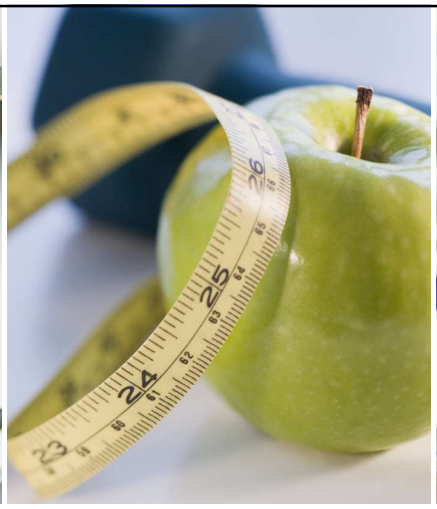
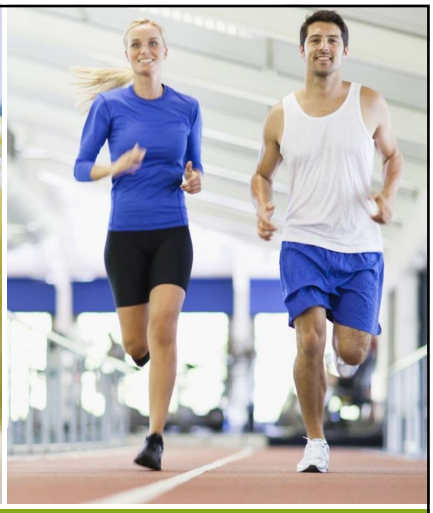




OPTIMIZING MOTOR AND COGNITIVE RECOVERY AFTER TBI

THE ROLE OF EXERCISE AND SLEEP

OPTIMIZING MOTOR AND COGNITIVE RECOVERY AFTER TBI

THE ROLE OF EXERCISE AND SLEEP

OPTIMIZING MOTOR AND COGNITIVE RECOVERY AFTER TBI

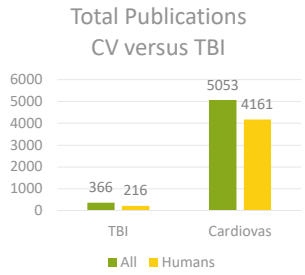
THE ROLE OF EXERCISE AND SLEEP

Learning Objectives

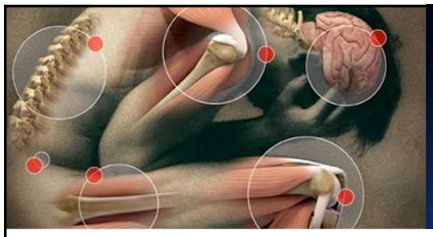
- Discuss the negative effects of prolonged bed rest after hospitalization.
- Contrast historical and contemporary rehabilitation strategies for patients with TBI.
- Discuss how aerobic exercise and sleep promote improvements in mood and cognition.
- Describe the evidence showing the benefits of early mobilization and High Intensity Interval Training (HIIT) after TBI.
- Understand current recommendations for initiating an exercise program for persons with TBI.

EXERCISE AS A BENEFIT TO HUMAN HEALTH

- *"…exercise was invented and used to clean the body when it was too full of harmful things."* -- Mendez, 1553
- *"Here it may be asked whether the organs of the brain increase by exercise? This may certainly happen in the brain as well as in the muscle."* --Spurzheim, 1815
- *"I have shown that the brains of domestic rabbits are considerably reduced in bulk, in comparison with those of wild hare…so that they have exerted their intellect, instincts, senses and voluntary movements but little."* --Darwin



TBI research is growing but still limited!



Physical Consequences

- Walking/Mobility
- Weakness
- Balance
- Coordination
- Endurance

Cognitive Consequences

- Level of Consciousness
- Memory
- Attention
- Executive Functioning
  - Cognitive Flexibility
  - Attentional Control
  - Impulse Control
  - Self-Monitoring
  - Planning, Reasoning

Emotional Consequences

- Mood Swings (Emotional Lability)
- Depression
- Anxiety
- Irritability
- Aggression/Outbursts

COMMON IMPAIRMENTS IN ACUTE TBI

OLD SCHOOL TBI—ACUTE RECOVERY

PROLONGED BEDREST HAS CONSEQUENCES!

