The dilemma of balance rehabilitation: prescribing the right dosage of difficulty for each patient’s program

Neurology Section: Balance and Falls SIG
Combined Sections Meeting, February 4-7, 2015, Indianapolis, IN
Your panel and presenters

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Timeline

- Course outline, content and objectives
  Beth Crowner - 5 min
- Unique attributes about balance measurement and treatment in neurological disorders
  Beth Crowner - 10 min
- Using balance measures to individualize treatment
  Mike Studer - 15 min
- Creating a dosage: challenging enough to improve balance in the clinical and home exercise
  Debbie Espy - 30 min
- Case studies x 3 (45 min total)
- Panel discussion and questions -15 min
Objectives

1) Accurately decide which balance measures to use for each person after screening
2) Apply a framework from which to build intervention on examination results
3) Dynamically adjust interventions to keep a “dosage” of balance intervention specific to each individual as they change
The dosage of balance: our dilemma

• Unique attributes about balance in neurologically impaired patients: WHO

• Using balance measures to develop a treatment plan: WHAT

• Creating a dosage for clinical and home use: HOW

• Case studies and applications: WHY
Unique attributes about balance measurement and treatment in neurological disorders
Postural Control: Influence of Internal Variables

• Peripheral sensory reception: somatosensory, visual, and vestibular
• Central sensory perception: brain’s ability to process environmentally available information (multi-sensory re-weighting)
• Central Motor Planning/Control
• Peripheral motor execution (ROM, strength, endurance)
• Other systems: attention, cognition, judgment
Postural Control: Influence of External Variables

• Must consider task demands and environmental context
  
  – Support surface
  – Visual conditions (optical flow/complexity, lighting)
  – Crowds/distractions: navigation, obstacles, cognitive demands, divided attention
Postural Control

- Musculo-skeletal Impairments
- Neuromuscular synergies
- Individual Sensory Systems
- Sensory Strategies
- Internal Representations
- Adaptive Mechanisms
- Anticipatory Mechanisms
Common Deficits Seen in Patients With Neuromuscular Conditions

• Posture/alignment
• Reduced limits of stability
• Inadequate muscle activation or altered sequencing of recruitment
• Muscle co-contraction
• Delayed/absent anticipatory postural adjustments or postural responses
• Impaired sensory organization or perception
• Deficits in cognition
Factors Unique to Patients with Neurologic Conditions Affecting Measurement Selection/Interpretation
Factors to Consider In Neurologic Pop.

• Heterogeneity between and among conditions
  – Cannot use a cookie cutter approach
• “Static” conditions
  – ? Will the examination occur during a window in which you would expect motor/functional recovery
    • How much recovery do you expect?
• Degenerative conditions
  – Rate of progression ?
  – Need to re-assess or have “check-ups” on a routine basis (Duncan RP, 2012)
Factors to Consider In Neurologic Pop. (con’t)

- Patients with neurologic conditions have other systems affected
  - Spasticity or dystonia: loss of ROM or poor lower limb positioning affecting performance (musculoskeletal)
  - CVA-disease of the cardiovascular system; may have concomitant co-morbidities (eg. DM: sensory loss)
  - PD-autonomic deficits; orthostasis
The Human Movement System
Additional Factors to Consider In Neurologic Pop. (con’t)

• Impact on treatment/intervention chosen:
  – Does the patient need restorative vs. compensation based treatment approach?
  – Treatment strategies will need to be tailored
An Adequate Measure Must Be Chosen In Order to Effectively Guide Treatment
Considerations for Measure Selection

• Practice setting/time constraints
• Equipment
• Patient’s initial level of performance/ability and prognosis
  – Floor/ceiling effects
• The past medical or subjective history (chief complaints)
• Results of other examination items (do your examination of impairments first!)
Current Measures of Postural Control

• Many tests are designed to capture a single balance system

• Depending on the measure chosen, key deficits affecting static or dynamic stability are often overlooked
How well do measures capture the many variables affecting postural control?
Types of Performance Based Balance Tests

- Quiet standing
- Active standing
- Sensory manipulation
- Vestibular
- Functional/combination test batteries
Dimensions/Factors

6 Balance Systems-Full BESTest

• Biomechanical constraints
• Stability limits/verticality
• Anticipatory postural adjustments
• Postural responses
• Sensory orientation
• Stability in gait

Horak FB et al, 2009
4 Systems Represented-Mini BESTest

- Anticipatory postural adjustments
- Postural responses
- Sensory orientation
- Stability in gait

- Biomechanical constraints and stability limits were found to have less influence on dynamic balance

Franchignoni F et al, 2010
Ideal Measurement Selection

• Match patient’s current/projected status
• Contains items that assess the impact of identified impairments
• Contain items that assess static and dynamic components of movement
• Assess a patient’s ability to adapt to the environment (eg. sensory and cognitive demands)
Using balance measures to individualize treatment
Using balance measures to individualize treatment

“We cannot treat what we cannot see…”

Dissecting the attributes of postural control systems that are impaired, is essential to proper treatment.
Using balance measures to individualize treatment

Attributes of balance:

• Limits of stability/verticality
• Biomechanical constraints
• Stability in Gait
• Sensory orientation
• Anticipatory postural adjustments
• Postural responses
Using balance measures to individualize treatment

Diagnosis
History of falls
Performance on testing
Using balance measures to individualize treatment

Diagnosis

Systems and impairments identified on exam
Using balance measures to individualize treatment

History of falls

Environmental and task-specific approach in an effort to replicate and prevent future falls
Using balance measures to individualize treatment

Performance on testing: Sensory

- Sensory orientation
- Anticipatory postural adjustments
- Postural responses
Using balance measures to individualize treatment

Performance on testing: Biomechanical

Resource-driven: strength, flexibility
Using balance measures to individualize treatment

Performance on testing: Motor control

• Limits of stability/verticality

• Stability in Gait
Using balance measures to individualize treatment

Performance on testing: Confidence

ABC

Falls efficacy
Creating a dosage

• Intensity in balance treatment “equation”

• Specific to dx, fall history, testing

• Specific to fear of falling

• Psychological tolerance of intensity, errors, loss(es) of balance in practice

• Home exercise: safety, caregivers, etc.
What is...dosage?

