

Advances in Balance Diagnosis and Treatment: Part 1

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Remember These?



Balance: What Is Bad Balance?

We need to define it better...

...to be able to treat it better

Learning Outcomes

- Evaluate patients with balance dysfunction using evidence-based tests and measures to develop a specific therapy diagnosis
- Determine fall risk in patients by utilizing gateway measures for balance dysfunction
- Interpret assessment findings to identify underlying determinants for balance dysfunction
- Formulate a balance diagnosis for people with balance dysfunction to guide interventions for improved functional mobility

Chapter 1

Practical Balance Assessment and Diagnosis



Hierarchy of Risk Factors / Predictors for Falls (Short List)

1

History of falls

2

Fear of falling

3

Slow gait speed

4

Balance dysfunction

5

Polypharmacy and urinary urgency

Anytime There Is a Fall History...

- Was it a fluke, e.g., knocked over by a dog, a random misstep in unfamiliar territory, or a slip while they were out hiking?
- OR did it occur outside at home or in their home?
- What shoes were they wearing when they fell? What shoes do they usually wear?
- Were they using AD? If not, why not?

Postural Control Strategies: Large Buckets

- **Steady-state postural control (SSPC)**
 - Ability to control the location of the body's center of mass within the area defined by the base of support under predictable static conditions
- **Anticipatory postural control (APC)**
 - Generation of postural adjustments prior to the onset of and during voluntary movement (feed-forward)
- **Reactive postural control (RPC)**
 - Balance response to unanticipated perturbations (feedback)



Movement system diagnoses for balance dysfunction: Recommendations from the Academy of Neurologic Physical Therapy's Movement System Task Force
– Gill-Body et al., 2021

Determinants

- **Musculoskeletal:** ROM, strength and endurance, alignment, and limits of stability (LOS)
- **Neuromuscular:** postural movement strategies, coordination, sensory integrity (includes all sensory systems), sensory processing, and verticality
- **Cognitive function:** executive, multitasking ability (attention allocation), arousal, and alertness
- **Behavioral:** balance confidence, fear of falling, falls efficacy, and activity avoidance

Musculoskeletal

**ROM, especially the ankle, specifically ankle DF
(standing on a wedge), directly affects LOS (Mini-BESTest)**

**Strength, specifically ankle DF and PF
(heel toe raises and Mini-BESTest)**

**Endurance (fatigue): ability to maintain strength and
gait quality and speed over time (2MWT or 6MWT)**

**Alignment (LOS): where they are in the cone of balance¹; if it is
posterior, this needs to be addressed**

1. Horak & Nashner, 1986

2. Gill-Body et al., 2021

Neuromuscular

Sensory processing (mCTSIB)

**Postural movement strategies
(hip and ankle stepping)**

Coordination: standard tests

Sensory integrity (includes all sensory systems)

Verticality (SVV) bucket test

Behavioral

Balance confidence: degree of certainty in their ability to maintain balance (ABC)

Fear of falling: a concern or worry about falling (FES)

