AN INTRODUCTION TO GRADED MOTOR IMAGERY

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Disclosure Statement of Financial Interest

Both Lindsay Marth and Rebecca Vogsland have a financial relationship with an organization that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation, it is:

Affiliation/Financial Interest: Faculty Assistant, Instructor  
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Disclosure

- Lindsay Marth & Rebecca Vogsland work for the Department of Veterans Affairs. The content of this presentation does not represent the position of the VA nor are any of the topics/content endorsed by the Federal Government.
Background

- **What:** A series of intervention strategies aimed at the treatment of people with complex pain problems.

- **Who:** Patients with
  - *Neuropathic pain problems*
     - Central sensitization
     - Peripheral sensitization
  - *High fear-avoidance*
  - *An inability to move or touch affected region*
  - *As a prophylactic intervention*
Interventions

■ Originally conceived as a 3-stage treatment plan
  - Laterality (Left/Right Discrimination)
  - Explicit Motor Imagery
  - Mirror Therapy

■ Practice has been expanded now to include
  - Pain Neuroscience Education
  - Sensory Retraining
    ■ Localization
    ■ Discrimination

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Graded Motor Imagery (GMI) – Complex series of treatments including graded exposure to left/right judgement exercises, imagined movements and use of mirrors to treat neuropathic pain problems.

http://www.gradedmotorimagery.com/

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Sequencing of Interventions

- Pain Neuroscience Education (PNE)
- Laterality
- Motor Imagery/Visualization
- Sensory Retraining
- Mirror Therapy
How Do We Educate About Pain? (Louw 2016)

Pain Neuroscience Education (PNE)

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Nerves as Alarms (Louw & Puentedura, 2013)
Nerves as Alarms cont’d (Louw & Puentedura, 2013)
PNE Basics
(Louw, 2013; Louw & Puendareda, 2013; Butler & Moseley 2003)

- Pain is not the nervous system’s only tool. The immune and endocrine systems play a large role in many people with complex pain.

- Other factors such as stress, environment, cognitions, and past experiences influence the lens through which our system processes pain.

- Anything that affects the nervous system affects the whole nervous system. This relates to the interplay between pain, sleep, mood, and cognition.
PNE Basics
(Louw, 2013; Louw & PuenteDura, 2013; Butler & Moseley 2003)

- Individualization: based on the person’s unique pain presentation and personal factors specific tools are used to teach lessons related to:
  - The complex nature of pain processing including pain vs nociception, central sensitization, and unusual pain stories.
  - Ion channels: role in providing input, peripheral sensitization, CNS control, and impact on pain.
Education Key Points

■ Your nerves act like an alarm system. Pain is a normal mechanism designed to keep you safe.

■ The sensitivity of that alarm can increase or decrease based on a number of factors.

■ There are things that you can do to influence this process.

■ Treatments are geared toward decreasing the sensitivity of the system and increasing tolerance for activities.
Pain Treatments

Top Down

* CBT
* Graded Motor Imagery
* Pain Science Education
* Relaxation/ Mind-Body Skills

Bottom Up

* Surgery
* Procedures
* Medication
* Rule Out Red Flags

* Biofeedback
* Social/ Leisure
* Pacing/ Task Modification
* Sleep

* AE
* Exercise
* Modalities
* Manual Therapy
* Nutrition

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The Homunculus
PNE in Practice

- The why, the buy in, the connection to treatment plan
- The somatosensory homunculus and smudging
- Patient education tools
Laterality (Left/Right Discrimination)
Right or Left Hand??
Laterality Testing

- Flashcards or Recognise App
- Normative data: Accuracy >80%,
  - hands/feet reaction time 2.0 seconds +/- 0.5; neck/ back 1.6 sec +/- 0.5
- Deviating from either above may indicate changes in SSH but may also be due to slow processing, difficulty with coordination, dyslexia.
- Scores which vary notably from the above and are not explained largely by confounding factors indicate a trial of laterality treatment.
- Variations- think somatosensory homunculus.
Laterality Treatment

- Treatment:
  - 5x/day for 5 min; This is exercise for brain - it can be very fatiguing!
  - If flares patient’s pain do opposite side or adjacent body part

- Magazines, flashcards, or Recognise app; vary factors and environments to grade

- When to move on to Visualization/Motor Imagery
  - If initially tests well or achieves norms.
  - Don’t get stuck.
Motor Imagery / Visualization

