

NeuroMetrix

NC-stat Bibliography

July 2009

Peer Reviewed Journal Publications

1. 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]
 - A statistical framework is proposed and described in detail for deriving NCS parameter reference ranges. These reference range specifications provide clinicians utilizing NCS techniques consistent with those described in the paper with an alternative to developing their own reference ranges.
2. 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.
 - Demonstrates that both work and personal factors mediate median nerve impairment, and that construction workers are at an increased risk of CTS. This finding suggests that awareness should be raised and interventions should specifically target this risk group.
3. 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.
 - The NC-stat demonstrated good criterion validity for testing the median nerve at the wrist.
 - The area under the ROC curve for normal/abnormal determinations in the median nerve as compared to a traditional neurology laboratory ranged from 0.91 to 0.97.
 - The ulnar nerve could not be evaluated because almost all subjects had normal ulnar nerve function, with little variability in measurements among the study group.
4. 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.
 - NC-stat had high (0.76 and 0.91, $p < 0.001$ in all comparisons) correlation to a traditional neurology laboratory for median, peroneal and sural nerve conduction.
 - 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 NC-stat was 88% and 82%, respectively.
 - The authors concluded that the NC-stat provides reasonable diagnostic accuracy and thus may represent a sufficiently accurate alternative to traditional nerve conduction - for detecting the diffuse electrophysiological criteria necessary to make the diagnosis of diabetic sensorimotor polyneuropathy.
5. Kong, X, Lesser EA, Pott 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.
 - Study showed that patients selected for diabetic neuropathy (DPN) testing with the NC-stat had appropriate demographic characteristics and in over 70% the specific diagnostic question of whether the patient had DPN was addressed.
 - Study further demonstrated that in about 33% of NC-stat tests for DPN, a post-test diagnosis other than DPN was suggested. This rate was similar to results of referral to traditional EMG laboratories. Therefore in about one third of the tests, the probable pre-test DPN diagnosis was altered by the NC-stat nerve conduction results.

6. Fisher MA, Bajwa R, Somashekar KN. Routine Electrodiagnosis and a multiparameter technique in lumbosacral radiculopathies. *Acta Neurologica Scandinavica*. 2008;118(2):99-105.
 - In 24 patients with abnormal NCS/nEMG as assessed in a traditional neurology laboratory, the NC-stat was abnormal in 22.
 - NC-stat amplitude and F-wave data provide reasonable electrodiagnostic “rule in, rule out” information for lumbosacral radiculopathy.
 - Traditional and NC-stat studies had comparable positive and negative likelihood ratios with radiographic findings based on blinded neuroradiological evaluation.
7. 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..
 - NC-stat used to confirm suspected carpal tunnel syndrome and ulnar neuritis at the wrist in study subjects.
8. 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.
 - NC-stat measurements of peroneal and tibial nerve conduction used as secondary outcome measures in a study evaluating the therapeutic efficacy of Anyodyne light therapy.
 - There was no statistically significant improvement in nerve conduction with light therapy as compared to sham treatment.
9. Fisher MA, Bajwa R, Somashekar KN. Lumbosacral radiculopathies--the importance of EDX information other than needle electromyography. *Electromyogr Clin Neurophysiol*. 2007;47:377-84.
 - NC-stat nerve conduction data identified lumbosacral radiculopathy in 85.3% of patients referred for evaluation of a possible radiculopathy. Routine electrodiagnostic testing including needle electromyography identified 70.6%.
 - An abnormality of the tibial mean F-wave latency had the highest agreement (0.76) to MRI confirmed lumbar stenosis among all nerve conduction measurements and needle electromyography. Needle electromyography alone had an agreement of 0.71.
10. Jabre JF, Salzsieder BT, Gnemi KE. Criterion validity of the NC-stat automated nerve conduction measurement instrument. *Physiol Meas*. 2007;28(1):95-104.
 - Demonstrates that NC-stat measurements in the peroneal and tibial nerves have acceptable to excellent validity as compared to an academic electromyography laboratory as the reference.
11. Hardy T, Sachson R, Shen S, Arbustner M, Boulton AJM. Does treatment with Duloxetine for neuropathic pain impact glycemic control. *Diabetes Care*. 2007;30:21-26.
 - Confirms test-retest reliability of NC-stat in a diabetes population. Reproducibility data used by FDA in their approval of Duloxetine HCl (Cymbalta).
12. 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.
 - Review article discussing history of NCS and role and value of NC-stat as a disruptive innovation advancing patient care.
13. Megerian JT, Kong X, Gozani SN. Utility of nerve conduction studies for carpal tunnel syndrome by FM/PCP/IM physicians. *J Am Board Fam Med*. 2007;20:60-64.
 - Shows that NCS studies (by NC-stat) performed by over 1000 PCP physicians follow evidence based guidelines, are used in appropriate patients, and generate clinically meaningful results.
14. 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.
 - Demonstrates that diabetic neuropathy testing (by NC-stat) of about 1,400 patients in primary care settings is clinically meaningful.

