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Decreasing Fall Risk with Aquatic Therapeutic Interventions

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Learning Outcomes

- List at least three factors that influence movement naming at least five subsystems that contribute to normal postural control.
- Describe at least three ways to determine a patient's fall risk utilizing reliable and valid balance tests that can be completed without computerized equipment.
- Outline at least two effective and specific aquatic exercise and treatment strategies to address the deficits found during testing.

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Learner Outcomes continued…

- List at least three benefits and three challenges that the aquatic environment presents when working with individuals with impaired balance, proprioception, and postural control.
- Describe at least three ways to safely incorporate land-based home exercise to improve outcomes within the patient's treatment plan.

CONTINUED

What do we mean by balance and mobility?

Get up → Stay up → Don't fall

Functionally speaking

Balance and Function

Balance – ability to maintain equilibrium; ability to maintain center of body mass over base of support

Static – ability to maintain posture during non-movement activities

Dynamic – ability to maintain body mass over base of support while the body is in motion

CONTINUED

Goal the Postural System

Stability
Control of COM relative to BOS

Orientation
To maintain the appropriate position of the entire body with respect to the environment and the task

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3 Factors that Influence Movement

- Individual
- Environment
- Task






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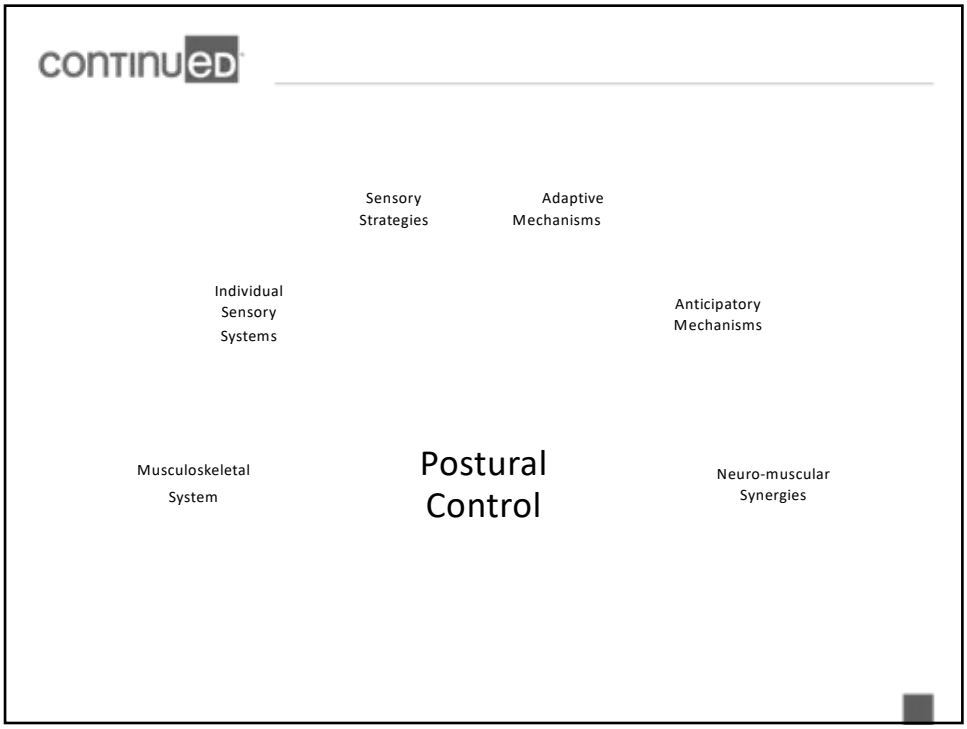
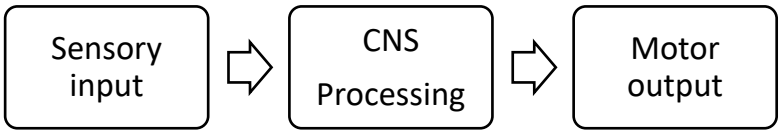


Postural Stability Requirements

- Able to determine movement of COG
- Balance responses triggered by availability and accuracy of the sensory inputs
- CNS weighs input from 3 primary sources



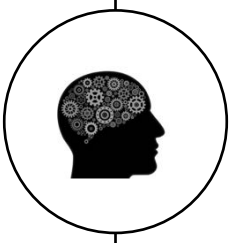
What are the 3 main sensory systems involved in balance?

