
NeuroMetrix

NC-stat[®] Abstract Book

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The following articles have been published in peer-reviewed medical journals. These articles address the diagnostic accuracy and reliability of the NC-stat, its clinical utility for evaluation and management of common clinical indications such as carpal tunnel syndrome and diabetic neuropathy, and its use in federally funded and FDA sanctioned clinical trials.

Kong X, Schoenfeld DA, Lesser EA, Gozani SN. Implementation and evaluation of a statistical framework for nerve conduction study reference range calculation. *Comput Methods Programs Biomed.* 2009, June 2. [Epub ahead of print]

Nerve conduction studies (NCS) play a central role in the clinical evaluation of neuropathies. Their clinical utilization depends on reference ranges that define the expected parameter values in disease-free individuals. In this paper, a statistical framework is proposed and described in detail for deriving NCS parameter reference ranges. The bootstrap technique is used to identify demographic and physiologic covariates that influence the NCS measurements. Multi-variate linear regression is used to improve the accuracy and effectiveness of NCS interpretation by reducing parameter variance. Non-linear mappings are used to transform parameters into a Gaussian distribution in order to minimize the influence of outliers. Modeling of heteroscedasticity observed in this and other studies leads to more sensible normal limits for several parameters. The proposed reference range method is automated using the MATLAB programming language. Data from a large sample of healthy subjects are used to establish reference ranges for 24 commonly measured NCS parameters. All but three parameters follow Gaussian distributions in their respective transformed domains. Excluding the distal motor latency difference between median and ulnar nerves, the reduction of the parameter variance as a result of regression in the transform domain is greater than 50% for all F-wave latency parameters and at least 10% for all other NCS parameters. Subject age is found to influence normal limits of all but one parameter and height has a statistically significant impact on all but three parameters. These reference range specifications provide clinicians with an alternative to developing their own reference ranges as long as their NCS techniques are consistent with those described in this paper. The proposed method should also be applicable to reference range development for other NCS techniques and physiological measurements.

Armstrong T, Dale AM, Franzblau A, Evanoff BA. Risk factors for carpal tunnel syndrome and median neuropathy in a working population. *J Occup Environ Med.* 2008;50(12):1355-1364.

OBJECTIVE: To assess whether work-related physical activities are associated with Carpal tunnel syndrome (CTS), even when controlling for personal risk factors. **METHODS::** A cross-sectional assessment of 1108 workers from eight employers and three unions completed nerve conduction testing, physical examination, and questionnaires. CTS was defined by median neuropathy and associated symptoms. **RESULTS::** Eighteen workers had CTS and 131 had evidence of median neuropathy. CTS was highest among construction workers (3.0%) compared to other subjects (<1%). Logistic regression models for median neuropathy both personal and work-related risk factors. Work-related exposures were estimated by two methods: self-report and job title based ratings. **CONCLUSIONS::** Both work and personal factors mediated median nerve impairment. Construction workers are at an increased risk of CTS so awareness should be raised and interventions should specifically target this risk group.

Armstrong TN, Dale AM, Al-Lozi MT, Franzblau A, Evanoff BA. Median and ulnar nerve conduction studies at the wrist: Criterion validity of the NC-stat automated device. *J. Occup Environ Med.* 2008;50(7):758-764.

OBJECTIVE: To compare results obtained with the NC-stat--an automated nerve testing device--to traditional nerve conduction studies relevant to carpal tunnel syndrome screening. **METHODS:** Thirty-three subjects recruited from patients referred for electrodiagnostic testing were studied. Measurements including the distal motor latency (DML), distal sensory latency (DSL), and median-ulnar latency difference (MUD) were obtained by the NC-stat and by standard nerve conduction studies. **RESULTS:** With modifications to the NC-stat's suggested reference ranges, sensitivity with respect to the traditional results ranged from 93.8% (sensory MUD) to 100% (median DML and DSL) and specificity ranged from 84.6% (motor MUD) to 94.1% (sensory MUD). Sensitivity was as high or higher and specificity was lower when using the manufacturer's suggested cutoffs. **CONCLUSION:** The NC-stat appears to be a convenient and sensitive method for detecting median nerve pathology at the wrist.

Conlon CF, Krause N, Rempel DM. A randomized controlled trial evaluating an alternative mouse and forearm support on upper body discomfort and musculoskeletal disorders among engineers. *Occup Environ Med.* 2008;65(5):311-8.

OBJECTIVES: The aim of this intervention study was to determine the effects of an alternative mouse and/or a forearm support board on the change in upper body discomfort scores and the development of incident musculoskeletal disorders. **METHODS:** This randomised controlled intervention trial followed 206 engineers for one year. Participants were randomised to receive (1) a conventional mouse only, (2) an alternative mouse only, (3) a forearm support board, or (4) an alternative mouse plus forearm support board. Outcome measures included weekly upper body discomfort scores and incident musculoskeletal disorders. **RESULTS:** During the study, 42 participants were diagnosed with an incident musculoskeletal disorder. The group that received the forearm support board experienced a reduction in their right upper extremity discomfort (beta-coefficient -0.35, 95% CI -0.67 to -0.03) in comparison to those who did not receive a forearm board. The group that received the alternative mouse had a protective, but non-significant ($p = 0.20$), effect on incident cases of right upper extremity musculoskeletal disorders (HR 0.57, 95% CI 0.24 to 1.34) and a non-significant reduction in neck/shoulder discomfort (beta-coefficient -0.23, 95% CI -0.056 to 0.10) in comparison to those who received a conventional mouse. **CONCLUSIONS:** In engineers who use a computer for more than 20 h per week, a forearm support board may reduce right upper extremity discomfort attributed to computer use.

Fisher MA, Bajwa R, Somashekar KN. Routine electrodiagnosis and a multiparameter technique in lumbosacral radiculopathies. *Acta Neurologica Scandinavica.* 2008;118(2):99-105.

