outcomes.

**Section Summary: Clinical Utility**
One nonrandomized study has reported on the clinical outcomes of NC-stat vs referral to standard electrodiagnostic testing. Health outcomes assessing patient symptoms or changes in functional status outcomes were not assessed. A data set from a NeuroMetrix registry on NC-stat did not report on relevant clinical or health outcomes.

**LUMBOSACRAL RADICULOPATHY**

**Clinical Context and Test Purpose**
The following PICOTS were used to select literature to inform this review.

**Patients**
The relevant populations of interest are individuals with lumbosacral radiculopathy.

**Interventions**
The relevant intervention of interest is automated POC nerve conduction testing.

**Comparators**
The comparators of interest are a standard clinical evaluation, and electrophysiologic NCS combined with needle EMG.

**Outcomes**
The primary outcomes of interest relate to diagnostic accuracy (i.e., test accuracy and validity) and health outcomes (i.e., symptoms, functional outcomes).

**Timing**
Diagnostic accuracy is a short-term outcome. Symptoms and functional outcomes would be measured over the long term after patients have been diagnosed and treated.

**Setting**
Patients would be tested in the primary care or specialty care setting (e.g., neurology or orthopedics).

**Technical Performance**
See the Technical Performance section above.

**Diagnostic Accuracy**
Fisher et al (2008) explored the relation between NC-stat and routine NCS/needle EMG in 34 consecutive patients with a clinical history and/or examination consistent with lumbosacral radiculopathy.\(^{19}\) Inclusion in the study was based on a chart review of symptoms from clinical history and/or examination (including low back pain or buttock pain, numbness, and/or paresthesia of one or both lower extremities) and having undergone testing with both NC-stat and routine electrodiagnostic studies. All testing was conducted by the principal investigator, and the reason for and timing of NC-stat testing was not specified. Of 34 patients included in the study, 28 had magnetic resonance imaging of the lumbosacral spine within 6 months of electrodiagnosis, 2 had a postmyelogram computed tomography scan, and 3 had lumbosacral spine radiographs. A neuroradiologist who was blinded to the clinical evaluation and electrodiagnostic results determined from magnetic resonance imaging or computed tomography that lumbosacral root injury was likely at the L4-S and/or L5-S1 levels in 18 (60%)
patients. The study found some correlation between the electrodiagnostic testing and NC-stat. However, 6 of 10 patients who had unremarkable routine electrodiagnostic results had abnormal F-wave and compound muscle action potential amplitude abnormalities with NC-stat testing. The clinical implications of this finding are uncertain.

A 2011 report by Schmidt et al assessed the accuracy of NC-stat diagnosis of lumbosacral radiculopathy in 50 patients and 25 controls with no history of lumbosacral radiculopathy. The patient cohort included patients referred to a tertiary referral EMG laboratory for testing of predominantly unilateral leg symptoms (pain, numbness, weakness). Control subjects were recruited from clinic employees and from patients referred to the EMG laboratory for upper-limb symptoms. All patients underwent a focused history and physical examination and both standard and automated electrodiagnostic testing. Automated testing was performed by experienced technicians who were unaware of the electrodiagnostic test results. Data were transmitted to the manufacturer and compared with a large database of previously recorded data, which were adjusted for the age and height of the patient, and subsequently determined to be normal or abnormal. In the patient cohort, the sensitivity of NC-stat was found to be 0% for L4 radiculopathy, 69% for L5 radiculopathy, and 64% for S1 radiculopathy compared with standard electrodiagnostic testing. By standard electrodiagnostic evaluation, 22 (44%) of the 50 symptomatic patients had findings consistent with L4, L5, or S1 radiculopathy, and 28 (56%) patients were found to be normal or to have a diagnosis other than lumbosacral radiculopathy; NC-stat identified only 4 of these 28 cases (specificity, 14%). Standard electrodiagnostic testing also identified other important diagnoses in 9 (18%) patients not identified by the automated test, while NC-stat reported 6 other diagnoses in patients found to be normal by standard electrodiagnostic testing. All standard electrodiagnostic tests in the control group were normal, but the automated test found that 18 of these subjects were abnormal (specificity, 32%). The study found that raw nerve conduction data were comparable for both techniques; however, computer-generated interpretations by the automated device showed low specificity (numerous false positives) in both symptomatic patients and normal control subjects. An accompanying editorial by England and Franklin (2011) stated that the use of automated nerve conduction devices is controversial and that the use of NC-stat for lumbosacral radiculopathy would likely lead to a high misdiagnosis rate and potentially inappropriate treatment, including surgery. England and Franklin also concluded that an overly sensitive but not very specific test for CTS, or other mono- or polyneuropathies, cannot replace expert use and interpretation of conventional electrodiagnostic testing.