Vision
Somatosensory
Vestibular

Cognition and Perception

Fear of falling leads to decreased activity, reduced mobility and fitness, in turn increasing risk for falls

Cognition does play a role in processing sensory information.



Somatosensory Inputs

Somatosensory System

- Mechanoreceptors provide body awareness
  - Pacinian Corpuscle
  - Ruffini Endings
  - Golgi-Mazzoni Corpuscle
  - Golgi Ligament Ending
  - Golgi Tendon Organ
  - Muscle spindle
  - Merkel receptors
  - Meissner corpuscles
- Neck proprioceptors connect head with body position to provide spatial orientation

What types of patients/ diagnoses present with somatosensory impairments?

Aquatic Environment Influence on Somatosensory Input

- Aquatic environment with hydrostatic pressure and drag forces add additional proprioceptive feedback not available on land. Drag forces available in all directions
- Reduced WB from the force of buoyancy reduces certain feedback.

What aquatic techniques stimulate the proprioceptors?

Immersion
Movement
Change in direction
Change in speed
Vary range of motion
Stretching into end range
Multiple plane movement
Manual pressure

Focal and Ambient Vision

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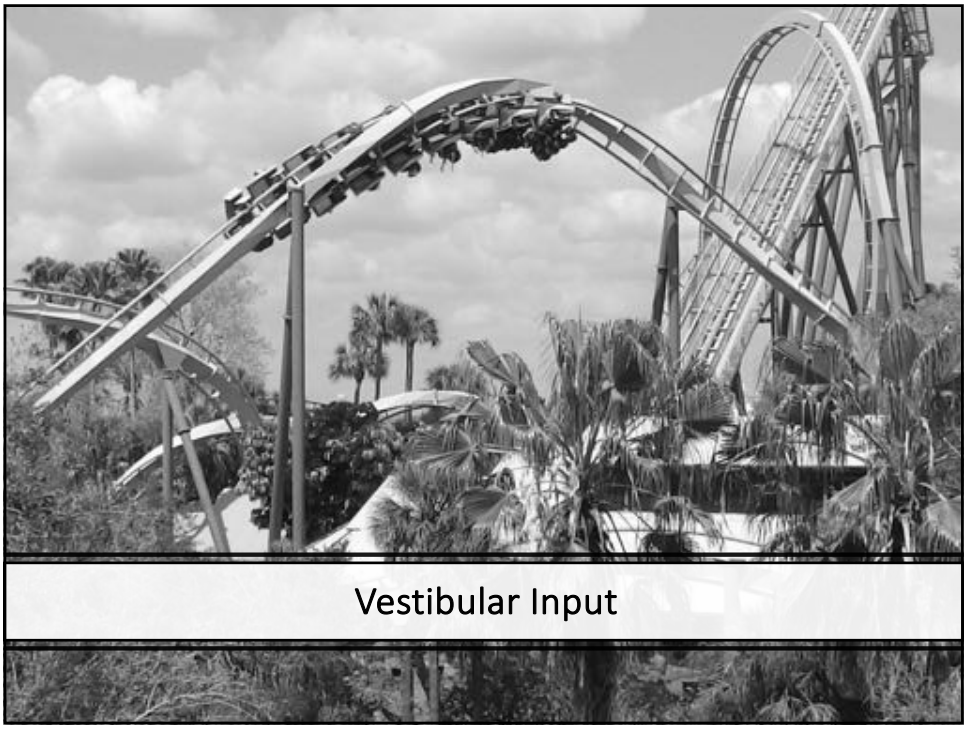
At what level of distance visual acuity will vision begin to have significant effect on a person's postural stability?

20/50

CONTINUED

How does the aquatic environment influence visual input?



Vestibular Input

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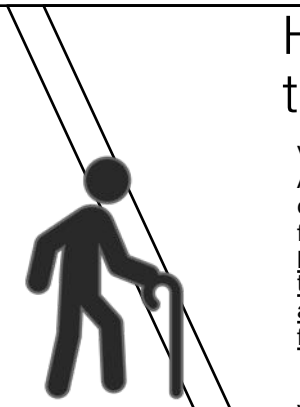

How does aging affect the Vestibular System?

