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REPORT

RAND/UCLA Quality-of-Care Measures for Carpal Tunnel Syndrome

Appendix V, Part B: Materials for Scoring Electrodiagnosis Quality Measures (Guidance Document)

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Supported by the California Commission on Health and Safety and Workers’ Compensation and by the Zenith Insurance Company
This research was jointly supported by the California Commission on Health and Safety and Workers’ Compensation and by the Zenith Insurance Company, and was undertaken within the RAND Center for Health and Safety in the Workplace.
Instructions

The Guidance Document contains detailed definitions and instructions; abstractors should refer to that document before scoring the measures and variables the first time, if they encounter unusual situations, or if they have any detailed questions. The purpose of the Scoring Instructions is to provide basic information that can be used to determine how to score the quality measures and related variables. Because the Scoring Instructions are long, recording data for individual patients on it would use a lot of paper. Instead, data for individual patients can be recorded on the separate and much shorter Data Form. Thus, if the Scoring Instructions are analogous to a test you might take in school, the Data Form is analogous to the sheet on which you record your answers to test questions.

In these documents, questions are numbered as follows:

- Questions pertaining to section or subsection eligibility are indicated by an “E” after the question.
- Questions pertaining to individual measures are indicated by “M” after the question number.
  - “ME” means that the question pertains to eligibility for the measure.
  - “MC” means that the question addresses components of an individual measure.
  - “MA” means that the question addresses whether or not care adhered to the requirements of the measure.
- Additional variables that are not directly related to an individual measure are indicated by “V” after the question number.

Answer the following questions as directed for each diagnostic test completed on the study hand. Complete one Data Form per electrodiagnostic test.

Overview of Electrodiagnostic Testing

The following provides an overview of electrodiagnostic testing for abstractors who may have a limited understanding of these tests. However, we recommend that physicians with expertise in electrodiagnostic tests score eligibility and adherence for these measures. Detailed information on eligibility and adherence requirements for each measure is provided after this background information.

Electrodiagnostic tests have two major components: nerve conduction studies and needle electromyography.

Nerve Conduction Studies

Nerve conduction studies assess conduction over nerve segments to identify dysfunction of motor and sensory nerves. The electrodiagnostician applies an electrical stimulus with a pair of stimulating electrodes on the skin overlying a nerve. The electrical stimulus depolarizes the nerve and initiates nerve action potentials that travel along the motor and/or sensory fibers within the nerve. Recording electrodes on the skin over nerves and/or muscles record the responses from the nerves and/or muscles. A permanent record can be made of the responses recorded by an amplifier and measurements made from the recorded tracings. Most nerves in the body include both sensory and motor nerve fibers, making them “mixed” nerves.
Nevertheless, the sensory and motor components are evaluated separately, if possible, by selective placement of the stimulating and recording electrodes.

**Motor Nerve Conduction Study**

This is a nerve conduction study designed to assess the function of motor fibers and the muscle innervated by the motor fibers in a mixed nerve. In this study, an electrical signal is applied by the stimulating electrodes to activate the nerve fibers, resulting in impulse conduction down the nerve and transmission across the neuromuscular junction. The resulting action potential in the muscle is detected at a recording electrode on the skin overlying the muscle. The signals detected by the recording electrodes are documented in a tracing, and this enables three key variables to be measured:

- **Motor distal latency**: This is the time (in milliseconds) between the application of the electrical stimulus (as indicated by a stimulus artifact on the tracing) and the start of the muscle action potential (as indicated by the initial deflection of the tracing from baseline, which is generally negative if the active recording electrode is placed over site of entry of the motor fibers into the muscle). Motor distal latency indicates the time for conduction along the fastest fibers within the nerve plus the time for nerve activation by the electrical stimulus and the time for transmission across the neuromuscular junction. Technically, the motor distal latency is an “onset” latency because the measurement is made to the initial deflection (onset) of the motor action potential.

- **Amplitude**: This is the magnitude (in millivolts) of the tracing signal at its negative peak relative to the baseline. This amplitude indicates the number of muscle fibers responding to the stimulation of the motor nerve. Reduced amplitude generally reflects motor nerve axonal damage, dysfunction, or loss.

