Therapeutic Exercise
Review of Last Lecture

- W/C Components
- Types of W/C
- Patient Propulsion with Bilateral UE
- Patient Propulsion with one UE & one LE
- Up a curb
- Down a curb
- Up a slope
- Down a flight of stairs
Definition of Therex

- TE is the systematic performance of planned physical movements, postures or activities intended to enable the patient/client to:
  - Remediate or prevent impairments
  - Enhance function
  - Reduce risk
  - Optimize overall health
  - Enhance fitness & well-being
Therex

- Therex may include:
  - Agility training
  - Balance training (static & dynamic)
  - Body mechanics training
  - Breathing exercises
  - Coordination exercises
  - Gait and locomotion training
  - Neuromuscular re-education
  - Postural stabilization
  - ROM exercises & soft tissue stretching
  - Relaxation exercises
  - Strength, power & endurance exercises
Formulate a general program of TE to:

- Maintain ROM
- Increase Flexibility
- Increase Strength
- Promote Endurance
Maintain ROM

- **AROM**: movements performed voluntary efforts of the patient without external aid
- **AAROM**: movements performed by both voluntary efforts by patient along with assistance of an external force
  - Assistance from another body part
  - Another person (PTA)
  - Device (cane)
- **PROM**: movements performed by external efforts only
ROM exercises

- When AROM, AAROM, PROM is performed for the purpose of maintaining current joint movement, it is considered a ROM exercise.
Benefits of ROM exercises

- Maintaining joint mobility
- Nutrition to a joint
- Prevention of tissue adhesion & contracture
Benefits specific to PROM

- Aid blood circulation
- Inhibit pain via stimulation of joint mechanoreceptors
- Promotion of ligament & capsule remodeling
Benefits specific to AROM/AAROM

• Increase blood circulation
• Prevent clot formation from venous stasis
• Increase proprioceptive input
• Maintain contractility
• Slow the rate of atrophy
• Improve coordination & motor control
Indications, Contraindications, & Precautions of Stretching

- **Indications**
  - When someone has limited ROM, especially when it can lead to bony deformities or decreased ADLs
  - When the goals are to regain normal ROM, prevent contractures, and increase flexibility
Indications, Contraindications, & Precautions of Stretching

- **Contraindications**
  - Bony block limiting Rom
  - Recent fracture or surgery
  - Acute inflammation or infection
  - Sharp acute pain with stretching
  - Hematoma
  - If the contracture helps the patient to function
Indications, Contraindications, & Precautions of Stretching

- **Precautions**
  - Know the patient’s normal ROM
  - Don’t passively force a joint
  - Watch out for recent fractures
  - Osteoporosis
  - Pain/soreness lasting more than 24 hours may be too aggressive
Stretching to Increase Muscle Flexibility

- **Muscle Flexibility**: the ability of a muscle to lengthen
- **Methods of stretching**:  
  - Manual  
  - Mechanical
- **Types of stretching**:  
  - Static  
  - Ballistic  
  - PNF
Manual Stretching

- The clinician provides the external force and controls the direction, speed, intensity and duration of the stretch.
Mechanical Stretching

- Long duration (20 minutes or more)
- Applied through positioning of the patient
- More effective than a manual stretch
Static Stretching

- A method by which the muscle is slowly elongated to tolerance
- A comfortable stretch, short of pain
- The position is held with the muscle in this greatest tolerated length
- Mild tension should be felt and pain / discomfort should be avoided
Duration of Static Stretch

- Younger than 65 years old:
  - 30 second hold
  - 4 X/day
  - 5 days/week
  - For 6 weeks

- Older than 65 years old:
  - 60 second hold
  - 4 X/day
  - 5 days/week
  - For 6 weeks
Ballistic Stretching

- Imposes repetitive bouncing or jerking movements on the muscles to be stretched.
- Ballistic stretching has fallen out of favor among most clinicians due to possibility of injury caused by uncontrolled jerking movements & b/c afferent nerve fiber activation of the muscle spindle causes a contraction of the same muscle that is being stretched.