Vestibular dysfunction occurs in 35.4% of Americans aged 40 years and older and contributes to the high number and frequency of falls in the elderly population http://www.annalsoflongtermcare.com/article/vestibular-disorders-aging-population-practical-applications-long-term-care-facilities#sthash.IXb92m7L.dpuf

Vestibular system also shows a reduction in function with a loss of 40% of the vestibular hair and nerve cells by age 70 (degeneration begins at about age 55)

Blood flow to inner ear is reduced with aging. www.Vestibular.org/aging

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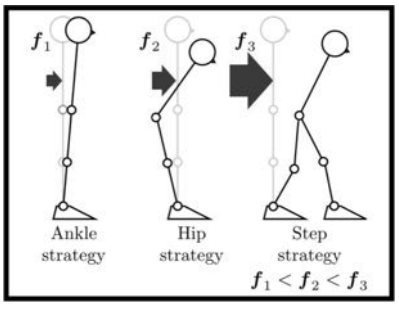
What concerns or modifications are needed for individuals with vestibular dysfunction?

Movement Strategies for controlling upright sway



Balance recovery reactions

Ankle

Hip

Stepping

Medial-Lateral Balance Strategies

- In parallel stance there is a hip load/ unload by the hip abductors and adductors.
- In gait hip abductors play a critical importance along with ankle invertors and evertors in medial lateral stability
- Tandem stance ankle invertors/ evertors play a larger role whereas the hip controls A-P motion

Based on normal medial-lateral balance strategies, what might you determine if your patient has difficulty with getting into tandem stance but once there able to maintain?

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Musculoskeletal Components

What muscles need to be strong for balance?

Ankle plantar-flexor strength and eversion ROM decrease with aging and are significantly correlated with balance stability (Bok et. al 2013)

Knee extensor strength correlates to balance and functional abilities.

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Kitchen Sink Exercises (Shumway-Cook)

Standing at kitchen sink, looking out the window, stand straight

- Toes up/ heels up
- Side kicks/ back kicks
- ¼ squats
- Knee to counter

Balance and Core Connection

CONTINUED

- Significant interaction occurred, with core strength training group (elerly males age 50-70) showing faster times with TUG test and increase in functional reach test after 6 weeks of core strengthening exercises. (Majida et al. 2015)
- 13 subjects (age 73.1±7.3) participated in a 20 minute exercise program to strengthen abdominals and back extensors 3 times per week for one month. Resulting in an increase in forward, right and left reach distance improving limits of stability along with reduced tremor during reach. (Petrofsky et al. 2005)
- A systematic review found small to medium correlations between trunk muscular strength/ trunk muscle composition and balance, functional performance, and falls in older adults. Further, core strength training (CST) and/ or pilates exercise training (PET) proved to be feasible exercise programs for seniors with high-adherence rates. (CTS mean strength gain =30%, mean balance/functional performance gain =23% and PET mean strength gain 12%, mean balance/functional performance gain 18%) (Granacher et al. 2013)
- Trunk extensor strength accounted for the greatest amount of variance in the Berg balance Scale and unipedal stance test in community dwelling older adults (N=70, mean age 75.9) (Suri et al. 2009)

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Proactive = anticipation
Reactive = trips and slips

