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Why this test? Clinical Decision Making for Balance

Clinical Decision Making in Balance Examination

Mike Studer, PT, MHS, NCS, CEEAA, CWT, CSST

Learning Outcomes

- Identify the difference in and indications for using screening measures of fall risk and tests of imbalance.
- Name the six balance systems and mechanisms to evaluate each for optimal treatment prescription.
- Identify how and when to use balance examinations as a motivational tool.
- Correctly identify which balance tests can be modified from a standard set of instructions including the process to follow.

2

CONTINUED

Course Outline

- The difference between a balance test and a screen – and the indication for each (10)
- The systems of balance – contributions, functional correlates, and related examination (50)
- How to use the balance examination to benefit your authorizations/advocacy, program development, and patient engagement (15)
- Evidence-based balance examination for the frail elderly and high-level elderly, as well as concussed athlete (10)
- Modification of balance examinations for unique circumstances: populations, precautions, and settings (10)
- Practical applications: case studies (20)
- Conclusions and questions (5)

3

CONTINUED

What this course is NOT…

- Balance treatment/interventions
- Review of things you can look up: Psychometric properties, cut scores, etc
- How do I conduct this test?

- Comprehensive and unbiased view of all measures of balance and function**

WARNING:
**Evidence, experience, and innovation

4

CONTINUED

The facts on falls*…

- One-third of Americans aged 65+ fall each year.
- Falls = #1 fatal injury in the elderly and the most common cause of nonfatal trauma-hospitalization
- Falls result in >2.5 million injuries in the ED
- From 2013 to 2015, falls-spending rose 32% to $38b
- Average cost/fall > $13,000

*NCOA.org/falls-prevention-facts

5

CONTINUED

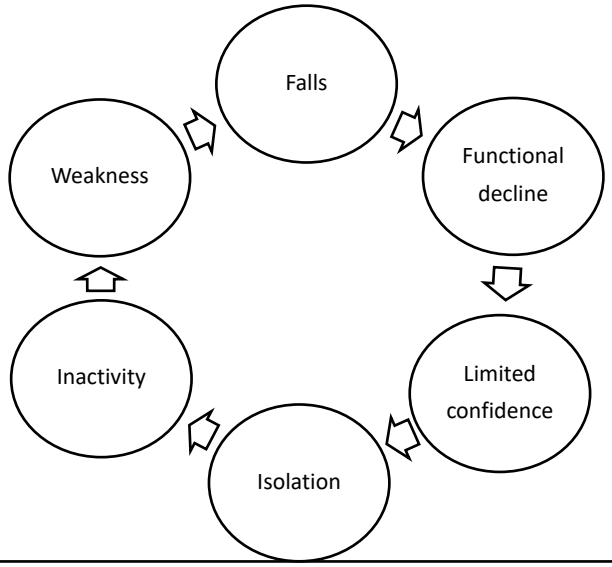
The facts on falls*…

- Falling ***once*** does not mean that your episodes and re-entries to the healthcare system is over
- ☐ > 65 fell once
- ☐ fell twice
- ☐ fell 3 or more times

6

CONTINUED

The effects of falling and fear…



7

CONTINUED

Balance Testing and Screening

Screening*:	Assessment*:
Is this patient at fall risk?	How impaired is this patient?
What level of fall risk?	What dosage is needed?
What areas should be more closely examined?	What interventions are indicated?
*Objective justification for an assessment	* Objective documentation and justification treatment

8

CONTINUED

Can a screen be a "measure"?

Yes…a balance screen CAN be a measure:

TUGO

30 second STS

5x STS

So…what *screens* are **primarily** *screens**

4 Stage Balance Test
Four Square Step Test

9

CONTINUED

Timed Up and Go: TUGO

- Self-selected pace
- 3 meter walkway
- Chair back to start/stop test

10

30 second STS

- Chair height
- Without UE support
- Complete a full repetition/up to stand

11

30 second STS: Scoring

	60-64	65-69	70-74	75-79	80-84	85-89	90-94
MALE	<14	<12	<12	<11	<10	<8	<7
FEMALE	**<12**	**<11**	**<10**	**<10**	**<9**	**<8**	**<4**

12

CONTINUED

4 Stage Balance Test

- Assistance to get into position
- Two full cycles of the quadrants
- 3 dimensional borders

13

CONTINUED

4 Stage Balance Test: Scoring

	① Stand with your feet side-by-side.	Time: _____seconds
	② Place the instep of one foot so it is touching the big toe of the other foot.	Time: _____seconds
	③ Tandem stand: Place one foot in front of the other, heel touching toe.	Time: _____seconds
	④ Stand on one foot.	Time: _____seconds

14

CONTINUED

The Cutoff: Screening Fall Risk

TUGO > 14 sec

30 second STS – See chart for age/gender

4 Stage balance – unable to complete Stage #3

15

CONTINUED

Screening algorithm

What scores/outcomes indicate fall risk?

If fall risk, then what?