http://www.youtube.com/watch?v=ep3Q1gzH8AQ&feature=related
Dynamic Stretching

- For athletes
- Static stretching immediately prior to participation in a sport can increase possibility of injury
- Static stretching is best for geriatric and non-athlete populations
- [http://www.youtube.com/watch?v=ExjrmhQBiGk&feature=related](http://www.youtube.com/watch?v=ExjrmhQBiGk&feature=related)
Proprioceptive Neuromuscular Facilitation (PNF)

- Knott & Voss
- Can be used to both strengthen & increase muscle flexibility
- Right now will discuss flexibility component
PNF continued

- The patterns of motion for PNF are mass movement patterns characteristic of normal motor activity
- The mass movement patterns are spiral and diagonal and closely resemble movements used in sports and work and ADLs
PNF continued

- PNF Patterns can be done...
  - Passive
  - Active assisted
  - Active
  - Resisted

- PNF Patterns
  - Are functional
  - Use multiple muscles at once
PNF continued

- There are 2 diagonals of motion for each of the major parts of the body
  - Head and neck
  - Upper trunk
  - Lower trunk
  - Upper extremities
  - Lower extremities
PNF Patterns - UE

- PNF Patterns – Upper Extremity
  - D1 flexion: flexion, adduction, ext rot
  - D1 extension: extension, abduction, int rot
  - D2 flexion: flexion, abduction, ext rot
  - D2 extension: extension, adduction, int rot
PNF Patterns - LE

- PNF Patterns – Lower Extremity
  - D1 flexion: flexion, adduction, ext rot
  - D1 extension: extension, abduction, int rot
  - D2 flexion: flexion, abduction, int rot
  - D2 extension: extension, adduction, ext rot
PNF stretch

- 3 types of stretch according to PNF
  - Autogenic Inhibition
  - Reciprocal Inhibition
  - Combination
Autogenic Inhibition

1. PTA passively stretches the muscle to the end of its range
2. Then the patient isometrically contracts that muscle (against the resistance of the PTA) for 15 seconds
3. The patient is instructed to relax & the PTA moves the muscle to its new end range (new stretch position) and held for 30 seconds
4. The process may be repeated 3-5 times.
Reciprocal Inhibition

1. PTA passively stretches the muscle to the end of its range
2. Then the patient concentrically contracts the opposite muscle (agonist), thereby actively causing more of a stretch
3. The PTA takes up the slack, patient relaxes and PTA holds the new ROM 30 sec.
4. Process can be repeated 3-5 times
Combination

1. PTA passively stretches the muscle to the end of its range.
2. Patient isometrically contracts that muscle for 10 seconds, then concentrically contracts the opposite muscle, while the PTA takes up the slack.
3. Patient relaxes 30 sec
4. Process can be repeated 3-5 times
Increasing Strength

• Terminology
  ◦ **Muscle Strength**: the maximum force that a muscle or muscle group can exert during a contraction
  ◦ **Endurance**: the ability of the muscle or muscle group to sustain contractions repeatedly or over a certain period of time
Resistance Training Principles

- Dosage
- Mode
- Repetitions
- Sets
- Duration
- Frequency

- Rest Intervals
- Overload
- Specificity
- Cross-Training
- Overtraining
- Precautions
Dosage

Can be modified by

- Increasing intensity
- Increasing resistance (amount of weight)
- Increasing sets & repetitions
- Decreasing rest intervals
- Increasing frequency
Mode

- The method of exercise (i.e., the use of free weights or theraband)
Repetitions

- The number of times the exercise is repeated consistently
- The number of reps makes up one set
Sets

- The performance of an exercise for a given number of consecutive repetitions, followed by rest or a different exercise
- Ex: 10 reps of bicep curls, followed by 2 minute rest, followed by another 10 reps = 2 sets
- Generally, most exercise programs include 2 or 3 sets of each exercise
Duration

- The number of sets or reps of a specific exercise session and the amount of rest between sets
Frequency

