Assessment of Balance and Gait in the Older Adult at Risk for Falls in the Clinical Setting

Peggy R. Trueblood, PhD, PT
Professor and Chair, Physical Therapy
California State University, Fresno
Objectives

• Describe key *fall risk factors* in the older adult across various settings.

• Identify the *effect of aging* on balance and gait

• Identify the multiple systems that contribute to the normal *postural control system* as a framework to identify impairments.
• Use *evidence-based tools* to assess fall risk in the area of gait and balance; cognition; depression; home and environmental barriers and fear of falling with attention to cultural variations and type of setting.

• Assess for and understand the varied *assistive devices/technology and protective wear* available.
Just the Facts

- California currently has the largest older adult population of any state in the USA.

- Older adults are the fastest growing segment of the population (20% of population by 2020)

- Although the 60+ age group represents 10% of the population, they account for over 40% of the hospitalizations due to injuries.
Balance Disorders and Falls are serious problems facing the older adult.

- 1 in 3 persons > 65 years of age will fall (1 in 2 persons > 80 years of age)
- Higher incidence in institutions vs community-dwelling (50% of residents of LTC facilities experience falls)
- 60% among those with history of falls
Falls can have serious consequences

- Leading cause of injury deaths
- 87% fractures in older adults due to falls
- People ages 85 years and older are 10 to 15 times more likely to sustain a hip fracture
- 1 in 4 survivors will never regain their prior level of function
- Falls and instability are one of the major reasons for nursing home admissions
Falls present a serious health risk even those that do not cause injury

- Psychological Trauma
  - Fear of Falling
  - Loss of Self-Confidence
    - Inactivity
    - Functional Decline
    - Decreased Quality of Life
Can Measure *Fear of Falling* through Standardized Self-Report Tests

- ABC (Activities-specific Balance Confidence Scale) (Powell and Myers, 1995)

- BES (Balance Efficacy Scale) (Rose DJ, 2003, 2010)

- FES (Falls Efficacy Scale) (Tinetti et al, 1990)
Causes of Falls are Multi-factorial

- Peripheral Sensory Loss
- Cognitive Impairment
- Environmental Hazards
- Change in Medications
- Social Setting
- External demands (busy environments)
- Slowed Central Processing
- Muscle Weakness
- Balance and Gait Impairments
- Intrinsics
- Externals
## Most Common Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Sig/Total</th>
<th>Mean RR-OR</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle weakness</td>
<td>10/11</td>
<td>4.4</td>
<td>1.5 – 10.3</td>
</tr>
<tr>
<td>History of Falls</td>
<td>12/13</td>
<td>3.0</td>
<td>1.7 – 7.0</td>
</tr>
<tr>
<td>Gait deficit</td>
<td>10/12</td>
<td>2.9</td>
<td>1.3 – 5.6</td>
</tr>
<tr>
<td>Balance deficit</td>
<td>8/11</td>
<td>2.9</td>
<td>1.3 – 5.6</td>
</tr>
<tr>
<td>Assistive Device Use</td>
<td>8/8</td>
<td>2.6</td>
<td>1.2 – 4.6</td>
</tr>
<tr>
<td>Visual deficit</td>
<td>6/12</td>
<td>2.5</td>
<td>1.6 – 3.5</td>
</tr>
<tr>
<td>Arthritis</td>
<td>3/7</td>
<td>2.4</td>
<td>1.9 – 2.9</td>
</tr>
<tr>
<td>Impaired ADL</td>
<td>8/9</td>
<td>2.3</td>
<td>1.5 – 3.1</td>
</tr>
<tr>
<td>Depression</td>
<td>3/6</td>
<td>2.2</td>
<td>1.7 – 2.5</td>
</tr>
<tr>
<td>Cognitive Deficit</td>
<td>4/11</td>
<td>1.8</td>
<td>1.0 – 2.3</td>
</tr>
<tr>
<td>Age &gt; 80 yrs</td>
<td>5/8</td>
<td>1.7</td>
<td>1.1 – 2.5</td>
</tr>
</tbody>
</table>