Falls efficacy: how they feel about their ability to manage a fall, subjective

**Activity avoidance: DHI
(Dizziness Handicap Inventory)**

**When all else fails, do a standard
VAS score for fear of falling**

Other Balance Domains That Need to Be Looked At

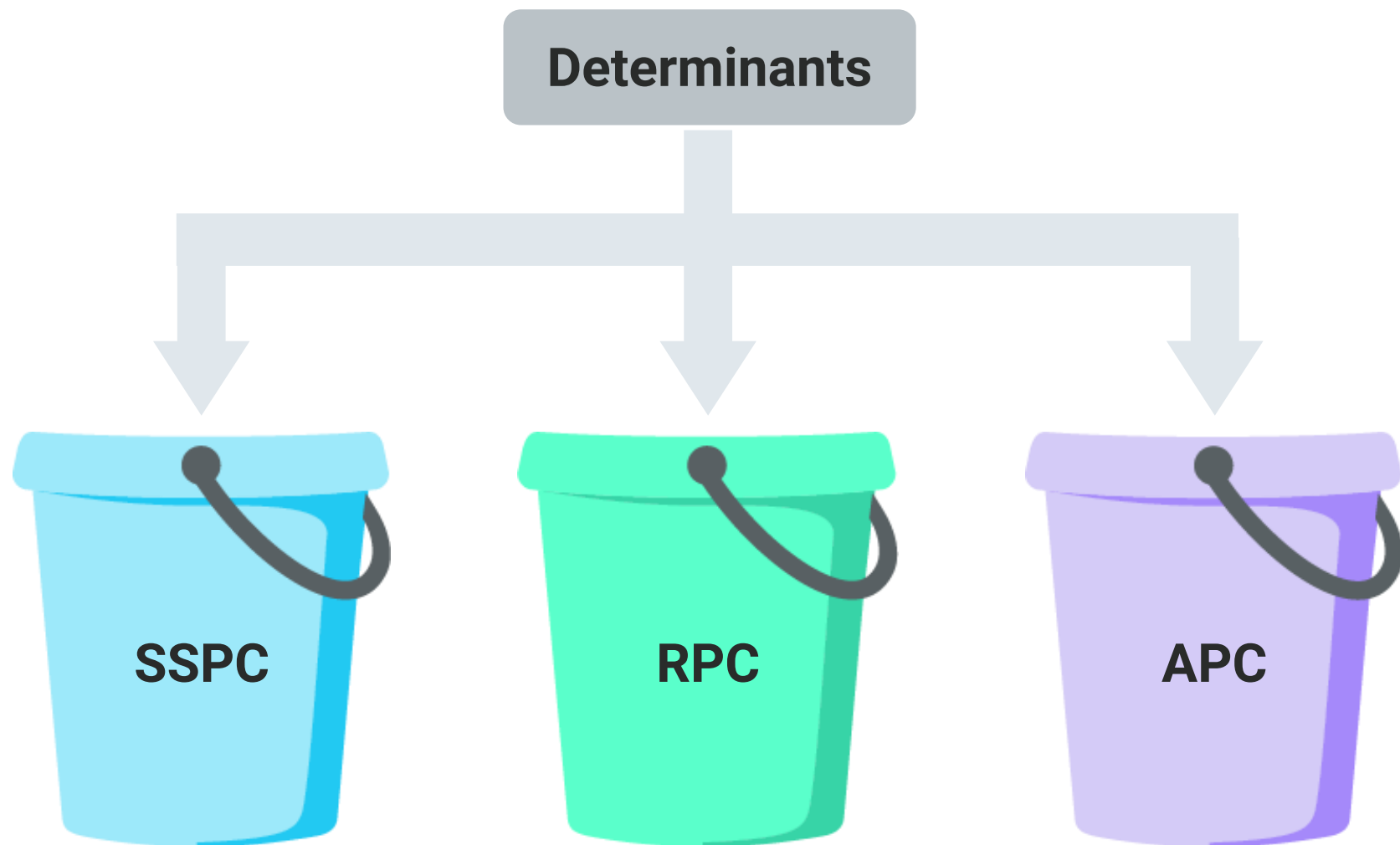
Stability while walking (DGI or FGA)

Attention allocation (TUG Cog)

BPPV (Dix–Hallpike test) vestibular agnosia

VOR dysfunction (walk with head turns)

Determinants



Balance / Fall Risk Measures

- We have so many of these... when deciding which tests you will choose, you need to consider what information you are getting from the test
- Don't choose redundant tests; know what they cover
- Here are some of the more popular ones:
 - **Berg Balance Scale, Mini-BESTest, 30 Sit-to-Stands, FRT, 5xSTS, 30-Second Sit-to-Stand, Tinetti Test, TUG, DGI, FGA, Four-Square Step Test (FSST)**

Which Tests the Most Categories?

- Time is always a pressure for us
- This gets the best bang for your buck
- Time/information ratio is important

List of Which Tests Cover These Postural Control Strategies

APC	STS, Berg Balance Scale, Mini-BESTest, TUG, 4xSTS, and Tinetti
RPC	Mini-BESTest, nudge in the Berg Balance Scale, and Tinetti
SSPC	LOS testing, verticality test, quiet standing, and Mini-BESTest

List of Which Tests Cover Each Domain

Fatigue	6MWT, 2MWT, and 30-Second Sit-to-Stand
Walking With Head Turns	Mini-BESTest, DGI, and FGA
Vestibular Function	Dix–Hallpike (DHT) and DVA
Sensory Organization	Mini-BESTest, mCTSIB, Berg Balance Scale and Tinetti EC/firm, and FGA has EC walking
Attention Allocation	TUG Cog, walking while talking, and Mini-BESTest
Balance Confidence	ABC, FES, and VAS
Verticality	SVV

List of Which Tests Cover Each Domain/Determinant

APC	STS, Berg Balance Scale, Mini-BESTest, TUG, 4xSTS, and Tinetti
Sensory Organization	Mini-BESTest, mCTSIB, Berg Balance Scale and Tinetti EC/firm, and FGA has EC walking
RPC	Mini-BESTest, nudge in Berg Balance Scale, and Tinetti
Attention Allocation	TUG Cog, walking while talking, and Mini-BESTest
Walking With Head Turns	Mini-BESTest, FGA, and DGI
Balance Confidence	ABC, FES, and DHI
Verticality	SVV
Fatigue	6MWT, 2MWT, 30-Second Sit-to-Stand, and step test