Adaptive Postural Control

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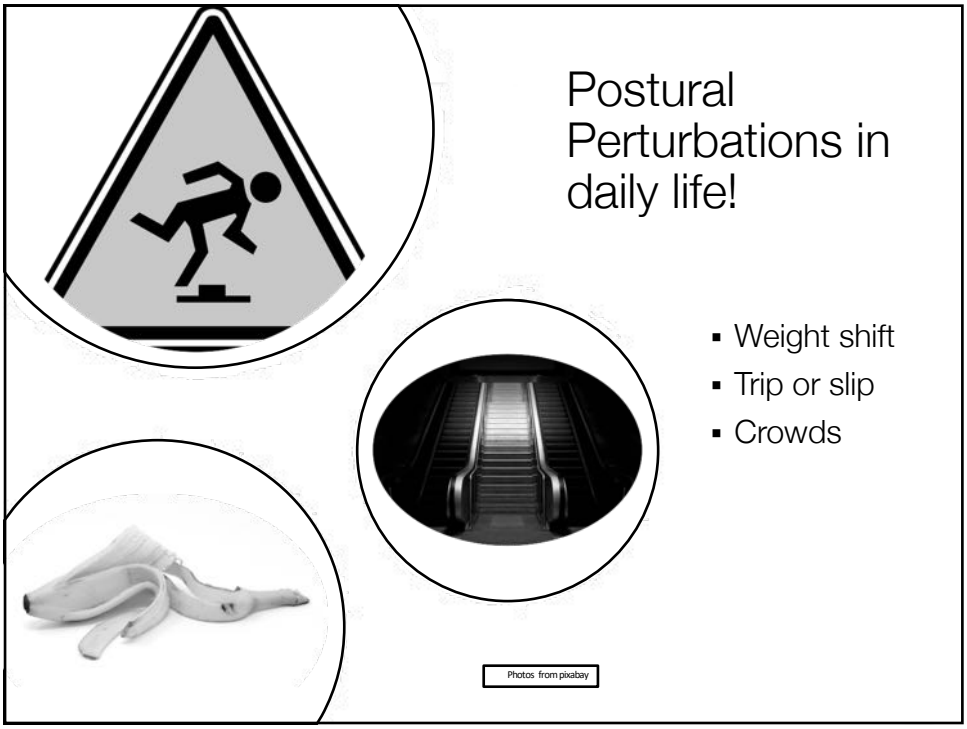

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Perturbation-Based Balance Training

- Perturbation-based balance training= balance training intervention that incorporates exposure to repeated postural perturbations to evoke rapid balance reactions with the goal of the individual improving control of these reactions with practice.
- Mansfield et al. (2015) Systematic Review and Meta-Analysis of RCT concluded perturbation-based balance training appears to reduce fall risk among older adults and individuals with Parkinson disease.

Anticipatory Postural Control

Fall Risk

- Medicare Population Fall Estimates 3.7-3.1 million in 2002 with 2.2 million medically injurious (Shumway-Cook 2009)
- 40% or more of stroke survivors will have a serious fall with in one year post-stroke! National Stoke Association 2011
- Falls in neurological in-patients are twice as frequent as in an age-matched population living in the community. Falls in neurological patients are particularly linked to medication and disorders affecting gait and balance.

Stolze H, et al. (2004) Falls in frequent neurological diseases--prevalence, risk factors and etiology. *Journal of Neurology.* 251(1):79-84.

Falls are not an inevitable part of aging

CONTINUED

Why Do Older Adults Fall?

Intrinsic (Internal) Risk Factors Cause 55% of Falls

Extrinsic (External) Risks Factors Cause 40% of Falls

Intrinsic (Internal) Risk Factors

- Age
- History of Falls
- Damage to Sensory Systems
- Poor Gait and Balance
- Medical Conditions
- Musculoskeletal Problems
- Increased Reaction and Movement Times
- Increased Postural Sway
- Urinary Incontinence
- Changes in Cognition

Extrinsic (External) Risk Factors

- Home Environment
- Social Setting (living alone)
- Medication (Especially Psychotropic Drugs)
- Shoe Style and Fit
- Surface Conditions
- Visual Conditions
- Busy Environments/External Demands
- Activity Level
- Assistive Devices

Evaluate and Measure….

1. Provide baseline, objective measures to demonstrate need and progress
2. Assist in documenting fall risk/ medical necessity
3. Document function
4. Guide treatment planning developing goals and establishing prognosis.

Individual/ single Balance tests

- Romberg/ sharpened Romberg
- 4 stage balance test (STEADI)
- Sit to stand/ Chair raise test
- Heel rise
- Step test
- 4 square step test
- TUG/ Dual task TUG
- SLS
- Functional reach test

CONTINUED

Sit to stand/ Chair raise test

- # of times a person with arms across their chest can sit to stand in 30 seconds
  - 13+ = low fall risk, 9-12 = moderate fall risk, 8 or less = high risk
  - 95% of average healthy males age 60-64 perform 23 reps, and females 21 reps
- 5 rep chair raise variation = time it takes to sit to stand 5 times and compare to norms
  - For the 5 times sit to stand version when looking at all ages the mean was 7.6 seconds (ranging from 4-16 seconds).