- Frequency of treatment
- Repetitions
- Intensity
  - Frequency of errors (losses of balance)
  - Risk of injury
- Task: motor, distraction, environment
Creating a dosage: challenging enough to improve balance in the clinic and for home exercise

Dosage

For all types of exercise: Dosage = FITT
  Frequency, Intensity, Time, Type
Dosage: Type

Type – covered here already......

Goals/need –
  adequate postural control for activities, gait
  fall prevention/response to perturbations
Based on results of examinations and assessment
  specific components of balance to address
  specific tasks and conditions
Underlying impairments addressed separately or as part of balance training
Dosage: Type

Will have determined the goal tasks/activities, “what” the client needs to be able to do

SAID: Specific Adaptation to Imposed Demands
Improvement in the “what” you are training indicates a need to increase the difficulty of the task until the client can manage the goal task

Theoretical hierarchies of balance task difficulty to progress program
static $\rightarrow$ dynamic
slower $\rightarrow$ faster
larger $\rightarrow$ smaller BOS

proactive $\rightarrow$ reactive
smaller $\rightarrow$ larger reach or motion
add dual task

and more
Dosage: Frequency

Often used as proxy for exercise intensity (e.g., Maughan et al, 2012)

Evidence that 3x/week is needed for effectiveness

Limited by, among others:
- ability to attend therapy that often
- ability of providers to provide therapy that often
- performance of home program that often
- tolerance, fatigue, boredom/engagement…….
Dosage: Time

Also often used as proxy for exercise intensity, “time on task”

Balance training is a motor learning (re-learning) task
Repetitions necessary for motor learning = hundreds to thousands for people post stroke

Also limited by, among others:
ability to attend therapy for such long sessions
ability of providers to conduct such long sessions
performance of home program for prolonged time
tolerance, fatigue, boredom/engagement......
Dosage: Intensity

In other exercise modes (e.g., strengthening, aerobic conditioning, stretching), initial load and modifications to the load (harder/easier) are determined by the person’s ability to manage the load:
- % one rep max then increase when not fatigued after sets
- run at a given speed within a given heart rate, %VO2 max, RPE → increase speed or incline to stay at that level
- Pain with movement/stretch to a certain ROM

There is no good measure of intensity in balance exercise, instead people use (Baker et al 2007, Haas et al 2012, Farlie et al 2013):
- Time on task or number of reps (Time)
- Times per week (Frequency)
- Hierarchies of theoretical difficulty level (Type)
Dosage: Intensity

“In determining optimum level of challenge of balance exercises, recommendations commonly relate to the difficulty of the balance task, rather than to the intensity of the activity relative to the ability of the individual....” from a systematic review of randomized trials of balance training exercises (Farlie et al 2013)

20 kg is heavier than 10 kg and 6 minute miles are faster than 9 minute miles........

........but 20 kg and 6 minute miles may or may not be the appropriate intensity for a specific individual
Indicators to increase or decrease difficulty of exercise tasks:

- Ability to perform task correctly/number of errors
- Ability to perform # of reps required.....
- ......within the time required/appropriate speed of movements
- Pain, anxiety, fear
- Client feels the task is too easy

May also be indicators to increase or decrease the repetitions or frequency instead modifying the particular task

Dosage: Indicators
Home vs. Supervised

Home program vs. in clinic or with therapist—
supervision possible – monitor safety, vital signs, etc
correct/guide for correct performance – i.e., can do more
challenging tasks
assist as needed – safety, avoid falls or injury, and to allow more
difficult activities to be practiced
structure and progress tasks optimally
client’s ability to understand

Can’t necessarily, feasibly accomplish the number of repetitions
necessary for motor learning in just clinic visits
Context of home – environment in which they will need the skills after all
Stroke – sensory, perceptual, learning, motor considerations, potential advantages of aerobic level exercise as well

Parkinson’s Disease – altered motor and procedural learning, blocked practice/more reps

Guilliane Barre, Post-Polio, Chronic Fatigue, ALS – risk of fatigue and risk of overworking motor units/muscles

Others.........
Other Systems Involved

Balance training tasks may pose challenges also to other body systems; balance program dosage (reps, frequency, intensity) may be limited by one or more of these rather than balance difficulty:

Cardiovascular
Cardiopulmonary
Muscular overwork, fatigue
Skeletal system/osteoporosis
Cognitive fatigue, ability to maintain attention
Assessment of Client Responses to Activities

Immediate/online – with the client during and just after the activities
understanding of task
ability to complete correctly, safely
pain, discomfort, fear, anxiety

Delayed –
how they felt later – after the supervised program
feedback about how the home exercises went
Adjust Accordingly

Increase/decrease reps,
Increase/decrease frequency,
Increase/decrease difficulty of (similar) tasks
Move to “harder” or “easier” class of tasks
Case study in Balance: Parkinson’s Disease

Catherine Printz, PT, DPT, NCS
University of California San Diego
Patient profile
Video
Case study in Balance: Concussion

Susan Linder, PT, DPT, NCS
Cleveland Clinic
Patient profile
Video
Case study in Balance: Stroke

Mike Studer, PT, MHS, NCS, CEEAA, CWT, CSST
Northwest Rehabilitation Associates
Patient profile
Panel discussion