Clinicians are on a daily basis faced with decisions related to the progression or introduction of exercises for their clients. The challenge is to properly sequence exercise demand to best match the clients’ capabilities. This course is designed to provide evidence for the progression of exercise as outlined/specified by electromyography (EMG) for the exercises commonly used for both the upper and lower extremity. Basic concepts of the value of EMG and how to best apply such will be provided. The data provide a logical progression of exercise applications and special recommendations for specific conditions.

Level: Basic – Intermediate

Course Objectives

Learners will be provided:

1. Analysis of the EMG literature as it related to the upper extremity
2. Analysis of the EMG literature as it relates to the lower extremity
3. Proper sequencing of exercises in both the upper and lower extremities to enable appropriate applications in physical therapy
4. Evaluation of the value and recommended use of EMG in physical therapy
5. Case presentations which demonstrate EMG based progressions
Schedule:

5 Minutes: Introduction – quick Intro of Speakers – General Format (TM)

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No disclosures related to these talks for any of the speakers

Tim Uhl has received loaner EMGs from Noraxon Inc during continuing education programs

15 Minutes – How to gather, analyze, and use EMG (TU)
What is EMG; Surface/Fine Wire Strengths & Weaknesses; day to day variation; Eccentric/Concentric values; What the #’s mean and how to best use them

Electromyography (EMG) is the recording and analysis of myoelectrical signals derived from motor unit activity

Kinesiological EMG is the study of the neuromuscular activation of muscles within postural tasks, functional movements, work conditions and treatment/training regimens.

Diagnostic EMG is the study of electrophysiological responses of muscle and nerve to pathology effecting the neuromuscular system

Kinesiological EMG can be utilized to:
1. Initiation of muscle activation (Onset)
2. Duration of muscle activation
3. Measure of fatigue occurring in a muscle
4. Amount of muscle activation
Measures of Amplitudes

- **Peak = highest point in a burst**
- **Mean amplitude = average activity of the burst**
- **Linear Envelop = area under the curve of the burst**

Limitations of Kinesiological EMG

- Interference sources are Movement artifact, external electrical noise, cross-talk from other muscles
- Reducing interference by use good equipment, small electrodes, and careful electrode placement
- Not a measure of force or strength - Moderate correlation in an isometric conditions

5 Minutes - Quick Scenario: Are EMG Data linear – UE Examples
Biceps brachii and Middle Deltoid (TU and TM)

How does load change EMG Amplitudes?

- Amplitudes are affected by load, velocity, type of contraction
- Although load increases muscular demand it is not perfect linear

40 Minutes - **Upper Extremity** – What EMG
data can be gathered and how best used to guide/inform exercise progressions (TU & AN)

Exercises are prescribed along a continuum respecting healing tissues and progressed or regressed based on individual responses. Knowing EMG amplitudes assists the clinician in prescribing the appropriate exercises and making modifications without overloading healing tissues.

During the healing phase following injury or surgery we do not want to overload the healing tendon. There is a balance between protecting the joint and surrounding tissue from developing stiffness and injuring the healing tissue. Identifying the exercises that have the lowest chance of disrupting the tissue is important. As patient progress during recovery it is easy to overload the tissue so progression of resistive exercises need to be performed gradually and proper neuromotor control exercises need to be mastered before adding loads especially with long lever arms.
5 Minutes – Quick Scenario: Are EMG Data linear – LE Example Quadriceps (TU & TM)

The quadriceps behaves linearly when isotonic exercises is performed controlling the velocity on a dynamometer but in the clinic not so linear.

**Isotonic torque**

![Isotonic Torque Graph](image1)

**Isotonic load (Isoinertial)**

![Isotonic Load Graph](image2)
40 Minutes – **Lower Extremity** – What EMG data can be gathered and how best used to guide/inform exercise progressions (LB & SS)

**Lori A Bolgla, PT, PhD, MAcc, ATC**  
**Scott Shaffer, PT, PhD, OCS, ECS**

A. Clinical “Quantification” of EMG Activation

<table>
<thead>
<tr>
<th>Level</th>
<th>EMG Activation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Level</td>
<td>0-20% MVIC</td>
</tr>
<tr>
<td>Moderate-Level</td>
<td>21-40% MVIC</td>
</tr>
<tr>
<td>High-Level</td>
<td>41-60% MVIC</td>
</tr>
<tr>
<td>Very High-Level</td>
<td>&gt; 60% MVIC</td>
</tr>
</tbody>
</table>

- Moderate-level EMG activation best used for facilitating endurance and neuromuscular re-education.
- High-level and very high-level activation required to promote “true” strength gains.

Escamilla et al, 2010  
Reiman et al, 2012

B. EMG Activity during Lower Extremity Exercises

Ayotte et al, 2007
C. Food for Thought: Confounding Variables

Type of Contraction

- Greater EMG activity generated during a concentric action

Data Reduction

- Reporting of peak or mean amplitude (which way best emulates "true" muscle demand)

Sex- Differences

- Preliminary evidence suggests possible between-sex differences in muscle activity during a given exercise

Targeted Patient/Client Population

- Rehabilitation versus prevention/wellness
D. Progression of Exercise
RROM Exercises for Scapular Muscles

- Scaption to 120
- Military press
- Flexion
- Diagonal Upper Cut
- Abduction
- Scaption ER
- ER at 90 (Elast. Band)
- Unilateral Shrug
- Prone ER at 90
- Throwing Deceleration (Elast. Band)
- One Arm Push-Up
- Prone Horizontal Abd.
- Throwing Acceleration (Elast. Band)
- Scapular Punches (Elast. Band)
- IR at 90 (Elast. Band)
- High Row (Elast. Band)
- Side-Lying Ex. Rot.
- Prone Unilateral Row
- Push-up feet elevated
- ER at 0 (Elast. Band)
- Seated Row Wide
- Side-lying Elevation Unsupported
- Shoulder Shrug
- Push-up
- Unilateral Supine Scapular Protraction
- Pointer
- Standing Press-Up
- Tripod
- Water Scaption Fast
- Prone Extension
- Ball Rolls
- Scaption Fast
- Wedge Press-Up
- Quadruped
- T-band Supine

EMG Activity (%MVIC)
Gluteus Maximus Figure from Reiman MP, Bolgla LA, Loudon JK. A literature review of studies evaluating gluteus maximus and gluteus medius activation during rehabilitation exercises. Physiother Theory Pract. 2012;28(4):257-68.

![Gluteus Maximus Figure]

**FIGURE 1** Gluteus maximus percent maximum voluntary isometric contraction ranking of exercises.

FIGURE 2 Gluteus medius percent maximum voluntary isometric contraction ranking of exercises.
Lower Extremity References:


Upper Extremity References
References


