Falls: Cognitive Motor Perspectives

Joe Verghese, MBBS, MS.

Integrated Divisions of Cognitive & Motor Aging (Neurology) & Geriatrics (Medicine)
Albert Einstein College of Medicine, Bronx, NY

joe.verghese@einstein.yu.edu
GOALS

1. Describe simple and easy to use cognitive-motor assessments that can be used to improve identification of falls in older patients.
   - Picture MIS
   - Neurological gait abnormalities
   - Walking while talking

2. ‘Cognitive treatments’ for falls
“Old age comes with the first fall, and death with the second.”

Gabriel Garcia Marquesa

Love in the time of cholera
AGS fall guidelines, 2001

Periodic case finding in Primary Care: Ask all patients about falls in past year

- No Falls
  - No intervention

- Recurrent Falls

- Single Fall

- Gait/balance problems

Check for gait/balance problem

- No Problem

Patient presents to medical facility after a fall

Fall Evaluation*

Assessment
- History
- Medications
- Vision
- Gait and balance
- Lower limb joints
- Neurological
- Cardiovascular

Multifactorial intervention (as appropriate)
- Gait, balance, & exercise programs
- Medication modification
- Postural hypotension treatment
- Environmental hazard modification
- Cardiovascular disorder treatment

*See text for details
<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Significant</th>
<th>Mean RR-OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle weakness</td>
<td>10/11</td>
<td>4.4</td>
<td>1.1 – 10.3</td>
</tr>
<tr>
<td>Previous 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>1.6 – 5.4</td>
</tr>
<tr>
<td>Use assist device</td>
<td>8/8</td>
<td>2.6</td>
<td>1.2 – 4.6</td>
</tr>
<tr>
<td>Visual</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>1.4 – 2.9</td>
</tr>
<tr>
<td>Depression</td>
<td>3/6</td>
<td>2.2</td>
<td>1.7 – 2.5</td>
</tr>
<tr>
<td><strong>Cognitive impaired</strong></td>
<td><strong>4/11</strong></td>
<td><strong>1.8</strong></td>
<td><strong>1.0 – 2.3</strong></td>
</tr>
<tr>
<td>Age &gt;80</td>
<td>5/8</td>
<td>1.7</td>
<td>1.1 – 2.5</td>
</tr>
</tbody>
</table>

Gait and balance should remain mainstay of fall screening. JAMA 2007
Fall risk factors: dementia

- Gait: Parkinsonian
- Postural imbalance
- Type and severity of dementia
- Behavioral disturbances
- Neuroleptics
- Functional status
- Low bone mineral density

Dementia as a Risk Factor for Falls and Fall Injuries Among Nursing Home Residents

Carol van Doorn, PhD, * Ann L. Gruber-Baldini, PhD, * Sheryl Zimmerman, PhD, † J. Richard Hebel, PhD, * Cynthia L. Port, PhD, * Mona Baumgarten, PhD, * Charlene C. Quinn, PhD, * George Taler, MD, ‡ Conrad May, MD,* and Jay Magaziner, PhD, MSHyg, * for the Epidemiology of Dementia in Nursing Homes Research Group

Table 2. Falls During 2-Year Follow-Up by Dementia Status in Newly Admitted Residents of 59 Maryland Nursing Homes, 1992–1995

<table>
<thead>
<tr>
<th>Dementia Status</th>
<th>Rate of Falling*</th>
<th>Unadjusted Relative Risk</th>
<th>95% Confidence Interval</th>
<th>Adjusted Rate of Falling†</th>
<th>Adjusted Relative Risk†</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without</td>
<td>2.33</td>
<td>1.00</td>
<td>—</td>
<td>1.87</td>
<td>1.00</td>
<td>—</td>
</tr>
<tr>
<td>With</td>
<td>4.05</td>
<td>1.74 ‡</td>
<td>1.34–2.25</td>
<td>3.61</td>
<td>1.93 ‡</td>
<td>1.54–2.42</td>
</tr>
</tbody>
</table>

* Rate per 365 patient days.
† † Adjusted for: resident believes could improve activities of daily living (ADLs), stroke history, presence of Alzheimer care unit in facility, and number of full-time nursing aides per 100 beds.
‡ P<.001.