OBJECTIVE: This study compares Routine nerve conduction studies (NCS)/needle electromyography (nEMG) with a multiparameter recording method (NC-stat; NeuroMetrix Inc., Waltham, MA, USA) in patients with lumbosacral radiculopathies (LSR). **METHODS:** Charts from 34 consecutive patients with a clinical history and/or examination consistent with an LSR were retrospectively reviewed. All underwent both Routine NCS/nEMG studies and NC-stat EDX. NC-stat testing included peroneal and posterior tibial nerve distal motor latencies and amplitudes and F-wave analysis. Twenty-eight patients had magnetic resonance imaging of the lumbosacral spine, and two had post-myelogram computerized tomography scan. **RESULTS:** In the 24 patients with abnormal routine NCS/nEMG, NC-stat EDX was abnormal in 22. Raw agreement values between specific abnormal Routine and NC-stat EDX parameters ranged from 0.65 to 0.76. NC-stat amplitude and F-wave data provide reasonable electrodiagnostic 'rule in, rule out' information for LSR. Routine and NC-stat EDX had comparable positive and negative likelihood ratios with radiographic findings based on blinded neuroradiological evaluation. This included good 'stand alone' values for NC-stat F-wave and compound muscle action potential (CMAP) amplitude abnormalities in patients with spinal stenosis. **CONCLUSIONS:** This report supports the value of multiparameter clinical neurophysiological evaluations in patients with LSR including CMAPs and F-waves.

Kong, X, Lesser EA, Potts F, Gozani SN. Utilization of nerve conduction studies for assessment of polyneuropathy in patients with diabetes. *J Diabetes Sci Technol.* 2008;2(2):268-274.

BACKGROUND: Diabetic polyneuropathy (DPN) is a disabling complication of diabetes mellitus. A population-based analysis of physician utilization of nerve conduction studies (NCS) for the assessment of DPN was conducted. **METHODS:** All electrodiagnostic encounters over a 30-month period using a computer-based neurodiagnostic instrument linked to a data registry were analyzed retrospectively. The DPN case definition was abnormal sural and peroneal nerve conduction. **RESULTS:** The study cohort consisted of a total of 63,779 electrodiagnostic encounters performed by 3468 physician practices. Primary care and internal medicine physicians represented 80.1% of the practices and accounted for 65.7% of the encounters. Endocrinologists represented 4.6% of the practices and 20.1% of the encounters. The demographics of patients were 52.7% female; 63.4 ± 11.8 (mean \pm standard deviation) years (age); 168.1 ± 10.9 cm (height); 92.2 ± 22.6 kg (weight); and 32.6 ± 7.2 kg/m² (body mass index). The most common peroneal abnormality was F-wave latency (33.6%). The sural nerve response latency and amplitude parameters had similar abnormality rates (58.3 and 62.7%).

DPN was identified in 52.6% of the encounters; in another 19.3% no neuropathy was found. **CONCLUSIONS:** For over 70% of the patients, the specific diagnostic question of the presence of DPN was addressed by NCS with evidence-based criteria. The demographic features were strongly associated with risk of diabetes and DPN, suggesting that NCS were applied to appropriate demographic subgroups. The rate of DPN was also comparable to levels seen by academic electromyography laboratories. In 32.6% of the encounters the NCS suggested a posttest diagnosis other than DPN. This rate was similar to the results of referral to traditional electromyography laboratories. This study demonstrated that NCS using computer-based electrodiagnostic equipment was a suitable tool for the diagnosis of DPN. Furthermore, this technology permits examination of DPN in large populations.

Lavery LA, Murdoch DP, Williams J, Lavery DC. Does Anodyne light therapy improve peripheral neuropathy in diabetes? A double blind, sham controlled randomized trial to evaluate monochromatic infrared photo energy. Diabetes Care. 2008;31(2):316-21.

OBJECTIVE: The purpose of this study was to determine the efficacy of anodyne monochromatic infrared photo energy (MIRE) in-home treatments over a 90-day period to improve peripheral sensation and self-reported quality of life in individuals with diabetes. **RESEARCH DESIGN AND METHODS:** This was a double-blind, randomized, sham-controlled clinical trial. We randomly assigned 69 individuals with diabetes and a vibration perception threshold (VPT) between 20 and 45 V to two treatment groups: active or sham treatment. Sixty patients (120 limbs) completed the study. Anodyne units were used at home every day for 40 min for 90 days. We evaluated nerve conduction velocities, VPT, Semmes-Weinstein monofilaments (SWM) (4-, 10-, 26-, and 60-g monofilaments), the Michigan Neuropathy Screening Instrument (MNSI), a 10-cm visual analog pain scale, and a neuropathy-specific quality of life instrument. We used a nested repeated-measures multiple ANOVA design. Two sites (great toe and fifth metatarsal) were tested on both the left and right feet of each patient, so two feet were nested within each patient and two sites were nested within each foot. To analyze the ordinal SWM scores, we used a nonparametric factorial analysis for longitudinal data. **RESULTS:** There were no significant differences in measures for quality of life, MNSI, VPT, SWM, or nerve conduction velocities in active or sham treatment groups ($P > 0.05$). **CONCLUSIONS:** Anodyne MIRE therapy was no more effective than sham therapy in the treatment of sensory neuropathy in individuals with diabetes.

Perkins BA, Orszag A, Grewal J, Ng E, Ngo M, Bril V. Multi-site testing with a point-of-care nerve conduction device can be used in an algorithm to diagnose diabetic sensorimotor polyneuropathy. Diabetes Care. 2008;31(3):522-4.

OBJECTIVE: We aimed to establish whether multi-nerve testing with a point-of-care nerve conduction device could be used to diagnose diabetic sensorimotor polyneuropathy. **RESEARCH DESIGN AND METHODS:** A total of 72 consecutive patients with diabetes underwent a full neurological examination and a concurrent evaluation for nine standard electrophysiological parameters using conventional nerve conduction studies (the reference standard) and a point-of-care device. **RESULTS:** Spearman coefficients for correlation of point-of-care and conventional parameters ranged between 0.76 and 0.91 ($P < 0.001$ in all comparisons). Agreement by the method of Bland and Altman was acceptable despite small systematic biases. Fifty subjects (69%) had neuropathy according to conventional criteria. The sensitivity and specificity for the point-of-care device to identify such neuropathy was 88 and 82%, respectively. **CONCLUSIONS:** A novel point-of-care device has reasonable diagnostic accuracy and thus may represent a sufficiently accurate alternative for detecting the diffuse electrophysiological criteria necessary to make the diagnosis of diabetic sensorimotor polyneuropathy.

Fisher MA, Bajwa R, Somashekar KN. Lumbosacral radiculopathies--the importance of EDX information other than needle electromyography. Electromyogr Clin Neurophysiol. 2007;47:377-84.

