AANEM American Association of Neuromuscular & Electrodiagnostic Medicine
Position Statement

Reporting the Results of Nerve Conduction Studies and Needle EMG

Nerve conduction studies (NCSs) and needle electromyography (EMG) performed by a physician (MD or DO) with the appropriate education, training, and experience are used to evaluate patients with neuromuscular (NM) diseases and diagnose the presence, distribution, and severity of nerve, NM junction, and muscle pathology. [1] After NCSs and needle EMG are completed, it is necessary to prepare a written report of the test results. This report serves as a communication tool to the referring physician and documents the results and conclusions of the electrodiagnostic (EDX) evaluation.

This educational document created by the American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) addresses the following two key clinical questions.

1. What information should be included regarding the needle EMG and NCS examination?
2. What is the best way to present the information?

The AANEM's goal in publishing this report is to provide practicing EDX physicians with recommendations for presenting data in their reports. It is not intended to require that all of these recommendations must be included in a report.

BACKGROUND

The EDX examination of a patient is structured to answer specific clinical questions. [2] The physician performing the examination (1) determines the initial tests to perform based on his or her education, training, and experience, and the patient's history and physical examination, and then (2) modifies the tests as data (visual and auditory) is obtained and analyzed in real time. When finished, the physician composes a report summarizing the data and providing the diagnostic conclusions which are determined by integrating the analysis of the tests results with the findings on the history and physical examination.[3] This integration process must occur concurrent to the performance of the studies and be performed by the interpreting physician at the time of testing, guiding both nerve and muscle selection.[4] Due to these requirements, the interpretation of the studies cannot be performed by a physician who is offsite.

This document addresses the presentation of the data in the EMG/NCS report. It does not address the correct analysis of the EMG/NCS data necessary to provide an accurate diagnosis. Therefore, a physician who follows all of these recommendations may still document an inaccurate diagnosis. Furthermore, a physician may establish an accurate diagnosis without following all of these recommendations.

The presentation of the data is an essential part of the EDX examination. A model report should include a description of the patient's clinical problem, the EDX tests performed, all relevant data derived from these tests, and the diagnostic interpretation of the data. The report permits (1) a review of the results by other physicians evaluating and treating the patient, and (2) comparison of these results to past and future test results. If, upon completion of testing, the physician provides only a conclusion without supporting data, it is difficult for other physicians treating the patient to determine (1) whether the test data support the conclusions, and (2) whether the identified NM disorder is stable, improving, or worsening based upon a comparison with previous and/or subsequent test results.

It is important to perform and document accurately the findings of the NCS and needle EMG examination to realize the full potential of the tests and to reduce the possible need for the patient to undergo repeated testing. These two goals are desirable because a needle EMG study is an invasive test and because both the needle EMG and NCS examination may be uncomfortable.

Providing complete NCS measurements is important. The name of each nerve tested, right or left side designation, site of stimulation, site of pickup, and distance over which the NCS was performed should be included in the data for NCSs. A quality report presents NCS data with amplitude and latency measurements. These response parameters must occur in a real-time fashion to facilitate interpretation. Amplitude measurements are important for the identification of nerve conduction block, axonal nerve pathology, and muscle pathology, and for prognostication. Latency measurements are important for determining the speed of nerve conduction in the area tested. Clearly identifying the segment over which the conduction velocity is calculated is essential for the localization of focal nerve pathology, when present. In addition to the aforementioned numerical data, including NCS waveforms within the report provides reviewing physicians the ability to ensure the quality of the study. Raw measurement data obtained and transmitted trans-telephonically, over the Internet or by other electronic means with delayed interpretation do not meet the "real time" requirement and so do not comprise quality studies.