- Electrolyte changes
- Muscle loss (atrophy)
- Reduced bone density
- Impact on heart rate
- Reduced cardiac output
- Reduced aerobic capacity
- Immune system suppression

EARLY MOBILIZATION IS CRITICAL!

- **Higher levels of mobility**
- **Reduced LOS**
- **Higher rates of discharge home**
- **Reduced infections**
- **And reduced anxiety**

Klein, K. et al. Clinical and psychological effects of early mobilization in patients treated in a neurological ICU. A comparative study. *Critical Care Medicine*. 2015;43(4):865-73.

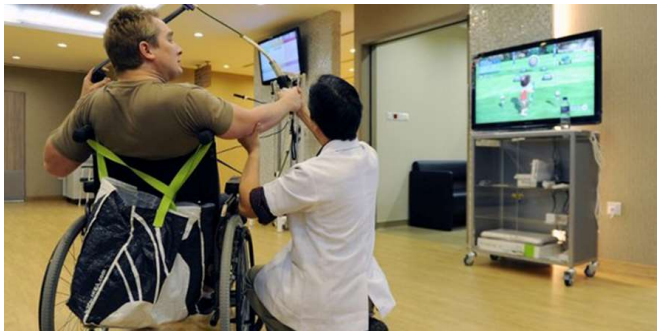
NEW SCHOOL TBI—ACUTE RECOVERY

TRADITIONAL TILT-TABLE

TILT-TABLE WITH STEPPER

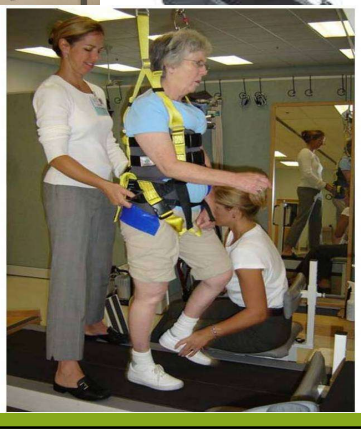
Krewer, C, et al: Tilt table therapies for patients with severe disorders of consciousness: a randomized, controlled trial. PLoS. 2015;10(12).

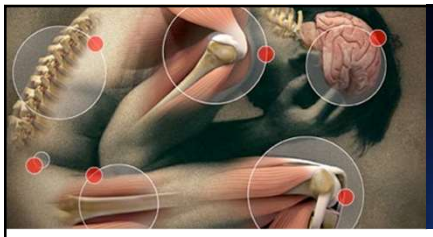
NEW SCHOOL TBI—ACUTE RECOVERY



MEET THEM
WHERE THEY ARE!

NEW SCHOOL TBI—ACUTE RECOVERY





Physical Consequences
- Walking/Mobility
- Weakness
- Balance
- Coordination
- Endurance*

*Mossberg KA et al. Aerobic capacity after traumatic brain injury: comparison with a nondisabled cohort. *Arch Phys Med Rehabil.* 2007 Mar;88(3):315-20.

Cognitive Consequences
- Memory
- Attention
- Executive Functioning
  - Cognitive Flexibility
  - Attentional Control
  - Impulse Control
  - Self-Monitoring
  - Planning, Reasoning

Emotional Consequences
- Mood Swings (Emotional Lability)
- Depression
- Anxiety
- Irritability
- Aggression/Outbursts
- Reduced Quality of Life

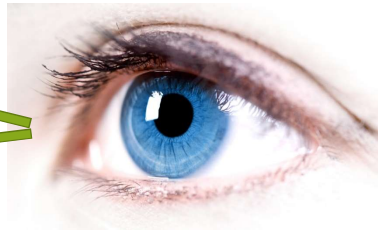
COMMON IMPAIRMENTS IN CHRONIC TBI

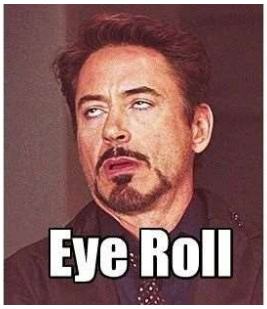
OLD SCHOOL TBI—POST-ACUTE REHAB

- Outpatient services typically lack intensity—Old School!
- "Counting Repetitions"