List of Which Determinants Each Test Covers

Mini-BESTest	APC, RPC, SSPC, sensory organization, walking with head turns, attention allocation, verticality, strength, and ROM
Sit-to-Stand Tests	APC, strength, and ROM
DGI/FGA	Walking with head turns, APC, and dynamic gait
Berg Balance Scale and Tinetti	APC, weak RPC, and weak sensory organization
TUG Cog	DTC/attention allocation
6MWT and 2MWT	Endurance/fatigue
ABC, FES, and DHI	Balance confidence

This Can Be Overwhelming

- I will outline a methodical approach to gather all the facts
- Don't be that PT who just focuses on strength
- Research shows that improving only strength in SNF residents actually increases falls

Chapter Summary

- We can no longer be general and broad in our balance assessment and diagnosis
- Postural control strategies were defined to help with treatment direction
- Underlying determinants that further qualify these deficits were defined

Chapter 2

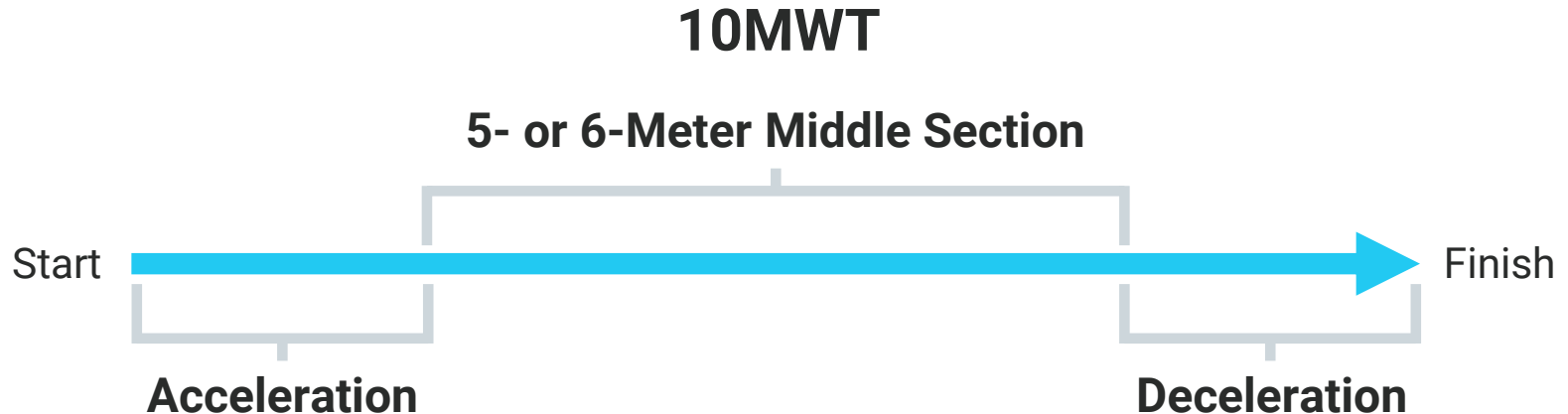
Gateway Measures for Balance Dysfunction



Primary Gateway Measure: Gait Speed



How Do We Measure Gait Speed?



Do the math: meters/seconds
 $5 \text{ m} / 5 \text{ sec} = 1.0 \text{ m/sec}$

Primary Gateway Measure

Gait Speed: Always

>1.0 m/sec

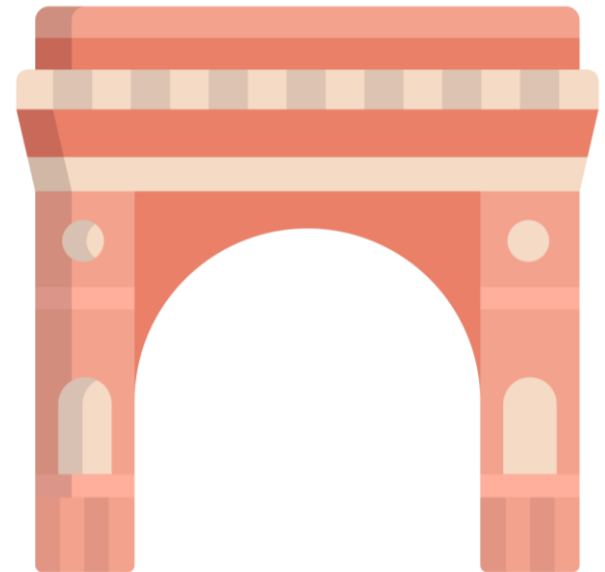
- No history of falls? Good to go.

0.8–1.0 m/sec

- Fall history? If yes, needs a drill-down and possible fall intervention.