- PT
- Otago
- Home modifications
- Other intervention: medication, vision, footwear*

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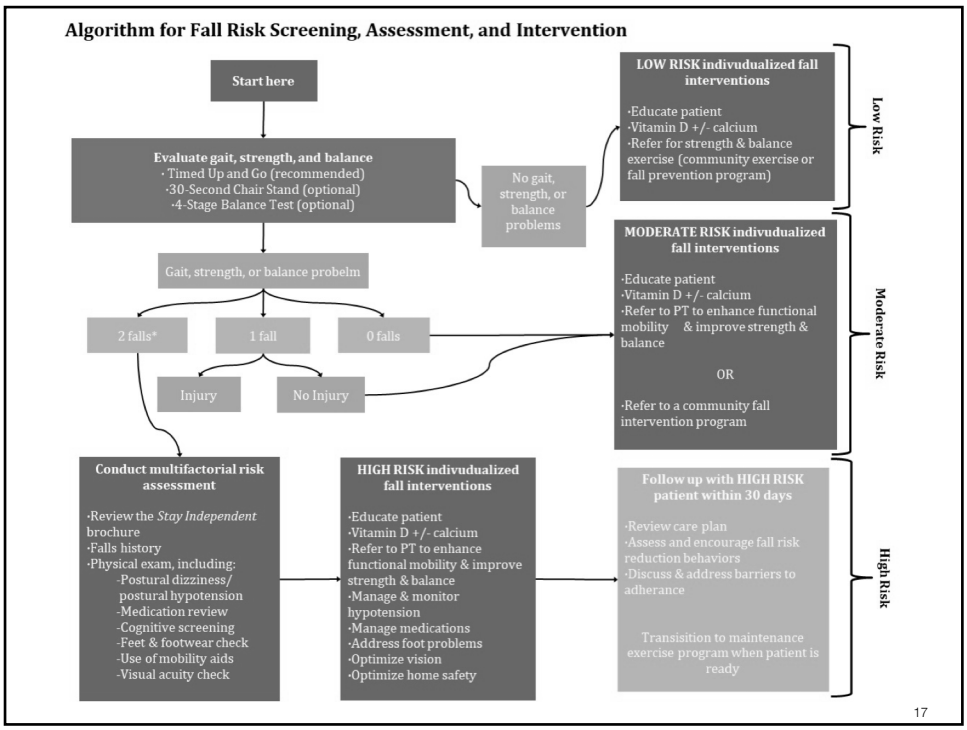
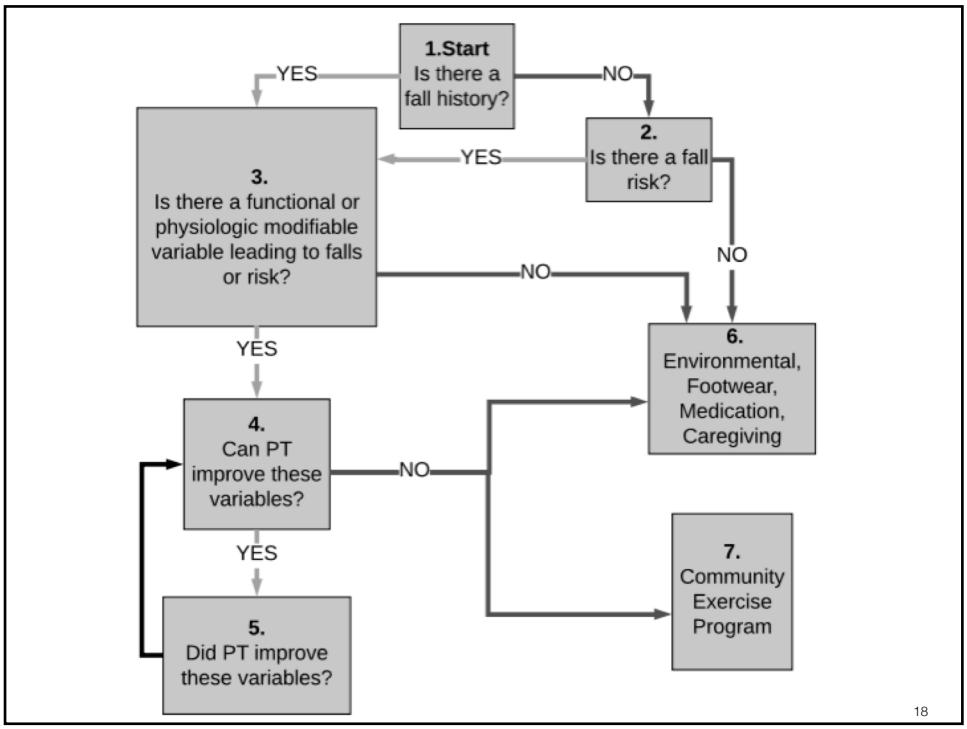

Algorithm for Fall Risk Screening, Assessment, and Intervention
Start here
Evaluate gait, strength, and balance
· Timed Up and Go (recommended)
·30-Second Chair Stand (optional)
·4-Stage Balance Test (optional)
No gait, strength, or balance problems
LOW RISK indivudualized fall interventions
·Educate patient
·Vitamin D +/- calcium
·Refer for strength & balance exercise (community exercise or fall prevention program)
Low Risk
Gait, strength, or balance probelm
2 falls*
1 fall
0 falls
Injury
No Injury
MODERATE RISK indivudualized fall interventions
·Educate patient
·Vitamin D +/- calcium
·Refer to PT to enhance functional mobility & improve strength & balance
OR
·Refer to a community fall intervention program
Moderate Risk
Conduct multifactorial risk assessment
·Review the Stay Independent brochure
·Falls history
·Physical exam, including:
-Postural dizziness/ postural hypotension
-Medication review
-Cognitive screening
-Feet & footwear check
-Use of mobility aids
-Visual acuity check
HIGH RISK indivudualized fall interventions
·Educate patient
·Vitamin D +/- calcium
·Refer to PT to enhance functional mobility & improve strength & balance
·Manage & monitor hypotension
·Manage medications
·Address foot problems
·Optimize vision
·Optimize home safety
Follow up with HIGH RISK patient within 30 days
·Review care plan
·Assess and encourage fall risk reduction behaviors
·Discuss & address barriers to adherance
Transisition to maintenance exercise program when patient is ready
High Risk
17