36 Active Minutes/Session

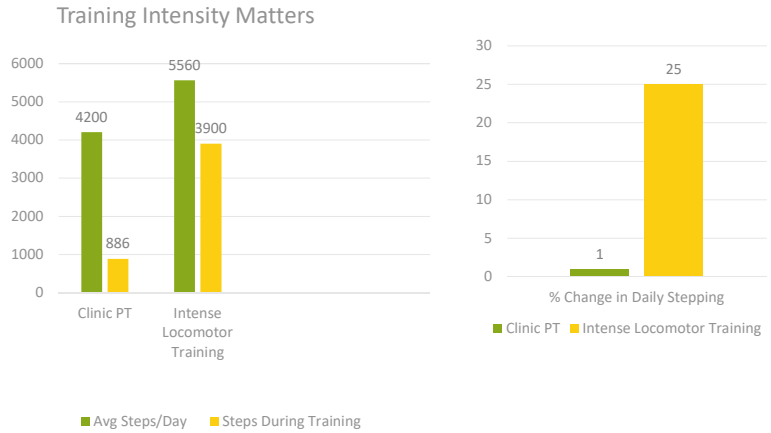
292 Steps/Session





Lang C. et al. Counting Repetitions: An Observational Study of Outpatient Therapy for People with Hemiparesis Post-Stroke. 2007. *JNPT;31*:3-10.

NEW SCHOOL TBI—POST-ACUTE REHAB



"Further analysis revealed that the average stepping dosage (# steps/session) provided to subjects each PT or subsequent LT session was correlated with improvements in daily stepping in the home and community"

Individuals Poststroke Who Have Reached a "Plateau" in Recovery. Jennifer L. Moore, Elliot J. Roth, Clyde Killian and T. George Hornby Stroke. 2010;41;129-135.

"Reasons why high intensity stepping practice is not provided more often are unclear, and the barriers to delivering this type of training should be identified."

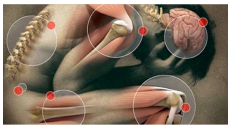
Neuroplasticity

- The term *NEUROPLASTICITY* was introduced into the study of neurosciences in 1906 by Ernesto Lugaro.
- Modern definition: the brain's ability to reorganize itself by the addition and subtraction of connections, in all stages of life, in response to their experiences and environment.

WHAT IS THE RELATIONSHIP BETWEEN EXERCISE AND COGNITION?

- Nepveu JF, et al. A single bout of HIIT improved motor skill retention in individuals with stroke. *Neurorehabil Neural Repair*. 2017;31(3):726-35.

CAN EXERCISE HELP?



Physical Consequences
- Walking/Mobility
- Weakness
- Balance
- Coordination
- Endurance*

Emotional Consequences
- Mood Swings (Emotional Lability)
- Depression
- Anxiety
- Irritability
- Aggression/Outbursts

What Gets Better?
- Improved cardiorespiratory capacity
- Improved strength
- Improved balance/coordination
- Anxiety
- Depression
- Anger
- Fatigue
- Confusion

Why Does it Get Better?
- Psychological Factors
  - Self-Esteem
  - Self-Efficacy
  - Social Interactions
- Physiologic Factors
  - Cerebral Blood Flow
  - Neurogenesis
  - BDNF

Weinstein AA[1] . Effect of Aerobic Exercise Training on Mood in People With Traumatic Brain Injury: A Pilot Study. *J Head Trauma Rehabil.* 2017 May/Jun;32(3):E49-E56.

CAN EXERCISE HELP?

Cognitive Consequences

- Memory
- Attention
- Executive Functioning
  - Cognitive Flexibility
  - Attentional Control
  - Impulse Control
  - Self-Monitoring
  - Planning, Reasoning

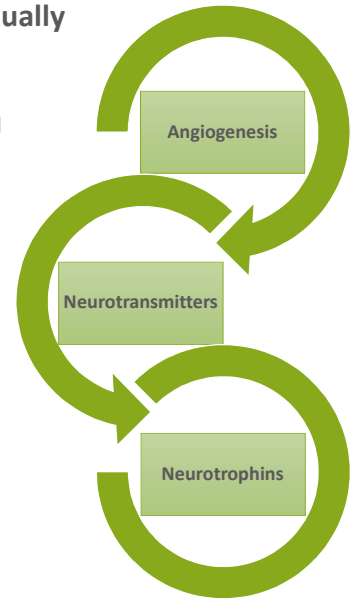
- Improved Cardiorespiratory Function
- Improved attention (25%)
- Global Cognitive Function (15%)
  - Visuospatial Ability
  - Language
  - Delayed Memory
- No change in sleep quality or depression

- 12 week treadmill walking program
- Exercised at 70-80% of their Maximum heart rate
- 30 minutes, 3x/wk
- **Dose-Response Relationship**

Chin et al. Improved cognitive performance following aerobic exercise training in people with TBI. *Arch Phys Med*. 2015;96(4):754-59.

