Don’t Just Sit There: Evidence-Based Sitting Balance Examination & Intervention

Combined Sections Meeting 2015
February 4-7, 2015

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Disclosure Statement

• Dr. Gorman is the creator of the FIST. She has no conflict of interest to report.

• Ms. Harro is an interprofessional team member for development and testing of the PocketPT. She has no conflict of interest to report.

• Dr. Platko has no conflict of interest to report.
Session Objectives

At the completion of this course, you will be able to:

1. Apply theoretical models of postural control and function in sitting to patient cases.
2. Select from reliable and valid measures of sitting balance at both the impairment and activity level of the International Classification of Functioning, Disability, and Health model.
3. Utilize results from sitting balance measures to develop intervention strategies specific to postural control problems in sitting.
4. Using current evidence, relate sitting balance dysfunction to patient prognosis in select patient populations.

Who’s here today?
Balance Models Applied to Sitting

Key Constructs of Balance Control

- Midline Stability
- Limits of Stability
- Proactive Postural Strategies
- Feedforward Control
- Automatic Postural Adjustments
- Feedback Control
“...many scientists believe that concepts important for stance postural control will be shown to be equally valid for postural control in sitting.”

(Shumway-Cook, 2011, p 192)

Reality can be so complex that equally valid observations from differing perspectives can appear to be contradictory.

Comparison to Standing Balance

<table>
<thead>
<tr>
<th>CONSTRUCT</th>
<th>STANDING</th>
<th>SITTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postural control</td>
<td>Static, proactive, reactive</td>
<td>Static, proactive, reactive</td>
</tr>
<tr>
<td>Stable trunk for limb motion</td>
<td>To allow for gait</td>
<td>To allow for standing &amp; gait</td>
</tr>
<tr>
<td>Direction of control</td>
<td>Anterior/posterior</td>
<td>Lateral &amp; anterior/posterior</td>
</tr>
<tr>
<td>Base of support</td>
<td>Feet</td>
<td>Feet, thighs, buttocks</td>
</tr>
<tr>
<td>Somatosensory input</td>
<td>Feet</td>
<td>Feet, thighs, buttocks</td>
</tr>
<tr>
<td>LE contribution</td>
<td>Multiple degrees of freedom</td>
<td>Less degrees of freedom</td>
</tr>
</tbody>
</table>
Postural Control Deficits in Sitting
Common Neurologic Impairments

- Abnormal postural alignment for stable BOS
- Impaired perception of midline & orientation in space
- Poor postural stability, dynamic stabilization
- Reduced & delayed anticipatory strategies
- Slowed & limited range of voluntary weight-shifts, poor LOS control
- Poor limb control without stable trunk posture
- Delayed or absent automatic postural reactions

Clinical Populations w/Sitting Balance Impairment
Acute Stroke
Early Sitting Balance Recovery

Patient with TBI:
Impaired Sitting Balance
Aging with TBI
Decline in Sitting Stability

Sitting Balance & Function

- Sitting balance at admission predicted both BBS & FIM (Feld 2001, Katz-Leurer 2008, Gorman 2014)
- Trunk Impairment Scale & PASS predicted FIM scores (DiMonaco 2010)
- FIM score improvement predicted by sitting balance s/p CVA (Carod-Artal 2007)
- Sitting balance predictive of depressive s/s & ADL outcomes s/p CVA (Hama 2007)
- Poor prognosis for independence for persons with limited sitting balance after acute CVA (Tyson 2007)
- Dual task challenges disrupted sitting balance after acute CVA (Harley 2006)
Sitting Balance & Locomotor Outcomes

• Mobility Outcomes
  – Mobility at 1 yr s/p CVA predicted in part by sitting balance (van de Port 2006)

• Walking
  – Balance (sit & stand) strongest predictor of recovery of walking (Tyson 2007)
  – Sitting balance at 2 wk s/p CVA predicted walking ability at 6 mo (Feigin 1996)
  – s/p CVA TIS score was highly related to walking ability (Verheyden 2006)

Sitting Balance & Discharge Disposition

• Trunk Impairment Scale & PASS predicted DC destination (DiMonaco 2010)
• Sitting balance 1 of 4 predictors of DC to home s/p CVA (Frank 2010)
• Sitting balance 1 of 5 predictors of DC to home s/p CVA (Meijer 2005)
• Function In Sitting Test at admission predicted home DC from IPR (Gorman in press)
Sitting Balance & TBI Prognosis