- **Provides background**
  - Imagine movements without pain before doing them without pain
  - Improves communication between body and brain

- **Select an activity**
  - Static > Dynamic > Activity Based
  - Patient imagines doing it **pain free**; incorporate all senses

**Tips:**
- Select activities important to the patient!

- **When to move on to Sensory Retraining**
  - When the patient is able to engage in dynamic visualization without flared pain or anxiety.
Motor Imagery / Visualization

- Where are you? What is the weather like? What kind of surface are you standing on?
- Is there anyone there with you? What are you wearing? How does it feel on your skin?
- What do you hear? What do you smell?
- How does it feel to move?
- What are you thinking about?
Sensory Retraining (Moseley, Zalucki, & Wiech 2008)

- Sensory Retraining vs Desensitization
- Testing: 2 point discrimination
- Localization: where am I feeling that??
  - body “grids”

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Sensory Retraining

- Discrimination: what am I feeling??
  - Sharp or dull; big or small; warm or cool; rough or smooth; carpet or tile (neuropathic foot pain)
  - Stereognosis
  - Graphesthesia

- Grading: you want the pt to be successful 75-80% of the time, it shouldn’t be too easy or too hard or the brain isn’t learning.

- When to move on to Mirror Therapy
  - When the patient is able to demonstrate sensory awareness at level needed for functional use or when progress has stalled.

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Mirror Therapy (McCabe, Haigh et al. 2003; Moseley 2005)

- **Purpose and preparation**
  - Builds on foundation
  - “Tricks” the brain
  - Prepare the patient

- **Setting up the Mirror**

- **Progressing Treatment**

- **When to move on to Traditional Therapies**
  - When the pt is able to begin tolerating movement of the affected limb/body part behind the mirror or as otherwise indicated.
Questions/Comments?
Phantom Limb Pain

- Residual limb pain: localized to the remaining body part after amputation.

- Phantom limb pain: Painful or unpleasant sensation in the distribution of the lost or deafferentated body part.

- Phantom sensations: non-painful perceptions emanating from the lost body part after deafferentation or amputation.
Traumatic Amputation Case

- 25 year-old male with 1 year history of traumatic above knee amputation on the left.
  - Suicide attack at a checkpoint in Afghanistan
  - Only survivor

- HPI:
  - Amputation occurred at field hospital; was stabilized and then sent to WRMC where he underwent rehabilitation and prosthetic training for 6mos. He has been at home for the past 6mos.
  - Patient reports ongoing residual limb pain in addition to phantom limb pain that is increasing in frequency and intensity.
  - Low back pain and residual limb pain worsen with prolonged gait.
  - 30# weight gain
Mobility:
- Has 3 different prosthetic legs for different activities but has now resorted to a w/c as his primary mode of locomotion.

Lives with his girlfriend and their 2 year-old son. He stays at home and provides childcare.

Comorbid Diagnoses:
- PTSD, anxiety, depression
- Sleep apnea
- HTN
- LBP

Medications:
- Gabapentin
- TCA
- Beta-blocker
- Hydrocodone
Questionnaires, Activity Level & Goals

- FABQ: PA 16
- Promis-29
  - outside normal range in physical function, anxiety (PTSD), depression, sleep, social roles, pain interference
- He can be up in his prosthesis for 15 minutes before he has to sit due to pain and fatigue.
- He is not doing any of the HEP from his rehab at WRMC.
- Patient Goals
  - be able to play outside at the park with his son out of his wheelchair.
  - be on fewer medications to improve childcare.
Exam- Physical

■ Palpation:
  - Scar adhesions, hyperalgesia, back pain

■ Gait: problems with socket fit and gait inefficiencies
Exam- GMI

- Left/Right Discrimination Testing: (using Recognise app)

<table>
<thead>
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<th>Accuracy</th>
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<tbody>
<tr>
<td>Feet:</td>
<td></td>
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<tr>
<td>RIGHT</td>
<td>3.3</td>
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<tr>
<td>LEFT</td>
<td>4.0</td>
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<tr>
<td>Back:</td>
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<td>RIGHT</td>
<td>2.5</td>
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<tr>
<td>LEFT</td>
<td>3.0</td>
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- 2-point discrimination- L thigh outside of norms and when compared to R

- Localization
  - LE – L thigh 70% accurate with 6 section grid
Treatment: Early phases