How does aerobic exercise actually improve cognition?

- Angiogenesis--(increased blood vessel density in the brain)
- Neurotransmitters—
  - Increased serum calcium
  - Increased calcium to brain
  - Increased concentrations of norepinephrine and dopamine
- Neurotrophins-- BDNF



WHAT IS THE RELATIONSHIP BETWEEN EXERCISE AND COGNITION?

Lojovich JM. The Relationship Between Aerobic Exercise and Cognition: Is Movement Medicinal? *J Head Trauma Rehabil*. 2010;25(3):184-92.

What types of exercise lead to these benefits?

High-Intensity Interval Training (HIIT)—training with bursts of concentrated effort; alternated with recovery periods that mitigate fatigue and increase cardiovascular safety.

Cardiovascular Studies-- High-Intensity Interval Training (HIT) produced superior results comparted to moderate-intensity continuous training (MICE-40-70% HRR)

WHAT IS THE RELATIONSHIP BETWEEN EXERCISE AND COGNITION?

Boyne et al. High-intensity interval training in stroke rehabilitation. *Top Stroke Rehabil*. 2013;20(4):317-330

Why is HITT Better and How to Apply to TBI?

Boyne Study (2016)—HIIT vs MICE with Stroke Survivors

- 25 Minutes, 3x/wk x 4wks
- 30 second max walking speed/ 30-60 sec passive rest
- Significantly better changes in aerobic capacity and gait speed!

Chin Study—used moderate to intense, continuous training and found improved mood and cognition.

…..IF….HIIT exercise if superior to MICE….

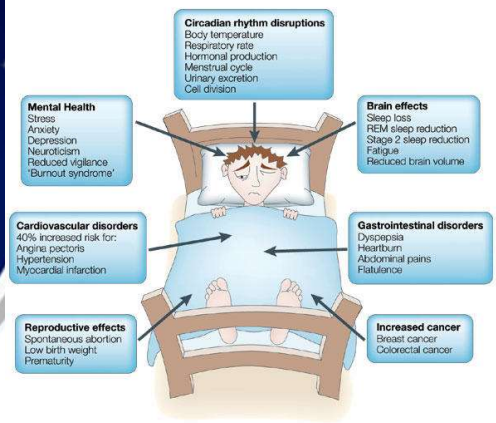
….IF….There is a dose-response relationship between improved aerobic capacity and improved mood and cognition….

WHAT IS THE RELATIONSHIP BETWEEN EXERCISE AND COGNITION?

Boyne P et al. High-Intensity Interval Training and Moderate-Intensity Continuous Training in Ambulatory Chronic Stroke: Feasibility Study. *Phys Ther*. 2016 Oct; 96(10): 1533–1544.

SLEEP HYGIENE IS CRITICAL!

- Sleep Wake Cycle Disturbances (SWCD) are common after TBI



Tips For Improving Sleep Hygiene

- ***Have a firm routine for bedtime***
  - Same time down and up
  - Have a relaxation routine (warm bath, reading, stretching etc)
- ***Avoid things that can prevent good sleep:***
  - Caffeinated drinks—soda, tea, coffee (4 hrs)
  - Moderate to vigorous exercise (2-3 hrs)
  - Heavy meals/spicy food (2-3 hrs)
  - Alcohol/nicotine (3-4 hrs)
  - Day time naps
  - Light emitting devices—TV, electronics, etc (30min)
- ***Make your bedroom comfortable and relaxing***
  - Low/no lighting
  - No noise
  - Use eye mask and ear plugs
- Your bed is only for ***SLEEPING*.*** No eating, drinking, working, TV in bed!
- Use a wearable sleep-tracking device
- Consult your doctor if difficulty sleeping persists

PRACTICAL RECOMMENDATIONS FOR IMPROVING SLEEP HYGIENE

What PTs should do for their patients with TBI:

1. Screen for SWCD
2. Educate about sleep hygiene
3. Prescribe exercise

Siengsukon CF, et al. Sleep health promotion: practical information for physical therapists. *Phys Ther*. 2017:97(8);826-36.