- **Functional Independence**
  - Recovery of sitting balance predictive of functional recovery up to 5 years after BI (Black 2000)
  - Dynamic sitting balance deficits related to functional limitations 1 yr s/p TBI (Duong 2004)

- **Productive activity** (Brown 2005)
  - Sitting balance predicted recovery 1 yr s/p BI

- **TBI severity** (Greenwald 2001)
  - Single global sitting balance rating at IPR admission associated with
    - Initial GCS
    - Acute care LOS & medical complications
    - Length of PTA

Sitting Balance & SCI

- **Complexity of the functional task matters**
  - MAS sit balance items + Sitting Balance Score had good reliability but little to mod validity compared to FIM (Jorgensen 2011)
  - Functional reach in sitting correlated with dressing (LB>UB) but not transfers or w/c propulsion (Jaskirat 2008)

- **Functional balance ≠ normal balance**
  - Paraplegia showed decreased static sitting & LOS compared to normal controls (Serra-Año 2013)
  - Sitting & standing balance not highly correlated (Forrest 2012)

- **Sitting balance tasks can differentiate high (C6-T7) vs. low (T8-L2) level of SCI & acute vs. chronic SCI**
  (Boswell-Ruys 2009)
Sitting Balance & Fall Risk

- Medio-lateral sway & rate of rise (sit to stand) related to falls
  - CVA w/fall ↑ med-lat sway & ↓ rate of rise compared to CVA w/o fall & controls (Cheng 1998)
  - Fear of falling ↑ med-lat sway during sit-to-walk (Aberg 2010)

- Sitting down task associated with falls in LTC
  12% of all recorded falls (Robinovitch 2013)

Gap in the literature!
Clinical Examination: Sitting Balance

• Importance of sensitive outcome measures
  – Diagnose sitting balance deficits
    • Possibly fall risk
  – Provide baseline measure of sitting function
  – Serve as prognostic indicator for functional outcomes
  – Guide interventions to remediate balance deficits
  – Document recovery or decline in sitting function
  – Assess effectiveness of targeted interventions

Psychometric Properties of Measures

• Reliability
  – Inter- & Intra-rater reliability
  – Test / Re-test reliability
  – Minimal Detectable Change
• Validity
  – Content validity
  – Concurrent validity
  – Discriminative validity
  – Predictive validity
• Responsiveness
  – To recovery of function
  – To decline in function
  – Clinically meaningful change
• Sensitivity
  – To detect fall risk
  – To detect functionally relevant change
ICF Model

Health Condition (disorder/disease)

Body function & structure (Impairment) → Activities (Limitation) → Participation (Restriction)

Environmental Factors

Personal Factors

Clinical Examination
Sitting Balance Tests/Measures

Body Structure & Function (Impairment)
- Postural Alignment
- Trunk Impairment Scale
- Trunk Control Test
- Clinical Scale for Contraversive Pushing
- Multidirectional Functional Reach test

Activities
- Function in Sitting Test
- Sitting Balance Scale
- Ottawa Sitting Scale
Postural Stability & Alignment

- **ICF level: Body Structure/Function**
  - Anatomical alignment
- **Photographic records**
  - Frontal & Sagittal planes
- **Videographic records**
  - Stability & dynamic tasks
- **Objective measure**
  - Head alignment
  - Spinal alignment

Constraints on Photo/Video

- Photo release
- Method to attach to EHR
- Department vs. personal device
- Dealing with the original
- Infection control
- Know policies & procedures!
Trunk Impairment Scale

Verheyden 2007

• **ICF level: Body Structure/Function**
  – Trunk control impairments in sitting
• **TIS Examines**
  – Static sitting balance
  – Isolated trunk movements
    • Shortening & elongation of trunk
    • Rotation of upper trunk on fixed lower trunk
    • Rotation of lower trunk on fixed upper trunk
• **Key Limitation**
  – Does not evaluate functional tasks in sitting