1.Start
Is there a fall history?
YES
NO
2.
Is there a fall risk?
YES
NO
3.
Is there a functional or physiologic modifiable variable leading to falls or risk?
NO
YES
6.
Environmental, Footwear, Medication, Caregiving
4.
Can PT improve these variables?
NO
YES
7.
Community Exercise Program
5.
Did PT improve these variables?
18

Screening: Stronger Prediction…

- ❑30 second STS*
- ❑TUG
- ❑4 Stage Balance

And…

- ❑Berg Balance
- ❑Self selected gait speed

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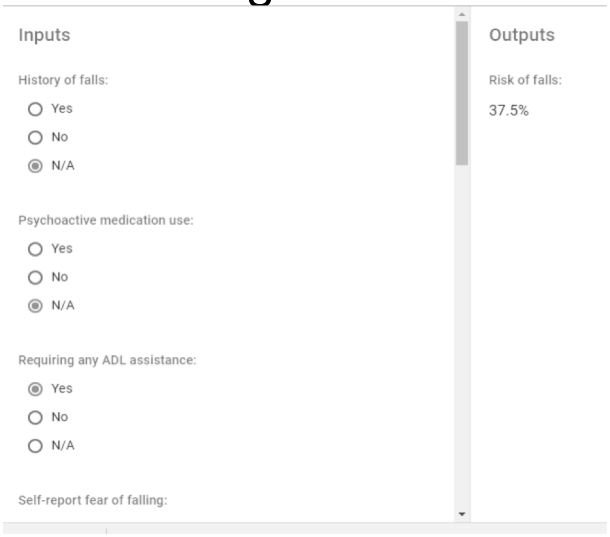
Screening: The Evidence



- ❑ https://jscalc.io/calc/Y53w0rSwoRCx0fuE

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Predictive values of fall risk (*positive* post-test)

- BERG SCORE < 50 = 59%
- TUG SCORE > 11 SEC = 47%
- SLS SCORE < 6.5 SEC = 45%
- 5XSTS SCORE > 12 SEC = 41%
- SELF-SELECTED GAIT < 1M/SEC = 39%

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Screening Question Value: (*positive* post-test predictive)

- BERG SCORE < 50 = 59%
- TUG SCORE > 11 SEC = 47%
- SLS SCORE < 6.5 SEC = 45%
- 5XSTS SCORE > 12 SEC = 41%
- SELF-SELECTED GAIT < 1M/SEC = 39%

22

Screening Question Value: (*positive* post-test predictive)

- HISTORY OF FALL = 44%
- FEAR OF FALLING = 38%
- REQUIRES ASSIST WITH ANY ADL = 38%
- PSYCHOACTIVE MEDICATIONS= 38%
- USES AN ASSISTIVE DEVICE TO WALK = 36%

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Screening equation

- > 65 years old
- ___ score TUG
- ___ score 5x STS or ____ 30 seconds STS
- ___ 4 Stage Balance
- ___ Berg
- ___ self selected walking speed

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Subjective Examination

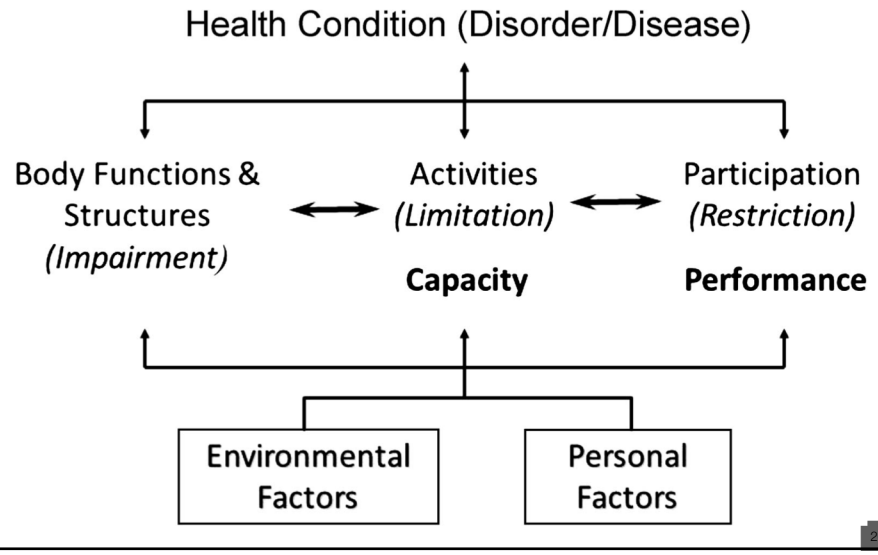
Beyond the STEADI: Subjective MUST include

International Classification of Function:

- Interests
- Avocations
- Activities
- Roles
- Responsibilities

25

The International Classification of Function



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Systems of Balance

Organizing Your Test Choices
AND
Interpretation

27

Systems of Balance

Biomechanical Constraints	Stability Limits / verticality	Anticipatory Postural Adjustments	Postural Responses	Sensory Orientation	Stability in Gait

