**Title and Focus of Activity:** Linking Mechanisms of Neurophysiological Changes to Goal Setting and PT Interventions in Patients with Neurological Diagnoses *Linking foundational and clinical sciences; intervention*

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**Course Information:** Neuromuscular Physical Therapy; 4 credits; second half of the sixth semester (Spring) of the second year. Prerequisite courses include basic and medical science courses and PT practice courses (basic skills and examination courses, cardiopulmonary, musculoskeletal, and two semesters of motor control and motor learning).

**Learning Activity Description:** Purpose: to help students make clinical decisions that link neurophysiology and neuropathology, to 1) impairments of body structure and function, activity limitations and participation restrictions (as part of a case study); 2)potential mechanisms for improvements; 3) prognosis including goals and plan of care; and 4) interventions.

1. Students review course notes and readings from previous semesters; and review current literature on neuroplasticity. Seven to nine groups of three students work outside of class to generate two lists:

 a) mechanisms for neurophysiological impairments of structure and function (e.g., demyelination, apoptosis, hyperexcitability).

 b) mechanisms for neurologic improvement including neuroplasticity (e.g., remyelination, neuronal sprouting, cortical re-mapping) and other mechanisms (e.g., hypertrophy of muscle fibers, compensatory strategies).

This must include three references that provide evidence for an item or items on the list.

*Faculty purposely do not provide examples of categories of neurophysiological mechanisms of impairment (such as metabolic, vascular, direct trauma) ahead of time. The rationale for this is to actively engage students in the learning process. Students are not graded on the length or completeness of the lists but on their effort. It is the intention of the faculty that as students engage in this learning activity the categories will become apparent to them.*

2. Faculty compile, modify, and organize the lists of neurophysiological impairments and improvements outside of class.

3. Faculty present the revised lists at the start of the next class and guide students in analyzing the relationships between the items on the two lists in regards to various neurological diagnoses.

4. Faculty facilitate the class through steps of decision making used to apply the compiled information to a sample case of a patient with Multiple Sclerosis (see Appendix A). This case is used as a model for completing neurological case studies of mock and real patients required of the students later in the semester. (Activity limitations, participation restrictions, selection of tests and measures, and specific outcome measures are not a part of this exercise but will be included in case study activities later in the semester). Faculty guide the class to:

a. Identify the Practice Pattern for the sample case using the Guide to PT Practice.

 b. List impairments associated with the medical diagnosis (MS).

 c. List impairments associated with the sample case (MS).

d. Discuss the physiological etiology(s) of each of the impairments.

e. Select functional goals appropriate for this patient.

f. Design interventions for each goal.

g. Analyze mechanisms for improvement related to suggested interventions.

Time for student to complete the activity: 1. preparation for activity outside of/before class*:* 3 hours 2. class time for completion of the activity*:* 3 hours

Readings and other preparatory materials: Recommended Readings: (*This list will be supplied to students after they have completed lists of impairments and improvements with references they have selected on their own.)*

Behrman AL, Bowden MG, Nair PM. Neuroplasticity after spinal cord injury and training: an emerging paradigm shift in rehabilitation and walking recovery**.** *Physical Therapy.* 2006;86:1406-1425.

Duffau H.Brain plasticity: From pathophysiological mechanisms to therapeutic applications. *J Clin Neurosci*. 2006;13:885–897.

Gros IT, Panmasiti MS, Chakrabarti B. The plasticity of the mirror system: How reward learning modulates cortical motor simulation of others. *Neuropsychologia*. 2015;70:255–262.

Guide to Physical Therapy Practice 3.0: <http://guidetoptpractice.apta.org>.

Nudo RJ. Role of cortical plasticity in motor recovery after stroke. *Neurol Report.* 1998;22:61-67.

Shumway-Cook A, Woollacott MH. Motor Control: Translating Research into Clinical Practice. 4th Edition. Wolters Kluwer Lippincott Williams and Wilkins, PA. 2012.83-103

Umphred DA. *Neurological Rehabilitation*: 6th ed. New York, NY: Elsevier Health Sciences; 2013.84-97

Learning objectives 1. List mechanisms for neurophysiological impairments of body structure and function. 2. List mechanisms for neurophysiological improvement of body structure and function. 3. Compare current evidence and didactic knowledge of mechanisms of neurophysiological impairments with expectations for Improvement. 4. Develop realistic functional goals for patients based upon the neurological possibilities for improvement. 5. Design appropriate intervention strategies for working with patients with various neurological diagnoses and impairments based upon physiological mechanisms for improvement.