Trunk Impairment Scale

<table>
<thead>
<tr>
<th>Item</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Static sitting balance</td>
<td></td>
</tr>
<tr>
<td>1. Keep sitting balance</td>
<td></td>
</tr>
<tr>
<td>2. Keep sitting balance with legs crossed</td>
<td></td>
</tr>
<tr>
<td>3. Keep sitting balance while crossing legs</td>
<td></td>
</tr>
<tr>
<td>Dynamic sitting balance</td>
<td></td>
</tr>
<tr>
<td>1. Touch seat with right elbow (task achieved or not)</td>
<td></td>
</tr>
<tr>
<td>2. Touch seat with right elbow (trunk movement)</td>
<td></td>
</tr>
<tr>
<td>3. Touch seat with right elbow (compensation strategies)</td>
<td></td>
</tr>
<tr>
<td>4. Touch seat with left elbow (task achieved or not)</td>
<td></td>
</tr>
<tr>
<td>5. Touch seat with left elbow (trunk movement)</td>
<td></td>
</tr>
<tr>
<td>6. Touch seat with left elbow (compensation strategies)</td>
<td></td>
</tr>
<tr>
<td>7. Lift right side of pelvis from seat (task achieved or not)</td>
<td></td>
</tr>
<tr>
<td>8. Lift right side of pelvis from seat (compensation strategies)</td>
<td></td>
</tr>
<tr>
<td>9. Lift left side of pelvis from seat (task achieved or not)</td>
<td></td>
</tr>
<tr>
<td>10. Lift left side of pelvis from seat (compensation strategies)</td>
<td></td>
</tr>
</tbody>
</table>

Coordination

1. Rotate shoulder girdle 6 times
2. Rotate shoulder girdle 6 times within 6 seconds
3. Rotate pelvic girdle 6 times
4. Rotate pelvic girdle 6 times within 6 seconds
Trunk Impairment Scale

• Excellent Reliability in subacute stroke
  – Inter-rater (ICC= .99)
  – Test / Re-test (ICC=.96)
• Excellent internal consistency
  – Cronbach alpha =.89
• Good concurrent validity with
  – Trunk Control Test (r= 0.83)
  – Barthel Index (r= 0.86)
  – PASS (r= 0.84)
• Lack of ceiling effect

Trunk Control Test
Collin 1990

• ICF level: Body Structure/Function
  – Trunk motor control impairments
• TCT Examines
  – Rolling (both sides)
  – Transfer supine to sitting
  – Static sitting (unsupported, w/out feet on floor)
• Key Limitation
  – Only 1 item specific to sitting balance
  – Does not evaluate functional tasks in sitting
Trunk Control Test

**ITEMS**
- Roll to weak side
- Roll to strong side
- Sitting up from lying down
- Balance in sitting position
  - On side of bed
  - Feet not on floor
  - Not using arms

**SCORING**
- 0 = Unable to do on own
- 12 = Able to do but only with non-muscular help (i.e., using arms to pull, using bed rail)
- 25 = Normal

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Trunk Control Test

Collin 1990

- Predictive Validity
  - TCT added to FIM at admission improved prediction of DC FIM more than admission FIM alone (RR .66 to .75)
- Quick, impairment-based test
- Test limitations
Pusher Syndrome: Diagnostic Criteria

a) Spontaneous Body Posture  
b) Abduction/Extension of Non-paretic Extremities  
c) Resistance to Passive Correction  


Clinical Scale for Contraversive Pushing  

Babyar 2009

- **ICF level: Body Structure/Function**  
  - Body posture under different conditions  

- **Contraversive Pushing Scale examines**  
  - Both in sitting & standing  
    - Spontaneous body posture  
    - Abduction & extension of non-paretic limbs  
    - Resistance to passive correction  
  - **Key Limitation**  
    - Does not evaluate PS during dynamic/functional activities
Clinical Scale for Contraversive Pushing

### Clinical Scale for Contraversive Pushing

<table>
<thead>
<tr>
<th></th>
<th>Sitting</th>
<th>Standing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous body posture</td>
<td>.75</td>
<td>1.0</td>
</tr>
<tr>
<td>Sum total (max=2)</td>
<td></td>
<td>1.75</td>
</tr>
<tr>
<td>Abduction and extension of non-paretic extremities</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Sum total (max=2)</td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td>Resistance to passive correction</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Sum total (max=2)</td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td><strong>5.75/6.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Sample Scoring Sheet from patient with Acute Stroke with Pusher Syndrome

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Clinical Scale for Contraversive Pushing

Babyar 2009

- **Test Psychometrics**
  - Excellent inter-rater reliability (ICC = .92)
  - Good concurrent validity with Barthel Index (r = .66)
  - Adequate sensitivity (64.7%) and specificity (100%) to detect PS based on diagnostic criteria

