# Prescribing Exercise: The Weekly Recommended Allowance and Tips for Maintaining Compliance

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### Musculoskeletal Medicine

- Non-operative treatment:
  - Muscles and nerves
    - Joints and bones
      - Osteoarthritis
        - Spine
        - Sports







## Physical Medicine and Rehabilitation

Focus on restoring function Exercise is the mainstay of treatment for most musculoskeletal conditions

# + Overview

**Benefits of Exercise** 

"Quality of Life" Insurance

"Quantity of Life" Insurance

What Does the Research Show?

Maintaining an Exercise Program

Recommendations and Prescription for Physical Activity

What's New in Exercise Science?







# ➡ Why Exercise? Top Ten List of Reasons to Exercise – Mayo Clinic

Exercise will reduce fatigue levels.

Aerobic exercise reduces the risk of diabetes, heart disease, cancer.

Aerobic exercise can help prevent heart attacks, and subsequent heart attacks.

Exercise activates the immune system, making you less susceptible to viral illness, such as colds and the flu.

Exercise and diet will help you lose weight and maintain weight loss.

Exercise can reduce tension, promote relaxation and decrease depression.

With long-term exercise, your heart is stronger, pumps blood more efficiently.

Aerobic exercise can favorably effect your cholesterol levels.

Aerobic exercise can help older people maintain muscle strength, maintain mobility, decrease falls, and decrease age-related cognitive decline.

People who participate in regular aerobic exercise appear to live longer than those who don't exercise regularly.





# Gait Speed - The Next Vital Sign?

- Predicted survival based on:
  - age, sex and gait speed
- was as accurate as predicted survival based on:
  - age, sex, chronic conditions, smoking history, blood pressure, body mass index and hospitalization.
- "Why does walking speed predict survival? Walking requires energy, movement control, and support and places demands on multiple organ systems, including the heart, lungs, circulatory, nervous and musculoskeletal systems."
- Studenski S, et al. Gait Speed and Survival in Older Adults. JAMA. 2011;305(1):50-58.







What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?"



# Do you have "Quality of Life" Insurance?

Exercise not only helps to prevent or manage disease, exercise may be the "Fountain of Youth" that maintains independence and quality of life as we age.





# Exercise – your "Quality of Life" Insurance

- People are less physically active as they age.
  - Nearly 40% of people age 55 or greater report no leisuretime physical activity.
- Loss of strength results in:
  - Decreased balance
  - Increased fall risk
  - Decreased ability to perform activities of daily living

- Inactive people lose muscle at a rate of 3-5% every decade after age 30.
  - 15% of muscle is lost by age 60.
- Decreased exercise tolerance results in a diminished "threshold of physical ability"
  - A minor illness or injury may result in complete dependence for daily care

# Physical Activity Guidelines: "Quantity of Life" Insurance

Minutes per week: moderate or vigorous physical activity	Relative risk
30	1
90	0.8
180	0.73
330	0.64
420	0.615

- The risk of dying prematurely declines as people become physically active.
- Few lifestyle choices have as large an effect on mortality as physical activity.
  - 40% lower risk of dying prematurely for those physically active 7 hours per week compared to 30 minutes per week.
- Any age, gender, race, ethnicity, body weight will gain this benefit.
  - US Dept Health and Human Services

# Physical Activity for Age-Related Degeneration – The Research

Conditions	Benefits
<ul> <li>Spine</li> <li>Disc degeneration</li> <li>Spondylosis</li> <li>Spinal Stenosis</li> <li>Facet Arthritis</li> <li>Hip/Knee</li> <li>Osteoarthritis</li> </ul>	<ul> <li>Improved physical function</li> <li>Strength</li> <li>Endurance</li> <li>Flexibility</li> <li>Improved psychosocial parameters</li> <li>Improved self-efficacy</li> <li>Increased coping skills</li> <li>Decreased helplessness</li> <li>Decreased ill-health beliefs</li> </ul>

## Normal "Abnormalities" – Degenerative Disc Disease is Really Just Gray Hair

- 98 asymptomatic
- L-Spine MRIs
  - 52% bulges
  - 27% protrusions
  - 1% herniations
  - 14% annular ligament tear
  - 8% facet arthropathy
  - 38% with multilevel abnormalities
    - Jensen, 1994

- 67 asymptomatic
- L-Spine MRIs
  - 20-39 yo:
    - 35% disc degeneration
  - <60 yo:
    - 20% herniations
  - >60 yo: 57% abnormal
    - 36% herniations
    - 21% stenosis
      - Boden, 1990

# Disc Degeneration is Found in Asymptomatic Children as Well as Adults

- Scottish study of spinal canal dimension
  - 154 asymptomatic 10 year-olds
  - MRIs
    - 9% with disc abnormality
    - 14 abnormal discs at L45 or L5S1
    - 4 with decreased T2 signal in nucleus pulposus
    - 10 with decreased T2 signal and posterior protrusion
      - Smith, 2003



Are Imaging Study "Abnormalities" in Asymptomatic Subjects Predictive for Pain?

