NEURODIAGNOSTIC TECHNOLOGY PROGRAM GRADUATE COMPETENCIES FOR PERFORMING NERVE CONDUCTION STUDIES – ADD-ON NCS

The following graduate competencies for performing Nerve Conduction Studies (NCS) are recommended as standards for the education of postsecondary students in neurodiagnostic technology (NDT) programs with NCS add-on. Employers can expect the graduates of CAAHEP-accredited NDT with add-on NCS programs to be competent in the areas defined below with appropriate supervision.

I. GENERAL COMPETENCIES FOR NCS

A. The graduate prepares for the study by:

1. ensuring that the laboratory or testing site adheres to Occupational Safety and Health Administration (OSHA) standards;
2. ensuring that standard precautions are followed;
3. ensuring that filters, sensitivity and time base are accurate according to protocol;
4. complying with HIPAA regulations, i.e. confidentiality, two patient identifiers, etc;
5. explaining the procedure to the patient;
6. communicating with patient at the age and educationally appropriate level;
7. addressing any patient concerns regarding the test;
8. adequately preparing the skin to reduce impedance; and
9. adequately warming site(s) to be tested.

B. The graduate identifies and eliminates or reduces artifact by:

1. positioning the patient to ensure adequate accessibility and patient comfort;
2. creating an environment that is optimal for patient relaxation;
3. cleansing the skin where the electrodes will be placed to reduce skin impedance;
4. placing the stimulus probe so that the cathode is directed towards the recording electrode when stimulating, *except for performing H-reflexes, F-waves (late responses)*;
5. recognizing, identifying and resolving artifact, and determining whether physiologic, non-physiologic;
6. applying stimulus at a low intensity level and slowly increasing intensity with each stimulus given;
7. verifying correct nerve stimulation by observing appropriate muscle contraction; and
8. removing or unplugging extraneous equipment, i.e. diathermy machine, fluorescent lighting, etc.

C. When studies are completed, the graduate:

1. removes recording electrodes and cleans electrode and stimulation sites according to recommended established guidelines;
2. is able to calculate conduction velocities, latencies, and amplitudes using basic mathematical principles;
3. stores copy of study according to facility protocol (paper, hard copy, electronic media); and
4. disinfects recording electrodes and stimulator probe according to standard precautions.

D. The graduate documents the following for physician review:

1. waveform latencies in milliseconds;
2. waveform amplitudes in microvolts or millivolts, as applicable for study;
3. conduction velocities in meters/second, if applicable;
4. limb temperature;
5. any anatomical variants, including Martin-Gruber anastomosis, accessory peroneal, etc;
6. any unusual characteristics of the waveforms; and
7. any technical difficulties encountered.

E. The graduate should have a basic understanding (knowledge of) the difference between normal and abnormal waveforms, and:

1. understand the physiology of the study being performed;
2. understand the importance of normative data;
3. perform studies with adherence to universal precautions and infection control guidelines;
4. understand the cause for variance, i.e., artifact vs. disease vs. anomaly;
5. understand the importance of accurate and consistent measurements;
6. understand the importance of limb temperature and its effect on certain studies;
7. understand the importance the effect of height can make on certain studies including conduction velocities, F-waves and H-reflexes;

8. understand the relevance of abnormalities as associated with clinical symptoms; and
9. understand the importance of morphology.

II. ELECTRICAL PRINCIPLES & INSTRUMENTATION

A. The graduate should adhere to the following with regard to electrical safety:

1. calibrate or have qualified personnel calibrate the electromyography (EMG)/NCS equipment as recommended by the facility's protocol or equipment manufacturer guidelines;
2. ensure the equipment is turned on prior to applying electrodes to the patient and ensure electrodes are removed from the patient prior to turning off equipment;
3. ensure equipment is grounded with a 3-prong electrical plug and outlet;
4. provide proper grounding for the patient, ensuring that additional metal near the patient does not form a "ground loop";
5. understand the physiology of electrical safety in electrically sensitive patients (pacemakers, cardiac catheters, etc.);
6. discard disposable electrodes or disinfect reusable electrodes after each patient;
7. disinfect stimulator probe after each patient through utilization of universal precautions guidelines;
8. perform studies with the electrodes plugged only into the equipment amplifier; and
9. guarantee the equipment is clear of all liquids.