Methods of evaluation of student learning:

This activity is worth 5% of the final grade for the course.

Grading: (100points)

List of Impairments

0 No Effort (Assignment not done).

10 Very Poor Effort (only a few items per list and no references).

20 Poor Effort (only a few items per list and 1 reference).

30 Fair Effort (List includes the majority of items and no references).

40 Good Effort (Comprehensive Lists and no references).

50 Excellent Effort (Comprehensive List and references).

List of Improvements

0 No Effort (Assignment not done).

10 Very Poor Effort (only a few items per list and no references).

20 Poor Effort (only a few items per list and 1 reference).

30 Fair Effort (List includes the majority of items and no references).

40 Good Effort (Comprehensive Lists and no references).

50 Excellent Effort (Comprehensive List and references).

**Appendix A Sample Case Study**

The following case study of a patient with Multiple Sclerosis was posted on a public web site by Rose JW, Houtchens M, Lynch SG. <http://library.med.utah.edu/kw/ms/clin_case01.html>.

Ms. C is a 35 year old white female. She came to Neurology Clinic for evaluation of her long-term neurologic complaints. The patient relates that for many years she had noticed some significant changes in neurologic functions, particularly heat intolerance precipitating a stumbling gait and a tendency to fall. Her visual acuity also seemed to change periodically during several years. Two months ago the patient was working very hard and was under a lot of stress. She got sick with a flu and her neurologic condition worsened. At that time, she could not hold objects in her hands, had significant tremors and severe exhaustion. She also had several bad falls. Since that time she had noticed arthralgia on the right and subsequently on the left side of her body. Then, the patient abruptly developed a right hemisensory deficit after several days of work. The MRI scan was performed at that time and revealed a multifocal white matter disease - areas of increased T2 signal in both cerebral hemispheres. Spinal tap was also done which revealed the presence of oligoclonal bands in CSF. Visual evoked response testing was abnormal with slowed conduction in optic nerves.

Today, the patient has multiple problems related to her disease: she remains weak and numb on the right side; she has impaired urinary bladder function which requires multiple voids in the mornings, and nocturia times 3. She became incontinent and now has to wear a pad during the day.  She also has persistent balance problems with some sensation of spinning, and she is extremely fatigued.

**REVIEW OF SYSTEMS** is also significant for a number of problems related to her suspected MS. The patient has a tendency to aspirate liquids and also solids. She complains of tinnitus which is continuous and associated with hearing loss, more prominent on the left. She has decreased finger dexterity and weakness of the hands bilaterally. She also complains of impaired short-term memory and irritability.

**FAMILY HISTORY** is significant for high blood pressure, cancer and heart disease in the immediate family.

**PERSONAL HISTORY** is significant for mumps and chicken pox as a child, and anemia and allergies with hives later in life. She also had a tubal ligation.

**NEUROLOGIC EXAMINATION:**

**Cranial Nerve II** - disks are sharp and of normal color. **Funduscopic examination** is normal.
**Cranial Nerves III, IV, VI** - no extraocular motor palsy or difficulties with smooth pursuit or saccades are seen. Remainder of the cranial nerve exam is normal except for decreased hearing on the left, and numbness in the right face, which extends down into the entire right side. The Weber test reveals greater conductance to the right. Rinne's test reveals air greater than bone bilaterally.   The palate elevates well. Swallow appears to be intact. Tongue movements are slowed, but tongue power appears to be intact.

Motor examination reveals relatively normal strength in the upper extremities throughout. However, rapid alternating movements are decreased in both upper extremities and the patient has dysdiadochokinesia in the left hand.  Mild paraparesis is noted in both legs without severe spasticity.

Deep tendon reflexes are +2 and symmetrical in the arms, +3 at the ankles and at the knees. Bilateral extensor toe sign are present.

Sensory exam reveals paresthesia on the right to touch and decreased pin sensation on the right diffusely. The patient has mild vibratory sense loss in the distal lower extremities.

Romberg's is negative.   Tandem gait is mildly unstable. Ambulation index is 7.0 seconds for 25 feet. (The patient takes 7.0 seconds to walk 25 feet.)