*American Geriatric Society Guidelines*
Risk Factor Categories

**INTRINSIC** (internal) (55%)

- Medical conditions
- Gait and Balance deficits
- Damage to Sensory Systems
- Musculoskeletal Problems (weakness)
- Cognitive impairments

A problem with ANY of these components can result in dizziness or vertigo.
• **EXTRINSIC (Environmental) HAZARDS (45%)**
  – Visual and Surface conditions
  – Social setting
  – Medications
  – Activity level
  – External demands (Busy Environments)
Most falls (85%) occur in the home during normal activities of daily living.
Multiple Risk Factors and Fall Risk

- Percentage of recurrent falls increases from 10-69% as # risk factors increases from 1-4

  (Nevitt et al, 1989)

- Risk of falling ranged from 12% (no risk factor) to 100% (3 risk factors): Hip weakness, unstable balance, greater than 4 meds

  (Robbins et al, 1989)
The greater the number of risk factors present, the greater the likelihood of falls.
The Four C’s

Fall Prevention must be:

• Consistent
• Cross Disciplines
• Coordinated
• Culture
Clinical Algorithm

- Systematic process of decision-making
- Guides intervention
- Management of older persons in clinical setting or emergency room
- Person presents with a recurrent fall or has difficulty walking/balance
The First Step: Identifying and Assessing Risk

• Intensity of initial assessment varies by target population (AGS Guidelines, 2001)

• High risk groups require more comprehensive and detailed assessments:
  • Circumstances of fall
  • Identification of risk factors for falls
  • Medical co-morbidity
  • Functional status
  • Environmental risk assessment
## Risk Factors Vary by Settings

<table>
<thead>
<tr>
<th>Community Settings</th>
<th>Hospital Settings</th>
<th>Nursing Home Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous fall causing fracture</td>
<td>Acute illness</td>
<td>Lower body weakness</td>
</tr>
<tr>
<td>Caucasian</td>
<td>Extended bed rest</td>
<td>Poor vision &amp; hearing</td>
</tr>
<tr>
<td>Impaired cognitive function</td>
<td>Decreased mobility</td>
<td>Disorientation</td>
</tr>
<tr>
<td>Impaired balance</td>
<td>Delirium</td>
<td>Number of falls</td>
</tr>
<tr>
<td>Psychotropic drug use</td>
<td>Acute illness</td>
<td>Impaired balance</td>
</tr>
<tr>
<td></td>
<td>Unfamiliar surroundings</td>
<td>Dizziness</td>
</tr>
<tr>
<td></td>
<td>Psychotropic medications</td>
<td>Low body mass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Being female</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use of mechanical restraints</td>
</tr>
<tr>
<td>Being female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of mechanical restraints</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Community Settings

- **Medications*** (antihypertensives, anti-diabetic agents and sedatives most often cited)
- Physical Disabilities
- Poor Vision
- Cognitive Impairment

Healthy older adults may overestimate physical abilities and fall due to risk-taking behaviors

*Lee et al (2006) noted medical illnesses more important than medications as risk factors of falls in older community dwellers.*
Falls Significantly Impact Acute Care Hospitals

• Among older adults, falls are the leading cause of injury deaths and the most common cause of hospital admissions due to injury.

• In Fresno county 75% of hospitalized unintentional injuries were due to falls in people over 60 years of age

• Every 18 seconds an older adult is in the emergency room because of a fall
Injury Related Hospitalizations by Age in Fresno County 2006

Age Groups

- 0-20
- 20-44
- 45-64
- 65+

Bar chart showing the number of hospitalizations by age group.
# Acute Care Risk Assessments