WHAT EXERCISE IS RECOMMENDED FOR GENERAL HEALTH PURPOSES?

"ACSM's physical activity recommendations for healthy adults, updated in 2011, recommend at least 30 minutes of moderate-intensity physical activity (working hard enough to break a sweat, but still able to carry on a conversation) five days per week, or 20 minutes of more vigorous activity three days per week. Combinations of moderate- and vigorous-intensity activity can be performed to this recommendation.
Examples of typical aerobic exercises are:

- *Walking*
- *Cycling*
- *Swimming*
- *Running*
- *Rowing*
- *Stair climbing*
- *Cross-country skiing*

In addition, strength training should be performed a minimum of two days each week, with 8-12 repetitions of 8-10 different exercises that target all major muscle groups. This type of training can be accomplished using body weight, resistance bands, free weights, medicine balls or weight machines."

ACSM Information On...

HIGH-INTENSITY INTERVAL TRAINING

The popularity of high intensity interval training is on the rise. High intensity interval training sessions are commonly called HIIT workouts. This type of training involves repeated bouts of high intensity effort followed by varied recovery times.

Getting Started—"Persons with a sedentary lifestyles or periods of physical inactivity may have an increased coronary disease risk to high intensity exercise. Family history, cigarette smoking, hypertension, diabetes (or pre-diabetes), abnormal cholesterol levels and obesity will increase this risk. Medical clearance from a physician may be an appropriate safety measure for anyone with these conditions before staring HIIT or any exercise training. Prior to beginning HIIT training a person is encouraged to establish a foundational level of fitness. This foundation is sometimes referred to as a "base fitness level". A base fitness level is consistent aerobic training (3 to 5 times a week for 20 to 60 min per session at a somewhat hard intensity) for several weeks that produces muscular adaptations..."

PRACTICAL RECOMMENDATIONS FOR HIIT TRAINING

ACSM Guidelines for High-Intensity Interval Training:

https://www.acsm.org/docs/brochures/high-intensity-interval-training.pdf

ACSM Information On…

HIGH-INTENSITY INTERVAL TRAINING

The popularity of high intensity interval training is on the rise. High intensity interval training sessions are commonly called HIIT workouts. This type of training involves repeated bouts of high intensity effort followed by varied recovery times.

There are several different ways to do HIIT! Different ratios of exercise and rest

- 1:1 ration = 3 minutes exercise : 3 minutes rest
- Sprint Interval Training– maximal effort 30 seconds : 4-5 minutes rest
- Boyne Study—Max walking speed for 30 sec: 30-60 sec rest (passive)

PRACTICAL RECOMMENDATIONS FOR HIIT TRAINING

ACSM Guidelines for High-Intensity Interval Training:

https://www.acsm.org/docs/brochures/high-intensity-interval-training.pdf

This presentation can be found at traumaticbraininjury.net Look under "Resources" and then "Community Presentations"

REFERENCES

- Schweickert, W. D., Pohlman, M. C., Pohlman, A. S., Nigos, C., Pawlik, A. J., Esbook, C. L., et al. (2009). Early physical and occupational therapy in mechanically ventilated, critically ill patients: A randomized controlled trial. Lancet, 373, 1874–1882.
- Klein, K. et al. Clinical and psychological effects of early mobilization in patients treated in a neurological ICU. A comparative study. *Critical Care Medicine*. 2015;43(4):865-73.
- Krewer, C, et al: Tilt table therapies for patients with severe disorders of consciousness: a randomized, controlled trial. PLoS. 2015;10(12).
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- Mossberg KA1, Aerobic capacity after traumatic brain injury: comparison with a nondisabled cohort. *Arch Phys Med Rehabil.* 2007 Mar;88(3):315-20.
- Mossberg KA, Orlander EE, Norcross JL. Cardiorespiratory capacity after weight-supported treadmill training in patients with traumatic brain injury. *Physical Therapy*. 2008;88(1):77-87.
- Weinstein AA[1] . Effect of Aerobic Exercise Training on Mood in People With Traumatic Brain Injury: A Pilot Study. *J Head Trauma Rehabil.* 2017 May/Jun;32(3):E49-E56.
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- ACSM Guidelines for High-Intensity Interval Training: https://www.acsm.org/docs/brochures/high-intensity-interval-training.pdf
- Odde M, et al. Optimizing sedation in patients with acute brain injury. 2016;20:128-138.