OBJECTIVE: This study evaluates the importance of varying electrodiagnostic (EDX) parameters abnormalities in patients with possible lumbosacral radiculopathies (LSR). **METHODS:** 34 patients referred for EDX studies

with clinical findings consistent with a LSR without other causes for their symptoms were evaluated. Studies included not only standard (Routine EDX) nerve conduction studies (NCS) including F-waves and needle electromyography (nEMG) but also a multiparameter automated analysis system using prefabricated nerve conduction electrodes without nEMG (NC-stat EDX). **RESULTS:** Abnormal Routine EDX was present in 24 of the patients. Abnormal nEMG was present in only 14 of these patients, all of whom also had other relevant NCS abnormalities. Abnormal NC-stat EDX was found in 29 of the patients. In all but one patient there was agreement in the radicular localization between Routine and NC-stat EDX. In 30 patients, there was recent computed tomography or magnetic resonance imaging of the lumbosacral region. Comparable statistical agreements with the radiographic information were obtained for Routine EDX and NC-stat data. This was true including when the analyses were based on the neuroradiological evaluation of likely root injury. **CONCLUSION:** This study emphasizes the importance of EDX studies other than nEMG in the evaluation of patients with possible LSR and supports the value of a computerized multiparameter methodology in these patients.

Hardy T, Sachson R, Shen S, Armbuster M, Boulton AJM. Does treatment with Duloxetine for neuropathic pain impact glycemic control. *Diabetes Care.* 2007;30:21-26.

OBJECTIVE: We examined changes in metabolic parameters in clinical trials of duloxetine for diabetic peripheral neuropathic pain (DPNP). **RESEARCH DESIGN AND METHODS:** Data were pooled from three similarly designed clinical trials. Adults with diabetes and DPNP (n = 1,024) were randomized to 60 mg duloxetine q.d., 60 mg b.i.d., or placebo for 12 weeks. Subjects (n = 867) were re-randomized to 60 mg duloxetine b.i.d. or routine care for an additional 52 weeks. Mean changes in plasma glucose, lipids, and weight were evaluated. Regression and subgroup analyses were used to identify relationships between metabolic measures and demographic, clinical, and electrophysiological parameters. **RESULTS:** Duloxetine treatment resulted in modest increases in fasting plasma glucose in short- and long-term studies (0.50 and 0.67 mmol/l, respectively). A1C did not increase in placebo-controlled studies; however, a greater increase was seen relative to routine care in long-term studies (0.52 vs. 0.19%). Short-term duloxetine treatment resulted in mean weight loss (-1.03 kg; P < 0.001 vs. placebo), whereas slight, nonsignificant weight gain was seen in both duloxetine and routine care groups with longer treatment. Between-group differences were seen for some lipid parameters, but these changes were generally small. Metabolic changes did not appear to impact improvement in pain severity seen with duloxetine, and nerve conduction was also not significantly impacted by treatment. **CONCLUSIONS:** Duloxetine treatment was associated with modest changes in glycemia in patients with DPNP. Other metabolic changes were limited and of uncertain significance. These changes did not impact the significant improvement in pain observed with duloxetine treatment.

Jabre JF, Salzsider BT, Gnemi KE. Criterion validity of the NC-stat automated nerve conduction measurement instrument. *Physiol Meas.* 2007;28(1):95-104.

The purpose of this study is to assess the criterion validity of peroneal and posterior tibial nerve conduction measurements obtained with the NC-stat system. Sixty patients referred to the Boston VA EMG laboratory were enrolled. Each subject had a full study of the lower extremity performed using traditional EMG equipment prior to obtaining the NC-stat measurements. These included peroneal and posterior tibial distal motor latency (DML), amplitude (AMP) and F-wave latency (FLAT) measurements. Excellent criterion validity was demonstrated for the peroneal and posterior tibial FLATs and the peroneal AMP. Acceptable criterion validity was identified in the peroneal DML and the posterior tibial AMP. The validity of the posterior tibial DML could not be demonstrated. With the exception of the peroneal DML, criterion validity was maintained in a sub-group analysis of the 50% most abnormal parameter values. The comparability of NCS performed with the NC-stat and in traditional settings has been demonstrated for motor studies of the median and ulnar nerves in previous studies. This study shows that the technology used by the NC-stat for studying the peroneal and posterior tibial nerves compares favorably as well with that obtained with traditional EMG equipment used under neurologist supervision.

Megerian JT, Kong X, Gozani SN. Utility of nerve conduction studies for carpal tunnel syndrome by FM/PCP/IM physicians. J Am Board FamMed. 2007;20:60-64.

INTRODUCTION: Nerve conduction studies (NCS) are increasingly being performed at the point-of-service by family medicine, primary care, and internal medicine (FM/PCP/IM) physicians. Carpal tunnel syndrome (CTS) is a common neuropathy often diagnosed with the aid of NCS. **METHODS:** A retrospective analysis of a point-of-service NCS data registry was conducted; 1190 patients who underwent NCS by 613 FM/PCP/IM physician practices, for evaluation of CTS were analyzed. Utility measures included demographic and electrophysiological characteristics of study population, adherence to evidence-based testing guidelines, and relevance of diagnostic outcomes. **RESULTS:** Tested patients tended to be over 40, female, and overweight or obese. The median nerve distal motor latency was 4.4 +/- 1.2 ms; 92.6% of studies met the testing guideline; 30.5% of tested limbs yielded normal results; 53.1% CTS; 5.4% ulnar neuropathy; and 11.0% nonspecific upper extremity neuropathy. **DISCUSSION:** This study demonstrated that point-of-service NCS by FM/PCP/IM physicians for CTS was applied to appropriate patient subpopulations, was performed in accordance with evidence-based testing parameters, and generated relevant diagnostic outcomes.

Lesser EA, Starr J, Kong X, Megerian JT, Gozani SN. Point-of-service nerve conduction studies: An example of industry driven disruptive innovation in health care. Perspect Biol Med. 2007;50(1):40-53.

Nerve conduction studies (NCS) and needle electromyography are useful and established diagnostic procedures for evaluating patients with signs and symptoms of neuromuscular disease. Although technological advances have occurred since the introduction of commercial electromyography instrumentation in the 1950s, most improvements have been evolutionary and were designed to benefit traditional users--neurologists and physiatrists specializing in electromyography. In the past seven years, instruments have been introduced that automate NCS and thereby enable a broader group of physicians, including internists and orthopedic surgeons, to perform these studies and utilize electromyographic data in the care of their patients. Automated NCS devices are an example of what Clayton Christensen terms a "disruptive innovation." In this article, automated NCS is contrasted with traditional electromyography, and the challenges and opposition to its widespread adoption are explored.

Wernicke JF, Wang F, Pritchett YL, Smith TR, Raskin J, D'Souza DN, Iyengar S, Chappell AS. An open-label 52-week clinical extension comparing duloxetine with routine care in patients with diabetic peripheral neuropathic pain. Pain Med. 2007;8(6):503-13.