15. Kong X, Lesser E, Megerian JT, Gozani SN. Repeatability of nerve conduction measurements using automation. *J. Clin Monit Comput* 2006;20(6):405-10.
 - Demonstrates that all NC-stat measurements have excellent test-retest reproducibility over a one-week interval.
16. 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.
 - Demonstrates that NC-stat measurements of sural nerve amplitude are comparable to academic electromyography laboratory specializing in diabetic neuropathy. Also shows that NC-stat diagnostic sensitivity and specificity for diabetic polyneuropathy is very high.
17. 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.
 - Demonstrates that NC-stat sensory measurements in the median and ulnar nerves are valid and reliable as compared to an academic electromyography laboratory.
18. Katz RT. NC-stat as a screening tool for carpal tunnel syndrome in industrial workers. *J Occup Environ Med*. 2006;48(4):414-8.
 - Concludes that NC-stat DML measurements are equivalent to “traditional” techniques. Further conclusions are invalid and addressed in response listed below.

Comment: Megerian JT, Kong X, Lesser E, Gozani SN. NC-stat as a screening tool. Upper extremity nerve conduction studies in diabetic patients with the NC-stat. *J Occup Environ Med*. 2006;48(8):755-6.
19. 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.
 - Clinical trial of Duloxetine (Cymbalta) in which NC-stat was used to monitor electrophysiological changes in treatment and placebo arms. Data submitted to FDA and drug approved and now on market.
20. Conlon CF, Rempel DM. Upper extremity mononeuropathy among engineers. *J Occup Environ Med*. 2005;47(12):1276-8.
 - NIH/NIOSH sponsored study evaluated whether keyboard use leads to mononeuropathies. NC-stat was used to evaluate median and ulnar nerve function and part of case definition.
21. Elkowicz 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.
 - Demonstrates high correlation between NC-stat and referral neurologist DML.
22. Fisher MA. Comparison of automated and manual F-wave latency measurements. *Clin Neurophysiol*. 2005;116(2):264-9.
 - Demonstrates very high correlation between peroneal F-wave latency assignments by NC-stat algorithm and neurologist specializing in F-waves.
23. 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.
 - Review article discussing history, definition and examples of automation in electrodiagnostic instruments. Describes NC-stat automation in detail.
24. 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.
 - Clinical trial of Duloxetine (Cymbalta) in which NC-stat was used to monitor electrophysiological changes in treatment and placebo arms. Data submitted to FDA and drug approved and now on market.

25. Guyette TM, Wilgis EF. Timing of improvement after carpal tunnel release. *J Surg Orthop Adv.* 2004;13 (4):206-9.
 - NC-stat median DML used as an outcome measure for carpal tunnel release. Showed that DML improves following release surgery.
26. Mani S, McDaid H, Hamilton A, Hochster H, Cohen MB, Khabelle D, Griffin T, Lebwohl DE, Liebes L, Muggia F, Horwitz SB. Phase I clinical and pharmacokinetic study of BMS-247550, a novel derivative of epothilone B, in solid tumors. *Clin Cancer Res.* 2004;10(4):1289-98.
 - NC-stat used as an adverse outcome measure in a Phase I trial of a novel chemotherapeutic agent. Results demonstrated that nerve conduction did not degrade in patients on the drug.
27. 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.
 - Demonstrates high correlation between NC-stat and referral neurologist for median DML, and high diagnostic sensitivity for detection of CTS.
28. 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.
 - Demonstrates high correlation between NC-stat median and ulnar DML and F-wave latency and same measurements by neurologist-supervised technician.

Comment: Megerian JT, Gozani SN. Upper extremity nerve conduction studies in diabetic patients with the NC-stat. *Diabetes Technol Ther.* 2006;8(2):258-60.
29. 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.
 - Demonstrates high NC-stat diagnostic sensitivity and specificity for MRI confirmed lumbosacral radiculopathy.
30. 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.
 - Demonstrates high correlation between median motor nerve measurements by NC-stat and academic electromyography laboratory. Also demonstrates high diagnostic sensitivity and specificity for CTS.