B. The graduate should adhere to the following with reference to the stimulator:

1. determine stimulation intensity to produce the proper waveforms by using milliamps (0 to 99 mA) or volts (0 to 400V);
2. coordinate the proper stimulus pulse duration (0.05 msec to 1.0 msec) with the correct stimulus intensity using the correct impulse for each study;
3. use the stimulator correctly via the anode (+) and cathode (-) to produce the appropriate waveforms and ensure desired polarity for the particular study being performed; and
4. use a conductive solution (saline or electrode gel) on the stimulator to maximize conductivity.

C. The graduate should adhere to the following with reference to the electrodes used in nerve conduction studies:

1. clean the electrode site to reduce skin impedance;
2. understand the basis of the active, reference, and ground electrodes as they apply to each study;
3. apply surface electrodes using disposable or metal electrodes with conductive gel;
4. evaluate how skin resistance (i.e. oily or rough skin) affects electrode impedance;
5. position electrodes correctly for each study as determined by protocol and normal values; and
6. ensure that the ground is placed between stimulating and recording sites.

D. The graduate should adhere to the following with reference to the equipment amplifier:

1. record the nerve conduction study at the appropriate sensitivity for each procedure;
2. understand the function of differential amplifiers, including input impedance, common mode rejection, and polarity convention;
3. maintain consistent sensitivity settings and filter settings for each study in accordance with normal values;
4. identify proper filter settings for each study;
5. use motor settings that filter frequencies below 1.6Hz and above 16KHz;
6. use sensory settings that filter frequencies below 32Hz and above 3.2KHz;
7. understand the effects of filter settings on each study;
8. understand the principles associated with averaging sensory responses;
9. assess the proper time base for each study;
10. ensure that the entire waveform acquired is fully displayed on the oscilloscope and is expressed in milliseconds per division, or full screen milliseconds; and
11. troubleshoot interference artifact (electrical, 60 Hz, muscle, movement, or stimulus artifact) and eliminate it.

III. F-WAVE STUDIES

A. The graduate obtains F-wave studies utilizing steps that include:

1. placing recording, reference, and ground electrodes, utilizing anatomical sites for study being performed;

2. having a completed motor study on the nerve from which the F-wave will be obtained to assess nerve status;
3. warming patient adequately;
4. orienting stimulator probe so that the anode is distal to the cathode, increasing from a low stimulus intensity to supramaximal until a series of sample F-waves can be obtained;
5. recording a series of F-waves to offer a true representation of proximal motor unit status;
6. displaying waveforms according to protocol/recommended standards;
7. measuring waveforms according to protocol/recommended standards;
8. performing additional studies if necessary to clarify abnormalities; and
9. recording comparison studies on the contralateral side if normal values are not established.

B. The graduate has knowledge of the difference between normal and abnormal waveforms, and:

1. cause for variance, i.e. artifact vs. disease;
2. relevance of abnormalities associated with clinical symptoms;
3. use of sensitivity, intensity, time base, and duration to maximize responses; and
4. appropriate studies to provide clarification of disease process and /or clinical correlation to aid physician in determining diagnoses.

IV. REPETITIVE NERVE STUDIES

A. The graduate obtains repetitive nerve stimulation (RNS) studies utilizing steps that include:

1. obtaining a pre-repetitive supramaximal motor conduction study to assess nerve function and ensure correct electrode placement;
2. ensuring the patient has not taken any form of cholinesterace inhibitor, such as Mestinon®, within the last 24 hours;
3. placing the stimulus probe in a manner that ensures consistent stimulus in a precise location;
4. securing the stimulating electrodes to the skin to reduce movement artifact;
5. utilizing 3-10 Hz to stimulate the nerve;
6. obtaining two pre-exercise repetitive stimulations utilizing a train stimuli determined by protocol to note any decrement and to ensure optimal placement of electrodes and to note any pre-exercise decrement;
7. isometrically exercise the patient's muscle and understand how the exercise protocol affects the study (either through directives to the patient, or using 50Hz stimulus if the patient is unable to cooperate);
8. instructing the patient to relax post-exercise;
9. continuing to test in time intervals as described in protocol;
10. continually supporting the patient through verbal reassurance; and
11. ensuring waveforms are displayed in accordance with protocol/recommended standards.