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Systems of Balance

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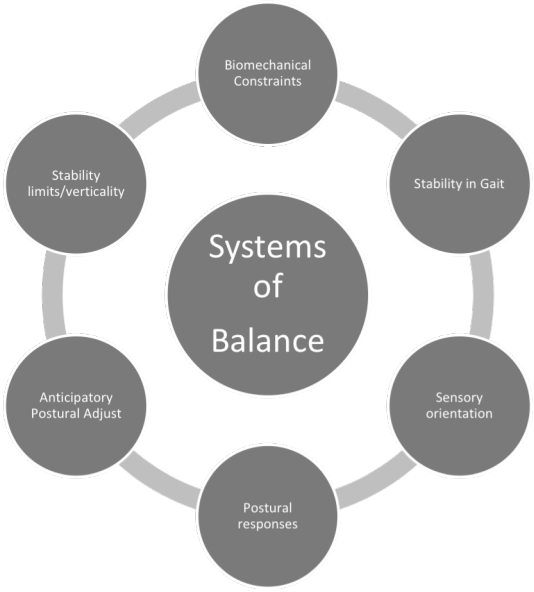
Systems of Balance



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Summary of Balance Evaluation Systems Test (BESTest) Items Under Each System Category[a]

I. Biomechanical Constraints	II. Stability Limits/Verticality	III. Anticipatory Postural Adjustments	IV. Postural Responses	V. Sensory Orientation	VI. Stability in Gait
1. Base of support	6. Sitting verticality (left and right) and lateral lean (left and right)	9. Sit to stand	14. In-place response, forward	19. Sensory integration for balance (modified CTSIB) Stance on firm surface, EO Stance on firm surface,EC Stance on foam, EO Stance on foam, EC	21. Gait, level surface
2. CoM alignment	7. Functional reach forward	10. Rise to toes	15. In-place response, backward		22. Change in gait speed
3. Ankle strength and ROM	8. Functional reach lateral (left and right)	11. Stand on one leg (left and right)	16. Compensatory stepping correction, forward		23. Walk with head turns, horizontal
4. Hip/trunk lateral strength		12. Alternate stair touching	17. Compensatory stepping correction, backward	20. Incline, EC	24. Walk with pivot turns
5. Sit on floor and stand up		13. Standing arm raise	18. Compensatory stepping correction, lateral (left and right)		25. Step over obstacles
					26. Timed "Get Up & Go" Test
					27. Timed "Get Up & Go" Test with dual task

[a] CoM=center of mass, ROM=range of motion, CTSIB=Clinical Test of Sensory Integration for Balance, EO=eyes open, EC=eyes closed.

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CONTINUED

Systems of Balance: GeriEdge

- Static: ability to maintain upright posture against gravity
- Anticipatory/dynamic: ability to prepare for movement and make appropriate postural adjustments during functional activity (internal perturbations)
- Reactionary/dynamic recovery: ability to respond appropriate adjustments to unanticipated environmental challenges during functional activity (external perturbations)

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Systems of Balance: Shumway-Cook + Wollacott

Shumway-Cook & Woollacott definitions

Postural orientation: ability to maintain appropriate relationship between body segments, and between body and environment in order to perform a given task

Postural stability (balance): ability to manage the body's center of mass in relationship to its base of support; differs across different activities and environmental conditions)

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Systems of Balance: Tests

A. Biomechanical constraints: ROM, Strength (BEST, reach, 30 sec STS)

B. Stability limits/verticality: Sitting vertical, reach (BEST, Berg, reach)

C. Anticipatory Postural Adjust (BEST, Berg, 4SST, Alternate step)

D. Postural responses (nudge, lean tests, platform tilt)

E. Sensory orientation (CTSIB, DGI, FGA, BEST)

F. Stability in Gait (TUG, BEST, DGI, HiMAT, C-TUG)

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Examination as a multi-purpose tool

35

Program + Patient Benefits

- Regulations: licensure + reimbursement
- Advocacy, policy and authorization appeals
- Program development and marketing
- Clinical efficacy metrics
- Patient engagement MOTIVATION

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Examinations: Reflecting Personal and Program sophistication

- Regulations: licensure + reimbursement
- "I must do an evaluation every ____ visit/days"
- "I have to document progress…"
- "Authorizations"

37

Examination: Patient advocacy

- Advocacy, policy and authorization appeals
- "PT is effective in fall prevention!"
- "This patient deserves more than 30 visits…"
- Manual Medical Review (MMR) is coming due

38

Examinations: Program marketing

- Program development and marketing

- We prevent falls better than _____ because
- Let's buy this equipment to improve our balance program
- Hey (referral sources)…send your patients to us, because…

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Examination: Program benchmarks

- Clinical efficacy metrics

- Fall rates
- Improvements in ____ balance score
- # visits to achieve ____ gains in _____ measures

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Examination: Program benchmarks

- Patient engagement
- MIPS
- Cancellation rates
- Net Promoter Scores (NPS)

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Examination:

The Draft Table of Treatment

42

Outcome Measures in Neurological Physical Therapy Practice: Part I. Making Sound Decisions

- What to measure* (…consider prognostications)
- Purpose of the measure
- Type of measure
- Patient Clinical factors
- Psychometric factors
- Feasibility