- How often the exercises are performed
- Frequency of exercise relates to the goal of the exercise program
Rest Intervals

- Rest periods vary from 1 to 3 minutes depending on purpose of exercise program and patient need
Overload

- All cells adapt to external stimuli
- The human body adapts to training
- When an increased training load challenges an individual’s current level of fitness, the response of the body occurs as an adaptation (such as an increase in muscle strength) to the stimulus of the training load
Overload continued

- This increase in training load that leads to an adaptation in muscle is called overload.
- The initial response to the training load is fatigue & adaptation.
- Overload causes fatigue, and recovery & adaptation allow the body to overcompensate and reach a higher level of fitness.
Specificity

- The nature of the training load determines the training effect.
- Each type of exercise has its own specific training effect, which results in specific adaptations.
- The load must be specific to the individual & to the activity for which he or she is training.
Cross Training

- Patients may improve performance in one mode of exercise by training in another mode.
- Although cross-training occasionally provides some transfer effects, the effects are not as great as those that could be obtained by increasing the specific training by a similar amount.
- Although cross-training benefits are sometimes observed, they are usually noted in physiologic measures & rarely in performance.
Overtraining

- When an individual does not take sufficient time to fully recuperate after chronic bouts of training
- When training loads are too demanding on the individual’s ability to adapt
- Results: fatigue, possible substitution patterns & injury, performance deterioration instead of performance improvement
Cautions

- **Valsalva Maneuver**: holding one’s breath during exertion; to be avoided; encourage the patients to breathe properly during all exercise
Cautions Continued

- **DOMS**: Delayed Onset Muscle Soreness
  - Dull, diffuse pain; stiffness & tenderness to direct pressure; loss of AROM; decreased ability to produce force
  - develops 24-48 hours after exercise & resolves within 1 week (most within 72 hours)
  - caused more by eccentric than concentric
  - can be reduced by incorporating warm-up & cool down
  - educate the patient
Strength: Types of Contractions

- **Isometric Contraction**: static; produced when muscle tension is created without a change in muscle length.
  - Isometrics performed at one angle results in strength gains only at the angle trained (or possibly the adjacent angles as well)
  - Generally used in the early stages of a rehab program for an acute injury or immediately after surgery
  - Usually performed at sub-maximal levels of intensity
  - Frequently termed “sets”
Types of Contractions

- **Isotonic Contraction**: contraction during dynamic change in muscle length
  - **Concentric**: as the muscle shortens
  - **Eccentric**: as the muscle lengthens

**Isotonic**: The muscle contracts while lifting a constant resistance, and the muscle tension varies over the full ROM due to changes in muscle length and lever arm.
Isotonic Continued

- *Functional*; concentric & eccentric occur during the performance of functional activities
- When *performing* the isotonic program: avoid causing swelling & pain while having the patient work to his/her max exercise tolerance
- When *progressing* patients through isotonic programs, ensure it does not lead to increased pain, crepitus & swelling
Isotonic Programs…

…incorporating the optimal amount of resistance & repetitions to produce max gains in muscular strength

- Delorme
- Oxford
- McQueen
### Delorme

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<th>Set</th>
<th>Weight</th>
<th>Repetitions</th>
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<tbody>
<tr>
<td>1</td>
<td>50% of 10 RM</td>
<td>10</td>
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<tr>
<td>2</td>
<td>75% of 10 RM</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>100% of 10 RM</td>
<td>10</td>
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- Progression from light to heavy resistance, adding resistance with each set
- Strengthening without injuring the joint
## Oxford

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- Goal is to achieve strengthening & increased endurance
- Appropriate if patient lacks endurance
- Ex: MS, cardiac patients, myasthenia gravis
McQueen

- Used specifically for strengthening
- 3 sets of 10 rep max
- 10 rep max = 60% of 1 RM (one rep max)
Generating Muscle Force

- Is dependent on:
  - Length – tension relationship of muscle
  - Moment Arm
  - Lever Arm
Length-Tension Relationship