- **Stronger test psychometrics than**
  - Burke Lateropulsion Scale
  - Modified Scale for Contraversive Pushing
Multidirectional Functional Reach Test

**ICF level: Body Function/Structure**
- Weight shift with UE reach in multiple directions

**MDFR Test Examines**
- Can be adapted to sitting
- Ability to maintain balance while weight-shifting and reaching
  - All directions (anterior *, posterior, right, left)
- Key Limitation
  - Measures only a single construct
  - Clinically challenging for reliable test administration

Multidirectional Functional Reach Test

**Reliability in SCI**
- Test / Retest (ICC=.85-.94)

**Concurrent validity with**
- BBS (r=.48), but best in forward direction
- TUG (r=-.44)

**Prone to measurement errors**
**Not comprehensive for sitting function**
Clinical Examination
Sitting Balance Tests/Measures

Body Structure & Function (Impairment)
- Postural Alignment
- Trunk Impairment Scale
- Trunk Control Test
- Clinical Scale for Contraversive Pushing
- Multidirectional Functional Reach test

Activities
- Function in Sitting Test
- Sitting Balance Scale
- Ottawa Sitting Scale

Function In Sitting Test

• **ICF level: Activity**
  - Performance-based test of functional tasks
• **FIST Examines**
  - Static Sitting
    - Static, eyes closed, turn head, lift foot
  - Dynamic Sitting
    - Forward reach, lateral reach, item off floor, item from behind
  - Reactive Sitting
    - Nudges in anterior, lateral, posterior
• **Key Limitation**
  - Limited to sitting

Gorman 2010
### Function In Sitting Test

#### Function In Sitting Test (FIST) Results

<table>
<thead>
<tr>
<th>Task</th>
<th>Date</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior edge, sit on surface back &amp; knees flexed to 90°</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Anterior edge, sit on surface back &amp; knees flexed to 90°</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Posterior edge, between scapula &amp; ilium</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Posterior edge, between scapula &amp; ilium</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Sitting, shake yes, left and right</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Sitting, eye closed for 30 seconds</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Sitting, lift feet, dominant side, 10 feet, 1 inch obese</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Pick up object from behind, object at midline, hands broadest posterior</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Forward reach, use dominant arm, must maintain full motion</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Reverse reach, use dominant arm, lift opposite shoulder posterior</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Pick up object from floor, object between feet</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Posterior scooting, move backwards 2 inches</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Anterior scooting, move forward 2 inches</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Lateral scooting, move to dominant side 2 inches</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>TOTAL</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
<tr>
<td>Administered by:</td>
<td>01/2/15</td>
<td>05/15/15</td>
</tr>
</tbody>
</table>

#### Function In Sitting Test

- Prospective, multicenter study
  - 4 inpatient rehab centers across US
  - N=125 participants
  - Variety of dx (CVA & TBI most common)
- Relationship of FIST at admission & d/c
  - FIM (both motor & total)
  - BBS
- Responsiveness of FIST
- MCID of FIST

Gorman 2014
Function In Sitting Test  
Gorman 2010, 2013, 2014

- **Excellent Reliability**
  - Inter- & Intra- rater (ICC=.99)
  - Test / Re-test (ICC=.97)
- **Excellent internal consistency**
  - Cronbach alpha = .98
- **Excellent/good concurrent validity**
  - mRS (r=-.76)
  - BBS (r=.85)
  - FIM (r=.71)
- **Responsiveness**
  - ES = .83
  - SRM = 1.04
  - MCD = 5.5 points
  - MCID = 6.5 points
- **Predicative validity**
  - DC to home
- **No floor effect, but ceiling affect by DC in IPR**
- **Free online training**
  - www.samuelmerritt.edu/fist

Sitting Balance Scale  
Medley 2011

- **ICF level: Activity**
  - Ability to maintain sitting w/ and w/o displacements
- **Sitting Balance Scale Examines**
  - Static sitting balance (3 items)
  - Sitting balance w/trunk displacement (6 items)
  - Sitting balance w/UE displacement (2 items)
- **Key Limitations**
  - Unknown responsiveness or concurrent validity
Sitting Balance Scale