## Hendrich Fall Risk Assessment

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Scale</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of Falls</td>
<td>YES</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Incontinence</td>
<td>YES</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Confusion</td>
<td>YES</td>
<td>3</td>
</tr>
<tr>
<td>Disorientation</td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Depression</td>
<td>YES</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Dizziness</td>
<td>YES</td>
<td>3</td>
</tr>
<tr>
<td>Vertigo</td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Poor Mobility</td>
<td>YES</td>
<td>2</td>
</tr>
<tr>
<td>Weakness</td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Poor</td>
<td>YES</td>
<td>3</td>
</tr>
<tr>
<td>Judgment</td>
<td>NO</td>
<td>0</td>
</tr>
</tbody>
</table>

## Morse Fall Risk Assessment

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Scale</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of Falls</td>
<td>YES</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Secondary Diagnosis</td>
<td>YES</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Ambulatory Furniture</td>
<td>Cane/Walker</td>
<td>30</td>
</tr>
<tr>
<td>Aid</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>IV/Heparin</td>
<td>YES</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Lock</td>
<td>NO</td>
<td>0</td>
</tr>
<tr>
<td>Gait/Impaired Transfers</td>
<td>Weak</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>0</td>
</tr>
<tr>
<td>Mental Status</td>
<td>Impaired</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>0</td>
</tr>
</tbody>
</table>
# Acute Care Risk Assessments

## Hendrich Assessment
- Only two categories: high and low risk (most put into high risk)
- Can use in LTC
- Interventions based on specific areas of risk
- Less research as Morse

## Morse Assessment
- High Risk > 45
- Moderate Risk 25-44
- Low Risk 0-24 driven
- Interventions standardized by level of risk
- Not designed for long-term care setting
Nursing Home Residents more vulnerable due to..

- Increased frailty
- More co-morbidities
- Cognitive deficits
- Inactivity
- Medical Side Effects
- Caregiver/patient ratios are poor
- Lack of skilled professionals

(Special Report, Office of Provincial Health Officer, 2004)
## Pros and Cons of Assistive Devices

### Advantages
- Provide biomechanic stabilization via increasing BOS
- Aids in recovery of equilibrium when instability occurs
- Provides tactile somatosensory information from the hand which contributes to postural stability via spatial orientation

### Disadvantages
- Increases attentional and neuromotor demands
- Potential destabilizing effect (eg when moves or advances device)
- Interfere with limb movement during balance recovery
- UE joint forces may be high
- Metabolic and physiologic demand may be high
Outpatient Risk Assessments

• Initial Screening:
  – TUG
  – Tinetti Gait and Balance Scale

• If at risk refer to physical or occupational therapy for more in-depth balance assessment
Measure of Fall Risk
Timed Up and Go (TUG)

>13.5 secs high risk for falls

Time it takes to stand up, walk 10 feet (3 meters) and return to the chair and sit down.
Tinetti Balance and Gait
(Tinetti, 1986)

- Uses a 3 point scale; Separate balance and gait portion
- Reliable (.85 inter-rater)
- Scores less than 12/16 on balance portion at risk for falls; Less than 8/12 on gait portion significant
- Scores less than 22/28 risk for falling
- Primarily used for screening
Other Performance Based Balance Tests

- **Berg Balance (Berg et al 1992)**
  
  - Functional balance measure - 14 items - uses 5 point scale (more sensitive than Tinetti)
  - Reliable and valid (.97-.98 inter and intra-rater)
  - < 46/56 risk for falling
  - Scores of 36 and less indicate a 100% risk of falling (Shumway-Cook, 1997)
  - Correlated to Tinetti (.91); TUG (.76)
Dynamic Gait Index (Anne Shumway-Cook 1995)

- Most appropriate test to assess fall risk in patients with vestibular dysfunction (Whitney et al, 2000)
- Scores of 19 or less predictive of falls in elderly
- Tests 8 facets of gait (with or without assistive device)
Clinical Approach to Falls

• **NOT** WHAT DISEASE caused the problem? (Based on one disease/diagnosis model)

• **BUT** WHAT COMBINATION of Physiologic changes, impairments and diseases are contributing?