B. The graduate has a basic understanding of the difference between an abnormal and normal set of waveforms, including:

1. understanding the applications of RNS in assessing the Neuromuscular Junction;
2. understanding the difference between a decremental and incremental response;
3. recognizing presence of nonartifactual decremental response and its significance; and
4. recognizing variations of waveforms that can be the result of other neurological disorders, such as myasthenia gravis, botulism poisoning or Lambert-Eaton.

V. H-REFLEX STUDIES

A. The graduate obtains H-wave studies utilizing steps that include:

1. placement of recording, reference and ground electrode utilizing anatomical sites for the study being performed;
2. stimulator probe oriented so that the anode is distal to the cathode;
3. appropriate submaximal stimulus rate and long duration level to obtain optimal results; and
4. series of waveforms showing initial appearance of H-reflex from onset through maximal height of amplitude and subsequent attenuation of H-reflex waveform with corresponding increase in motor response;
5. waveforms displayed according to protocol/recommended standards;
6. waveform measurements according to protocol/recommended standards;
7. studies tailored to patient history, maximizing information for best diagnostic capability; and

8. comparison studies on the contralateral side if normal values are not established.

B. The graduate has a basic understanding of the difference between normal and abnormal waveforms, and:

1. the cause for variance, i.e. artifact vs. disease;
2. relevance of abnormalities associated with clinical symptoms;
3. use of sensitivity, time base, intensity, and duration to maximize responses;
4. observe appropriate limb movement with stimulation of the nerve; and
5. determine appropriate studies to provide clarification of disease process and/or clinical correlation to aid physician in determining diagnoses.

VI. BLINK REFLEXES

A. The graduate obtains the blink reflex study by utilizing steps that include:

1. appropriately grounding the patient;
2. placement of the recording electrode over the orbicularis oculi bilaterally;
3. placement of the reference electrode over the outer canthus bilaterally;
4. connecting the electrodes from the stimulated side of the face into the EMG instrument to display appropriate responses;
5. connecting the electrodes from the indirectly stimulated side of the face into the EMG instrument to display appropriate responses;
6. locating the supraorbital notch for stimulation;
7. ensuring that the cathode is distal to the anode;
8. applying the stimulus at a slow and low intensity level, increasing with each subsequent stimulus given until optimal response is recorded;
9. maintaining dialogue with patient to prepare him/her for next stimulus;
10. ensuring correct nerve stimulation by observing muscle response, i.e. blinking of the eyes;
11. recording 3 to 4 waveforms representing the R1, R2 and R2 prime components if obtainable;
12. measuring latencies for each of the R1, R2 and R2 prime components;
13. repeating the process for the contralateral side: and
14. ensuring waveforms are displayed according to policy/recommended standards.

B. The graduate has a basic understanding of the difference between normal and abnormal waveforms, including:

1. recognizing the presence or absence of all components (R1, R2, R2 prime) and their significance; and
2. recognizing variations of waveforms for various disease processes, i.e. Bell's palsy, cerebropontine angle tumors, Guillain-Barre syndrome, and multiple sclerosis.

VII. KNOWLEDGE BASE STATEMENTS

A. The graduate has knowledge of how to correlate patient history and clinical symptoms in order to determine the appropriate nerve conduction studies in the following disease processes:

1. understand anatomy and physiology of the Peripheral Nervous System and its related disorders, including Diabetes Mellitus, AIDP, CIDP, etc;
2. understand anatomy and physiology of the Central Nervous System and its related disorders and Cranial Nerve testing;
3. motor Neuron Disease, including ALS, SMA, etc;
4. understand anatomy and physiology of the NMJ and disorders of neuromuscular transmission, including myasthenia gravis, Lambert-Eaton, botulism poisoning, etc;
5. brachial Plexus injuries/lesions;
6. lumbar Plexus injuries/lesions;
7. radiculopathy; and
8. other peripheral nerve injuries and disease processes that may be present.