- The most efficient length of muscle fiber is the slightly elongated position (when the crossbridges of actin & myosin seem to couple most effectively & produce the greatest tension).
- The amount of tension of muscle contraction decreases as the muscle is shortened or lengthened from the optimal muscle length b/c effective coupling of crossbridges cannot take place.
Moment Arm

• The perpendicular distance from the axis of motion to the line of action of the muscle
• The farther away from the joint axis the muscle inserts into the bone, the greater the moment arm and therefore the greater the force production
Lever Arm

- The perpendicular distance from the resistance to the joint axis
- The longer the lever arm, the more difficult the task
Isotonic Contractions

- Due to changing muscle length, moment arm and lever arm during isotonic contractions, muscle tension is less than maximal through the full ROM
- The ability of the muscle to move a load throughout the ROM is limited by the weakest point in the range
Open Chain vs. Closed Chain

- **Open-Kinetic-Chain Exercise**: one in which the distal segment is not fixed and the segment can move freely
  - LAQ

- **Closed-Kinetic-Chain Exercise**: one in which the distal segment is fixed and a force is transmitted directly through the foot or the hand in an action
  - Squat
  - Push-up
OKC vs. CKC

- Most functional movements, such as walking, contain a combination of OKC and CKC components.
- Both open and closed chain exercises should be addressed during rehab.
Open Chain

- Patient should not be introduced to maximal stress immediately, but be guided in a sequence of resistance exercises involving sub-maximal work.
- Proper progression may incorporate limited ROM exercise first, progressing to full ROM while still using sub-max effort and finally cumulating in unrestricted ROM with max effort.
Closed Chain

- Usually in a weight bearing position
- Improves joint proprioception, thereby increasing dynamic stability of the joint
- Facilitates muscular cocontraction of force couples, which provides dynamic stabilization
- May activate type I and II mechanoreceptors, helping to reduce pain
Closed Chain continued

- If the patient is experiencing significant pain & inflammation, the early initiation of low level CKC exercises in the acute phase may be appropriate.
- Limitation: if specific muscle weakness is present, other agonistic muscles within the kinetic chain can generate forces to help compensate.
PNF

- Strong segments are used to facilitate the weak
- Improved function is always the goal
- PNF is best known for its diagonal movement patterns
- For strengthening purposes, there are specific PNF techniques for providing manual resistance (starting pg 138 of TE for PTA)
Plyometrics

• A quick powerful movement involving a prestretching of the muscle, thereby activating the stretch-shortening cycle of the muscle.

• Stretch-shortening exercises use the elastic and reactive properties of a muscle to generate maximum force production.

• Design this program with sport-specificity in mind.
Plyometrics Continued

- Precautions:
  - Acute inflammation or pain
  - Gross instabilities
  - Individuals who have not been weight training

- Examples: box jump, ball tossing, etc

- Reserved for the competitive athlete
Balance

- The process of controlling the body’s COG over the BOS, or within the limits of stability, whether stationary or moving.
  - Static: ability to maintain a stable antigravity position while at rest
  - Dynamic: ability to maintain a stable antigravity position while at motion
Balance Terminology

- **Base of Support:**
- **Center of Gravity:**
- **Limits of Stability:** To maintain balance in standing, the COG must be kept within specific boundaries of space, referred to as limits of stability. It is the greatest distance a person can lean away from the BOS without changing that base.
3 systems vital to Balance

1. Proprioception/Somatosensory
2. Vision
3. Vestibular
Testing Balance

- **Romberg Test:**
  - Patient stands shoulder width apart, can balance be maintained 30 seconds with eyes open? 15 seconds with eyes closed?