- Longitudinal Assessment of Imaging and Disability of the Back (LAIDBack)
  - 148 asymptomatic subjects (36-71 yo)
  - MRIs at baseline and 3 years
    - 83% disc degeneration, 64% bulge, 32% protrusion, 6% herniation
  - ~ 67% developed back and/or leg symptoms over the 3 year period
    - Annular ligament tears, bulges and protrusions did not predict pain
    - Self-described depression most important predictor
      - Jarvik, 2001

Imaging Study "Normals" in Symptomatic Subjects

- MRI in Symptomatic
  - 20 patients with:
    - History of LBP with radiating leg pain
    - PE findings with single nerve root distributions of neurologic deficits
  - 16 of 20 MRIs:
    - lesion consistent with history and exam findings
      - Modic, 1995

- Do normal studies = no pathology
  - Misinterpreted films
    - Review your own
  - Non-compressive radiculopathy
    - Diabetic amyotrophy
  - Radiculopathy-like presentations
    - LS plexopathy

# + The Case for Exercise

### Hurley

The psychosocial benefits derived from exercise are as important as the physiological benefits

#### Miner

 Exercise may be the most effective, malleable, and inexpensive modality available to achieve optimal outcomes for people with OA

# + Exercise for Acute Low Back Pain (0-6 weeks)

### Malmivaara, NEJM

- Randomized controlled trial:
  - Bed Rest vs. Exercise vs. Ordinary Activity
- Exercise:
  - Specific PT "extension" program, pain contingent
- Results:
  - Ordinary activity group had favorable pain, work and disability outcomes at 3 and 12 weeks

#### Linstrom, Spine

- Randomized controlled trial:
  - Passive PT vs. Graded Exercise & Activity
- Exercise:
  - Quota based, gradually increasing program
- Results:
  - Graded activity group had better back function, less symptoms, less disability, and less lost work time

# +Exercise for Subacute Low Back Pain (6-12 weeks)

### Indahl, Spine

### Randomized controlled trial:

- Passive PT vs. Advice to Perform Light Exercise and Return to Normal Activities
- Exercise:
  - Not fixed, but patients encouraged to set own goals, avoid illness behaviors, not be fearful
- Results:
  - Advice group had less work disability at 1 and 3 years

### Mitchell, Spine

- Observation of cohorts:
  - Passive PT vs. Intense Active Exercise
- Exercise:
  - Quota based, aggressive
- Results:
  - Intensive exercise group had quicker return to work and lower cost

# + Exercise for Chronic Low Back Pain (>12 weeks)

### Frost, Brit Med J

- Randomized controlled trial:
  - Fitness/Exercise Program vs. Back School

### Exercise:

 Stretching and strengthening (non-pain contingent)

### Results:

 Exercise group had decreased disability and decreased pain

# Observational Trials – Functional Restoration

- Mayer, JAMA
- Hazard, Spine
- Estlander, Scan J Rehab Med
- Manniche, Pain
- Rainville, Spine
- Nelson, Orthopedics

# + Exercise for Hip/Knee Osteoarthritis

### Kovar, et al

- 102 knee OA subjects
- Randomized to 2-month walking program or control
- intervention group had significant improvements in walking distance and functional status
- No worsening pain or exacerbating knee symptoms

### Topp, et al

- 102 knee OA subjects
- Randomized to 4-month isometric or dynamic resistance training, or control
- Resistance training groups had significant improvements in functional tasks such as stair climbing, with decreased pain compared to control

# + Exercise for Hip/Knee Osteoarthritis

### Ettinger, et al

### 439 knee OA subjects

- Randomized to 3-month resistance or aerobic exercise program and 15-month homebased program, or control
- Exercise groups had improvements in disability, pain and physical function compared to control
- Exercise compliance

#### Hopman-Rock, et al

- 105 hip/knee OA subjects
- Randomized to 6-week education/exercise group, or control
- Intervention group met weekly for 2 hours, one hour of exercise
- Moderate improvement in pain and QOL
- No differences seen at 6-month follow-up

# + Exercise for Hip/Knee Osteoarthritis

### Van Baar, et al

- 201 hip/knee OA subjects
- Randomized to 3-month exercise group vs. patient education/ traditional treatment
- One exercise protocol was used for both knee and hip OA
- Exercise frequency was not standardized

#### Van Baar, et al

- Baseline characteristics differed between intervention and control
- Exercise therapy was associated with reduced pain and disability at 3 months post-intervention
- At the 6-month f/u, no significant differences between groups

# +

# **Exercise Adherence**

Now that you are exercising, how do you stick with a program?