Top Down

- **PNE:**
  - CNS and vigilance
  - Explanation for PLP

- **L/R:**
  - Magazines
  - Games with son

- Visual Imagery:
  - Observation
  - Virtual reality/Avatar
  - Guided imagery

Bottom Up

- Prosthetist for socket revision
- Plan for cardio
- Stretch for hip flexors
- HEP for graded spine mobility and functional activation (playing with son)
- Scar mobilization
Treatment: Late phases

Top Down

■ Discrimination:
  - Fabrics
  - Toys

■ Mirror therapy
  - Dynamic movement
  - Combined with sensory
  - TENS on intact limb
  - Homework- door mirror

Bottom up

■ Graded gait training in prosthesis
■ Proprioception work in standing with prosthesis
■ Injection at site of possible neuroma

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Complex Regional Pain Syndrome

- Budapest Clinical Criteria (2007)
  1. Continuing pain disproportionate to any inciting event
  2. Must report at least one symptom in 3 of the 4 following categories:
     1. Sensory
     2. Vasomotor
     3. Sudomotor/edema
     4. Motor/trophic
  3. Must display at least 1 sign at time of evaluation in two or more of the following categories:
     1. Sensory
     2. Vasomotor
     3. Sudomotor/edema
     4. Motor/trophic
  4. There is no other diagnosis that better explains the signs and symptoms
Hemiparesis

- Many interventions for acute/subacute are based on neuroplasticity principles

- Some evidence for GMI & Mirror Therapy
  - Difficult to grade
  - Improvements in limb function, attention, ADLs, pain, cortical changes (mirror therapy)
“Frozen Shoulder”

- Limitations in ROM in at least 2 motions. Primarily abduction and external rotation.

- 3 clinical phases: Freezing, Frozen, Thawing

- Use of Neuroscience Education, Tactile Discrimination, Limb Laterality and Graded Motor Imagery in a Patient With Frozen Shoulder (Mintken, 2016)

- Immediate effects of mirror therapy in patients with shoulder pain and decreased ROM (Louw, 2017)
  - 69 patients with shoulder pain
  - Mirror therapy only
  - Clinically and statistically significant improvement in active flexion
  - Statistically significant improvement in pain, catastrophization, and kinesiophobia
Spinal Cord Injury/ Disorder and Neuropathic Pain

- Incongruence between motor and sensory feedback may play a role
- 5 patients with paraplegia
  - Virtual walking with mirror
  - Guided imagery
  - Watching a film

- Results
  - Decreased pain in ¾
  - 1 patient withdrew due to distress

- More research indicated

(Moseley 2007)
Chronic Illness Case

■ HPI
  - 60 year old man
  - PAD, lower extremity ulcers, tobacco dependence, HTN, HLD, hyponatremia

■ SOCIAL HISTORY
  - Was living in North Carolina working as an engraver; moved back to Mpls to be with brother and sister-in-law and for improved medical care after recent health issues
  - Tobacco- cigarettes; Alcohol 3-4 beers a week

■ PLOF:
  - Fully (I); had started using a SEC of late, thought he was experiencing age related aches and pains
Recent Health Change

- Admitted to hospital in North Carolina mid-July 2016 for LLE cellulitis
- Presented to hospital in MN 8/10/16 w/ fatigue and dizziness; transferred for further management of lower extremity and sacral ulcers

PHYSICAL EXAMINATION:

- Back: Sacral ulcer on the left buttock ~4x3cm with deep tunneling
- LE: nickel sized ulcers L knee; left lateral malleolus with large 7x5cm superficial ulcer with brown/black discoloration; multiple superficial weeping ulcers on b/l lower extremities

Patient Goals:

- 1. To find out why I'm so weak
- 2. To care for the wounds on my legs and buttocks

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**Medical**

- Pain 5/10, worst with elevation and dressing changes; insomnia; wounds worsening, necrotic
- Vascular bypass surgery; unfavorable prognosis

**PT**

- High falls risk (0.28m/s); LE Strength 4-5/5;
- Nu-step 10 min level 0; ambulating 80 ft FWW CGA

**OT**

- Weakness impacting ADL/IADLs; UE MMT 4/5
- Focus on w/c seating and positioning; neck pillow for sleep

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Post Surgery

**PT**
- Walking (FWW, restorative RN support); LE strengthening
- D/C: rollator 400' with FWW, low to moderate fall risk

**OT**
- Goals focused on ADLs with SBA/CGA or mod I; UE strengthening
- (I) With UE strengthening; ADL plateau 2/2 wound vac
Pending Amputation?- February

- Medical
  - New bone infection

- Patient Response
  - Emotional, reduced motivation
  - Declined psychology and peer mentoring

- OT
  - Sleep and mind-body tools
  - Exercise (UE and walking)
  - Pain neuroscience education- skeptical

- It’s all about the timing...