• **AND** WHICH ONES can be modified? (Multifactorial impairment and intervention model)
From Horak (2006)

Resources Required for Postural Stability and Orientation

Biomechanical Constraints
- Degrees of Freedom
- Strength
- Limits of Stability

Cognitive Processing
- Attention
- Learning

Movement Strategies
- Reactive
- Anticipatory
- Voluntary

Control of Dynamics
- Gait
- Proactive

Sensory Strategies
- Sensory Integration
- Sensory Reweighting

Orientation in Space
- Perception
- Gravity, surfaces, vision
- Verticality

Incidence of Falls vs Age
Biomechanical Constraints

- Size and Quality of the Base of Support
Biomechanical Constraints

- **Limits of Stability**: The furthest distance in any direction a person can lean away from midline (vertical) without altering the BOS (by stepping, reaching or falling)
Factors affecting **Center of Gravity** and **Limits of Stability**

Mechanical (actual):
- COG position & control
- Base of Support
- Biomechanics
  - Range of Motion
  - Strength

Internal (perception)
- Accurate interpretation
- Experience (anxiety/fear)
- Pain
Clinical Test: Functional Reach Test

- Reliable (.89 test – retest)
- Scores less than 6-7 inches indicate limited functional balance (Healthy normal adults can reach 10 inches or more)

Duncan et al, 1990
Assessing Lower Extremity Strength

- 30 Second Chair Stand
  - # of times person stands in 30 seconds
  - [http://www.exrx.net/Calculators/SeniorChairstand.html](http://www.exrx.net/Calculators/SeniorChairstand.html)

Senior Fitness Test (Rikli & Jones, 2001)
Adaptive Movement Strategies
Selection is context specific

**Ankle Strategy:**
- Slow Adjustments
- COG Near Center
- Broad Support Base

**Hip Strategy**
- Rapid Adjustments
- COG Near Perimeter
- Narrow Support Base

**Suspension & Step**
- COG exceeding LOS
Anticipatory Postural Set

- Muscle activation prior to an expected COG disturbance
- Preparatory in nature
- Designed to counteract a predicted COG shift
- Tested during Tinetti Balance
CENTRAL MOTOR IMPAIRMENTS

- Strategy selection problems
- Increased reaction times
- Increased movement times
- Selection of strategies to counteract falls not optimal
- Anticipatory postural adjustments slowed
Sensory Strategies

Visual System

Vestibular System

Somato-Sensation

Lighting; movement of self or environment

Gravity; Linear & Angular Head and Eye Movement

Surface changes & irregularities; BOS changes
SOMATOSENSORY SYSTEM

Information from skin, joints, and muscles sent to the brain to provide information about joint and body position necessary for balance control.
Impairments in Somatosensation

- Nerves that carry sensory information to brain deteriorate with age
- Decreased proprioception
- Increased threshold to vibratory sensation
VISUAL SYSTEM

Vision plays two major roles:

1) object identification (central vision)

2) motion sense (peripheral vision)
Impairments in Visual System

- Reduced visual acuity
- Ability to accommodate
- Inability to adapt to the dark
- Contrast sensitivity
- Depth perception disorders (can be caused by cataracts in one eye)
- Glaucoma (difficulty with peripheral vision)
- Cataracts (cloud the lens)
- Macular Degeneration (near and distant vision primarily affected)
Common Impairments in Peripheral Visual System

Normal Vision

Glaucoma

Macular Degeneration

Cataract
VESTIBULAR SYSTEM

Receptors containing hair cells within the “inner ear” send information to the brain about the position of the head in space and sudden changes in the direction of movement of the head; also plays role in stabilizing our gaze during movement.
Two major roles:

**Gaze Stability**
- The ability to maintain gaze or visual focus on an external target during movement
- A function of an intact vestibulo-ocular reflex (VOR) at speeds > 85 degrees/second

**Postural Stability**
- The ability to maintain the body’s center of gravity (COG) over the base of support (BOS) in a given sensory environment
Impairments in Peripheral Vestibular System

- **Deficiencies**
  - Loss of hair cells
  - Reduction in VOR gain
Need to be able to **choose** accurate sensory system in any given task for normal balance.
Abnormal Sensory Organization