OBJECTIVE: To assess the safety of duloxetine at a fixed-dose of 60 mg twice daily (BID) for up to 52 weeks, and compare duloxetine with routine care in the management of patients with diabetic peripheral neuropathic pain (DPNP). **DESIGN AND INTERVENTIONS:** Patients who completed a 13-week, randomized, double-blind, placebo-controlled acute therapy period were randomly reassigned in a 2:1 ratio to therapy with duloxetine 60 mg BID (N = 197) or routine care (N = 96) for an additional 52 weeks. **PATIENTS:** The trial included outpatients > or =18 years of age diagnosed with moderate to severe DPNP caused by type 1 or type 2 diabetes. **RESULTS:** Fourteen patients discontinued due to adverse events or death (11 [5.6%] duloxetine- and 3 [3.1%] routine care-treated patients). There were no significant therapy-group differences observed for patients with > or =1 serious adverse event. In total, 110 (55.8%) duloxetine- and 47 (49%) routine care-treated patients had > or =1 treatment-emergent adverse event (TEAE). The TEAE with a significant therapy-group difference, with patients in the duloxetine therapy group experiencing a higher percentage of events, was asthenia (11 [5.6%] duloxetine- vs no routine care-treated patients). Duloxetine did not appear to adversely affect lipid profiles, or nerve or eye function. There were no significant therapy-group differences observed in mean change in systolic blood pressure, weight, or electrocardiogram parameters. Significant therapy-group differences were observed in favor of duloxetine in the SF-36 physical component summary score, and subscale scores of physical functioning, bodily pain, mental health, and vitality. **CONCLUSIONS:** The results of this study provide support for the use of duloxetine in the long-term management of DPNP.

Gozani SN, Kong X, Fisher MA. Factors influencing F-wave latency detection of lumbosacral root lesions using a detection theory based model. Clin Neurophysiol. 2006 Jul;117(7):1449-57.

OBJECTIVE: To evaluate the F-wave dilution hypothesis; which implies that absolute F-wave latencies obscure the much smaller delay associated with slow intra-lesion conduction, such is caused by nerve root compression in lumbosacral radiculopathy. A corollary objective is to determine how F-wave measurement and pathological factors influence diagnostic accuracy. **METHODS:** An analytical model is developed based on signal detection theory and a number of simplifying assumptions. Diagnostic accuracy, quantified by the area under the receiver operating characteristic (ROC) curve, is determined for various model realizations derived from the clinical and experimental neurophysiology literature. A preliminary experimental validation of model predictions is also performed. **RESULTS:** Absolute F-wave latency does not influence the accuracy of focal lesion detection. F-wave latency variance and lesion pathology are the determinant factors. F-wave latencies and distal latencies are estimated to have qualitatively similar detection characteristics, although distal latencies have quantitatively better diagnostic efficacy for comparable focal pathology. Preliminary experimental results support the modeled dependence of diagnostic accuracy on latency variance and lesion severity. **CONCLUSIONS:** Absolute F-wave latency does not dilute slow conduction within focal lesions, such as in lumbosacral radiculopathy. The dominant measurement factor is F-wave latency variance. **SIGNIFICANCE:** To maximize the diagnostic utility of F-wave latencies, focus must be placed on reducing latency variance, such as through correction for demographic covariates. This model calls into question the F-wave dilution hypothesis.

Katz RT. NC-stat as a screening tool for carpal tunnel syndrome in industrial workers. J Occup Environ Med. 2006; 48(4):414-8.

OBJECTIVE: The initial purpose of this study was to establish a normal data set for median nerve studies in industrial workers using NC-stat technology. **METHODS:** Sixteen hundred ninety-five persons applying for employment at a single heavy industry plant without symptoms of carpal tunnel syndrome (CTS) were studied. **RESULTS:** Values for median distal motor latency (DML), amplitude, and F-waves were recorded in the dominant limbs. The DML was 3.81 +/- 0.57 milliseconds, with a 95% cut-off value of 4.75 milliseconds. Amplitude of the compound muscle action potential was 0.95 +/- 0.46 mV, reflecting the use of volume conduction by this technology. Most of the workers who were characterized as having borderline, prolonged, or very prolonged distal motor latencies according to NeuroMetrix automated report actually fell below the 95% cut-off of this independent data analysis. **CONCLUSION:** NC-stat technology using DML appears to be no more sensitive or specific than a traditionally performed DML for the diagnosis of CTS. Until recently promoted sensory studies using NC-stat technology are better defined, this technology cannot be recommended for screening or diagnosis of CTS in an industrial population.

Kong X, Gozani SN, Hayes MT, Weinberg DH. NC-stat sensory nerve conduction studies in the median and ulnar nerves of symptomatic patients. Clin Neurophysiol. 2006;117(2):405-13.

OBJECTIVE: This study evaluated validity and reliability of automated median and ulnar sensory nerve conduction study (NCS) measurements by the NC-stat. **METHODS:** Median and ulnar distal sensory latencies (DSL) and amplitudes (SNAP) were measured in sixty subjects with the NC-stat and by a neurologist (reference) using traditional instrumentation. The median-ulnar DSL differences (MUD) was calculated. Validity was quantified by the Pearson correlation. Reliability was evaluated by the intraclass correlation coefficient (ICC), Bland-Altman analysis, and inter-rater agreement of MUD abnormalities. **RESULTS:** As a result of differences in electrode placement, NC-stat and reference mean values had systematic differences. The correlation ranged from 0.70 (ulnar DSL) to 0.91 (median DSL). The ICC ranged from 0.69 (ulnar DSL) to 0.91 (median DSL). In Bland-Altman analysis of DSLs, NC-stat measurements had a bias of 0.56 ms (median) and 0.31 ms (ulnar) and precision of 0.31 and 0.30 ms. Inter-rater agreement for MUD abnormalities was 93.8% (raw) and 0.80 (Kappa). **CONCLUSIONS:** NC-stat validity and reliability metrics were similar to traditional NCS. Use of the NC-stat would require applicable reference ranges. **SIGNIFICANCE:** NC-stat median and

ulnar NCS are valid and reliable. This device may be useful for increasing availability of NCS when clinically appropriate.

Kong X, Lesser E, Megerian JT, Gozani SN. Repeatability of nerve conduction measurements using automation. J. Clin Monit Comput 2006;20(6):405-10.