# Exercise Adherence

### Complex, multifactorial

- perceptions of personal capabilities
- positive attitudes toward exercise
- sense of control over exercise
- level of confusion regarding exercise
- attrition rates of 50% within the first 6 months



# Exercise Adherence

## Jette et al

- 102 sedentary older subjects
- Home-based resistance training program
- Identified adherence factors
  - Physical factors:
    - Indicators of overall exercise participation
  - Psychological factors:
    - Indicators of program adherence



# + Exercise Adherence

### McAuley et al

- 114 middle-aged subjects
- Randomly assigned to 5 month exercise program with an education vs. control group
- Education group included educational intervention focusing on increasing confidence regarding ability to exercise
- Education group had increased adherence, decreased attrition over time



"It's a deal - two more years, then we let ourselves go."

# Exercise Adherence

## Keeping it simple:

- Get out of the house!
- Peer support
  - Work out with someone or in a group
- Do exercises that you like
  - Any activity is better than no activity





# Physical Activity Guidelines U.S. Department of Health & Human Services -Research Findings

- -Types of Physical Activity
- -Which Physical Activity is Best
- -Recommendations for Youth, Adults, Older Adults



<sup>&</sup>quot;The only diet shake I recommend is the shake your booty makes when you exercise."

# Physical Activity Guidelines: Research on Health Benefits

#### What are the Benefits?

- Decreased risk of adverse health events.
- Increased amount of physical activity is associated with increased benefits.
- Both aerobic and resistance activities are beneficial.
- Decreased risk of premature death (heart disease, some cancers).

#### Who Benefits?

- Children
- Adolescents
- Adults
- Older adults
- Every racial and ethnic group
- Disabilities
- Chronic disease

# Physical Activity Guidelines: Type of exercise



- Aerobic (endurance, cardio)
  - Brisk walking
  - Running
  - Jumping rope
  - Cycling
  - Swimming
- Components
  - Intensity
  - Frequency
  - Duration

# Physical Activity Guidelines: Type of exercise



- Muscle-strengthening (resistance)
  - Machines
  - Free weights
  - Elastic bands (theraband)
  - Body weight (push-ups)
- Components
  - Intensity
  - Frequency
  - Repetitions

# Physical Activity Guidelines: Type of exercise



#### Bone-strengthening

- Weight-bearing exercises
- Promotes bone growth and strength
- "Impact" activities
  - Brisk walk, weight lifting

### Flexibility

- Stretching
- Yoga
- Pilates

# Physical Activity Guidelines: Adults

## Aerobic

- At least 3 days per week
- At least
  - 150 minutes per week of moderate
  - or 75 minutes of vigorous activity
- For additional health benefits:
  - 300 minutes of moderate
  - or 150 minutes of vigorous

## Muscle-strengthening

- 2 or more days per week
- Involve all major muscle groups



# Physical Activity Guidelines: Older Adults

### Same as for adults, plus:

- If unable to do 150 minutes per week, be as active as chronic condition allows.
- If at risk of falling, do exercises that maintain/improve balance.
- Determine level of physical activity relative to fitness level.
- Determine how chronic condition will affect ability to do regular activity.



# + A Function-Based Approach to Age-Related Degeneration and Pain



Flexibility

 This is a process that takes months (especially as we get older), not days or weeks

Rethinking Back Pain Based on Epidemiology and Basic Science Discoveries

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James Rainville, MD Dept of PM&R Harvard Medical School The Spine Center New England Baptist Hospital Boston, MA

# Active vs. Passive Treatment

### **Physical Activity**

- Why Self-Induced Pain Feels Less Painful than Externally Generated Pain: Distinct Brain Activation Patterns in Self- and Externally Generated Pain
  - Wang Y, et al.
  - PLoS ONE, 2011; 6(8):e23536

#### **Prospective Cohort Study**

- 25 subjects, asked to hold "ring" with points or spheres
  - Trial 1–squeeze with other hand
  - Trial 2–examiner squeezes hand
- Results
  - Active movement inhibited pain response in somatosensory cortex
  - Pain-inhibiting effect of voluntary activity may explain beneficial impact of exercise on pain