- 1044 no dementia
- 971 dementia
Survival curve showing time to first fall by diagnosis.

http://www.plosone.org/article/info:doi/10.1371/journal.pone.0005521
• PMIS
• Neurological gait
• WWT
BRIEF METHODOLOGICAL REPORTS

Picture-Based Memory Impairment Screen for Dementia

Joe Verghese, MBBS,* Moban L. Noone, DM,† Beena Johnson, MBBS,‡ Anne F. Ambrose, MBBS,‡ Cuiling Wang, PhD,§ Herman Buschke, MD,* Vayyattu G. Pradeep, DM,† Kizhakkaniyakath Abdul Salam, DM,‡ Kunnukatil S. Shaji, MD,‖ and Pavagada S. Mathuranath, DM#

Journal of the American Geriatrics Society, 2012; 60(11):2116-20

Kerala-Einstein study (NIA/Fogarty)
Qualities of an ideal cognitive screening test

- High sensitivity and specificity
- Cheap
- Fast
- Easy to use
- Quick training
- Does not need a doctor
- Culture fair
- Not educationally biased
- Not affected by depression
MMSE

Difficult to translate
Age and gender effect
Strong education effect

Mathuranath et al, Int J Geriatr Psychiatry. 2004
Memory Impairment Screen. Buschke et al. Neurology 1999

- 4-minute, 4-item, delayed free- and cued-recall test of memory impairment.
- 483 Bronx seniors (50 dementia)

Alzheimer’s Association recommendations for operationalizing the detection of cognitive impairment during the Medicare Annual Wellness Visit in a primary care setting

Cyndy B. Cordell*, Soo Borson, Malaz Boustani, Joshua Chodosh, David Reuben, Joe Verghese, William Thies, Leslie B. Fried; the Medicare Detection of Cognitive Impairment Workgroup
Qualities of an ideal cognitive screening test for resource poor settings

- High sensitivity and specificity ✓
- Cheap ✓
- Fast ✓
- Easy to use ✓
- Quick training ✓
- Does not need a doctor ✓
- Culture fair ✗
- Not educationally biased ✗
- Not affected by depression ✗

KERALA-EINSTEIN STUDY

Baby Memorial Hospital, Kozhikode city, Kerala
- Outpatient clinics

304 subjects
65 dementia, 27 MCI

Mean age 68 y
55% men
Mean education 8 y
167 <10y school
Transportation?

Body part?

Ornament?

Animal?
Picture Memory Impairment Screen

2 Minute distraction before recall (any of following)

- Count back from 20
- IADL questionnaire
- Non-memory tests

Picture Memory Impairment Screen

SCORING

Free recall: 2 points
Cued recall (providing clue): 1 point
Total: 8 points, range 0 to 8

Abnormal: 5 and below
Picture Memory Impairment Screen

SCORING

Free recall: 2 points
Cued recall (providing clue): 1 point
Total: 8 points, range 0 to 8

Abnormal: 5 and below

PMIS is based on MIS, but is not the same!
Validity: P-MIS versus MMSE

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMSE ≤ 24</td>
<td>90</td>
<td>80</td>
<td>64</td>
</tr>
<tr>
<td>P-MIS ≤ 5</td>
<td>90</td>
<td>95</td>
<td>90</td>
</tr>
</tbody>
</table>

Overall
N 304
65 dementia

PMIS scores
Dementia 1.5
Normal 7.5

Low correlation
- Age
- Sex
- Depression

## Low education/illiteracy

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<tr>
<td>MMSE ≤ 24</td>
<td>90</td>
<td>80</td>
<td>64</td>
</tr>
<tr>
<td>P-MIS ≤ 5</td>
<td>88</td>
<td>96</td>
<td>90</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMSE ≤ 24</td>
<td>100</td>
<td>71</td>
<td>63</td>
</tr>
<tr>
<td>P-MIS ≤ 5</td>
<td>98</td>
<td>99</td>
<td>93</td>
</tr>
</tbody>
</table>

Education ≤ 9 years
N 167
30 dementia

Qualities of an ideal cognitive screening test for resource poor settings

- High sensitivity and specificity ✓
- Cheap ✓
- Fast ✓
- Easy to use ✓
- Quick training ✓
- Does not need a doctor ✓
- Culture fair ✓
- Not educationally biased ✓
- Not affected by depression ✓