Potter, K et al. Journal of Neurologic Physical Therapy: June 2011 - Volume 35 - Issue 2 - p 57–64

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Examination for Treatment

- Performance/functionally based
- Feasible (cost, time, space, equip)
- Multidimensional and comprehensive
- Clinimetrically sound

44

Examination for Treatment

- Performance/functionally based

- Sitting, standing static balance
- Transitional movements
- Functional reach and endurance
- Dynamic balance in gait, stairs

45

Examination for Treatment

- Feasible (cost, time, space, equip)

46

Examination for Treatment

Multidimensional and comprehensive

- All systems screened or tested
- Logical AND COMPREHENSIVE treatment

47

Systems of Balance

48

Examination for Treatment

- Clinimetrically sound

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VISION	BASE
EYES CLOSED HEAD NODDING HEAD ROTATION (SIDE-SIDE) OBSTRUCTION/DISTRACTION	ONE LEG TANDEM FEET STAGGERED FEET TOGETHER
ARMS LENGTH REACH SIT TO STAND REACH BEYOND ARM'S LENGTH STOOPING/FLOOR RETRIEVAL	FIRM CUSHIONED UNEVEN SLICK
MOTION	SURFACE

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CONTINUED

Outcome Measures in Neurological Physical Therapy Practice: Part II. A Patient-Centered Process.

An algorithm for clinical decision making as related to measurements

Sullivan, Jane E, et al. JNPT: June 2011. 35:2.65-74

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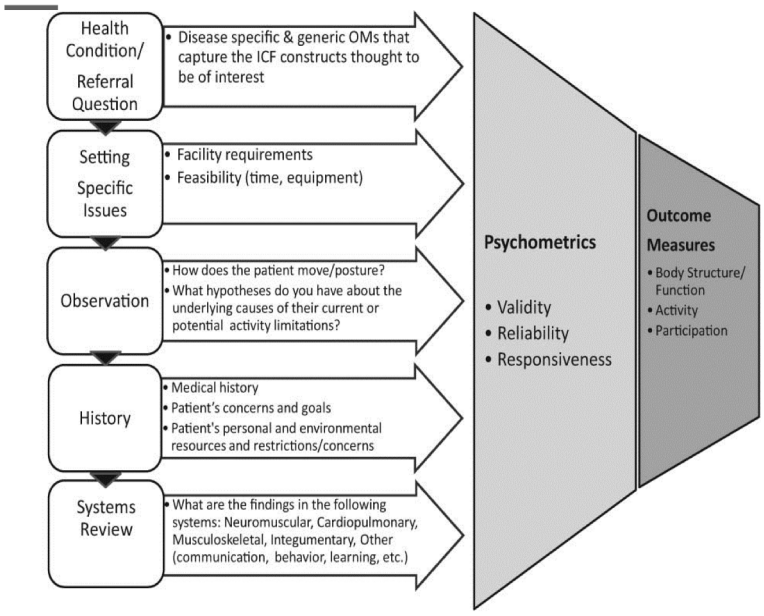

Abbreviations: ICF, International Classification of Functioning, Disability, and Health; OM, outcome measure.

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Algorithms of Clinical Decision Making

Data comes at a cost and the risk of:
…too much data

53

What do I *NEED* to know?

1. Is there a fall history?
2. Is there a fall risk?
3. Is there one or more functional or physiologic modifiable variable leading to falls or risk?
4. Can PT improve these variables?
5. ***DID*** PT improve these variables?

INTERVENTIONS:
1-1 PT
Community ex. Program
Environmental, medication, foot/eyewear, caregiver

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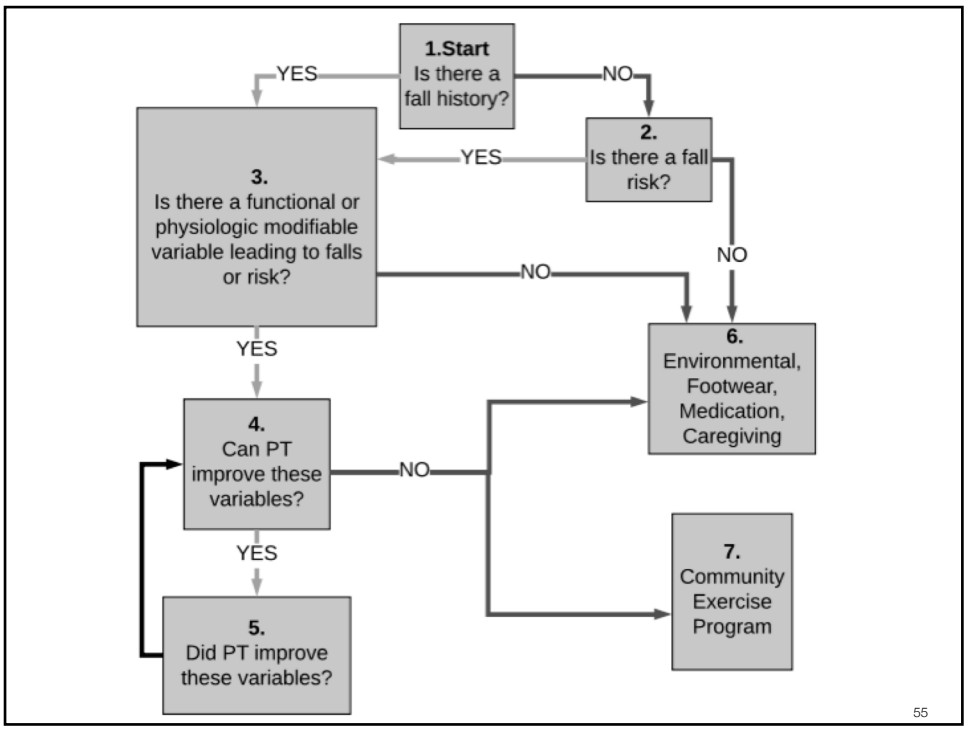