- **Conduction velocity**: Conduction velocity is assessed by placing stimulating electrodes at proximal and distal points on a nerve, then measuring the motor latency for each motor response with the same set of recording electrodes on the skin over the muscle. The time for an impulse to conduct between the proximal and distal electrodes is called the conduction time, and can be determined by subtracting the distal latency for the distal stimulating electrodes from the proximal latency for the proximal stimulating electrodes. Because both latency measurements include the time for nerve activation and neuromuscular transmission, subtracting the distal latency measurement from the proximal latency measurement yields time for conduction along the nerve segment between the proximal and distal stimulating electrodes. The conduction velocity (meters/second) can be determined by dividing the distance (millimeters) between the stimulating electrodes by the conduction time (milliseconds). A decrease in conduction velocity generally reflects demyelination.

- **Response unobtainable**: Sometimes no impulse is detected at the response electrode. If steps are taken to exclude technical causes for the absence of the response, then the result is described as “unobtainable” or “no response.”

**Sensory and “Mixed” Nerve Conduction Study**

This is a nerve conduction study designed to assess the function of the sensory fibers in a sensory nerve or mixed nerve. In this study, an electrical signal is applied by the stimulating electrodes, it activates the nerve fibers resulting in a nerve impulse, the impulse conducts along the nerve, the impulse is detected by a pair of recording electrodes on the skin, and the nerve impulse signal is documented in a tracing. Studies can be performed with either the stimulating or the recording electrodes in the distal location (the former reflecting “orthodromic” and the latter “antidromic” transmission). In mixed nerves in healthy patients, the impulses transmitted along sensory nerve fibers can be distinguished from those of motor fibers because the
former have lower stimulation thresholds and conduct faster. However, in disease states, the sensory and motor components of the impulses in mixed nerves cannot always be distinguished. The study produces two key variables:

**Peak latency:** This is the time between the application of the electrical stimulus and the negative peak of the nerve impulse detected at the recording electrodes. It is also possible to measure the time to the onset of the nerve impulse (onset latency). Because the peak latency is a more reproducible measurement than the onset latency, most sensory nerve conduction studies use the peak latency for distal measurements of sensory and mixed nerve conduction in the hand.

**Amplitude:** This is the magnitude (in microvolts) of the signal at its negative peak relative to its baseline, or sometimes the difference between negative and positive peaks. This variable reflects the number of fibers (axons) within the nerve. Reduced amplitude generally reflects axonal damage, dysfunction, or loss.

**Conduction velocity:** Conduction time can be calculated in a similar manner as for the motor nerve conduction study. As is the case with the motor nerve studies, one uses the onset latency measurements to compute the sensory or mixed nerve conduction velocity. Conduction velocity (meters/second) equals the distance (in millimeters) between the stimulating and recording electrodes divided by conduction time (milliseconds). A decrease in conduction velocity generally reflects demyelination.

**Response unobtainable:** Sometimes no impulse is detected at the response electrode. If steps are taken to exclude technical causes for the absence of the response, then the result is described as “unobtainable” or “no response.”

**Conduction distance:** The distance (millimeters) along the length of a nerve between a stimulating electrode and a recording electrode.

**Needle Electromyography**

Needle electromyography is a technique that involves inserting a needle electrode into muscle to record the electrical potentials generated by muscle fibers at rest and during voluntary muscle contractions initiated by the patient. The technique not only can distinguish muscle weakness due to diseases of the nerves from diseases of the muscle, but also estimate the severity of the diseases.

The interpretation of the electrical activity recorded from the muscle during a muscle contraction is based on the anatomy and physiology of the motor unit. A motor unit consists of a single motor neuron (anterior horn cell within the spinal column) and all of the muscle fibers it innervates. In normal patients, nerve signals produce simultaneous responses across all of the muscle fibers within a motor unit, which are together called the “motor unit action potential.” The activity of individual motor units is recorded during needle electromyography. Several variables affect the motor unit action potential in health and disease states: the number of muscle fibers per motor neuron, the density of the muscle fibers, the integrity of neuromuscular transmission, and the velocities of the action potentials in the muscle fibers within the motor unit.