OBJECTIVE: To quantify nerve conduction study (NCS) reproducibility utilizing an automated NCS system (NC-stat, NeuroMetrix, Inc.). **METHOD:** Healthy volunteers without neuropathic symptoms participated in the study. Their median, ulnar, peroneal, and tibial nerves were tested twice (7 days apart) by the same technician with an NC-stat instrument. Pre-fabricated electrode arrays specific to each nerve were used. Both motor responses (compound motor action potential [CMAP] and F-waves - all nerves) and sensory responses (sensory nerve action potentials [SNAP] - median and ulnar nerves only) were recorded following supramaximal stimuli. Automated algorithms determined all NCS parameters: distal motor latency (DML), mean F-wave latency (FWL), distal sensory latency (DSL), CMAP amplitude, and SNAP amplitude. Latency was adjusted for skin temperature deviation from reference. Pearson correlation coefficient (CC), intraclass correlation coefficient (ICC), coefficient of variance (CoV), and relative intertrial variation (RIV) were calculated. **RESULTS:** Fifteen subjects participated in either upper or lower extremity studies with nine participating in both. With the exception of CMAP amplitude, all parameters had CoV less than 0.06. Upper extremity amplitude parameters had CCs greater than 0.85. CCs for latencies were greater than 0.80 except for the median nerve FWL (CC = 0.69). For lower extremity nerves, ICCs were highest for mean FWL (>0.90), followed by DML (>0.82) and then CMAP (peroneal 0.33, tibial 0.73). The 10th to 90th RIV percentiles were bounded by +/-7% for F-wave latencies; +/- 9% for all DSLs; and +/- 11% for DML (except peroneal at 15%). **CONCLUSIONS:** The reproducibility of NCS parameters obtained with an automated NCS instrument compared favorably with traditional electromyography laboratories. F-wave latencies had the highest repeatability, followed by DML, DSL, SNAP and CMAP amplitude. Given their high reproducibility, automated NCS instrument may encourage wider utilization of NCS in clinical and research applications.

Perkins BA, Grewal J, Ng E, Ngo M, Bril V. Validation of a novel point-of-care nerve conduction device for the detection of diabetic sensorimotor polyneuropathy. Diabetes Care. 2006;29(9):2023-7.

OBJECTIVE: The diagnosis of diabetic sensorimotor polyneuropathy using objective electrophysiological tests is hindered by limited access to the specialized laboratories and technicians that perform and interpret them. We evaluated the performance characteristics of a novel portable and automated point-of-care nerve conduction study device, which can be operated by nontechnical personnel, and compared it with conventional nerve conduction studies performed in a specialist setting. **RESEARCH DESIGN AND METHODS:** Seventy-two consecutive patients with diabetes (8 type 1, 64 type 2) from a diabetes and a neuropathy outpatient clinic were evaluated concurrently with conventional nerve conduction studies (the reference standard) and the point-of-care device for sural nerve function (sural nerve amplitude potentials in microvolts [microV]). **RESULTS:** Sural nerve amplitude potentials measured by the point-of-care device shared very strong correlation with the reference standard (Spearman's correlation coefficient 0.95, $P < 0.001$). The Bland and Altman method yielded agreement despite a small systematic underestimation by the point-of-care device of 1.2 ± 3.4 microV. Despite this small systematic bias, the sensitivity and specificity of normal and abnormal sural nerve amplitude potentials measured by the point-of-care device for the detection of diabetic sensorimotor polyneuropathy defined by standard clinical and electrophysiological criteria were 92 and 82%, respectively. **CONCLUSIONS:** A novel point-of-care device has excellent diagnostic accuracy for detecting electrophysiological abnormality in the sural nerve of patients who have diabetes. This automated device represents an alternative to conventional nerve conduction studies for the diagnosis of diabetic sensorimotor polyneuropathy.

Raskin J, Smith TR, Wong K, Pritchett YL, D'Souza DN, Iyengar S, Wernicke JF. Duloxetine versus routine care in the long-term management of diabetic peripheral neuropathic pain. J Palliat Med. 2006;9(1):29-40.

INTRODUCTION: Duloxetine hydrochloride is a dual reuptake inhibitor of both serotonin and norepinephrine. In the present open-label study, the safety of duloxetine at a fixed-dose of 60 mg twice daily (BID) for up to 52 weeks was evaluated and compared to routine care in the therapy of patients diagnosed with diabetic peripheral neuropathic pain (DPNP). **METHODS:** Patients who completed a 13-week, double-blind, duloxetine and placebo acute therapy period were rerandomly assigned in a 2:1 ratio to therapy with duloxetine 60 mg BID (N=161) or routine care (N=76) for an additional 52 weeks. Routine care consisted primarily of gabapentin, amitriptyline, and venlafaxine. The study included male or female outpatients 18 years of age or older with a diagnosis of DPNP caused by type 1 or type 2 diabetes. **RESULTS:** A higher percentage of routine care-treated patients experienced 1 or more serious adverse events. No statistically significant therapy-group difference was observed in the overall incidence of treatment-emergent adverse events (TEAEs). The TEAEs reported by 10% or more of duloxetine 60 mg BID-treated patients were nausea, and by the routine care-treated patients were peripheral edema, pain in the extremity, somnolence, and dizziness. Duloxetine did not appear to adversely affect glycemic control, lipid profiles, nerve function, or the course of DPNP. There were no statistically significant therapy-group differences observed in the 36-item Short-Form Health Survey subscales or in the EuroQol 5-Dimension Questionnaire. **CONCLUSIONS:** In this study, duloxetine was safe and well tolerated compared to routine care in the long-term management of patients with DPNP.

Timpson WL, Kong X, Hamlet WP, Gross P, Gozani SN. Time-dependent changes in median nerve sensory amplitude after local anesthetic administration and tourniquet application. Am J Orthop. 2006;35:515-9.

Indirect visualization, as used in several newer mini-open and endoscopic carpal tunnel release (CTR) procedures, may increase the possibility of nerve injury in some cases. Intraoperative neural monitoring may be used to evaluate nerve location and integrity. In the study reported here, we assessed the feasibility of intraoperative neural monitoring by systematically exploring the effect of local anesthetic and tourniquet on median sensory amplitude. Results for 30 median nerves (7 symptomatic) showed that sensory amplitude decreased, on average, 54% with lidocaine injection, 15% with tourniquet application, and 47% with the combination. Sensory amplitudes of 9 of 10 nerves were still above 1.0 microV 15 minutes after anesthetic administration and tourniquet application. Study results demonstrate that intraoperative monitoring, using the amplitude of the median sensory nerve response, is viable under CTR conditions.