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TUG/ Dual task TUG

Timed Up and Go (Podsiadlo & Richardson, 1991) focuses on functional mobility

- Fall risk >13.5 seconds (3 meters/ 9.8 feet)
- < 10 seconds = independent
- 20-29 sec = normal for frail or disabled
- >30 sec dependent in mobility and ADL

Timed Up and Go Cognitive or Dual Task TUG

- Individuals were asked to complete the test while counting backward by threes from a randomly selected number between 20 and 100.
- Elderly subjects who completed the TUG (Cognitive) in > 15 seconds were classified as fallers with an overall correct prediction rate of 87%.

CONTINUED

Functional Reach Test

Interpretation

- Normal 15 inches
- < 10 inches: increased risk of fall
- 5 inches: x 5 increased risk of fall
- For every inch less than 10 x 1 increased risk of fall

Multi-task balance tests

- Berg Balance Scale
- Tinetti Performance Oriented Mobility Assessment
- Dynamic Gait Index
- CTSIB/ m-CTSIB
- BESS test
- BESTest (Balance Evaluation Systems Test)

Fatigue and balance testing…

Self Reported Scales

- Activities- Specific Balance Confidence
  - ABC "indicate the level of confidence in doing an activity without losing your balance or becoming unsteady.
    - <50 = low level of physical functioning
    - > 50-<80 = moderate level of function >80 = high function
- Modified Falls Efficacy Scale
  - how confident are you are doing the activity without falling, score < 8 = fear of falling

Beyond special tests

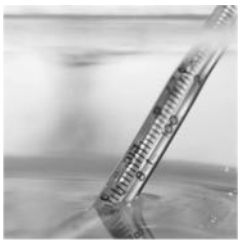
Clinical observation:

- Stability
- Use of UE (sculling with hands, wall or noodle for support)
- Amount of postural sway
- # time loss of balance
- Amount of assist to recover loss of balance

Compared performance on land to water activity

- independent vs. assist
- willingness to perform

Why Chose Water ?




Aquatic Environment: Benefits

Warmth of water reduces pain/ tone increasing mobility

Buoyancy: allows enhancement for functional ability/ therapist can safely reduce the amount of physical support provided, the patient can become more independent in movement problem solving **Safely challenge LOS**

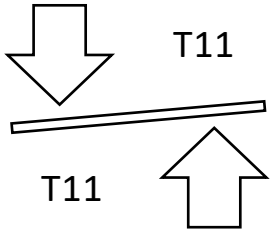
Hydrostatic pressure: proprioceptive input

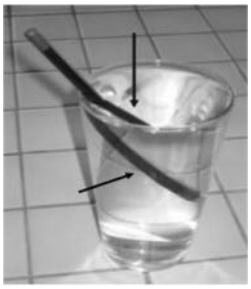
Drag force:

- Proprioceptive input and strengthening
- Slows movement down allows time for balance recovery

Turbulence: perturbations to challenge balance

Aquatic Environment Challenges & Considerations





Buoyancy

- Reduced mechanoreceptor/ weight bearing input
- T11 change from gravity dominant to buoyant dominant
- Difficultly maintaining balance/ trunk control can lead to increased tone and associated reactions

Refraction/ Reflection

- Altered visual input due to refraction challenging vestibular system.
- Glare changes visual input

Temperature

- Too cold can increase tone and spasticity

Turbulence

- With high activity pools can be too great for patient to control

Effect of Aquatic Immersion on Static Balance (Louder et al. 2014)

- Static standing, limits of stability and perceived stability measured in young healthy adults
- Static sway and center of pressure velocity increased with depth compared to land (155%/ 74% at greater trochanter and 317%/ 209% at xiphoid respectively) Vision (eyes open/ eyes closed did not alter results in this group)
- Self reported less stable in deeper water
- Limits of stability compared to land excursions increased in all direction 9-13% at greater trochanter and 7-12% at xiphoid

