Entry-level Educational Curriculum Content Guidelines for Electrophysiological Examination and Evaluation

Section on Clinical Electrophysiology and Wound Management
American Physical Therapy Association

Introduction:

The purpose of these guidelines is to identify the student-oriented educational objectives that are recommended in the areas of electrophysiological examination and evaluation for the preparation of students in professional physical therapist educational programs. Electrophysiological examination and evaluation consists of the application of stimulation and/or recording procedures, to include, but not limited to, nerve conduction studies (NCS) and electromyography (EMG), to examine the physiological integrity of peripheral nerve, cranial nerve and central nervous system pathways. These guidelines were prepared to assist educators in understanding both the content and the level of instruction that should be included in professional curricula on this dimension of physical therapist practice. The guidelines are consistent with APTA policy[1] (HOD P06-96-20-04) that states "The professional education of the physical therapist includes diagnostics, gross anatomy, neuroanatomy, muscle and nerve physiology, clinical neurology, myology, pathology, physical and clinical sciences of electrophysiologic examination and evaluation, clinical practice experience, and provides the knowledge base for the independent performance of electrophysiological examinations and evaluations." In addition, the guidelines are also supported by the requirements for physical therapist professional education as expressed in "*A Normative Model for Physical Therapist Professional Education*"[2] which articulates the profession's "preferred prerogatives" and "perspectives' and serves as a resource in academic programmatic assessment by the Commission on Accreditation of Physical Therapy Education (CAPTE).[2,pg 5] The recommendations outlined are also consistent with of the *Guide to Physical Therapist Practice*[3] which delineates the tests and measures used in physical therapist practice."

Many options exist in professional physical therapist educational curricula for the delivery of content in electrophysiological examination and evaluation. The 13 specific educational objectives pertaining to electrophysiological examination and evaluation listed below may be included in a single academic course or may be distributed among several courses within a curriculum. One option to address these objectives is to include them in coursework on neurological or neuromuscular examination and evaluation. Some academic programs include electrophysiological examination and evaluation learning objectives in courses that include content on electromyographic biofeedback or other physical agent interventions, such as electrotherapy, where students learn how to safely apply electrical stimulation to foster therapeutic outcomes. Wherever faculty choose to include instruction in this area, it is critical to appreciate that electrophysiological tests and their outcomes are important in establishing a) the existence of changes in nerve or muscle that may provide an explanation for a patient's functional limitations, b) a patient's prognosis for recovery, and c) a plan of care that maximizes the return of function.

Recommended Course Objectives for Electrophysiological Examination and Evaluation: Upon completion of the educational experiences related to clinical electrophysiological examination and evaluation (nerve conduction studies and needle electromyography), the student will:

1. Discuss the common signs and symptoms, findings on physical examination, and diseases or disorders that would indicate the need for performing nerve conduction studies (NCS) and needle electromyography (EMG).

2. Discuss the relevance of performing motor and sensory nerve conduction studies and needle EMG in characterizing the physiological deficits associated with selected neuromuscular disorders.

3. Explain the basic procedures for performing motor and sensory nerve conduction studies.

4. Describe a Compound Muscle Action Potential (CMAP) and Sensory Nerve Action Potential (SNAP) and parameters associated with these responses including latencies, amplitudes, and durations of these electrical responses.

5. Perform a motor nerve conduction study on the median, ulnar, tibial, or fibular nerve and a sensory nerve conduction study on the median, ulnar, sural, or superficial fibular nerve.

6. Correctly calculate a segmental nerve conduction velocity using the data derived from performing a motor nerve conduction study as performed in objective #5.

7. Discuss the use of a table of normal NCS values in establishing normal and abnormal findings on NCS evaluation.

8. Discuss the procedures of performing a needle EMG examination. For interested students, perform needle electromyographic examination on an extremity muscle (e.g., deltoid, biceps, triceps, gastrocnemius, soleus, and tibialis anterior).

9. Compare and contrast the general characteristics of normal and abnormal electromyographic potentials and correlate these potentials to possible underlying neuromuscular pathology.

10. Compare and contrast the nerve conduction study and EMG findings in a patient with:
    A. Mononeuropathy
        a) partial neuropraxia with or without axonal conduction block,
        b) a neuropraxia with complete conduction block,
        c) a partial axonotmesis or neurotmesis with or without conduction slowing, and
        d) a complete axonotmesis or neurotmesis.
    B. Polyneuropathy
    C. Radiculopathy
    D. Plexopathy (brachial or lumbosacral)
    E. Myopathy (muscle disease)
    F. Neuromuscular junction disorders
    G. Lower motor neuron (lower motoneuron) disease

11. Interpret and critique a nerve conduction study/EMG report and integrate this interpretation with the findings derived from a comprehensive clinical neuromuscular examination and evaluation.

12. Discuss the principles, procedures and indications for performing repetitive nerve stimulation tests, Somatosensory Evoked Potential (SSEP) testing, H-reflex testing, Motor Evoked Potential testing, and F-wave testing.

13: Given a clinical case study of a patient with possible neuromuscular pathology, recommend electrophysiological testing procedures that may assist in the establishment of a diagnosis.

Foundational and Clinical Sciences: Prerequisite and/or Concurrent Curricular Course Objectives

Note: The content addressed in the learning objectives outlined below is derived from A Normative Model of Physical Therapist Professional Education: Version 2004. These learning objectives are those that correlate with content associated with an understanding of performing and interpreting nerve conduction studies and electromyography. These learning objectives are addressed in coursework, such as gross anatomy, neuroanatomy, physiology, neurophysiology, pathology, musculoskeletal or neuromuscular examination and evaluation. In addition, these learning objectives may be accomplished in either the classroom or laboratory or alternatively during clinical internships.