The determination of normality is best made by the physician performing the test, taking into consideration all of the relevant clinical information. Inclusion of this information in the report is important to assist others in the proper interpretation of the data. Options include providing normal (reference) values for NCSs and criteria for abnormalities in the report or citing appropriate reference material upon which normal values are based[6], which allow the reader of the report to verify why specific test data were designated as normal or abnormal. However, this designation of abnormalities depends upon several patient variables including: age, height, weight, and limb temperature during testing which are not always included in reference values. Clinical variables including, but not limited to, underlying medical conditions and prior surgeries also have an impact on whether a finding is considered normal or abnormal. The definition of normal can also vary between laboratories. The diagnostic interpretation of the needle EMG and NCS data is an integral part of the EDX examination. The diagnostic determination that the needle EMG findings are normal or abnormal occurs during the test in real time. Due to technical limitations, there is generally no complete, permanent record of the EMG waveforms analyzed during the test. Documenting in the report both the spontaneous and voluntary activity in each muscle examined with the needle EMG electrode is therefore extremely important.

Presenting the needle EMG examination findings in a way that incorporates the following data (preferably in a tabular format) makes the report easier to understand. The report should include (1) the name and side (left or right) of each muscle examined, (2) a description of insertional activity, (3) the presence or absence of abnormal spontaneous activity, and (4) assessment of the potentials generated with voluntary activity. For voluntary activity, both the morphology and the recruitment of the motor units should be described. Spontaneous and voluntary activity observed during the needle EMG examination should be reported as normal or abnormal and, if the activity is identified as abnormal, the specific abnormalities should be described in detail.

Descriptions of the findings on the needle EMG examination such as "needle EMG studies of the right upper limb muscles were normal" are not helpful. It is essential to list the specific muscles examined. Without a list of the exact muscles tested, it is impossible to determine whether the examination was adequate to evaluate the clinical problem. Tables of the findings on needle EMG examination, in contrast to narrative reports, make it easier to identify the distribution and relative severity of needle EMG abnormalities in the muscles examined. Physicians therefore may find it beneficial to list findings in a tabular format with an additional narrative description of abnormalities.

The EDX report should include the name of the individuals who performed and interpreted the study. The needle EMG examination must be performed by a physician specially trained in EDX medicine, as these tests are

simultaneously performed and interpreted. When the entire examination is performed by one physician, the physician's name should be clearly identified on the report with an appropriate signature. Some laboratories have appropriately trained NCS technologists who perform NCSs under the direction of the EDX physician. In these cases, the physician must be on-site, evaluate the patient, determine the testing to be performed, and oversee and add NCSs as deemed necessary to provide a quality test. The name of the technologist and the physician should both be included on the report, along with the signature of the physician. In cases involving a resident or fellow, the name of the trainee should also be included.

AANEM EDX Laboratory Accreditation (https://www.aanem.org/Practice/EDX-Laboratory-Accreditation) has been introduced to provide a voluntary peer review process to ensure quality EDX testing for patients. Accreditation acknowledges EDX laboratories for achieving and meeting a level of quality, performance, and integrity based on professional standards. Accreditation provides laboratories specializing in EDX medicine with a structured mechanism to assess, evaluate, and improve the quality of care provided to their patients. Laboratories that have attained accreditation or accreditation with exemplary status should include this status on their EDX reports.

EDX testing requires the use of instruments designed to meet minimum requirements in order to provide the amplitude, latency, and configuration of the waveform data needed to make a diagnosis.[5] Some devices do not meet these requirements. Including the make and model of the EDX instrument utilized demonstrates that an appropriate device was used.

Below are specific recommendations and options for information to include in an EMG and NCS report. These recommendations do not preclude other reasonable methods of presenting EDX data. An example of an EDX report that follows the recommendations and options in this document can be found at: https://www.aanem.org/Advocacy/Position-Statements.

SPECIFIC RECOMMENDATIONS FOR REPORTING NCS AND NEEDLE EMG RESULTS

A. Description of Patient Data and the Clinical Problem Section

1. **Recommendation.** Describe the patient's demographic data.
    a. **Recommendation.** Include name, medical record number, weight, height, gender, and age or birth date.
    b. **Option.** Include handedness for upper-limb studies, and relevant medical diagnoses (e.g., diabetes, chronic renal failure) and surgical treatments with dates (e.g., carpal tunnel surgery, August 2000).

2. **Recommendation.** Describe the reasons for the referral.
    a. **Recommendation.** Include a brief description of relevant symptoms and/or physical examination findings that support the performance of the EDX study.
    b. **Option.** Include possible diagnoses.