<0.8 m/sec

- Red flag warning
- Drill-down and fall intervention are needed



Gateway Measures



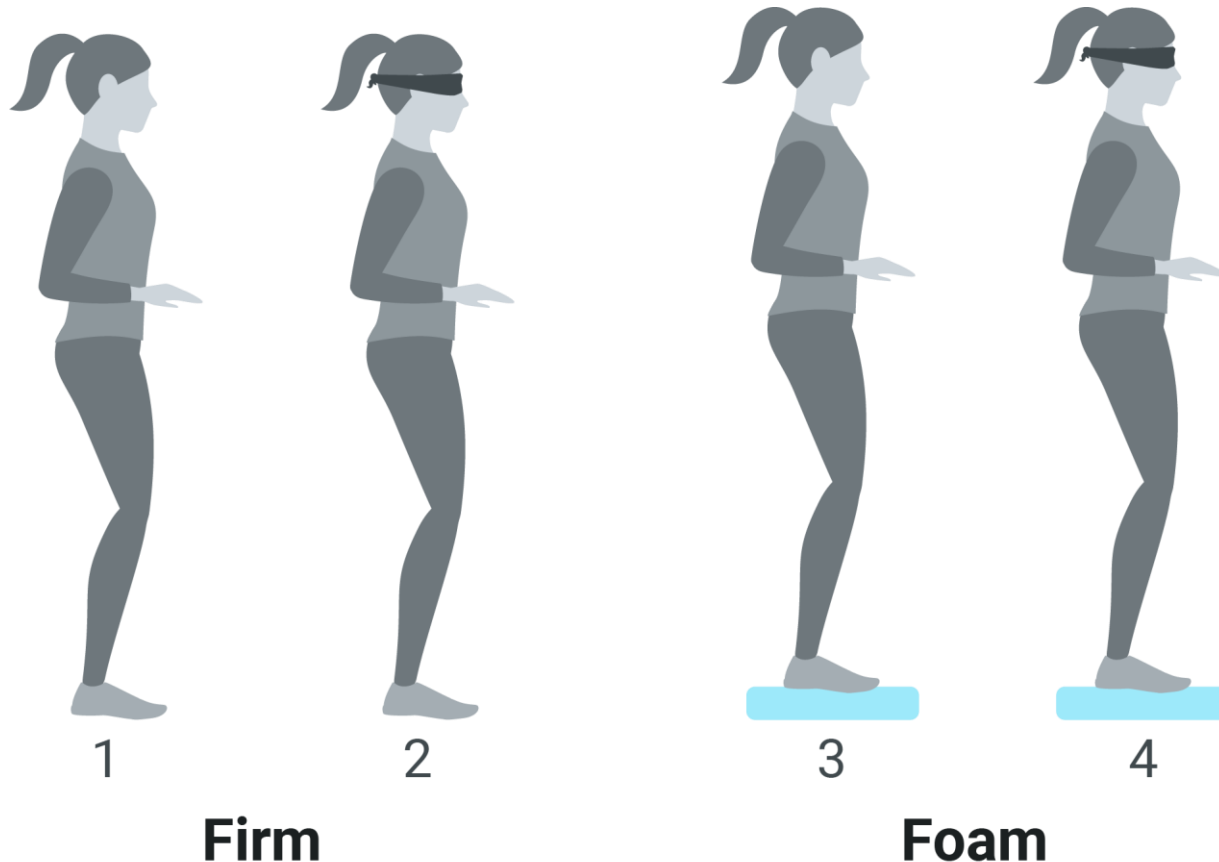
Always

- **Walk with head turns**
 - Path sway or LOB require more drill-down
- **TUG Cog**
 - Attention allocation deficits
- **DF ROM: DF/PF strength**
- **mCTSIB**
 - If EC conditions failed, need to drill down
- **DHT**
 - Especially if they've had a fall

Take a Breath

How Do You Determine Sensory Processing From Sensory Integrity?