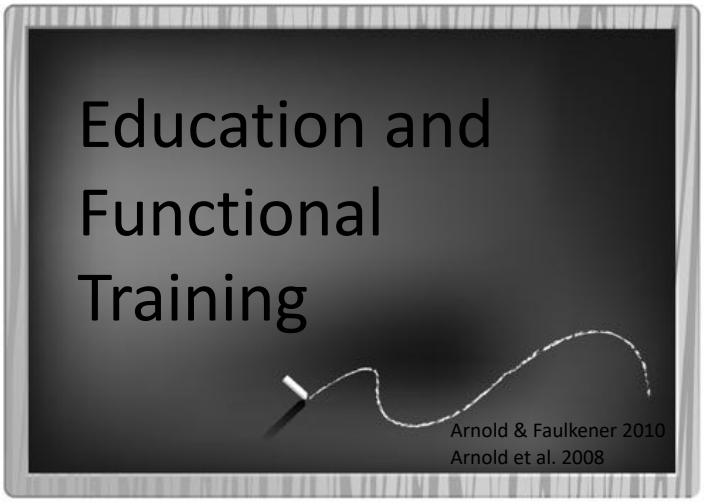
CONTINUED

Research= Aquatic Therapeutic Exercise Improves Balance

Aquatic Research Summary

- Often done in group setting
- Land ex often same as water
- 2-3 x/ wk, 40-60 minute sessions, ranged from 4 weeks to 20 weeks
- High compliance and perceived outcomes with water exercise
- Land and water programs had similar results
- Education and functional practice important

Education and Functional Training



Frequency matters…

If you don't use it you lose it!

Balance = motor skill

- Must challenge limits of stability both statically and dynamically.
- Use variety of progressive activities targeting postural muscle groups
- Balance can improve at any age given the duration, frequency and intensity is sufficient to overload.

Challenge Balance

- Wide to narrow BOS
- Double leg to single
- Stable to unstable surface
- Eyes open to eyes closed
- Movement in multiple planes
- Work in multiple postures & functional activities
- Add head turns
- Anticipatory tasks (throw a ball)
- Reactive tasks (perturbations)
- Dual task
  - Add Mental task
  - More than one physical task

Vary stance….

Dual Task Challenge: Physical

- Ball toss/ throw
- Hold or carry items (harder if they have to balance the item such as glass of water)
- Tie and untie towel in a knot
- VOR drills (use post it notes or other objects for focus)
- UE activity or opposite LE movements (SLS)

Cognitive dual task ideas

- Name things/ words: for example types of flowers, breeds of dogs, flavors of ice cream, men's names, states etc.
- Random digit generation: ask patient to randomly state a number through a given range such as 0-300.
- Counting backwards: by twos, threes etc.
- Imagine and verbally give road directions, for example: from home to post office
- Recite backwards: numbers, days, months etc.
- Alphabet math: add or subtract a number to a letter for example k-1=j

CONTINUED

Effect of Water Immersion on Dual-task Performance: Implications for Aquatic Therapy

Conclusion

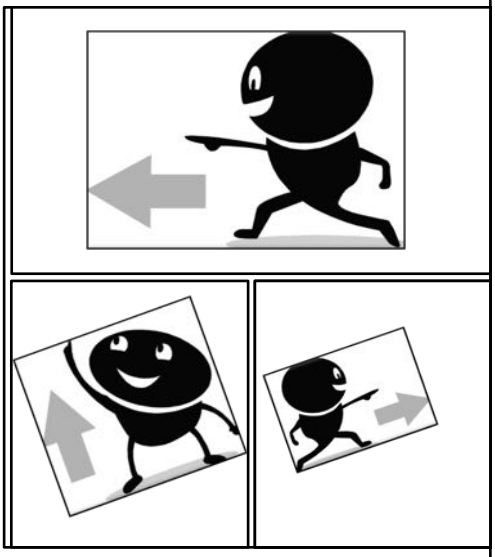
- Participants tended to make fewer 'cognitive' errors while immersed chest-deep in water than on land. These same participants also tended to display less postural sway under dual-task conditions, but more in water than on land.
  - Schaefer, S. Y., Louder, T. J., Foster, S., and Bressel, E. (2016)

Working on random stepping and weight shifting (important in decreasing fall risk)

Pool Techniques to Challenge Balance

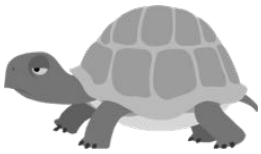
- Perturbations
  - Manual
  - Self turbulence
  - External turbulence
    - Push
    - Scoop
    - Therapist runs around
- Stop/ start quickly and hold
- Change direction
- Immerse above T11

Multiple Directions



You want me to walk backwards?