- Sit unsupported (60 s)
- Sit unsupported, eyes closed (30 s)
- Sit w/arms as levers (90° shld flex w/2lb cuff wt)
- Forward reach
- Pick up object from floor
- Alternate foot touch (3-3.5 inch ht)
- Lateral reach
- Turn to look over both shoulders
- Lateral bend to elbow
- Sit to stand
- Pick up object from floor

Scoring: ordinal scale (0-4) for each individual item

Sitting Balance Scale

Medley 2011, Thompson 2013

- Good to Excellent Reliability
  - Intra-rater (ICC=.96-.99)
  - Inter-rater (ICC=.87)
- Good Internal Consistency
  - Cronbach alpha = .76
- Moderate concurrent validity
  - TIS (r=.60 to .92, varied by setting)
  - Ambulatory status (r=.67)
- Equipment required & 2 items require bilateral LEs
- 1 study sample included persons w/o sitting balance dysfunction
Ottawa Sitting Scale

**ICF level: Activity**
- Movement within & outside BOS in sitting

**Ottawa Sitting Scale Examines**
- Static sitting
- Weight shifts of small & longer distance
- Lift hips
- Walk hips forward & back

**Key Limitations**
- Lack of validity studies

### Ottawa Sitting Scale

<table>
<thead>
<tr>
<th>Items</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain static sitting position</td>
<td>0-4 point ordinal scale</td>
</tr>
<tr>
<td>Moves short distance (12 cm)</td>
<td>Different scale for each item</td>
</tr>
<tr>
<td>Anterior, right, left</td>
<td></td>
</tr>
<tr>
<td>Moves longer distance (25 cm)</td>
<td></td>
</tr>
<tr>
<td>Anterior, right, left</td>
<td></td>
</tr>
<tr>
<td>Trunk rotation ability</td>
<td></td>
</tr>
<tr>
<td>Sitting on 1 hip</td>
<td></td>
</tr>
<tr>
<td>Walking on hips</td>
<td></td>
</tr>
<tr>
<td>Forward &amp; back</td>
<td></td>
</tr>
</tbody>
</table>

**6 items scored twice**
- Feet supported
- Feet unsupported
Ottawa Sitting Scale

- Excellent Reliability
  - Intra-rater (ICC=.99)
  - Inter-rater (ICC=.96-.98)
- Ceiling effect noted
  - Corresponded to BBS scores of ~10
- Lack of validity studies
  - Compared to BBS & PFMP, no analysis
- Lack of studies on responsiveness of test

Other Activity-level Measures (with limitations)

- Global Rating Scales (N, G, F, P)
  - Subjective
  - Poor operational definitions that vary
- Kansas Sitting Balance Scale (Kluding 2006)
  - Single study, limited research
  - Limited test psychometrics
- Berg Balance Scale (Berg 1995)
  - Single item “static sitting x 30 seconds”
Other Activity-level Measures
(with limitations)

- Motor Assessment Scale (Carr 1985)
  - Single item “balanced sitting”
- Postural Assessment Scale (PASS) (Benaim 1999)
  - Static sitting & supine ↔ sit transfers
- Stroke Impairment Assessment Set (Liu 2002)
  - Trunk subsection: 2 items (verticality & abd MMT)
- Brunel Balance Assessment (Tyson 2004)
  - 3 items (static, arm lift, forward reach)

Participation-level Measures
(with limitations)

- Activities-specific Balance Confidence Scale (Botner 2005)
  - No sitting items, all items in standing
- Falls Efficacy Scale (Delbaere 2010)
  - No sitting items, sit to stand only
- Stroke Impact Scale (Guidetti 2014)
  - 1 sitting item: sitting without losing balance

GAP ➔ Participation level measures relevant to sitting function
Emerging Technologies

- Force platform systems
- Pressure mat sensors devices
- Accelerometers & movement sensors
- Videographic movement analysis (eg. Dartfish)

- Clinical utility?
- Affordability
- Portability?