Modified CTSIB (mCTSIB), Another Gateway Measure



Sensory Preference Hierarchy

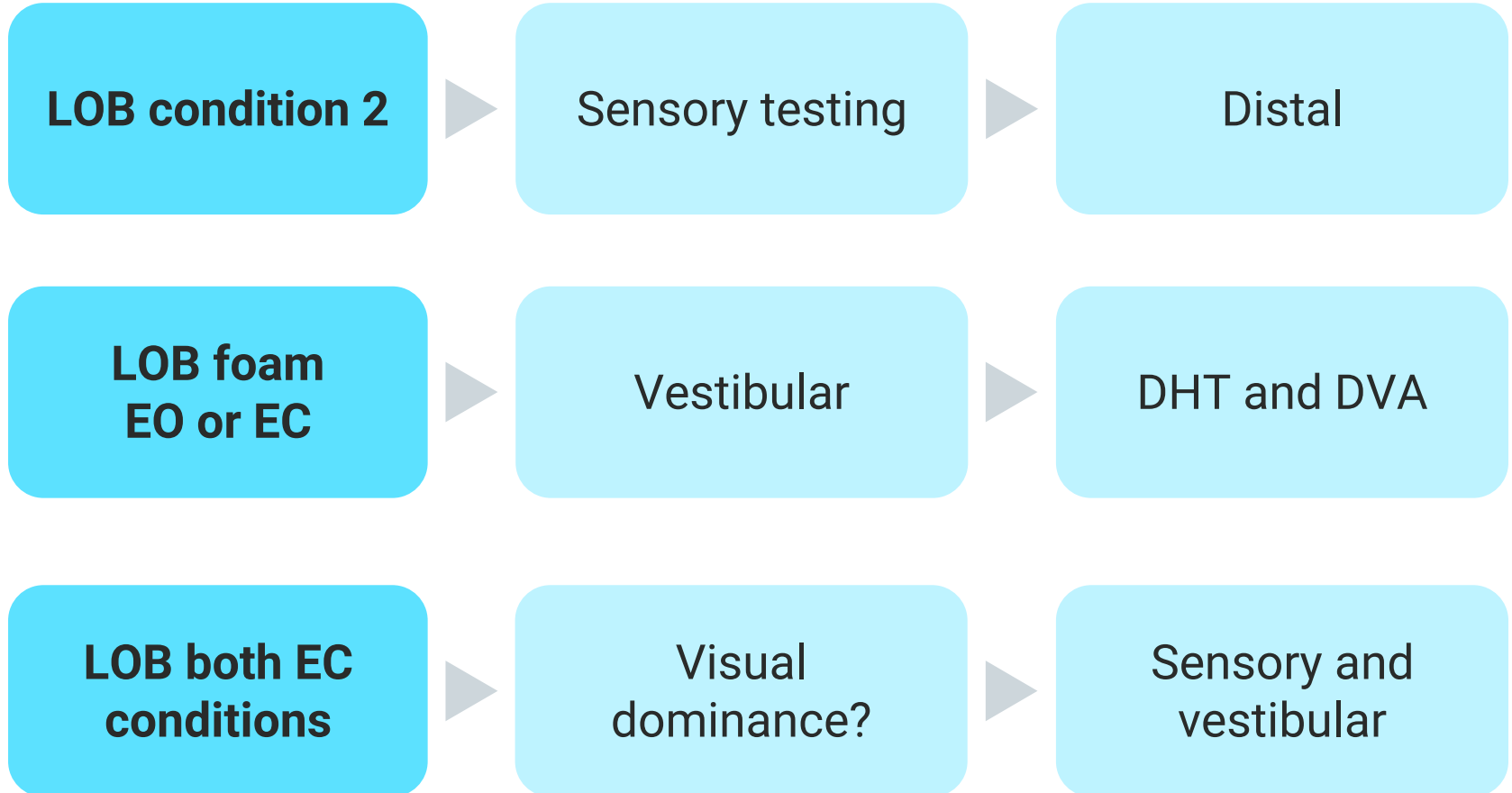
Firm Surface

1. Somatosensory: 70%
2. Vision: 20%
3. Vestibular: 10%

Compliant Surface

1. Vestibular: 60%
2. Vision: 20%
3. Somatosensory: 20%

Testing



Domains: Determinants and Tests

These Are What Affect Each Balance Domain

- **APC**
 - Sensory processing
 - mCTSIB, Mini-BESTest, Berg Balance Scale*, Tinetti*
 - Balance confidence
 - FoF scales: VAS, ABC, and FES
 - Ankle ROM affects LOS: STS, Functional Reach Test (FRT)



Domains: Determinants and Tests (cont.)

These Are What Affect Each Balance Domain

- **RPC**
 - Sensory processing
 - mCTSIB, Mini-BESTest, and Tinetti*
 - Postural movement strategies:
Push and Release Test, Mini-BESTest



Domains: Determinants and Tests (cont.)