Vinik AI, Kong X, Mergian JT, Gozani SN. Diabetic nerve conduction abnormalities in the primary care setting. Diabetes Technol Ther. 2006;8(6):654-662.

BACKGROUND: Nerve conduction studies (NCS) are the most objective measure of nerve function, and their use is recommended in the clinical and epidemiological evaluation of diabetic polyneuropathy (DPN). The purpose of this study was to utilize automated NCS technology to characterize nerve conduction of patients with diabetes in primary care settings. **METHODS:** The Diabetes cohort was drawn from 28 community clinics. The Control cohort consisted of subjects without diabetes and without evidence of neuropathy. Bilateral peroneal NCS were performed with an automated NCS instrument (NC-stat, NeuroMetrix, Inc., Waltham, MA). Neuropathic symptoms were quantified using an abbreviated form of the NTSS-6 questionnaire. Risk factors for abnormal NCS were determined using multivariate regression modeling. **RESULTS:** Data were collected for 172 control subjects and 1,358 subjects with diabetes. Statistically significant differences in peroneal NCS were found. Of the Diabetes cohort, 75.1% had at least one NCS abnormality, and 53.2% had bilateral abnormalities. Of the asymptomatic patients, 45% had bilateral NCS abnormalities. By contrast, 40% of those with clinically significant symptoms lacked bilateral NCS abnormalities. Independent predictors for bilateral NCS abnormalities were age, height, weight, hemoglobin A1c (HbA1c), and duration of diabetes. Up to 16% of the variance in NCS measurements was explained by HbA1c, duration of diabetes, and several demographic variables. **CONCLUSIONS:** This study suggests that automated NCS can provide nerve conduction confirmation of DPN in primary care settings and has clinical utility. These findings have important implications for the clinical and epidemiological evaluation of DPN.

Conlon CF, Rempel DM. Upper extremity mononeuropathy among engineers. J Occup Environ Med. 2005;47(12):1276-8.

OBJECTIVES: The objectives of this study were to estimate the prevalence of mononeuropathy at the wrist among engineers who use computers and to identify associated risk factors. **METHODS:** This is a cross-sectional study of 202 engineers using questionnaires and electrophysiological nerve testing. The definition for median or ulnar mononeuropathy required the combination of distal upper extremity discomfort and abnormal distal motor latency. **RESULTS:** The prevalence of neuropathy at the wrist among engineers was 10.3% (right median), 3.4% (left median), 1.8% (right ulnar), and 2.9% (left ulnar). Logistic regression analysis identified three variables with positive associations (body mass index, hours of computer use, and antihypertensive medication) and three variables with negative associations (typing speed, driving hours, total break time). **CONCLUSIONS:** Mononeuropathies at the wrist occur among computer-using engineers and are related to a number of factors, including hours of computer use.

Elkowitz SJ, Dubin NH, Richards BE, Wilgis EF. Clinical utility of portable versus traditional electrodiagnostic testing for diagnosing, evaluating, and treating carpal tunnel syndrome. Am J Orthop. 2005;34 (8):362-4.

Data indicate that a portable electrodiagnostic device (NC-Stat; Neurometrix, Inc, Cambridge, Mass) provides objective preoperative evidence of the severity of median nerve dysfunction as well as useful objective postoperative data. With traditional electrodiagnostic studies for comparison, we studied the utility of this device as a diagnostic tool, evaluated patient satisfaction with the instrument, and found statistically significant improvement in recorded distal motor latency at 6-month follow-up. Such data can be of great value in treating a patient who does not exhibit subjective symptom improvement. This portable electrodiagnostic device provides a reliable, convenient, and relatively inexpensive way to obtain objective data that can be used in diagnosing, evaluating, and treating carpal tunnel syndrome.

Fisher MA. Comparison of automated and manual F-wave latency measurements. Clin Neurophysiol. 2005; 116(2):264-9.

OBJECTIVE: F-waves are well-established clinical neurophysiological studies. F-wave analysis is now cumbersome limiting the usefulness of F-waves. This study evaluates the accuracy and reliability of an automated analysis method for F-wave latencies. **METHODS:** F-waves following 20 supramaximal stimuli recorded from the extensor digitorum brevis muscle of 80 limbs (55 subjects) were analyzed. F-wave latencies were determined using a computer program developed by NEUROMetrix (Waltham, MA). These results were compared in a blinded fashion with manual measurements of the same datasets by a clinical neurophysiologist with established expertise in F-waves. The manual measurements were repeated once. **RESULTS:** The yield rate of automated median F-wave latencies was 100% with a correlation coefficient (CC) of 0.996 when compared with manual assignment results. For individual F-wave latency measurements, comparable values were 90% and 0.977, respectively. The repeated manual measurements revealed a yield rate and CC for median latencies of 100% and 0.998, respectively, with comparable values for individual latency measurements of 95% and 0.992. **CONCLUSIONS:** These results indicate the feasibility of a reliable computerized automated analysis of F-wave latencies. **SIGNIFICANCE:** A reliable automated analysis of F-waves should add meaningfully to the value of these responses in clinical neurophysiology.

Gozani SN, Fisher MA, Kong X, Megerian JT, Rutkove SB. Electrodiagnostic automation: principles and practice. Phys Med Rehabil Clin N Am. 2005 Nov;16(4):1015-32.

Automation is an integral component of nearly all nerve conduction studies (NCS) performed using modern instrumentation. In this review, the definition, history and examples of electrodiagnostic automation are provided with a particular focus on NCS. Recent advances are described, along with limitations and appropriate

clinical use of automation technology. Finally, future directions and the potential impact on physicians and patients are discussed.

Raskin J, Pritchett YL, Wang F, D'Souza DN, Waninger AL, Iyengar S, Wernicke JF. A double-blind, randomized multicenter trial comparing Duloxetine with placebo in the management of diabetic peripheral neuropathic pain. *Pain Med.* 2005;6(5):346-56.