- Dysfunction - person who is unable to use a sense
- People who select inaccurate sense
  - elderly who are “visually dependent”
  - patients with post traumatic dizziness often select vision as a reference and become unstable in an environment
- **Assessing Sensory Systems**
  - **Romberg Test** (feet together, EO, 20 sec compared to feet together, EC, 20 sec); originally used to test for posterior column disorders (Thyssen 1982)
  - **Tandem (Sharpened) Romberg** to increase challenge
  - **Clinical Test for Sensory Interaction on Balance (CTSIB)**
    - Condition 1 = EO, firm surface
    - Condition 2 = EC, firm surface
    - Condition 3 = EO, foam surface
    - Condition 4 = EC, foam surface

Modified Clinical Test for Sensory Interaction on Balance (mCTSIB) (Horak & Shumway 1986)
Determination of Body Position

Compare, Select & Combine Senses

Visual System  Vestibular System  Somato-Sensation

- Process inputs from the periphery
- Weight inputs based upon relevance (Sensory Weighting)
- Select appropriate sensory input based upon
  - Availability
  - Accuracy
  - Value to the task at hand

Orientation in Space
Control of Dynamics

Functional walking is a smooth progression of the COG as weight is shifted from one limb to the other, minimizing the associated energy demands.
Resources Required for Normal Gait

• Free passive joint mobility
• Appropriate timing of muscles
• Appropriate intensity of muscle action
• Normal sensory input (proprioceptive, vestibular, visual)
• Appropriate attention and motivation
• Adaptation (change surfaces; avoid obstacles; alter speed)
Normal Aging

• Should not affect range of motion
• Should not affect timing of muscle activity

• Can produce muscle weakness
• Can affect visual, proprioceptive, and vestibular systems
• Decline in dual-tasks
• Decrease in adaptation of gait
Detectable gait abnormalities are present in.....

20-40% of adults age 65 and over and 50% of adults age 85 and over
Muscle Weakness

- Hip extensors
- Knee extensors
- Plantarflexors
- Dorsiflexors
THEORETICAL EXPLANATIONS?

• Multisystem degradation and pathology
• Preferential Shift in Strategy Used
  – Trading speed for accuracy
• Altered information-processing
  – Overall slowing in planning and execution
  – Change in way movement problem is solved
• Older adults with cognitive problems have 2 X higher risk of falls than cognitively normal older adults.
• Postural control is impaired by a secondary cognitive task
• Falls can result from insufficient cognitive processing to control posture while occupied with a secondary cognitive task
• Aging leads to a decline in attention and can lead to increased dual task cost
Impact of Aging on Cognitive Skills

Cognitive Tests

- **Mini Mental Exam (<26/30 impaired)** (Folstein et al, 1975)
  - Primarily tests orientation, recall and praxis (doesn’t address goal selection, planning, motor sequencing, selective attention)
- **Attention (Walkie-Talkie)** (Rose DJ, 2003)
- **TUG motor and TUG cognitive**
TUGc and TUGm

• Now have modified TUG to add a secondary task
• TUG cognitive (TUGc) = counting backwards from a number between 80-100 (> 15 seconds increased risk for falls)
• TUG manual (TUGm) = carrying a glass of water (> 14.5 seconds or more than 4.5 seconds difference between regular TUG and TUGm increased risk for falls)
Extrinsic Risk Factors

• Home Fall Hazards
• Public Fall Hazards
Home Safety Checklists

- Self-report
- Quick Screening of safety hazards
- Most also include recommendations
- Few have demonstrated reliability/validity studies
- Focus on hazards rather than the use of the environment
- Resources: Center for Disease Control (CDC) and Rebuilding Together
Other Extrinsic Risk Factors

- Social Situation
  - Living alone
  - Socially isolated
- Activity Level
  - Active versus sedentary
  - Prior experience
Many, if not all, risk factors can be reduced or eliminated using evidence-based intervention strategies.