These Are What Affect Each Balance Domain

- **SSPC**
 - Verticality (SVV)
 - mCTSIB, Mini-BESTest
 - Sensory processing
 - FoF scales: VAS, ABC, and FES
 - Balance confidence
 - Ankle ROM affects LOS



Subjective Visual Vertical (SVV)

- Easy to assess
- Appropriate for anyone who states they feel off-kilter or complains of veering, especially in CVA, TBI, or other neurological conditions
- Phone app: Visual Vertical
 - *The presenter has no financial relationships, commercial affiliations, or ownership stake in the developers of this application. Its inclusion is for educational and illustrative purposes only and does not imply endorsement by the presenter or the hosting organization.*

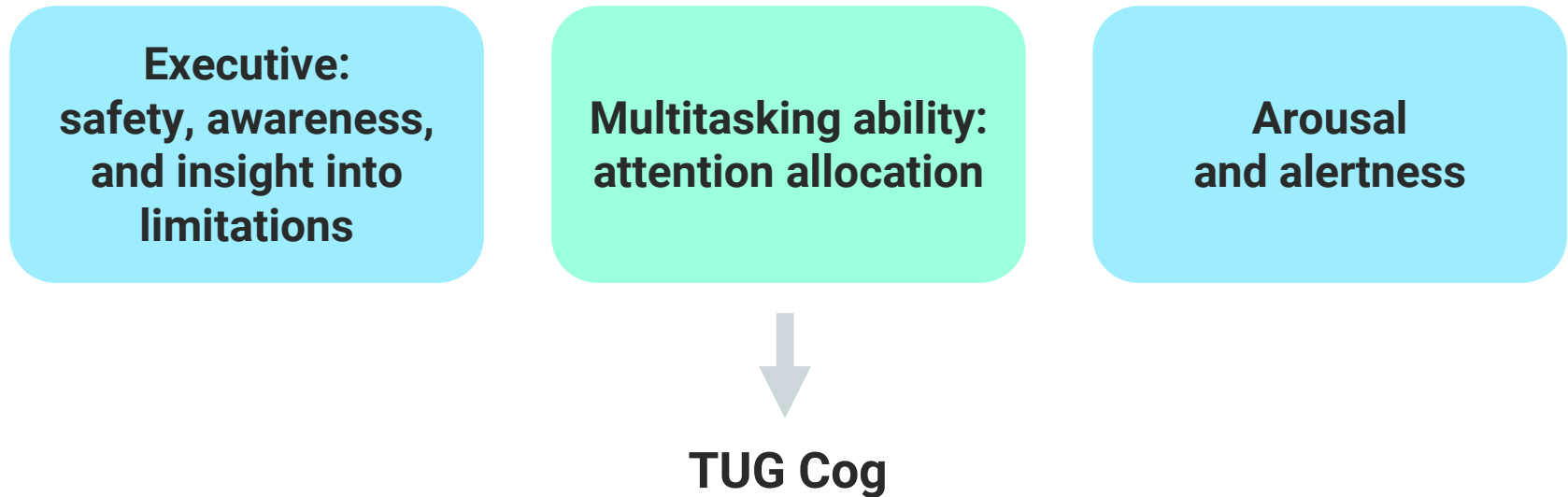
Domains: Determinants and Tests

These Are What Affect Each Balance Domain

Attention Allocation

- Cognition distractibility
 - Walking while talking
 - TUG Cog
 - Mini-BESTest

Cognitive Function



1. Varela-Vásquez et al., 2020

2. Shumway-Cook & Woollacott, 2000

Domains: Determinants and Tests

These Are What Affect Each Balance Domain

Stability While Moving/Walking

- Path sway while moving the head and walking
 - Stepping over objects
 - FGA, DGI
 - Mini-BESTest

Domains: Determinants and Tests (cont.)

These Are What Affect Each Balance Domain

Fatigue

- 6MWT or 2MWT
- 30-Second Sit-to-Stand
- Strength tests or TUG
Cog after they are tired

That's a Lot of Tests

So, you are probably thinking, “That’s a lot of stuff to evaluate. Who has time for that?”



Which Test Has Components of Most Domains?

- Mini-BESTest partially covers all (except DHT)
 - <https://www.sralab.org/rehabilitation-measures>
- Tinetti (reactive and sensory organization components are weak): AVOID
- DGI or FGA (no reactive)
- The Berg Balance Scale (considered the gold standard) has good predictive value for CVA functional outcomes, but it takes time to complete
 - No reactive
 - No DTC
 - No path sway while walking with head turns

Chapter Summary

- Defined specific tests that can be used to quickly ferret out which determinants are issues
- Reviewed some standardized tests and found which gives the best bang for the buck
- Considered gait speed
 - Primary gateway measure
 - Triage patients into high-, moderate-, and low-risk categories
 - Drives the need for further evaluation of specific determinants
- Defined secondary gateway measures
- Reviewed several standardized tests and the domains that they cover

Chapter 3

Developing a Balance Diagnosis



Assess DHTs (Always) If They Have Had a Fall

Vestibular Agnosia Is a Real Thing!