Neuromuscular anatomy or Neuroanatomy Associated with Clinical Electrophysiological Examination and Evaluation

- Discuss the structure and function of skeletal muscle.
- Discuss the structure and function of the nervous system including histology of nervous tissue, central nervous system (brain, brainstem, and spinal cord), peripheral nervous system (motor, sensory and autonomic – PNS and SNS) and central nervous system motor, sensory and autonomic pathways.
- Define a motor unit.
- Draw a cross-sectional diagram of the spinal cord at the cervical, thoracic, and lumbar levels illustrating the white and gray matter, the dorsal and ventral roots, the mixed spinal nerve, and recurrent meningeal nerve.
- Identify and describe the cranial and peripheral nerve pathways, muscular and cutaneous innervation in the head, neck, trunk, upper extremity and lower extremity.
- Describe peripheral neuromuscular anatomy including but not limited to the course of peripheral nerves from the spinal nerve roots to their termination in muscle(s) or in areas of the skin (i.e. dermatome).
- Describe the patterns of peripheral and cranial nerve innervation of the skin and skeletal muscles.

- Discuss the term myotome (spinal nerve root innervation of the muscles of the upper and lower limbs) and describe the significance of this concept with respect to neuromuscular examination.

- Discuss the term dermatome and describe the significance of this concept with respect to neuromuscular examination.

Neurophysiology and Muscle Physiology

- Explain the physiological basis for electrophysiological testing procedures (electrical stimulation of peripheral; nerve and electrophysiological recording of nerve and muscle activity).

- Explain the physiological processes of action potential initiation and conduction in peripheral nerves/CNS pathways and skeletal muscles, neuromuscular junction transmission, and muscular contraction.

- Compare and contrast the types of motor units in skeletal muscle in terms of metabolic characteristics and contractile properties.

- Explain the normal changes in peripheral nerve function associated with the life cycle from infancy (pediatrics) to old age (geriatrics).

- Describe and discuss the muscle stretch reflex pathway including the receptors, afferent pathway, spinal cord connections, efferent pathway and normal muscular response.

- Describe and discuss the principles and theories underlying motor learning and motor control.

Pathology

- Explain the pathological structural or functional changes in peripheral nerve and skeletal muscle that may:
    a. impair action potential propagation and result in altered nerve conduction velocities and action potential amplitudes and durations,
    b. block action potential propagation and stop normal nerve conduction,
    c. cause axonal degeneration, muscle fiber denervation or muscle fiber degradation and result in abnormal EMG recordings/findings.

- Explain the pathophysiological changes that may occur to produce the more common symptoms of neuromuscular disorders and diseases including but not limited to numbness (anesthesia), tingling (paresthesia), weakness, pain, and skin changes (color, temperature, texture).

- Discuss the causes and consequences of axonal or neuronal degeneration in peripheral nerves, cranial nerves and in central nervous system motor, sensory or autonomic pathways.

- Compare and contrast signs, symptoms and postural and functional impairments associated with:

a. peripheral nerve diseases and injuries (e.g., carpal; tunnel syndrome, cubital tunnel syndrome, tarsal tunnel syndrome, cervical or lumbosacral radiculopathy, plexopathies, and polyneuropathies (e.g., diabetic, Charcot-Marie-Tooth, and Guillain–Barré syndrome).
b. muscle diseases (e.g., inflammatory muscle diseases, muscular dystrophies, drug-induced myopathies, poisoning myopathy, autoimmune myopathies, or infective myopathy, etc.).
c. neuromuscular junction disorder/disease (eg., myesthenia gravis, Lambert- Eaton syndrome)
d. central nervous system and spinal cord disorders/diseases (e.g., multiple sclerosis, amyotrophic lateral sclerosis, spinal cord injury, traumatic brain injury, and cerebrovascular accident).

Neurological Examination and Evaluation

- Conduct a clinical interview/history and systems review and use the information to select specific tests and measures that may assist in the formulation of the differential diagnosis.

- Perform and interpret selected special clinical tests (e.g.: provocative tests) associated with peripheral nerve pathways, neuromuscular or musculoskeletal disorders

- Perform and interpret tests of
  a. individual and group muscle function;
  b. cutaneous sensory function;
  c. autonomic nervous system function;
  d. cranial nerve function;
  e. muscle stretch reflexes; and
  f. pathological reflexes.

- Use the findings from tests and measures to identify other examination procedures that are indicated to establish a more definitive diagnosis (e.g.; nerve conduction studies, needle EMG, imaging procedures, etc).

- Evaluate gait, locomotion and balance.

- Evaluate movement and motor control.

- Given a patient case scenario, including the patient history, signs and symptoms, outcomes of tests and measures, functional disorders or deficits, and postural abnormalities differentiate between:
  a. neuropathy and myopathy.
  b. mononeuropathy, polyneuropathy, radiculopathy, and plexopathy.
  c. neuromuscular disorders and musculoskeletal disorders.

References:

1. Electrophysiologic Examination and Evaluation. (HOD P06-96-20-04). American Physical Therapy Association House of Delegates Position. 2004.

2. American Physical Therapy Association. A Normative Model of Physical Therapist Professional Education: Version 2004. Alexandria, VA: American Physical Therapy Association; 2004.

3. American Physical Therapy Association. *Guide to Physical Therapist Practice.* Rev 2nd ed. American Physical Therapy Association. Alexandria, VA; 2003.

Educational Resources for Teaching Nerve Conduction Studies and Electromyography to Entry-level Physical Therapist Student

The Section on Clinical Electrophysiology and Wound management is committed to providing support for academic PT programs that require assistance in implementing educational content on electrophysiological examination and evaluation. Information and resources related to personnel, presentations, equipment, clinical case studies and training may be found at the Section's website for members of the APTA.

Website: http://www.aptasce-wm.org/

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