CONTINUED

This exam This person Now

- Patient goal
- Facility/family goal
- Recognized and unrecognized potential
  - Diagnosis
  - Prognosis
  - Past therapy experiences
- Rehabilitation vs. compensation
- Payer source
- Time

56

Barriers to measurement

- Time
- Projected patient perception
  "I came here for therapy – not testing."
- Equipment
- Space
- Knowledge: "…how do I run this test?"
- "This test is not validated for…"

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What are we missing in balance examinations?

Real life pressure situations: time
Distractions and task complexities
- Carrying objects of load
- Picking up objects
- Cognitive, auditory, visual distractions

Testing fear in an active balance exam (not on paper)
Return to sport testing – high level skill + decisions

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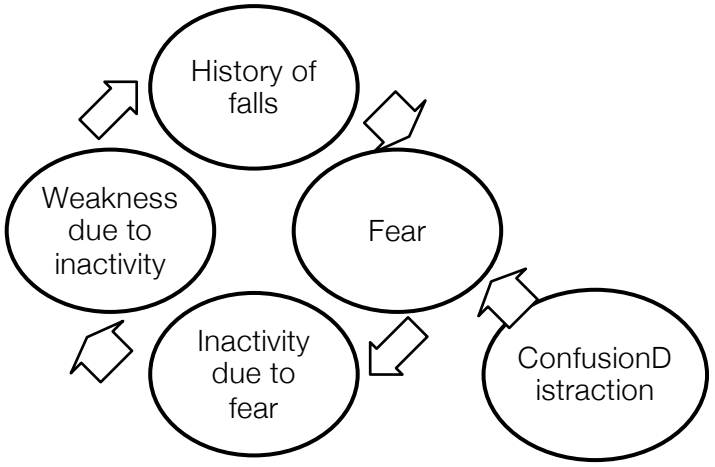
Psychological and cognitive aspects of imbalance



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Functional Performance: Falls Efficacy

Falls Efficacy Scale-International (English)

I would like to ask some questions about how concerned you are about the possibility of falling. For each of the following activities, please circle the opinion closest to your own to show how concerned you are that you might fall if you did this activity. Please reply thinking abou how you usually do the activity. If you currently don't do the activity (example: if someone does your shopping for you), please answer to show whether you think you would be concerned about falling IF you did the activity.

		Not at all concerned 1	Somewhat concerned 2	Fairly concerned 3	Very concerned 4
1	Cleaning the house (e.g. sweep, vacuum, dust)				
2	Getting dressed or undressed				
3	Preparing simple meals				
4	Taking a bath or shower				
5	Going to the shop				
6	Getting in or out of a chair				
7	Going up or down stairs				
8	Walking around in the neighborhood				
9	Reaching for something above your head or on the ground				
10	Going to answer the telephone before it stops ringing				
11	Walking on a slippery surface (e.g. wet or icy)				
12	Visiting a friend or relative				
13	Walking in a place with crowds				
14	Walking on an uneven surface (e.g. rocky ground, poorly maintained pavement)				
15	Walking up or down a slope				
16	Going out to a social event (e.g. religious service, family gathering, or club meeting)				
	Sub Total				
				TOTAL	/64

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Activity-Specific Balance Confidence

The Activities-specific Balance Confidence (ABC) Scale*

Instructions to Participants: For each of the following activities, please indicate your level of confidence in doing the activity without losing your balance or becoming unsteady from choosing one of the percentage points on the scale from 0% to 100% If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity. If you normally use a walking aid to do the activity or hold onto someone, rate your confidence as if you were using these supports.

0% 10 20 30 40 50 60 70 80 90 100%
No Confidence Completely Confident

How confident are you that you will not lose your balance or become unsteady when you…

1. …walk around the house? _____%
2. …walk up or down stairs? _____%
3. …bend over and pick up a slipper from the front of a closet floor? _____%
4. …reach for a small can off a shelf at eye level? _____%
5. …stand on your tip toes and reach for something above your head? _____%
6. …stand on a chair and reach for something? _____%
7. …sweep the floor? _____%
8. …walk outside the house to a car parked in the driveway? _____%
9. …get into or out of a car? _____%
10. …walk across a parking lot to the mall? _____%
11. …walk up or down a ramp? _____%
12. …walk in a crowded mall where people rapidly walk past you? _____%
13. …are bumped into by people as you walk through the mall? _____%
14. …step onto or off of an escalator while you are holding onto a railing? _____%
15. …step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? _____%
16. …walk outside on icy sidewalks? _____%

*Powell LE & Myers AM. The Activities-specific Balance Confidence (ABC) Scale. Journal of Gerontology Med Sci 1995; 50(1):M28-34.