OBJECTIVE: Assess efficacy and safety of duloxetine, a selective serotonin and norepinephrine reuptake inhibitor, on the reduction of pain severity, in patients with diabetic peripheral neuropathic pain (DPNP). **METHODS:** This was a multicenter, parallel, double-blind, randomized, placebo-controlled trial that enrolled 348 patients with pain due to peripheral neuropathy caused by type 1 or type 2 diabetes mellitus. Patients (N = 116 per group) were randomly assigned to receive duloxetine 60 mg once daily (QD), duloxetine 60 mg twice daily (BID), or placebo, for 12 weeks. The primary outcome measure was the weekly mean score of 24-hour average pain severity evaluated on an 11-point Likert scale. Secondary outcome measures and safety were evaluated. **RESULTS:** Compared with placebo-treated patients, both duloxetine-treated groups improved significantly more ($P < 0.001$) on the 24-hour average pain score. Duloxetine demonstrated superiority to placebo in all secondary analyses of the primary efficacy measure. A significant treatment effect for duloxetine was observed in most secondary measures for pain. Discontinuations due to adverse events were more frequent in the duloxetine 60 mg BID- (12.1%) versus the placebo- (2.6%) treated group. Duloxetine showed no adverse effects on diabetic control, and both doses were safely administered and well tolerated. **CONCLUSIONS:** In this clinical trial, duloxetine 60 mg QD and duloxetine 60 mg BID were effective and safe in the management of DPNP.

Guyette TM, Wilgis EF. Timing of improvement after carpal tunnel release. *J Surg Orthop Adv.* 2004;13 (4):206-9.

This prospective study of 52 patients from the authors' institutional carpal tunnel database investigated which patient subpopulations were most likely to benefit from carpal tunnel release and documented the time course of recovery. Preoperatively and postoperatively at 6 and 12 months, patients completed a Levine-Katz questionnaire, and NC-Stat studies and clinical parameters were recorded by a certified occupational therapist. For individual parameters from preoperative to 6 months postoperative, statistical improvements were found in Tinel's and Phalen's signs, pinch strength, delayed motor latency, and symptom severity and functional scores. None of these parameters changed significantly from 6 to 12 months. Grip strength did not change significantly postoperatively. Analysis based on age or carpal tunnel release technique showed no differences postoperatively. Preoperative symptom and functional scores correlated statistically with postoperative scores, peaking at 6 months postoperatively. The study concluded that most clinical signs and symptoms of carpal tunnel release fail to improve after 6 months postoperatively.

Rotman MB, Enkvetchakul BV, Megerian JT, Gozani SN. Time course and predictors of median nerve conduction after carpal tunnel release. *J Hand Surg [Am].* 2004;29(3):367-72.

PURPOSE: To identify predictors of outcome and of electrophysiologic recovery in patients with carpal tunnel syndrome (CTS) treated by endoscopic carpal tunnel release using a nerve conduction testing system (NC-Stat; NEUROMetrix, Inc, Waltham, MA). **METHODS:** Validity of the automated nerve conduction testing system was shown by comparing presurgical distal motor latencies (DMLs) against a reference obtained by referral to an electromyography laboratory. The DML was evaluated in 48 patients with CTS. Measurements were obtained within 1 hour of surgery and at 2 weeks, 6 weeks, 3 months, and 6 months after carpal tunnel release. Presurgical and postsurgical DMLs were then compared and correlated with variables and possible predictors of outcome including age, body mass index, gender, and presurgical DMLs. **RESULTS:** The automated nerve conduction testing system DMLs matched those of reference electromyography/nerve conduction study values with high correlation. Sensitivity of the automated nerve conduction testing system when compared with a standardized CTS case definition was 89%, with a specificity of 95%. A significant correlation was found

between the DML before release and the DML 1 hour after release. Moreover, maximal postsurgical DML improvement was highly dependent on the presurgical DML, with no improvement shown for the <4-ms group, mild improvement for the 4-to-6-ms group, and maximal improvement in the >6-ms group. Among the clinical variables of age, gender, and body mass index only age was mildly predictive of postrelease DML changes at 6 months. No other correlations between clinical variables and postsurgical DMLs were significant. In addition the predictive value of age was lost when combined with the presurgical DML in a multivariate analysis. CONCLUSIONS: Postsurgical changes in the median nerve DML were highly dependent on the prerelease latency. The sensitivity and specificity of a nerve conduction monitoring system in detecting and aiding in the diagnosis of CTS is useful in the long-term management of patients with CTS and can aid in determining the level of improvement in median nerve function after endoscopic carpal tunnel release.

Vinik AI, Emley MS, Megerian JT, Gozani SN. Median and ulnar nerve conduction measurements in patients with symptoms of diabetic peripheral neuropathy using the NC-stat system. Diabetes Technol Ther. 2004;6(6):816-24.

BACKGROUND: Diabetic peripheral neuropathy (DPN) is a common, disabling, and costly complication of diabetes mellitus. Although there are multiple methods for detecting and monitoring DPN, nerve conduction studies (NCS) are generally considered to be the most sensitive and reproducible. However, utilization of NCS in patients with diabetes is low, presumably because of limited access and economic issues. Advanced point-of-service NCS systems, already widely used in the assessment of entrapment neuropathies, may address these issues in the arena of diabetes. METHODS: Seventeen patients with diabetes and clinical evidence of neuropathy were enrolled in the study. NCS were performed using the NC-stat nerve conduction testing system (NEUROMetrix, Inc., Waltham, MA) and compared against results from a neurologist-supervised study using a standard electromyography system, which was considered the reference method. Results for ulnar and median distal motor latencies (DMLs) and F-waves, obtained by both methods, were compared with each other. The NC-stat measurements were also compared with a historical control population. RESULTS: A high correlation between the two methods of NCS assessment was demonstrated. The Pearson correlation coefficients between the NC-stat system and the reference measurements were 0.96 (DML) and 0.89 (F-wave latency) for the median nerve and 0.70 (DML) and 0.78 (F-wave latency) for the ulnar nerve. Significant differences were observed between the NC-stat and reference median ($P < 0.001$, paired t test) and ulnar ($P < 0.05$, paired t test) nerve DMLs. F-wave latencies did not demonstrate significant differences ($P > 0.05$, paired t test). The rate of abnormalities ranged from 17.7% for the median nerve DML to 26.7% for the ulnar nerve F-wave latency. The rate of upper extremity nerve involvement in DPN according to a case definition requiring both median and ulnar nerve abnormalities was 25.0%. The rate of median neuropathy at the wrist, which is the second most common neuropathy in individuals with diabetes, was 17.6%. CONCLUSIONS: NC-stat-based NCS of the median and ulnar nerves provide results similar to those obtained with traditional neurologist-supervised NCS using a standard electromyography system. The number of subjects meeting electrophysiological criteria for DPN, affecting the upper extremities, is similar to prior studies. The widespread availability of the NC-stat system may provide a robust and objective method for identifying DPN and other neuropathies in patients with diabetes.