The needle electromyographic evaluation generally has four components:

- Insertional activity caused by movement of a needle electrode with the muscle. In denervated muscle, changes in insertional activity (positive sharp waves and fibrillations) can be observed.
- Spontaneous activity recorded in a resting muscle (i.e., with the needle stationary in a relaxed muscle). Normal resting muscles show no spontaneous activity except when the electrode
irritates the nerve end-plate region. Greater spontaneous activity generally indicates denervation of the muscle fibers.

- Motor unit action potentials evoked by isolated nerve discharges during mild voluntary contractions of the muscle. See below.
- Recruitment and interference patterns during progressively increasing levels of voluntary contraction to a maximum level. See below.

**Motor unit action potentials**

The amplitude of the motor unit action potential is determined by the synchronized activity of the five to ten individual muscle fibers within a motor unit that are located within 0.5 mm of the tip of the recording electrode. Indeed, the distance between the electrode and the nearest muscle fiber is the principal determinant of amplitude. This means that the recording site within a given motor unit substantially affects the recorded amplitude. Thus, measurements of motor unit action potentials are generally performed in five to 20 different locations within each muscle.

The duration of the action potential (measured from the initial signal deflection to the return to baseline) reflects the synchronized activity of muscle fibers within a motor unit within up to 2.5 millimeters from the tip of the recording electrode. When nerves have been damaged, the surviving motor neurons reinnervate the orphaned muscle fibers, which means that the number of muscle fibers per motor unit increases. In electromyographic tracings, this change is manifest as recorded signals with abnormally high amplitudes and prolonged durations.

**Recruitment**

When a healthy subject voluntarily contracts a muscle with progressively increasing force, initially only one or two motor units are activated and then additional motor units are added in a consecutive manner. Electromyography performed as the force of the voluntary contraction of the muscle increases will demonstrate two changes: a conversion of resting motor units to excited units (called recruitment), and more rapid firing of the motor units that are already active. When the firing is so rapid that individual motor unit action potentials cannot be distinguished from each other, this is called a full interference pattern. A reduction or decrease in recruitment in a muscle is evidenced by a reduction in the number of motor units firing for the force of muscle contraction. This abnormality indicates that fewer motor units are available for activation than would normally be expected, which can occur with loss of motor units (i.e., peripheral neuropathies). Increased or rapid recruitment can occur when muscle fibers are lost from each individual motor unit in a random fashion so that more motor units fire to achieve the same level of force of muscle contraction (i.e., in myopathies). Diseases of the central nervous system such as basal ganglia and upper motor neuron disorders can also alter recruitment patterns as the recruitment patterns are quite different from those seen with neuropathies and myopathies.

**Common Abbreviations Used in Electrodiagnostic Testing**

- **EMG**: needle electromyography study. Exclude electromyography studies done with surface instead of needle electrodes.
- **NCS**: nerve conduction study.
- **m**: meter
- **cm**: centimeter
- **mm**: millimeter (to convert to cm, divide mm by 10)
ms or msec or Msec: milliseconds
V: volt
mV: millivolts
microV: microvolts
sec: second
APB = abductor pollicis brevis muscle (median innervated)
ADQ = abductor digiti quinti muscle (ulnar innervated)
MUAPs = Motor unit action potentials
CD = conduction distance
CV = conduction velocity
SNAP = sensory nerve action potential
Specific Guidance for Electrodiagnosis Measures

Overview and General Information

- Use one Data Form per test
- Electrodiagnostic tests on the median nerve in the study hand: a nerve conduction study or electromyography. Exclude electromyographic studies done with surface instead of needle electrodes.
- Note that these measures are scored at the test level rather than at the patient level.

