

## REPORTING THE RESULTS OF DIAGNOSTIC NEUROMUSCULAR ULTRASOUND: AN EDUCATIONAL REPORT

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**ABSTRACT:** *Introduction:* Neuromuscular ultrasound (NMUS), an emerging diagnostic subspecialty field, has become an important extension of the electrodiagnostic examination. However, there are no formal guidelines on how to appropriately report NMUS results. *Methods:* The AANEM convened an expert panel to develop recommendations for reporting NMUS findings. *Results:* Providers should describe the reason for referral, the nerves or muscles studied, and normal values as well as numerical values for the results of imaging. Muscle imaging reports should also include a description of how gray-scale values were calculated. NMUS-guided needle placement reports should include a description of the length and gauge of needle, the type of probe used, and an indication of how well the patient tolerated the procedure. All reports should clearly state whether the findings were normal or abnormal and include a definitive diagnosis. *Conclusions:* NMUS reports should provide comprehensive information along with a succinct conclusion, mirroring guidelines for electrodiagnostic reports.

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**P**eripheral nerve and muscle ultrasound (US), collectively referred to as neuromuscular ultrasound (NMUS), is an emerging diagnostic subspecialty field. Recent technological advances in US allow physicians to study peripheral nerves to evaluate neuromuscular (NM) diseases. In the past, electrodiagnostic (EDx) testing was used to diagnose these diseases; however, NMUS can now complement the EDx findings. NMUS can be used to guide procedures, including injections and dia-

phragm electromyography (EMG), but it also has diagnostic utility in EDx medicine. The American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) published a position statement supporting the use of diagnostic NMUS by its physicians.<sup>1</sup> To date, there are no formal guidelines on how to appropriately report the NMUS results.

This educational document addresses the following key questions:

1. What information should be included regarding the NMUS examination?
2. Should images be incorporated into the report?
3. Can this information be incorporated into the nerve conduction study (NCS)/EMG report, or is a separate report necessary?
4. How should US-guided procedures be reported?

### BACKGROUND

NMUS is becoming an important extension of the EDx examination and a widely accepted means of enhancing diagnostic capabilities in the EMG laboratory, particularly in patients with entrapment mononeuropathies. Academic practices were the first to implement NMUS, but it now is being utilized in other practice settings. NMUS currently is used to assess nerve tumors, nerve trauma, and inflammatory neuropathies, and to guide both diagnostic and therapeutic procedures.

As with NCS/EMG reports, adequate documentation of peripheral nerve and muscle US is essential for high-quality patient care. The report must include basic elements and present data in a structured and succinct format that is easily interpreted. Below are specific recommendations and options for information to include in an NMUS report. These recommendations do not preclude other reasonable methods of presenting EDx data. An example of a report that follows the recommendations and options outlined below may be found at: <http://www.aanem.org/Practice/Position-Statements.aspx>.

The AANEM Professional Practice Committee appointed a panel of 2 neuromuscular US experts to draft recommendations for reporting the results

**Abbreviations:** AANEM, American Association of Neuromuscular and Electrodiagnostic Medicine; CSA, cross-sectional area; EDx, electrodiagnostic; EMG, needle electromyography; NCS, nerve conduction study; NM, neuromuscular; NMUS, neuromuscular ultrasound; US, ultrasound

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This practice topic was developed by members of the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) Professional Practice Committee. Approved by the AANEM Board of Directors on July 26, 2012.

**Key words:** imaging; muscle ultrasound; needle EMG; nerve conduction studies; neuromuscular ultrasound; peripheral nerve ultrasound, ultrasound guidance; ultrasound report

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of NMUS. This document was then reviewed by members of the AANEM Ultrasound Task Force for additional input prior to final review and approval by the Professional Practice Committee.

## **SPECIFIC RECOMMENDATIONS FOR REPORTING NMUS RESULTS**

### **A. DESCRIPTION OF PATIENT DATA AND THE CLINICAL PROBLEM SECTION**

1. **Recommendation.** Describe the patient's demographic data.
  - a. **Recommendation.** Include the patient's name, date of birth, age, height, weight, ethnicity, and gender. Medical record identification numbers should be included, if used. The referring physician should be noted.
  - b. **Option.** Include patient handedness for upper limb studies and relevant medical diagnoses (e.g., diabetes mellitus, neurofibromatosis) and prior relevant surgical therapy (e.g., ulnar nerve transposition, May 2009).
2. **Recommendation.** Describe the reasons for the referral.
  - a. **Recommendation.** Include a brief description of relevant symptoms and brief physical examination findings that support the performance of the NMUS study.
  - b. **Option.** Include possible diagnoses.

### **B. PERIPHERAL NERVE US RESULTS SECTION**

1. **Recommendation.** List the nerves and the side (left or right) examined.
2. **Recommendation.** Describe patient positioning for nerve imaging, when relevant (e.g., ulnar nerve, fibular nerve).
3. **Recommendation.** Describe the region of the nerve that was imaged (e.g., the right ulnar nerve was imaged from the distal wrist crease to the axilla). The orientation of the US transducer in relation to the nerve also should be reported (e.g., the median nerve was imaged in longitudinal section at the antecubital fossa). When feasible, it is recommended that the structure of interest be imaged in at least 2 different planes.
4. **Recommendation.** Provide numerical values for the results of nerve imaging.
  - a. **Recommendation.** Cross-sectional (transverse) measures of nerve area (known as cross-sectional area, or CSA) are the most accurate and reproducible measurements in NMUS. Increasing area is associated with nerve entrapment and focal inflammation.<sup>2</sup> Area values should be provided in standard units (mm<sup>2</sup> or cm<sup>2</sup>). The location of each measurement should be described in easily understood anatomical terms (e.g., the median

nerve measured 8 mm<sup>2</sup> at the antecubital fossa). CSA is measured within the epineurium, using either the trace or elliptical methods.