Section Summary: Diagnostic Accuracy
One nonrandomized study comparing results of NCT-stat with results of standard EMG plus NCSs to evaluate the potential diagnosis of lumbosacral radiculopathy found a poor correlation. A second nonrandomized study using an asymptomatic control group reported an unacceptably high false-positive rate in both the patient and control groups when definitive electrodiagnostic testing was performed. Reference ranges were not validated, and normative values were not defined in these studies.

Clinical Utility
No clinical outcome studies were identified to inform this review.

DIABETIC PERIPHERAL NEUROPATHY

Clinical Context and Test Purpose
The following PICOTS were used to select literature to inform this review.
Patients
The relevant populations of interest are individuals with suspected diabetic peripheral neuropathy (DPN).

Interventions
The relevant intervention of interest is automated POC nerve conduction testing.

Comparators
The comparators of interest are a standard clinical evaluation, and electrophysiologic NCS combined with needle EMG.

Outcomes
The primary outcomes of interest relate to diagnostic accuracy (i.e., test accuracy and validity) and health outcomes (i.e., symptoms, functional outcomes).

Timing
Diagnostic accuracy is a short-term outcome. Symptoms and functional outcomes would be measured over the long term after patients have been diagnosed and treated.

Setting
Patients would be tested in the primary care or specialty care setting (e.g., neurology or endocrinology).

Technical Performance
See the Technical Performance section above.

Diagnostic Accuracy
A nonrandomized study has assessed the validity of NC-stat to diagnose DPN through sural nerve testing in patients from diabetes and diabetic neuropathy outpatient practices.22 Perkins et al (2006) enrolled 72 consecutive patients (64 with type 2 diabetes) who completed a clinical evaluation, a conventional NCS, and a POC NC-stat assessment.22 The POC assessment was independently conducted by nontechnologist research staff following a single 1-hour lesson in the NC-stat protocol. The amplitude potential of the sural nerve was tested as an early indicator of diabetic neuropathy. Using a threshold of 6 µV, the authors reported that the sensitivity and specificity of NC-stat for diagnosis of diabetic sensorimotor polyneuropathy, as defined by clinical and conventional electrophysiologic evaluation, were 92% and 82%, respectively. The Spearman correlation coefficient (vs the reference standard) was 0.95. Further study is needed in a broad spectrum of patients, including those who present with atypical neuropathy in a clinical setting.

In 2015, Sharma et al assessed the technical accuracy of NC-stat DPN-Check in 162 patients with diabetes and 80 healthy controls.23 Based on the 10-point Neuropathy Disability Score (NDS), DPN was categorized as none, mild, moderate, or severe. Measurements with the POC device were conducted by blinded assessors. Receiver operating characteristic curves showed high overall accuracy in participants with either no neuropathy or severe neuropathy. However, for patients with mild neuropathy who would benefit most from early diagnosis, accuracy was substantially lower.

In 2016, Chatzikosma et al reported on the diagnostic accuracy of NC-stat DPN-Check by comparing sural nerve conduction in the diagnosis of peripheral neuropathy in 114 patients with type 2 diabetes (58 men, 56 women) with an age- and sex-matched group of 46 healthy controls (24 men, 22 women).24 Diagnosis of DPN was based on the standardized NDS developed by Young et al (1993).25 An NDS of 3 or more was considered diagnostic of DPN. DPN was diagnosed in 42 (36.84%) patients using the NDS.
Examination with NC-stat DPN-Check exhibited 90.48% sensitivity, 86.11% specificity, 79.17% positive predictive value, and 93.94% negative predictive value. The positive likelihood ratio was 6.51, and the negative likelihood ratio was 0.11. In the control group, the NDS was normal in all subjects, while automated NCS was abnormal in 2 subjects. The investigators concluded that the NC-stat DPNCheck “exhibited a very good diagnostic performance” to rule in DPN and was “especially reliable as a screening tool to rule out DPN.” Limitations of this study were identified as the inclusion of patients from a tertiary care setting and not the general diabetic population, exclusion of patients with type I diabetes, and no confirmation of the diagnosis of DPN by classical NCS.

Section Summary: Diagnostic Accuracy

Three nonrandomized studies reported on the diagnostic accuracy of POC automated nerve conduction testing to evaluate a diagnosis of suspected DPN. Two studies used the NC-stat DPNCheck. The 2015 study using NC-Stat DPNChek used laser Doppler technology as a comparator. The 2016 study using NC-Stat DPNChek used standardized clinical examination as its comparator. High sensitivity indicated there may be potential diagnostic value to detect DPN in symptomatic patients. However, specificity was low and inconsistent across the trials. No reference ranges were validated, and normative values were not defined in 2 of the 3 studies. No validation of testing by trained medical assistants vs trained specialist was reported in the studies.

Clinical Utility

No clinical outcome studies were identified to inform this review.