# Neuroscience Effects of Exercise on Pain

Aerobic exercise for 5 weeks

- Results of exercise
  - Reversed mechanical sensitivity of limb
  - Normalized injury induced changes in dorsal ganglia and spinal cord
    - peripheral nerve growth factors (NGF)
    - brain-derived neurotrophic factor (BDNF)
    - phosphorylation status of PLCI-1
    - astrocyte and microglia hyperactivity



# Neuroscience Effects of Exercise on Pain

Low intensity exercise

- Results of exercise
  - Reduced pain behaviors
  - Brainstem
    - Increased serotonin (5-HT) production
    - Decreased 5-HT transport
    - Increased 5-HT receptors
    - Reduced inflammatory cytokines, tumor necrosis factor-alpha, and interleukin-1 beta
    - (These factors are known to modulate pain)

Bobinski F, et al. Role of brainstem serotonin in analgesia produced by low-intensity exercise on neuropathic pain after sciatic nerve injury in mice. Pain 2015;156(12):2595-606.



# Neuroscience Effects of Exercise on Pain

High intensity exercise

- Results of exercise
  - Reduced withdrawal reflex
  - Mu-opioid receptors
    - Altered expression of mu-opioid receptors in brain stem and spinal cord shifting balance of pain modulation to inhibition.
    - This effect is blocked by opioid receptor antagonist naloxone.



Kim YJ, Byun JH, Choi IS. Effect of Exercise on µ-Opioid Receptor Expression in the Rostral Ventromedial Medulla in Neuropathic

Pain Rat Model. Ann Rehabil Med 2015;39(3):331-9.

Stagg NJ, et al. Regular exercise reverses sensory hypersensitivity in a rat neuropathic pain model: role of endogenous opioids.

Anesthesiology 2011;114(4):940-8.

# Neuroscience Effects of Exercise on Pain

- <u>Graded</u> exercise
- Results of exercise
  - Reduced hyperalgesia in the skin
  - Neurological changes
    - Prevented nerve fiber sprouting in the skin
    - Lowers neurotrophic factors in the sciatic nerve
    - Reduced NGF and BDNF in sensory neurons and spinal cord
    - Normalized pain disregulated ion transport in dorsal ganglia and spinal cord
    - Reduce microglia cell proliferation in spinal cord



Anesth Analg 2012;114(6):1330-7.



# + Neuroscience

The stimulus from exercise reverses pain sensitizing changes in the brainstem, spinal cord, dorsal ganglia and peripheral nerves.



Ossipov MH, et al. Descending pain modulation and chronification of pain. Curr Opin Support Palliat Care 2014;8:143-51.

# + Human studies of exercise











#### Spinal stabilization

General exercise



#### Improvements in pain and disability similar in both groups.

Woo SD, Kim TH. The effects of lumbar stabilization exercise with thoracic extension exercise on lumbosacral alignment and the low back pain disability index in patients with chronic low back pain. J Phys Ther Sci (2016 Jan) 28(2):680-4



#### **Pilates exercise**

#### General exercise





#### Improvements in pain and disability similar in both groups.

Mostagi FQ, et al. Pilates versus general exercise effectiveness on pain and functionality in non-specific chronic low back pain subjects. J Bodyw Mov Ther (2015 Oct) 19(4):636-45



#### Motor control impairment

#### General exercise



#### Improvements in pain and disability similar in both groups.

Saner J, et al. A tailored exercise program versus general exercise for a subgroup of patients with low back pain and movement control impairment: Short-term results of a randomized controlled trial. J Body Mov Ther (2016 Jan) 20(1):189-202



### High load lifting



### Low load motor control





#### Improvements in pain and disability similar in both groups.

Michaelson P, et al. High load lifting exercise and low load motor control exercises as interventions for patients with mechanical low back pain: A randomized controlled trial with 24-month follow-up. J Rehabil Med (2016 Apr 28) 48(5):456-63



#### Supervised walking





**Fitness training** 

#### Improvements in pain and disability similar in both groups.

Hurley DA, et al. Supervised walking in comparison with fitness training for chronic back pain in physiotherapy: results of the SWIFT single-blinded randomized controlled trial Pain 2015;156:131-7.

# + The neurological effects of exercise are non-specific!

Specific exercise techniques may be less important than reaching a certain threshold of exercise needed to induce neurological changes that reduce pain stimulus threshold



"We are not responsible for what patients believes before they come to our practice."

"We are responsible for what they believe when they leave."



Aage Indahl, Spine 1995

# Goals: STAY FIT FOR QUALITY AND QUANTITY LIFE

- The best exercise?
- Meet the physical activity guidelines
  - Aerobic
  - Muscle-strengthening
  - Flexibility
- Develop exercise buddies
  - Peer support
- Maintain an exercise program over time



The Poor Man's Plastic Surgery!

# Any activity is better than no activity!