Emerging Quantitative Measures

- PocketPT™ Trunk Movement Battery

Movement Sensor Assessment Technology
PocketPT Trunk Movement Battery

Trunk Movement Battery
Beel-Bates 2011, Englesma 2014

• Assessment component of PocketPT™
  – Quantitative Limits of Stability test
    • Anterior, Posterior, Lateral maximal trunk lean
    • Initial position, maximal COM excursion & average movement velocity
  – Excellent to Moderate Reliability (adults w/BI)
    • Intra-rater Reliability (ICC=.70-.91)
    • Inter-rater Reliability (ICC=.75-.99)
  – Good to excellent concurrent validity (adults w/BI)
    • FIST, Multidirectional FRT, global rating scale
  – Excellent discriminative validity
Don’t Just Sit There: Evidence-Based Sitting Balance Examination & Intervention

CSM 2015

Total Maximum Excursion

Designing Interventions to Promote Recovery of Sitting Function
Examination Findings ➔ Guide Directed Interventions

• **Clinical decision-making**
  – What balance components need remediation?
    • Voluntary, Proactive, Reactive, Sensory or Motor Strategies
  – What are the activity limitations? What functional tasks are inefficient or ineffective?
    • Task demands, transitional movements, dual tasks
  – What environmental conditions are challenging or pose fall risk?
    • With/without trunk support, UE support, feet on ground
    • Surface conditions, base of support, visual context

Examination Findings ➔ Guide Directed Interventions

• **Clinical Decision-making**
  – What are the primary system impairments contributing to sitting balance deficits?
    • Trunk weakness, dynamic trunk control
    • LE weakness affecting stable BOS
    • Impaired perception of vertical/midline
    • Sensory or Perceptual deficits
    • Musculoskeletal limitations
    • Abnormal tone/alignment issues
    • Impaired postural strategies; motor control issues
    • Attention/cognition
**Treatment Principles**

Promote Neuroplasticity

- Apply motor learning concepts to facilitate recovery of sitting balance skills
- Apply task-specific training concepts
- Practice meaningful tasks, saliency
- Practice in functionally relevant environments
- Build in repetition & intensity of practice
- Learning from errors
  - YES! Errors = loss of balance so CNS learns

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**Task Oriented Balance Training**

- Practice balance skills in context of specific task goals vs. “balance exercises”
  - Embed balance demands into task design
  - Be explicit regarding task goal & FB on success
- Encourage active problem-solving and motor learning
  - Promote self-evaluation of task demands
  - Highlight critical aspects of environment
  - Encourage patient to evaluate their performance
- Address underlying impairments affecting balance in the context of TO balance training
Balance Training Interventions
Application of Ecological Model

Customized Interventions for Balance Training

**Task Demands** ⇨ Forced use of PC system

**Reaching Tasks**
- Single UE or both UEs
- Load or unloaded
- Distance, speed, timing demands

**Trunk Movement**
- Limits of Stability demands
- Segmental trunk motions/rotation
- Transitional movement demands

**Dual Task Demands**
- Balance + motor demands
- Balance + cognitive demands
- Environmental distraction/ attn.
Customized Interventions for Balance Training

**Environmental Conditions**

- **Support Surface**
  - Stable/unstable/moving
  - Level/unlevel, surface area support
  - Bed, w/c, mat table, couch

- **Level of External Support**
  - Thigh and feet support
  - Back/trunk support & support location
  - UE support & location of support

- **External Environment**
  - Lighting conditions, eyes open/closed
  - Attention demands
  - Cognitive processing load

Targeted Balance Treatment Design

What aspects of balance is Rx focus?

- Postural stability & Voluntary postural control
- Proactive postural control
- Reactive postural control
- Effective motor strategies
- Functional task demands
Sitting: Voluntary Postural Control

- Address postural alignment & create stable BOS
- Retrain midline for static and dynamic tasks
  - Use of external cues, internal recalibration
- Expand limits of stability (perceptual workspace)
  - A/P, Lateral, Functional rotational planes
- Embed task demands that require ↑ LOS
- Challenge stability on moving base of support
  - Exercise ball, equilibrium board, dynadisc
  - Environmental feedback re: stable center

Sitting: Proactive Balance Strategies

- Practice self-generated movements
  - Initially in midline with min. displacement of COM
  - Progress to increasing dynamic COM excursion
- Progress demands for UE, LE, & trunk motions
  - Add amplitude, speed, load, timing demands
  - Reaching, leaning, lifting, hitting, kicking, turning
- Practice transitional movements
  - Sit/sidelying, scooting, sit to standing, s/p transfers
Sitting: Reactive Balance Strategies

Promote timely & effective postural responses to perturbations or any loss of balance

- Manual perturbations
  - First in midline, then during dynamic tasks
  - Progress from expected to unexpected
- Challenge in unstable/moving surface conditions
  - Inclines, foam, balance board, ball
  - Progress from midline to dynamic tasks
- Safe practice at edge of LOS where fall risk zone
  - Working on safe recovery from loss of balance

What is the Evidence for Sitting Balance Interventions?