- b. **Recommendation.** Normal values should be reported along with the nerve measurements.
  - c. **Option.** The source of normative values may be mentioned in the report, specifying if they were derived at the location of imaging or obtained from another source.
  - d. **Option.** Nerve thickness, or diameter, measurements are appropriate in certain circumstances and can provide important information. These values should be reported in standard units (mm), and the location should be described adequately.
5. **Recommendation.** Describe any areas of abnormal nerve appearance.
    - a. **Recommendation.** Abnormalities in nerve signal (echogenicity) can provide additive information regarding nerve pathology. No quantitative measure of this parameter currently exists. The report should describe these findings qualitatively (e.g., the nerve appeared hypoechoic at the right ulnar groove).
    - b. **Option.** Abnormalities in nerve mobility, such as decreased mobility of the median nerve at the wrist or subluxation of the ulnar nerve at the elbow, should be reported when present.
    - c. **Option.** Abnormalities in nerve vascularity, such as increased vascularity of the median nerve at the wrist, should be reported when present, along with a description of how it was determined.
    - d. **Option.** If physicians have developed a standard quantitative means of measuring nerve echogenicity, it may replace the descriptive terms. However, normal values and an explanation of the method also must be provided.
  6. **Recommendation.** Describe abnormalities extrinsic to the nerve, including cysts, encroaching surgical hardware, osseous abnormalities, and other external sources of compression.
  7. **Recommendation.** If an abnormality extrinsic to the nerve exists, the location, signal characteristics, and size of the lesion should be provided. These abnormalities should be imaged in at least 2 different planes. A differential diagnosis also should be included.
  8. **Recommendation.** US transducer frequency and gain setting should be included with the report.

### **C. MUSCLE US RESULTS SECTION**

1. **Recommendation.** List the muscles and side (left or right) imaged.

2. **Recommendation.** Although muscle US parameters are still under investigation, muscle thickness at the mid-point should be reported in standard units (mm or cm).
3. **Recommendation.** A qualitative description of muscle echogenicity and the homogeneity or heterogeneity of these findings should be presented (e.g., the deltoid had homogeneously increased echogenicity). Include information regarding qualitative parameters, such as muscle motion (normal, absent, paradoxical, in response to electrical stimulation, etc.) and muscle vascularity, as clinically indicated.
4. **Recommendation.** As US system settings strongly affect the appearance of muscle signal, the US transducer frequency, depth of imaging, and gain settings must be included with each report. Also include a notation as to whether any post-processing, such as compound imaging or time-gain compensation, was used for the study.
5. **Option.** Gray-scale values may be provided as a means of quantitating muscle signal. If provided, the report should describe how these were calculated and should reference the source for the normal values used.

#### **D. NMUS-GUIDED NEEDLE PLACEMENT RESULTS SECTION**

- a. **Recommendation.** Describe the muscle or nerve targeted, and the reason for the use of US guidance (such as decreasing risk of inadvertent puncture of vital structures or improved accuracy after failing to locate the target with non-guided attempt).
- b. **Recommendation.** Describe the length and gauge of needle used. Note that an aseptic technique was used.
- c. **Recommendation.** Describe the type of probe used (curvilinear vs. linear, size, MHz range).
- d. **Recommendation.** Note any complications or poor tolerance that occurred during the procedure.
- e. **Recommendation.** Include a paragraph on informed consent and observation of a procedural pause when clinically indicated.
- f. **Recommendation.** Note location of stored images, for referring physician's reference, as needed.

#### **E. CONCLUDING THE REPORT**

1. **Recommendation.** Each NMUS report should provide a clinically meaningful conclusion, and a final report should be included in the patient's medical record.

- a. **Recommendation.** The conclusion should clearly state if the NMUS findings were normal or abnormal.
- b. **Recommendation.** A definitive diagnosis should be provided. If not possible, a short list of relevant possibilities may be listed (e.g., this is an abnormal ultrasonographic study revealing a cystic mass compressing the right fibular nerve at the fibular head. This is most likely a synovial ganglion cyst, although a peripheral nerve sheath tumor cannot be excluded).
- c. **Option.** A recommendation for further testing to clarify the diagnosis may be mentioned in the conclusion.

#### **F. INCORPORATION OF IMAGES INTO THE NMUS REPORT**

1. **Recommendation.** As with other radiology reports (MRI, echocardiography, etc.), there is no need to incorporate images into the report document.
2. **Recommendation.** Images should be saved and available for review if requested by the referring physician. Digital storage of images is advised.
3. **Recommendation.** When performing US-guided needle placement, there should be at least 1 ultrasonographic image of the needle once it has reached its target.
4. **Option.** The inclusion of representative images in the NMUS report can be helpful to the referring physician and is encouraged.

#### **G. SHOULD THE NMUS REPORT STAND ALONE?**

1. **Recommendation.** NCS/EMG and NMUS provide adjunctive information that should be interpreted together. The NMUS report can be included as a separate section of the full NCS/EMG report if the procedures are performed the same day. If not, a full separate report should be prepared.
2. **Option.** Physicians may choose to prepare a separate NMUS report as standard practice, but they should reference relevant NCS/EMG results in this report.

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#### **REFERENCES**

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