Wells MD, Meyer AP, Emley M, Kong X, Sanchez R, Gozani SN. Detection of lumbosacral nerve root compression with a novel composite nerve conduction measurement. Spine. 2002;27(24):2811-9.

STUDY DESIGN: Multivariate logistic regression techniques were used to develop a composite nerve conduction measurement that detects lumbosacral (L5, S1, or both) nerve root compression. OBJECTIVES: To evaluate the diagnostic efficacy of a composite nerve conduction measurement for detection of lumbosacral nerve root compression. SUMMARY OF BACKGROUND DATA: Nerve root involvement is characterized by clinical abnormalities and confirmed by radiologic and electrodiagnostic studies. Imaging studies visualize structural abnormalities; however, they are associated with high false-positive rates. Electrodiagnostic methods assess the physiologic integrity of the nerve roots. One form of electrodiagnostic testing, nerve conduction

studies, is widely used for evaluation of musculoskeletal and neuromuscular complaints. Although similar clinical value is expected for the evaluation of nerve root compromise, prior applications of nerve conduction studies have yielded widely varying results. **METHODS:** Two groups of subjects were compared. The L5-S1 compression group was composed of 25 patients with magnetic resonance imaging-confirmed lumbosacral (L5, S1, or both) nerve root compression and symptoms in the appropriate segmental distribution. The majority of subjects (22) had at least one of the following findings on physical examination: positive straight-leg raise test, diminished ankle reflexes, sensory loss, or weakness. The control group consisted of 35 asymptomatic individuals with no history of radiculopathy or potentially confounding neuropathology. The posterior tibial and deep peroneal nerves were evaluated bilaterally in all study subjects using standard nerve conduction procedures, which consisted of the measurement of distal motor latencies and F-wave latencies that assess nerve root pathophysiology. A composite nerve conduction measurement was determined using multivariate logistic regression analysis. The efficacy of the composite measurement was assessed by receiver operating characteristic curve analysis and by the diagnostic sensitivity and specificity. **RESULTS:** Five F-wave latency parameters (peroneal mean F-wave latency, odds ratio = 0.42; peroneal seventh F-wave latency decile, odds ratio = 2.71; tibial mean F-wave latency, odds ratio = 8.90; tibial first F-wave latency decile, odds ratio = 0.47; tibial maximum F-wave latency, odds ratio = 0.44) were found to be predictive of nerve root compression. A composite nerve conduction measurement, NC composite, constructed from these five parameters ($NC\ composite = \exp(\phi)/(1 + \exp(\phi))$, $\phi = -31.2 + 1.0 * Per7\ Decile - 0.88 * PerMean + 2.2 * TibMean - 0.88 * Tib1\ Decile - 0.83 * TibMax$) yielded an area under the receiver operating characteristic curve of 0.91. At a threshold of 0.20, NC composite had a diagnostic specificity of 84.3% and a sensitivity of 83.3%. **CONCLUSION:** This preliminary study suggests that a novel composite nerve conduction measurement, based on F-wave latency parameters, may be highly effective at detecting magnetic resonance imaging-confirmed lumbosacral nerve root compression. Because these measurements provide objective evidence of functional nerve root compromise and are noninvasive, they may be of diagnostic value to clinicians evaluating patients presenting with low back and leg pain.

Leffler CT, Gozani SN, Cros D. Median neuropathy at the wrist: diagnostic utility of clinical findings and an automated electrodiagnostic device. J Occup Environ Med. 2000;42(4):398-409.

Clinical findings have limited value in predicting electrophysiologically confirmed median neuropathy at the wrist (MNW). To determine the value of clinical findings and an automated electrophysiologic neurodiagnostic device (AEND) in diagnosing MNW, we studied two groups of 75 consecutive patients (an initial group and a validation group, 150 total) referred to an academic electrophysiology laboratory for upper extremity complaints. The definitive standard for MNW was the neurologist's diagnosis after formal clinical and electrodiagnostic evaluation. The neurologist was blinded to the results of the AEND (NC-Stat, NeuroMetrix, Inc). In the validation group, the AEND yielded a distal motor latency (DML) in 97% of hands with a conventional motor response, and the correlation of the AEND DML with the conventional DML was 0.94 ($P < 0.001$). Of 248 symptomatic hands, the neurologist diagnosed 117 (47%) with MNW. At 90% specificity, the AEND DML had a sensitivity of 86% for MNW. Age, body mass index, sensory symptoms in digits 1 to 3, and nocturnal awakening were independent clinical predictors of MNW. Each 1-msec increase in the adjusted AEND DML was independently associated with an OR of 298 (95% confidence interval, 40 to 2233) for MNW. Each 1-msec increase in the F-wave latency was independently associated with an OR of 2.6 (95% confidence interval, 1.3 to 4.9) for MNW. Compared with a model based solely on clinical variables, an algorithm including symptom variables plus the AEND DML had an odds ratio for correct diagnostic classification of 6.3 (95% confidence interval, 3.8 to 12.3). The sensitivity at 90% specificity improved from 40% for the clinical model to 86% for the model with DML. A practical method for integrating clinical and electrophysiologic findings to assess the risk of MNW was proposed. This method correctly stratified 79% of control and MNW patients into very low- and high-risk groups, respectively. We concluded that MNW diagnosis is significantly improved with an AEND.

Leffler CT, Gozani SN, Nguyen ZQ, Cros D. An automated electrodiagnostic technique for detection of carpal tunnel syndrome. Jrln Neur and Clin Neurophys. Sep 2000.

We designed an automated electrophysiologic neurodiagnostic device (AEND) yielding a distal motor latency (DML) using automated stimulation and analysis, volume-conducted waveforms, and physiologic adjustments. AEND screening was studied in 75 symptomatic patients, who also had conventional electrodiagnostic studies, and 22 asymptomatic subjects. The AEND yielded a DML in 92% of hands with a conventional motor response. The correlation between AEND and conventional DML was .90 ($P < .001$). The neurologists diagnosed 62 of 129 symptomatic hands with median neuropathy at the wrist (MNW). At 90% specificity, AEND DML had a sensitivity of 82% for MNW diagnosed by the neurologist and 87% for MNW defined by symptoms plus conventional electrophysiology. DML adjustment for age, height, and temperature was associated with an odds ratio for correct diagnostic classification of 1.80 in receiver operating characteristic curve analysis. A volume-conducted latency determined by an automated technique, designed for screening for MNW in an occupational medicine or primary care setting, is highly correlated with conventional techniques. Physiologic adjustments nearly double the odds of correct diagnostic classification.