Check DHTs to rule out

Not only if they have complaints of being dizzy

Should be part of a standard comprehensive balance assessment

If you find nystagmus (NY) or symptoms, TREAT one side at the time of assessment

NEVER treat both sides in the same session

Determinant Checklist

(* Indicates Always)

	* RPC: Mini-BESTest, push/pull, etc.
	* APC: Mini-BESTest, STS
	* Attention allocation deficits: TUG Cog walking while talking, part of the Mini-BESTest
	* Biomechanical: ankle ROM and strength, Mini-BESTest covers ankle DF ROM and bilateral heel rise
	* Gaze stabilization deficits: walking with head turns, Mini-BESTest, DGA, or FGA, then if impaired, test DVA, manual VOR
	* Positional vertigo: DHTs
	* Balance confidence / fear of falling: ABC, FES
	* Sensory processing: mCTSIB
	Verticality: SVV only if veering and complaints of leaning
	Fatigue: 6MWT; if suspicious of this, I may do a second visit
	Somatosensory deficits: STD sensory tests if EC balance on CTSIB is impaired

What Are the Most Overlooked Areas in a Standard Balance Eval?

1. RPC
2. Attention allocation
3. Ankle strength and ROM
4. Footwear that the patient usually wears or prefers to wear
5. Gaze stabilization deficits
6. DHTs

The Process/Diagnosis

- Let's pull it all together into a one-hour assessment
- It is time to formulate a diagnosis and then a treatment plan

Eval Template

- **Subjective**

- How many falls and how did these occur?
- **Balance confidence:** ABC scale (scores less than 60 indicate FoF) OR
- **Fear of falling;** FES scale (scores greater than 70 indicate FoF)
- Or the **VAS** score for FoF

- **Objective**

- **Gait velocity:** m/sec; this score indicates the patient is or is not at risk of falling

Eval Template (cont.)

- **Postural control**
 - Modified Clinical Test for Sensory Integration and Balance (mCTSIB)
 - Anticipatory balance: bilateral heel raise, come to stand, SLS
 - Reactive postural control
 - Walking with head turns
 - Timed Up and Go (scores >13.5 sec indicate fall risk), TUG Cog
 - 5-Times Sit-to-Stand Test (5xSTS): scores >15 sec indicate fall risk
 - Mini-BESTest: total score (fall risk indicated at scores <20), APC, RPC, sensory organization, and dynamic gait

Eval Template (cont.)

- **Physical status**

- A. ROM: cervical ROM (helpful for DHT)

- Ankle DF ROM: stand on an incline

- B. Strength: bilateral heel raises, SLHR (best)

- Ankle DF: rock back on heels

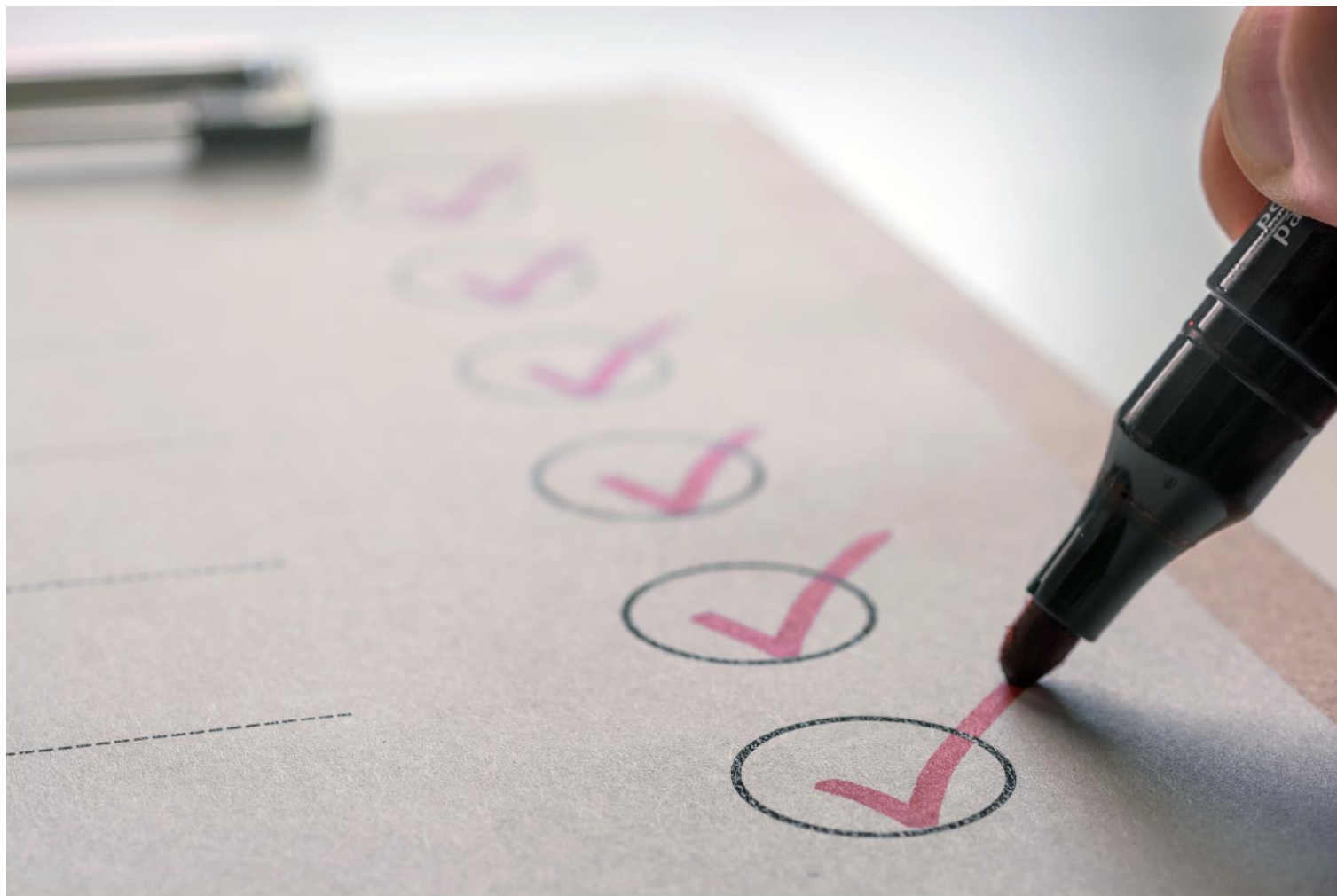
- C. Sensation: EC balance (normal/abnormal)