SUMMARY OF EVIDENCE

For individuals who have entrapment carpal tunnel syndrome who received automated POC NCSs, the evidence includes studies on the technical accuracy, diagnostic accuracy, and clinical outcomes from industry-sponsored trials, nonrandomized trials, and registry data. Relevant outcomes are test accuracy and validity, symptoms, and functional outcomes. Four RCTs have reported on the diagnostic accuracy of automated POC nerve conduction testing to diagnose carpal tunnel syndrome. Sensitivity testing has suggested there could be diagnostic value in detecting carpal tunnel syndrome; specificity testing was inconsistent across trials. No reference ranges were validated, and normative values were not defined in these studies. No validation testing by trained medical assistants vs trained specialist was reported in the studies. The evidence on clinical outcomes was limited to a single nonrandomized clinical trial and NeuroMetrix registry data. Neither reported health outcomes assessing patient symptoms or changes in functional status. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals with lumbosacral radiculopathy who received automated POC NCSs, the evidence includes industry-sponsored trials and a nonrandomized study of technical accuracy and diagnostic accuracy. Relevant outcomes are test accuracy and validity, symptoms, and functional outcomes. The evidence on the technical and diagnostic accuracy of POC NCS in this population has shown variable test results across reported trials. No normative values were defined. Weaknesses of the studies included lack of applicable or valid reference ranges for testing, and variable test results validating or confirming pathology. The results of the 2 studies on diagnostic performance were inconclusive, with high false-positive results in a single trial. No trials on health outcomes assessing patient symptoms or changes in functional status were identified. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals with diabetic peripheral neuropathy who received automated POC NCSs, the evidence includes industry-sponsored observational trials and nonrandomized studies on the technical accuracy
and diagnostic accuracy. Relevant outcomes are test accuracy and validity, symptoms, and functional outcomes. The evidence on the technical accuracy for POC NCS in this population has shown variable test results across reported trials. No normative values were defined. Weaknesses of the studies included lack of applicable or valid reference ranges for testing to validate or confirm pathology. Of 3 studies reporting evidence on diagnostic accuracy, two used NC-stat DPN-Check. Sensitivity testing has suggested there could be diagnostic value in detecting diabetic peripheral neuropathy in symptomatic patients; the evidence to detect patients who are suspected of disease but who have mild symptoms was inconsistent. No reference ranges were validated, and normative values were not defined in 2 of the 3 studies. No validation testing by trained medical assistants vs trained specialist was reported in the studies. No trials on health outcomes assessing patient symptoms or changes in functional status were identified. 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

In 2006 the American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) issued a position statement that illustrated how standardized nerve conduction studies (NCSs) performed independently of needle electromyography (EMG) studies may miss data essential for an accurate diagnosis. AANEM discussed how nerve disorders are far more likely to be misdiagnosed or missed completely if a practitioner without the proper skill and training is interpreting the data, making a diagnosis, and establishing a treatment plan. The Association stated that, “the standard of care in clinical practice dictates that using a predetermined or standardized battery of NCSs for all patients is inappropriate,” and concluded that, “It is the position of the AANEM that, except in unique situations, NCSs and needle EMG should be performed together in a study design determined by a trained neuromuscular physician.” This position statement was reviewed, updated, and approved by AANEM in 2014. No changes were made to the earlier statement on NCSs.

U.S. PREVENTIVE SERVICES TASK FORCE RECOMMENDATIONS

Not applicable.

MEDICARE NATIONAL COVERAGE

There is no national coverage determination. In the absence of a national coverage determination, coverage decisions are left to the discretion of local Medicare carriers.

ONGOING AND UNPUBLISHED CLINICAL TRIALS

A search of ClinicalTrials.gov in July 2017 did not identify any ongoing or unpublished trials that would likely influence this review.

REFERENCES


**CODES**

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<tr>
<td>CPT</td>
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<td>Motor and/or sensory nerve conduction, using preconfigured electrode array(s), amplitude and latency/velocity study, each limb, includes F-wave study when performed, with interpretation and report</td>
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<td></td>
<td>95999</td>
<td>Unlisted neurological or neuromuscular diagnostic procedure</td>
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<tr>
<td>HCPCS</td>
<td>G0255</td>
<td>Current perception threshold/sensory nerve conduction test (SNCT), per limb</td>
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<td>ICD-10-CM</td>
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<td>Investigational for all diagnoses</td>
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<tr>
<td>ICD-10-PCS</td>
<td></td>
<td>Not applicable. ICD-10-PCS codes are only used for inpatient services.</td>
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**POLICY HISTORY**

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<td>08/30/17</td>
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<td>Blue Cross of Idaho adopted changes to policy as noted. Policy updated with literature review through July 6, 2017; references 11-13, 22, and 25-26 added. Rationale section revised. Policy statement unchanged.</td>
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