- Task Specific Training (Dean et al 2007)
  - Sitting reaching training beyond arms length
  - Varied distance, direction, thigh support, loads
  - RCT demonstrated significantly improved reach distance, paretic LE loading, & speed of reach
  - No carry over to walking function

- Early Intensive Forced Use (Tang et al 2014)
  - Comparison of early sitting, standing, walking task training with contemporary “Bobath approach”
  - Patients with severe motor deficits post-stroke
  - Significantly higher STREAM and Berg scores at 4 & 8 wk in Early Task-specific training group
What is the Evidence for Sitting Balance Interventions?

- Mental Practice added to Task Specific Training
  - Combining physical with mental practice primes system for motor strategy, enhances limb loading during STS task (Malouin 2009)
  - Mental imagery of sit to stand and reach tasks resulted in task-specific increases in speed (Guttman 2012)
  - Combining visual image with mental & physical practice of sitting trunk lean task (anterior and lateral) enhanced loading on paretic side (Saito 2013)

- Patient’s ability to use motor imagery varies; evaluate with published measures
- Use of external imagery vs. internal imagery (kinesthetic feel of movement) in training
- Weak levels of evidence of MP in sitting balance recovery

What is the Evidence for Sitting Balance Interventions?

- Efficacy of trunk exercises (Verheyden et al 2009)
  - Rx: selective trunk exercises in supine and sitting (CVA)
    - Dosing: 4 x week for 5 weeks vs control group “conventional” PT/OT
  - RCT Findings: Significant gains only in dynamic balance subscale of Trunk Impairment Scale (TIS) for exercise group
  - No differences in functional outcomes

- Trunk exercises effect on balance & function (Saeyes 2012)
  - Additional 16 hrs (8 wks) of trunk exercise in acute CVA
  - Focus of exercises: strength, coordination, selective motion
  - Significant higher gains in TIS for exercise group
  - Carryover to higher Berg and DGI scores in exercise group
Use of Emerging Technology in Balance Interventions

- Augmented visual BFB enhances sitting symmetry (Mudie et al 2002)
  - Balance performance monitor, carryover to function?
- Video-gaming effect on dynamic sitting balance
  - Sony Play Station II EyeToy (s/p stroke) (Rand 2008)
  - Case Series x 3 (SCI and TBI) (Betker 2007)
  - Advantages: motivational, increased practice time
  - Limitations of commercial video-gaming technology
    - High level of task demands and complexity
    - Limited ability for therapist to customize training for patient

Pocket PT™ Technology (Englesma et al 2014)

- 3d Sensor transmits data to ipad, wireless technology
- PocketPT app interprets & stores test results for each patient on backend dashboard portal for PT online access
- PocketPT is a personalized, therapeutic gaming platform for retraining dynamic balance
- Assessment findings drive PT-directed game parameters and goals
PocketPT
Interactive Gaming System for Balance Retraining

Pocket PT
PT-Directed Goals Set for Trunk Motion
Putting It All Together

Cases

• Case #1:  
  – Patient with acute stroke

• Case #2:  
  – ICU patient pneumonia who developed critical illness polyneuropathy

• Case #3:  
  – Patient with TBI
Take Home: Summary Points

Selection of right measure for right patient at right time

Selection of both measure & intervention for tasks, environment, needs

Use measurement to drive interventions systematically; Reexamine periodically

Questions?
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Don’t Just Sit There! Evidence-based Sitting Balance Examination & Intervention

CSM 2015 SL Gorman, CC Harro, C Platko


Dean CM, Channon EF, Hall JM. Sitting training early after stroke improves sitting ability and quality and carries over to standing up but no to walking: a randomized controlled trial. Austr J Physiother. 2007;53(2):97-102.


Feigin L, Sharon B, Czaczkes B, Rosin A. Sitting equilibrium 2 weeks after a stroke can predict the walking ability after 6 months. Gerontology. 1996;42(6):348-353.


**Gorman in press**


Spruit-van Eijk M, Zuidema SU, Buijck BI, Koopmans RT, Geurts AC. To what extent can multimorbidity be viewed as a determinant of postural control in stroke patients? Arch Phys Med Rehabil. 2012(7);93:1021-1026.