Meanwhile in the Bronx...
Prevalence of Abnormal Gait across Age

- % Abnormal
- % Mild
- % Moderate
- % Severe

Einstein Aging Study

Community based aging study in Bronx
632 adults age 70 and over
Mean age 80.6 years, 62% women
Mean follow-up of 21 months
244 (39%) subjects fell
Mean fall rate: 0.47 falls per person year
MCQ 1

The following gait abnormalities predict increased risk for dementia except:

A. Hemiparetic gait
B. Neuropathic gait
C. Frontal gait
D. Unsteady gait.

<table>
<thead>
<tr>
<th></th>
<th>Neuro gait (n = 120)</th>
<th>Not neuro-gait (n = 532)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education, year (mean SD)</td>
<td>13.6 3.5</td>
<td>13.9 3.4</td>
<td>0.267</td>
</tr>
<tr>
<td>Illness index (mean SD)</td>
<td>1.6 1.3</td>
<td>1.2 1.0</td>
<td>0.001</td>
</tr>
<tr>
<td>Parkinson’s disease, %</td>
<td>2.6</td>
<td>0.4</td>
<td>0.018</td>
</tr>
<tr>
<td>Strokes, %</td>
<td>19.1</td>
<td>5.2</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>22.6</td>
<td>16.0</td>
<td>0.091</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>69.8</td>
<td>58.8</td>
<td>0.028</td>
</tr>
<tr>
<td>Medications (mean SD)</td>
<td>5.3 4.0</td>
<td>5.0 3.7</td>
<td>0.390</td>
</tr>
<tr>
<td>Fall previous year, %</td>
<td>39</td>
<td>29</td>
<td>0.035</td>
</tr>
<tr>
<td>Disability score, (mean SD)</td>
<td>1.3 1.8</td>
<td>0.6 1.0</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

# Neurological gaits & Falls

<table>
<thead>
<tr>
<th>Gait subtypes</th>
<th>N = 632</th>
<th>Risk ratio (95% CI) *</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurological gait</td>
<td>120</td>
<td>1.49 (1.11 – 2.00)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Adjusted for age, sex, education, illness index, medication count, falls in the previous year, Blessed test scores, and disability score.

*J Neurol 2010; 257: 392–8*
## Neurological gaits & Falls

<table>
<thead>
<tr>
<th>Gait subtypes</th>
<th>N</th>
<th>Risk ratio (95% CI) *</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurological (overall)</td>
<td>120</td>
<td>1.49 (1.11 – 2.00)</td>
<td>0.007</td>
</tr>
<tr>
<td>Hemiparetic</td>
<td>15</td>
<td>0.92 (0.47 – 1.80)</td>
<td>0.81</td>
</tr>
<tr>
<td>Frontal</td>
<td>9</td>
<td>1.59 (0.72 – 3.50)</td>
<td>0.25</td>
</tr>
<tr>
<td>Parkinsonian</td>
<td>10</td>
<td>0.90 (0.36 – 2.22)</td>
<td>0.82</td>
</tr>
<tr>
<td><strong>Unsteady</strong></td>
<td>42</td>
<td><strong>1.52 (1.04 – 2.22)</strong></td>
<td><strong>0.03</strong></td>
</tr>
<tr>
<td>Spastic</td>
<td>12</td>
<td>1.20 (0.47 – 3.11)</td>
<td>0.69</td>
</tr>
<tr>
<td>Neuropathic</td>
<td>23</td>
<td>1.94 (1.07 – 3.52)</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Adjusted for age, sex, education, illness index, medication count, falls in the previous year, Blessed test scores, and disability score.
Gait speed predicts:

- Falls (J Am Geriatr Soc 2002)
- Dementia (JNNP 2009)
- Stroke (Stroke 2008)
- Disability (J Am Geriatr Soc 2012)
- Death (J Am Geriatr Soc 2012)

SLOW GAIT = 0.7 m/sec or less
.... so dumb he can't walk and chew gum at the same time.
Walking While Talking Test


40 feet: sec

A, C, E...
Functional Near Infra-red Spectroscopy (fNIRS)