Conference Papers, Abstracts and Presentations

General Topics

1. Armstrong A, Al-Lozi M, Dale AM, Franzblau A, Evanoff B. Median and ulnar nerve conduction studies at the wrist: Comparison of portable and traditional methods. Accepted for presentation at the Sixth International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders, Boston, MA, August 27-30, 2007.
2. Armstrong A, Dale AM, Franzblau A, Evanoff B. Risk Factors for Carpal Tunnel Syndrome in a Population of Newly Hired Workers: A Cross-Sectional Analysis. Accepted for presentation at the Sixth International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders, Boston, MA, August 27-30, 2007.
3. Bajwa R, Somashekar KK, Fisher MA. Traditional EDX and a multiparameter technique in lumbosacral radiculopathies. Presented at the Annual Meeting of the American Clinical Neurophysiology Society, Chicago, IL, November 9-12, 2006.
4. Sridhar Mani, Hayley McDaid, Heng-Jia Shen, Joseph A Sparano, Anne Hamilton, Carolyn Runowicz, Howard Hochster, Franco Muggia, Abbey Fields, Bharat Damle, Stephen Letrent, David Lebwohl, Susan B Horwitz. Phase I Evaluation of an Epothilone B Analog (BMS-247550): Clinical Findings and Molecular Correlates. Presented at ASCO Annual Meeting, 2001. Proc Am Soc Clin Oncol 20: 2001 (abstr 269).

Diabetes Topics

5. Mamkin A, Mamkin I, Isakova V, Murali P, Pavlakis S, Ten S. Subclinical diabetic peripheral neuropathy is a frequent complication in children with diabetes as measured by the NC-stat[®] System. Presented at the Pediatric Academic Societies Annual Meeting, Baltimore, MD, May 2-5, 2009.
6. Strotmeyer ES, Cauley JA, Iuliano D, Schwartz AV, Orchard TJ. Poor Motor Nerve Conduction is Associated with Total Hip Bone Area in Type 1 Diabetic Adults: The Epidemiology of Diabetes Complications Study. Presented at the 68th Annual Meeting of the American Diabetes Association, San Francisco, CA, June 6-10, 2008.
7. Lavery LA, Williams JR, Murdock DP, Lavery D. F Does Light Therapy Improve Sensation in Diabetes? A Double Blind, Sham Controlled Randomized Trial to Evaluate Monochromatic Infrared Photo Energy. Abstract at the 67th Annual Meeting of the American Diabetes Association, Chicago, IL, June 22-26, 2007.
8. Perkins BA, Bri VI. A novel point-of-care nerve conduction device accurately identifies diabetic sensorimotor polyneuropathy when used in the modified San Antonio criteria algorithm. Presented at the 7th International Symposium on Diabetic Neuropathy (2007), South Africa, November 29 – December 2, 2006.
9. Anderson RL, Johnson ML, Davick BC, Kendall DM, Oglesby AK, Kan HJ, Bergenstal RM. Association between diabetic microvascular complication among people with diabetes attending a comprehensive annual diabetes assessment. Presented at the 65th Annual Meeting of the American Diabetes Association, San Diego, CA, June 10-14, 2005.
10. Gozani SN. Projected diagnostic outcomes of point-of-service nerve conduction studies performed in patients with diabetes. Presented at the 65th Annual Meeting of the American Diabetes Association, San Diego, CA, June 10-14, 2005.
11. Johson ML, Anderson RL, Kendall DM, Davick BC, Oglesby AK, Kan HJ, Bergenstal RM. Diabetic peripheral neuropathy is the most common microvascular complication among people with diabetes attending a comprehensive annual diabetes assessment. Presented at the 65th Annual Meeting of the American Diabetes Association, San Diego, CA, June 10-14, 2005.

12. Kong X, Gozani SN, Megerian JT. Prevalence and characteristics of neuropathies in a national point-of-service nerve conduction registry: Preliminary analysis. Presented at the 65th Annual Meeting of the American Diabetes Association, San Diego, CA, June 10-14, 2005.
13. Kong, X, Krishnamachari S, Gozani SN. Point-of-service sural nerve conduction Studies using the NC-stat system. Presented at the 65th Annual Meeting of the American Diabetes Association, San Diego, CA, June 10-14, 2005.
14. Gozani SN, Kong X. Assessment of diabetic peripheral neuropathy in community clinical setting using automated nerve conduction technology. Presented at the 64th Annual Meeting of the American Diabetes Association, Orlando, FL, June 4-8, 2004.
15. Gozani SN, Megerian JT, Waninger A, Xie L, Wernicke J. Automated nerve conduction testing technology to assess peripheral nerve function in diabetic neuropathic pain patients during Duloxetine treatment. Presented at the 64th Annual Meeting of the American Diabetes Association, Orlando, FL, June 4-8, 2004.