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Graded Motor Imagery- Phase I

- **L/R Discrimination**
  - **Feet:**
    - 63% 2 sec then 100% 3.1 sec
    - Progressed to 100% 1.5 sec
  - **Knee**
    - 65% 3 sec

- **Imagery/ Visualization**
  - walking, stretching, and basketball
  - Weekly engagement, buy-in limited

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Reconsulted for L knee contracture

688' on the 6-minute walking test; 12 steps with B railing; 10 degrees shy full extension

2 point; localization, graphesthesia; discrimination; vibration; continued L/R with knee

Senior apt secured; Community reintegration goals-hesitation
Then

Scheduled tylenol QID
MSContin 30mg q.12H
Oxycodone 5-10mg q.4H prn
IV dilaudid and Urojet

Now

Tylenol 650 QID
Oxycodone 5-10mg TID prn
Oral dilaudid and Urojet
Approaching Discharge

■ Mirror Therapy
  - Static > static and dynamic
  - Mirror issued- tracking use (daily)
  - Continued sensory training

■ IADL training
  - Standing functional tasks- LBP, re-enter PNE
  - Mobility (walking 2X/day > 4X/day)
  - "My back pain is better today. I think it's because I'm in a good mood."

■ Medical
  - Infection
  - Angioplasty and stent placement to facilitate success with grafting
Discharge

- June d/c to senior apartment, alone, close to sister-in-law and brother
- Modified (I) all ADLs/IADLs except assist from sister-in-law for shopping
- Laterality testing conducted for
  - FEET
    - 63% 2 sec. reaction time > 100% 1.5 sec
  - KNEE
    - 65% 3 sec > 75% 1.5 sec
- Medications- continues to reduce,
  - oxycodone 5-10mg ev 12 hrs; Tylenol down to 650mg ev 8 hrs; oral dilaudid only prior to dressing changes;
  - last MD note pain was no longer a factor they were commenting on
- NRS: past month only 3 reports >=5 (5,5,7)- mainly 2-3

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Now What Do I Do??

cLBP  Immobilized

Post-Op  Neuropathy

GMI?

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PNE Resources

- International Spine and Pain Institute website has courses, booklets for patients, and handouts


- Pain Fundamentals and Treatment Fundamentals by Greg Lehman: Free downloadable workbooks on pain science and pain treatment methods that can be used with patients to guide treatment [http://www.greglehman.ca/pain-science-workbooks](http://www.greglehman.ca/pain-science-workbooks)

- Books: Explain Pain by D. Butler  Why Do I Hurt? by A. Louw  Painful Yarns by G. L. Moseley  Therapeutic Neuroscience Education: Teaching Patients About Pain by A. Louw & E. Puentedura

- Videos: Understanding pain in 5 minutes  The Backwards Brain Bicycle  Lorimer Moseley TED talk “Why things hurt”
GMI Resources

- **Neuro Orthopaedic Institute (NOI):** [https://www.NOIgroup.com](https://www.NOIgroup.com)
- **General overview and research**
- **Recognise app or NOI flash cards for testing laterality-tests accuracy and reaction time**
- **Videos:**
  - What is GMI? [https://www.youtube.com/watch?v=fWYUJscRBRw](https://www.youtube.com/watch?v=fWYUJscRBRw)
  - Smudging of the brain: [https://www.youtube.com/watch?v=3QVAY5stO3U](https://www.youtube.com/watch?v=3QVAY5stO3U)
  - Mirror therapy: [https://www.youtube.com/watch?v=hMBA15Hu35M](https://www.youtube.com/watch?v=hMBA15Hu35M)
  - Nerves, knowledge and tubing: [https://www.youtube.com/watch?v=gdKldyXgkgs](https://www.youtube.com/watch?v=gdKldyXgkgs)
References

- NOI | Neuro Orthopaedic Institute www.noigroup.com/