Youtube:
http://tinyurl.com/l7a9pfd
http://tinyurl.com/lxdao22

Holtzer, et al.
J Gerontol Med Sci 2011
### Factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>Model 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Model 2&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>P-value</td>
</tr>
<tr>
<td>Rhythm Factor</td>
<td>0.917 (0.81-1.04)</td>
<td>0.161</td>
</tr>
<tr>
<td>Variability Factor</td>
<td>1.041 (0.92-1.18)</td>
<td>0.539</td>
</tr>
<tr>
<td>Pace Factor</td>
<td>1.174 (1.04-1.33)</td>
<td>0.011</td>
</tr>
</tbody>
</table>

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**WWT and falls**

646 EAS seniors  
Mean follow-up 2.6y  
337 fallers

Ayers, et al.  
Gerontology in press
National estimate of injuries related to cell phone use among pedestrians and drivers.


Nasar JL, Troyer D. Accident Analysis & Prevention 2013
MCQ 2

An elderly woman who has had several falls has to stop to talk while walking. The ability to walk while talking depends on the following cognitive process.

a. Divided attention
b. Memory
c. Judgment
d. Language
Executive attention    Executive attention   Executive attention
Memory    Memory    Memory
Verbal IQ    Verbal IQ    Verbal IQ

A, C, E

Holtzer, Neuropsychology 2006
Holtzer, Neuropsychology, 2007
New cognitive treatments?

- Pharmacological
- Brain games
Attention training: rationale

- Observational studies
- Common brain substrates
- Common risk factors: genetics, vascular
- Cognitive-motor responds to treatment: Methylphenidate, DBS, dopamine
- Dual task training: balance
Gait and Cognition: A Complementary Approach to Understanding Brain Function and the Risk of Falling

Manuel Montero-Odasso, MD, PhD, AGSF,* † Joe Verghese, MB, BS, ‡ Olivier Beauchet, MD, PhD, § and Jeffrey M. Hausdorff, PhD ||***

• **Methylphenidate:**
  PD gait (Auriel E, Clin Neuropharmacol 2006)
  Normal elderly executive function and gait (Ben Itzhak R, JAGS 2008)

• **Galantamine:**
  Alzheimer’s gait (Assal F, JAGS 2008)

• **Donepezil:**
  AD/MCI normal and dual task gait (Montero-Odasso M, JAGS 2009)
23 PD patients: 6 weeks of donepezil or placebo with a 3-week washout between phases
Effect of Cognitive Remediation on Gait in Sedentary Seniors

Joe Verghese, 1 Jeannette Mahoney, 1,2 Anne F. Ambrose, 3 Cuiling Wang, 4 and Roe Holtzer 1,2

Journal of Gerontology: Medical Sciences 2010;65(12):1338-43
24 subjects
• >70 years
• Sedentary
• < 1m/sec

12 Cog Rem
12 usual care

3 sessions/week
10 weeks
Telephone contact
10 weeks

Week 1: Baseline assessment
• Walking: normal, WWT
• Cognitive, ANT
• fNIRS

Safe ambulation
Exercise facilities

Week 12: Post assessment
Effect on Gait Velocity

<table>
<thead>
<tr>
<th>Time:</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (baseline)</td>
<td>12/12</td>
</tr>
<tr>
<td>3 months (Post-trial)</td>
<td>10/10</td>
</tr>
<tr>
<td>6 months (3-month follow-up)</td>
<td>9/9</td>
</tr>
</tbody>
</table>

Percent change in gait velocity
Mean ± SEM

J Gerontol Med Sci 2010
WWT: Walking while reciting alternate alphabets

Percent change in gait velocity

Mean ± SEM

<table>
<thead>
<tr>
<th>Time</th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (baseline)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 months (Post-trial)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 months (3-month follow-up)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

J Gerontol Med Sci 2010
Dancing and risk of dementia
Adjusted Hazard Ratio 0.24 (0.06-0.99)

Summary

• Cognitive evaluations are an essential component of the falls toolbox
• Cognitive-motor approaches might help identify cognitive or neurological pathways to falls
• Cognitive based interventions
Disclosures:

Funding received from NIH grants PO1 AG03949 (NIA), RO1 AG025119 (NIA), RO1 AG039330 (NIA), RO1 AG036921 (NIA/Fogarty), and R21 25572 (NIA/Fogarty)