- Monofilament testing (if EC balance was bad)

Eval Template (cont.)

- Vestibular function
 - Manual VOR function: normal/abnormal tracking, increased symptoms?
 - Manual DVA: abnormal if loses more than two lines or if symptomatic
 - Subjective visual vertical (SVV): scores greater than $\pm 1.5^\circ$ normal
 - **Hallpike testing: whether dizzy or not**
 - Seated vertebral artery test: negative
 - Negative/+ (R) negative/+
 - If (+) will go to treatment

Evaluation Findings



Example for Assessment Summary (Template)

- Exam findings and symptoms are consistent with multifactorial balance dysfunction
- Based on fall risk measures administered, patient does (not) appear to be a fall risk at this time
- Based on the DHI score, the patient presents with minimal/moderate/severe limitations in activity and participation due to balance dysfunction
- Patient presents with deficits in the following areas

Assessment (Bullet List) Summary

	Postural instability because of biomechanical deficits (ankle strength and ROM)
	Postural instability because of somatosensory and/or sensory processing deficits (neuropathy)
	Postural instability because of sensory deficits (neuropathy) or sensory processing deficits
	Attention allocation deficits (poor multitasking ability)
	Gaze stabilization deficits
	Positional vertigo
	Reactive postural control deficit (RPC)
	Anticipatory postural control deficits (APC)
	Deficits in steady-state postural control (SSPC)
	Abnormal sensory weighting
	Poor balance confidence / FoF resulting in high-threat postural control strategies
	Verticality perception deficits
	Poor safety judgment / cognitive deficits

Typical Goals

1. Inhibit the effects of vertigo/dizziness to allow the patient to return to their previous level of activities
2. Decrease fall risk as evidenced by increased balance confidence, improved gait speed, and/or fall risk scores
3. Improve balance through the use of alternate (unaffected) systems, as evidenced by improved gait speed and improved fall risk scores
4. Improve VOR function as seen by improved DVA scores and tolerance to visual motion, with less path sway when walking
5. Substitute for sensory impairment with alternative devices as evidenced by improved balance confidence scores and/or gait speed
6. Independent in-home exercise program / patient education

Chapter Summary

- Covered BPPV and the importance of assessing and treating for it
- Reviewed how to pull it all together once the data is obtained
- Examined reason(s) a patient is falling
- Learned to go down the checklist and identify a specific area that needs attention during treatment
- Reviewed the importance of avoiding generic comments about bad balance; DEFINE IT!

Course Summary

- We have covered current research in the diagnosis of balance dysfunction
- We covered the underlying determinants that affect the three main postural control strategies (SSPC, APC, and RPC)
- We discussed which tests specifically evaluate each of the determinants
- We discussed the use of gateway measures to facilitate an efficient and effective evaluation strategy
- We pulled it all together by using an example evaluation template and documentation examples
- We summarized the patient-specific balance diagnosis

Chapter 4

Additional Demonstration Examples



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Medbridge

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