Vary the Speed



- SLOW
  - Learn and integrate the movement pattern
  - Note: very slow challenges stability
- MEDIUM
  - Develop flow
- FAST
  - Challenge systems

Slow motion

Stop start

Unpredictable Command Technique

- Developed by David Ogden
- Familiar and unfamiliar movements in random patterns to improve somatic awareness, voluntary movement, balance, coordination, agility and reaction time.
- Use multiple movements simultaneously
- Random sequence and non-conforming # reps.
- Progress with tubing and turbulence

Unpredictable Command Technique

Clinical purpose:

- Body awareness
- Fall prevention
- Control of motor skills
- Neurogenesis

"At its best, life is unpredictable"
Christopher Walken

Specificity

You get what you train: linking test findings to treatment interventions

BESTest (Balance Evaluation Systems Test)

- Aims to target 6 different balance control systems so that specific rehabilitation approaches can be designed.
  - Grades performance for:
    - Biomechanical constraints
    - Stability limits/ verticality
    - Anticipatory Postural Adjustments
    - Postural responses
    - Sensory orientation
    - Stability in gait

BESTest continued

- If a patient shows difficulty in on section do not limit therapy to practicing the specific tasks that were difficult for the patient but should aim therapy at the underlying system deficit
- Although each section is to help identify a system remember each test time may involve more than one system
- A single pathology can have interaction among systems

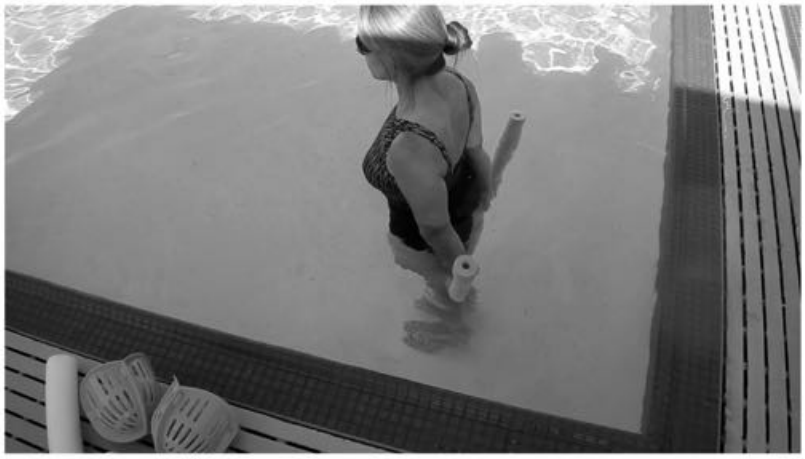
Recent study indicates all 3 versions of the BESTest are reliable and valid for patients post TKA.

Chan A, Pang M. (2015) Assessing balance function in patients with total knee arthroplasty. *Physical Therapy.* 95(10) 1397-1407.

Tested at 2, 12 and 24 weeks post operatively
Age 50-85
N=46

Biomechanical Restraints

- Lower extremity weakness
- Foot pain or deformities
- OA
- Poor postural alignment



Stability Limits/ Verticality

- Limited functional reach
- Instability with leaning
- Difficulty with returning to vertical with eyes closed
- Sensory deficits

Anticipatory Postural Adjustments

- Difficulty with postural transitions
  - Sit to stand
  - Heel raise
  - Single leg stance
  - Step test
  - Standing arm raise

Postural Responses

- Limited ankle, hip or stepping strategies
- Challenged with perturbations and in place responses

Sensory Orientation

- Vestibular impairments
- Sensory integration impairments
- Challenged with unstable or incline surfaces especially with eyes closed
- Increased body sway during stance

Stability in Gait

- Decreased speed
- Challenges with change of speed, head turns and pivot turns during gait.
- LOB or slowing with stepping over obstacles
- Slow speeds with TUG especially with dual task

Berg Balance Pool Progression

Berg balance test predicts fall risk on land & becomes balance training in the pool

- Sit unsupported
- Rise from a chair
- Transfer chair to chair
- Reach forward
- Pick up an object
- Look behind each shoulder
- Turn in full circle
- Alternate toe touches
- Maintain tandem stance
- Stand on one leg

Patient Education

- Assistive device
- Transfer techniques
- Home adaptations
- Awareness

* When a patient is high risk, fall prevention education should take priority.

CONTINUED

Transition to Land

- Safety
- Introduce land early (core and LE strength, use corner and other support for safety)
- Patient education on transfers and functional movements essential
- Incorporate into daily activities
- Don't forget sitting balance

CONTINUED

Thank You!

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