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CONTINUED

Dual Task Cost (DTC)

$$DTC = \frac{(DT - ST)}{ST} \times 100$$

DTC = the additional expense in task performance that can be attributed to the addition of a secondary task

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CONTINUED

C-TUG

- TUGO: Stand, walk 3 m, return and sit
- Secondary task: subtract by 3 from a random number between 66 and 100.
- Measurements: times for walking in single and dual task
- Cut-off: 15 sec discriminate subjects with a history of falls
- Limitation: Cognitive task difficulty varies based on education, math ability.*

Expose and test EACH as SINGLE, prior to DUAL

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CONTINUED

Manual TUG (TUG-M)

- TUGO baseline.
- Secondary task: carry a cup of water
- Measure: times for walking in single and dual task
- Cut-off value: 4.5 sec+ in dual task condition associated a greater fall risk for frail older adults in next 6 months.
- Limitations: must be able to ambulate with at least one hand free, have sufficient motor control to carry a cup.

* Is this a secondary task or a complex primary?

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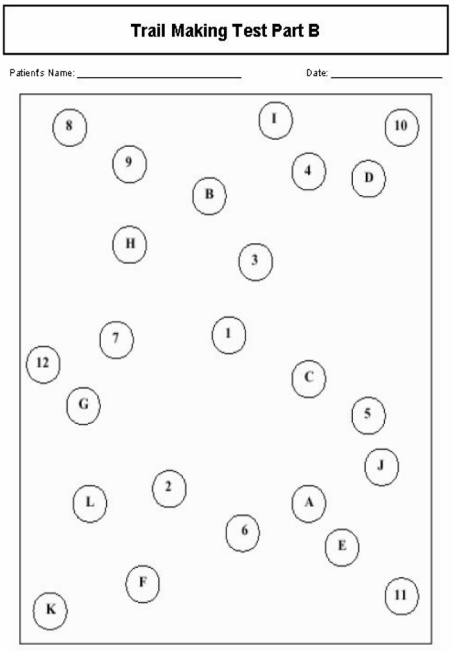
Trails A & B



65

Completely Stable *Standing/sitting undisturbed on solid ground*	**1**
Steady *Balance does not feel challenged, but may have some body movements*	**2**
	3
Unsteady *Feels like work to keep balanced, but still do not need to step*	**4**
	5
Mildly Unbalanced *Feels like I might/could have to take a step **OR** reach for support to maintain balance*	**6**
Moderately Unbalanced	**7**
Unbalanced *Feels that even the smallest or sudden movements will cause a fall*	**8**
Very Unbalanced	**9**
About to Fall *Extremely challenged; and have to step or grab support to keep balance*	**10**

Espy, D

Used with personal permission

66

Modifying an existing tool

CASE EXCEPTIONS

67

Balance Battery Essentials: Performance

- Mini-BEST
- Timed walk tests: 4m, 10m
- 5x STS or 30 second STS
- 6 (or 2*) MWT
- Four Square Step Test
- mCTSIB
- Berg

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CONTINUED

Frail Elderly

MCHST

TUGO

10m walk

Four Stage Balance Test

5x STS

Sitting Balance Scale

http://www.ncbi.nlm.nih.gov/pubmed/21574772

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CONTINUED

Modifying for the frail elderly…

- Seat height
- Body weight support
- Time to endure
- Functional contexts: bed mobility, STS, sitting

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Patient Specific Functional Scale

The Patient-Specific Functional Scale

This useful questionnaire can be used to quantify activity limitation and measure functional outcome for patients with any orthopaedic condition.

Clinician to read and fill in below: Complete at the end of the history and prior to physical examination.

Initial Assessment:

I am going to ask you to identify up to three important activities that you are unable to do or are having difficulty with as a result of your _____ problem. Today, are there any activities that you are unable to do or having difficulty with because of your _____ problem? (Clinician: show scale to patient and have the patient rate each activity).

Follow-up Assessments:

When I assessed you on (state previous assessment date), you told me that you had difficulty with (read all activities from list at a time). Today, do you still have difficulty with: (read and have patient score each item in the list)?

Patient-specific activity scoring scheme (Point to one number):

0 1 2 3 4 5 6 7 8 9 10

Unable to perform activity

Able to perform activity at the same level as before injury or problem

(Date and Score)

Activity	Initial					
1.						
2.						
3.						
4.						

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CONTINUED

Functional Performance: Elderly Mobility Scale

- EMS > 14 = home

  EMS between 10 and 14 = borderline = home with help.

  EMS < 10 = high level of help with mobility and ADL

Fall risk

Supervision

72

High-level Elderly

- BEST and derivatives
- DGI, FGA
- 6MWT
- Tandem
- Dynamic posturography
- HiMAT
- Dual task

73

Concussion* (balance only)

- CTSIB
- BESS
- HiMAT
- FGA, DGI
- Dual tasking overlay*

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Modifying a Test: When/Why

- Time
- Place
- Equipment
- Patient precautions: weightbearing/other injuries
- Patient fatigue, cognition, preference or fear
- Circumstance: Clinical vs. Research???