3. **Option.** Describe relevant safety considerations for the performance of NCS (e.g., cardiac pacemaker with defibrillator, sensitive to electrical stimuli) and needle EMG (e.g., anticoagulation therapy, bleeding disorder), and limitations to NCSs (e.g., limb in a cast) and needle EMG (e.g., patient unable to turn over to permit examination of hip girdle and paraspinal muscles), if applicable.

B. Nerve Conduction Studies Section

Specific details of the NCS procedures, including the techniques utilized, distances, laboratory reference values, and temperature monitoring may be best included in the report or referenced in a standard operating procedure manual maintained by the laboratory.

1. **Recommendation.** List the nerves and the side (left or right) studied by NCS.

2. **Recommendation.** Provide the numerical values for the results of each NCS as follows:

    a. *Sensory NCSs*
        i. **Recommendation.** Indicate the nerve studied, the sites of nerve stimulation, and the distances between distal stimulation sites and recording sites.
        ii. **Recommendation.** For each site of stimulation and recording, report the sensory nerve action potential (SNAP) amplitude. (An option is to describe whether the amplitude measurements are (a) baseline to peak or (b) peak to peak.)
        iii. **Recommendation.** Report the peak latency of the SNAP or conduction velocity determined from onset latency measurements for SNAPs at each site of stimulation.

    b. *Motor NCS*
        i. **Recommendation.** Indicate the nerve studied, the sites of nerve stimulation, the distances between distal stimulation and recording sites, the distances between different stimulation sites, and recording site of compound muscle action potentials (CMAPs).
        ii. **Recommendation.** Report the CMAP amplitude (baseline to negative peak) for each site of stimulation and recording.
        iii. **Recommendation.** Report latency, amplitude, and distance for each site of nerve stimulation.
        iv. **Recommendation.** Report limb conduction velocity for motor NCSs and specify nerve segment for conduction velocity (e.g., forearm segment or elbow segment for the ulnar nerve) if there is potential ambiguity.

    c. *F-wave studies*
        i. **Recommendation.** Indicate the nerve studied.
        ii. **Recommendation.** Report the minimum F-wave latency.
        iii. **Recommendation.** Indicate the site of nerve stimulation and muscle recording.

    d. *H-reflex studies*
        i. **Recommendation.** Indicate the nerve studied if not the tibial nerve.
        ii. **Recommendation.** Report the H-wave latency. (Recording amplitude is optional.)
        iii. **Recommendation.** Indicate the site of nerve stimulation and muscle recording.

    e. *Repetitive motor nerve stimulation studies*
        i. **Recommendation.** Indicate the nerve studied.
        ii. **Recommendation.** Indicate the sites of nerve stimulation and muscle recording.

iii. **Recommendation.** Indicate the physiological state of the muscle at the time of nerve stimulation (e.g., at rest or after exercise) and, if after exercise, the duration of the exercise and the time interval after exercise.
iv. **Recommendation.** Indicate the number of stimuli and the rate of stimulation, e.g., 5 stimuli at a rate of 2/s.
v. **Recommendation.** Indicate the initial amplitude, the method of calculation of the increment or decrement (e.g., percent change of the amplitude or area of the 4th or 5th M wave compared to the 1st M wave).
vi. **Recommendation.** Indicate if and when the patient last used a medication that can affect the results of NM transmission and the name and dose of the medication.

f. *NCS Waveforms*
i. **Option**. Include waveforms of SNAPs, CMAPs, F-waves, and H-reflexes.

3. **Recommendation.** Include reference laboratory values for NCS data to permit independent review of NCS data by an outside reviewer *or* provide literature references or other sources for the normal values if requested. If the report does not contain reference laboratory values, abnormal results should be clearly identified.

4. **Recommendation.** Confirm that limb temperature was monitored continuously during the NCS and repetitive stimulation and that (a) the hand temperature was maintained between 32°C and 36°C and (b) the foot temperature was maintained between 30°C and 36°C. NCS abnormalities such as prolonged distal sensory or motor latencies could otherwise be due to coolness of the limb. For repetitive stimulation, if the limb is not warmed, the results may be assessed inaccurately as normal.

5. **Recommendation.** Use non-narrative, preferably tabular format for NCS data.