EDX.01.V Hand Studied

- The study hand is the hand that has been selected for the purpose of studying quality of care. If a person has bilateral symptoms, one hand can be selected to be the study hand. See Appendix IV Section 1 for information on how to select the study hand.
- Selecting a study hand is optional, however. Some organizations may wish to use this form to evaluate all electrodiagnostic tests. In this case, select the hand that is the subject of this electrodiagnostic test when scoring EDX.01.V.

EDX.02.V Test Date

EDX.03.E Eligibility for EDX Measures

- The complete electrodiagnostic test report, including both the interpretation portion and the portion with the raw data (including latency times, etc) are required to score the measures below.

EDX.04.M Essential components of EDX evaluation for CTS

Please refer to the extensive definitions of terms provided above.

- **Motor nerve conduction study on median nerve:**
  - If there is documentation of a motor nerve conduction study including motor amplitude, distal latency AND nerve conduction velocity, give credit.
  - If there is no motor nerve conduction response, or it is documented as “unobtainable,” give credit.

- **Sensory nerve conduction study on median nerve:**
  - If there is documentation of a sensory or “mixed” nerve conduction study, including peak latency AND amplitude, give credit.
  - If there is no sensory nerve conduction response, or it is documented as “unobtainable,” give credit.

- **Sensory nerve conduction study on ipsilateral radial or ulnar nerve:**
If there is documentation of a motor nerve conduction study including motor amplitude, distal latency AND nerve conduction velocity, give credit.

It is highly unlikely that the sensory nerve conduction responses would be unobtainable for both the radial and ulnar nerve.

EDX.05.M Skin temperature should be measured during EDX testing

- Documentation of skin temperature: Any notation in Fahrenheit or Celsius of the temperature of the skin in the arm being tested.
- 32 degrees Celsius equals 89.6 degrees Fahrenheit.

EDX.06.M Low skin temperature should be normalized before EDX testing

- The report does not need to state that provider warmed the skin, but rather that the final temperature was in the normal range.
- Some providers may use a nomogram to adjust for low skin temperature. In such instances, the test would pass measure EDX.05.M but not measure EDX.06.M.

EDX.07.E Eligibility for EDX.08.M through EDX.20.M

- Eligibility is based on:
  - The test was interpreted in the report as positive for or consistent with CTS
  - If the test was not conclusive, the study is not eligible for these measures (e.g., the study was interpreted as borderline positive for CTS)

EDX.08.ME through EDX.19.MA

- These many questions all pertain to one quality measure which determines whether an electrodiagnostic test result should be called positive for or consistent with CTS. There are four different component studies that the measure recognizes and a positive result on any of these justifies the diagnosis of CTS.
- The Scoring Instructions contain detailed questions that guide the user through scoring the component studies and the measure as a whole. This information is sufficiently detailed that it is not repeated here.
- The sensory latency comparison compares sensory latency (also accept sensory/mixed latency) between the median nerve and the ipsilateral radial or ulnar nerve. To do this comparison, the conduction distance between the two nerves needs to be the same so that any differences in latency are not due to nerve signals traveling over different distances.
- A variety of different conduction distances can be used when assessing sensory latency.
• To confirm CTS, ideally it should be clear that the latency is normal for the ipsilateral radial or ulnar nerve and abnormal for the median nerve; however, this can be hard to determine reading reports.

• A simpler standard is to ensure that the latency for the median nerve is greater than that of the comparison nerve. The criteria for the various component studies are listed on the Scoring Instructions.

**EDX.20.M Criteria for calling positive EDX test for CTS severe**

• This measure assesses whether an interpretation of the CTS as “severe” is justified, so it only applies to reports that were interpreted as severe.

• Muscles innervated by median nerve: first and second lumbricals, abductor pollicis brevis, flexor pollicis brevis, and opponens pollicis.

• See background material above for definitions of “reduction in recruitment” and “motor unit action potential” (MUAP).

• The measure is satisfied (care “passes”) only if both reduction in recruitment and abnormal MUAPs are present (except abnormal MUAPs need not be present with acute CTS).

• Acute CTS is defined as CTS with onset over a short period of time, and is usually due to major trauma to the upper extremity. CTS should be considered non-acute unless the onset occurs within one week or less.