75

Modified 4 Stage Balance Test

- Assistance to get into position
- Length of test
- Extrapolations of difficulty
  High ceiling
  Low ceiling
- Use of an assistive device unilateral

76

Modified Four Square Step Test

- Use of an assistive device unilateral
- One cycle through vs. twice
- Lines/tape (two dimensional construct)

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Timed Up and Go: TUGO

- Self-selected pace vs. high speed
- 3 meter walkway +/-
- May elect to add a maximal speed
- May add a dual task (CTUG, other)

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30 second STS

- Chair height
- Use of UE support
- Completing a repetition

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4 Stage Balance Test

- Assistance to get into position
- Length of test
- 3 dimensional borders

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Practical applications: Cases

81

Emerging tests: The Future

More of:

Body worn sensors: Gyroscopes

Instrumented treadmills

Virtual reality

Dual task paradigms

82

Dual task defined

Dual task is the concurrent performance of two tasks that can be performed independently, measured separately and have distinct goals

Dual tasking is **NOT** a complex single task, such as:

Carrying a cup of water, backpack, suitcase

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Dual tasking

https://www.youtube.com/watch?v=kbgMrqTCgY0

https://www.youtube.com/watch?v=xsTlfXXoIkg

http://www.cnn.com/2015/04/09/health/your-brain-multitasking/

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Distractibility + dual task intolerance

Inability to:

Focus on a single task
Endure focus
Alternate between stimuli
Filter insignificant information
Prioritize between competing stimuli
Divide attention when shared resource

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Functional relevance of DT

Distractibility and dual task intolerance predict:

- Fall risk
- Dependence on assistive device
- Dependence on caregivers for mobility
- Relative activity levels
- Vocational performance

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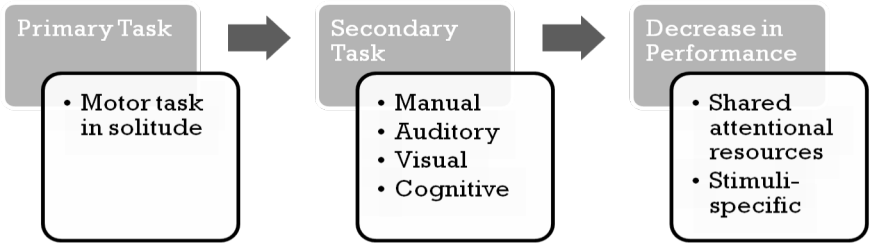
Attentional and Procedural networks



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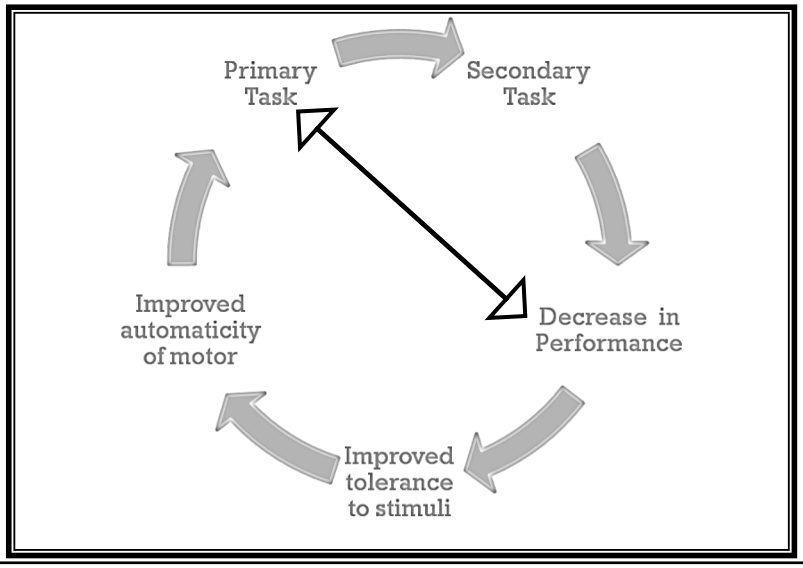
Attentional and Procedural networks



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Experimental and Clinical Relevance

Dual task intolerance can be implicated in:

- Falls in the elderly
- ADL dependence
- Driving safety
- Aspiration pneumonia
- Early dementia screen
- Worklife productivity and accuracy

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Cognitive FSST

Four square step test: A measure of agility
Predictive of fall risk at > 14 seconds

Experimental application: Combine with DT

Patient autonomy (choice):
Conversational topic (6 item generation)
Serial 3's subtraction
6 word recall*

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Cognitive Four Square Step Test: CFSST

- 6 words presented. 1 minute to memorize. Recheck words. Say words aloud as moving through the FSART, relying on working memory. since the pattern of movement is described and then completed during the test, requiring memory of the required directional pattern.
- DT with the simultaneous recall and reiteration (aloud) of the words, during the FSST = FSART.
- % words recalled
- Remembered sequence with direction change
- DT cost in terms of %, a function of time loss

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Four Square Step Test

- Not considered a dual task→requires visuospatial sketchpad component of the working memory since the pattern of movement is described and then completed during the test, requiring memory of the required directional pattern.
- The cog requirement of remembering and executing the appropriate stepping sequence
- Obstacle avoidance has been effective in studies of mild TBI to identify dual task performance problems and is part of the FSST.

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Cognitive Four Square Step Test: CFSST

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93

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CONTINUED

CFSST Video

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CONTINUED

Modified Ambulatory Trail Making Test

- Measures the ability to alternate attention
- Measures response speed and visual scanning

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Trailmaking Test – with a twist

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It all comes down to…

Falls are multi-factorial; examinations MUST comprehensively examine all factors*

Exams reveal impairments and guide treatment that is individualized.

Perform a screen
Perform a multifactorial assessment
Think outside of the box and AT this person

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CONTINUED

Conclusions & Questions

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CONTINUED

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