- **Berg Scale**
  - Performance based assessment of function requiring an armchair, armless chair, stopwatch & a step. Patient is assessed in static & dynamic activities

- **Tinetti**
  - Standardized assessment tool, like the Berg, requiring minimal equipment

- **Timed Up & Go Test (TUG)**
  - Tool to evaluate balance during mobility. Patient is asked to stand, walk 3 meters, then turn around, return and sit. This is timed and if it takes < 10 sec, no mobility issues, > 30 sec indicates limited mobility & assistance may be required
Automatic Postural Reaction Strategies

- If sway occurs outside the patient’s limits of stability (the cone), a strategy must be used to restore balance.
- There are 3 primary strategies used for controlling AP sway:
  - Ankle strategies
  - Hip strategies
  - Stepping strategies
- These strategies adjust the body’s COG so that the body is maintained within the BOS, preventing LOB & falling.
Automatic Postural Reactions

- **Ankle Strategies:**
  - Small disturbances in COG caused by slow speed perturbations can be compensated by ankle motion. Anterior sway countered by gastroc & post sway by ant tib

- **Hip Strategies:**
  - If disturbance to COG is too great to be counteracted by ankle, hip strategies are used, usually in response to a moderate or large postural disturbance

- **Stepping Strategies:**
  - A sudden, large amplitude force displaces the COG beyond limits of stability, a step is used to enlarge the BOS
Interventions to...

- Improve ankle strategies:
  - SLS on firm surface, SLS with hip flexion, shoulder flex, ball toss; all firm surface

- Improve hip strategies:
  - Unstable surface, SLS with hip flexion, ball toss to reach, SLS on trampoline, rocker board, slider board, bolster, SLS hop from stool

- Improve stepping strategies:
  - Step ups, downs, fwd & lat, carioca
Promoting Endurance

- The ability of the whole body to sustain prolonged exercise
- AKA Aerobic training

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<tr>
<th>Signs &amp; Symptoms of Aerobic Exercise Intolerance</th>
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<tr>
<td>Angina: chest, left arm, jaw, back, or lower neck pain or pressure</td>
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<tr>
<td>Unusual or severe shortness of breath</td>
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<td>Abnormal diaphoresis</td>
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<tr>
<td>Pallor, cyanosis, cold &amp; clammy skin</td>
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<tr>
<td>CNS symptoms: vertigo, ataxia, gait problems, confusion</td>
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<tr>
<td>Leg cramps or intermittent claudication</td>
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<tr>
<td>Physical or verbal manifestations of severe fatigue or SOB</td>
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</table>
Benefits of regular aerobic exercise

- Decreased fatigue
- Improved performance in work & sports related activities
- Improved blood lipid profile
- Enhanced immune function
- Improved glucose tolerance
- Improved body composition
- Enhanced sense of well-being
- Decreased risk of CAD, colon & breast CA, HTN, type II DM, osteoporosis, anxiety & depression
Exercise Prescription

- **Intensity:** How hard should the patient exercise? Use maximal HR due to correlation between HR & stress on the heart & it is easy to monitor

- **Duration:** optimal duration is 20-60 minutes (include min 5 minutes warm up & cool down)

- **Frequency:** optimal = 3-5 X/week
Exercise Prescription continued

- **Mode**: the greatest improvement in aerobic capacity is achieved through activities involving large muscle groups (walking, running, hiking, cycling, rowing, swimming).
  - Unfit patients should start with activities that can be maintained at a constant intensity (treadmill).
  - Consider WBing vs. NWBing
Building a program that prepares a patient for ADLs

- First, consider which functional activity the patient is having difficulty with.
- Second, consider why. What is the impairment? Decreased ROM, MMT, balance, etc.
- Address the impairments individually.
- Address the impairments combined (simulate the activity).
Recognizing a Change in Status

- The PTA must recognize when a change in the patient’s status occurs & should report it to the PT
- This change may be a significant improvement, or a regression in the status of a patient
How do you recognize a change?

- By collecting data:
  - Vital signs, cognition, skin integrity/condition, patient safety while using assistive devices, gait, balance, MMT, muscle tone, administer standardized pain questionnaires, assessment of posture, ROM, recognizes cyanosis & activities that aggravate or relieve edema, pain, dyspnea…..
Recap Lecture

- Interventions to increase flexibility
- Generating muscle force depends on...
- Open chain vs. closed chain
- PNF
- Balance strategies
- Benefits of aerobic exercise
Looking Ahead

- Normal Gait
Questions???