6. **Recommendation.** Describe limitations in the study due to low tolerance of the patient for the electrical stimuli and/or other technical factors that may have affected the performance and results of the NCS (e.g., thickness of subcutaneous tissues, limb edema).

C. Needle Electromyography Section

1. **Recommendation.** Examine an appropriate number of muscles to evaluate the possible diagnoses.

2. **Recommendation.** Describe the insertional, spontaneous, and voluntary activity (e.g., amplitude, duration, phases, and recruitment should all be noted) for each muscle studied as normal or abnormal and, if abnormal, provide specific details of the abnormalities.

3. **Recommendation.** Use a tabular format for presentation of needle EMG data for each muscle studied to permit an independent reviewer to identify easily the myotome/peripheral nerve distribution of muscles with normal and abnormal needle EMG findings.

4. **Recommendation.** Describe limitations in the study such as limited effort or low tolerance of the patient for the examination including pain with needle insertion and during contraction of the muscle, as well as the effect of this pain on the scope and interpretation of the examination.

5. **Option.** State whether the examiner used a monopolar or concentric needle electrode for the examination.

D. Summary Section

1. **Recommendation.** Summarize NCS abnormalities. Describe which NCS studies are normal and which NCS are abnormal, and list the specific abnormalities (e.g., low amplitude, prolonged peak or distal latency, slowing of conduction).

2. **Recommendation.** Summarize needle EMG abnormalities. Describe the results as normal or abnormal, and if abnormal, describe the abnormalities including the distribution of the abnormalities if relevant (e.g., peripheral nerve, plexus, or spinal root).

E. Diagnostic Interpretation Section

1. **Recommendation.** State whether the results of the study are normal or abnormal and, if abnormal, describe the specific abnormalities for NCS and needle EMG as noted above.

2. **Recommendation.** Provide the probable electrophysiological diagnosis. Describe the location of the nerve, NM junction, or muscle pathology based on the results of the NCS and needle EMG studies (e.g., median nerve pathology at the wrist affecting primarily the median sensory nerve fibers in the carpal tunnel segment).

3. **Recommendation.** Describe any limitation on the interpretation of the results of the NCS and needle EMG studies due to technical factors including patient volitional factors and/or contraindications for specific studies.

4. **Recommendation.** Describe (1) whether there is an interval change and (2) the nature of the change (e.g., improved, stable, worsening) in the NCS and needle EMG findings if results of previous studies are available at the time of the composition of the report and if such results or reports are adequate for comparison.

5. **Option.** Provide the probable clinical diagnosis, if indicated, based on a synthesis of the clinical information and the electrophysiological results (e.g., a clinical diagnosis of carpal tunnel syndrome).

6. **Option.** Provide a differential diagnosis of abnormal results of the NCS and needle EMG studies if indicated.

7. **Option.** Indicate whether additional NCSs and needle EMG examination are indicated now or in the future, if appropriate.

8. **Option**. Indicate whether additional diagnostic yield/refinement may be obtained from another study modality (e.g. neuromuscular ultrasound).

F. Identification

1. **Recommendation**. The physician specially trained in EDX medicine performing the study should be clearly identified and a signature included on the report.

2. **Recommendation.** If a NCS technologist, resident, or fellow performs a portion of the study, this should be indicated in the report and the name of the individual(s) clearly identified.

G. AANEM Laboratory Accreditation

1. **Recommendation.** If obtained, the AANEM laboratory accreditation or exemplary status should be included on the report.

H. EDX Instruments

1. **Option.** Identify the instrument manufacturer and model on the report.

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REFERENCES

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4. What Does 'On Site' and 'Real Time' Mean? American Association of Electrodiagnostic Medicine website https://www.aanem.org/Advocacy/Position-Statements,
5. Electrodiagnostic Study Instrument Design Requirements. American Association of Electrodiagnostic Medicine website https://www.aanem.org/Advocacy/Position-Statements,
6. American Association of Neuromuscular & Electrodiagnostic Medicine. *Electrodiagnostic Reference Values for Upper and Lower Limb NCS in Adult Populations* (available at https://www.aanem.org/clinical-practice-resources/guidelines).