Dementia and Falls

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14th Annual Alzheimer’s Disease Update
November 11, 2016
Outline

• Cognitive impairment and risk of falling
• Adverse outcomes associated with falls and cognitive impairment
• Potential mechanisms
• Reducing falls risk
Outline

• Cognitive impairment and risk of falling
  • Adverse outcomes associated with falls and cognitive impairment
  • Potential mechanisms
    • Walking is a cognitive task
    • White matter changes
• Subtle cognitive decline and falls risk: The Kenosha County Falls Prevention Study
## Community populations

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Data Recording</th>
<th>Incidence of falls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horikawa, 2005</td>
<td>Community; Alzheimer’s disease</td>
<td>Retrospective every 2 weeks</td>
<td>42% over 1 year</td>
</tr>
<tr>
<td>Tinetti, 1988</td>
<td>Community; cognitive impairment subgroup (5+ errors SPMSQ)</td>
<td>Prospective, continuous</td>
<td>67% over 1 year</td>
</tr>
</tbody>
</table>
Subtle cognitive decline is associated with increased risk for falls

• Secondary analysis of control group of randomized clinical trial of multifactorial falls intervention

• Clarify the relationship between subtle cognitive impairments, as measured with the Mini Mental State Exam (MMSE) and risk for falls.

Subjects

Older adults residing in Kenosha County who were at-risk for falling

1) a history of two or more falls in the last year,

or

2) one fall within two years prior to entering the study with either injury or gait and balance problems
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Older adults residing in Kenosha County who were at-risk for falling

1) a history of two or more falls in the last year, or

2) one fall within two years prior to entering the study with either injury or gait and balance problems

and

Age 65 years or older, living independently

In the control group
Subjects

Exclusion criteria

• Enrollment in hospice
• Intention to move out of the area in the next year
• Inability to provide informed consent (and not living with related caregiver)
Results: Multivariate Model

Estimated RR for falls and 95% CIs for individual MMSE scores (relative to MMSE score 30/30) down to MMSE score of 22

*Indicates significant (p<0.05) difference in falls rate compared to next highest MMSE score
Conclusions

• Even mild cognitive changes were associated with increased rate of falls in a group at-risk for falls
  – Multivariate model predicted 16% increased rate of falls for MMSE of 29/30 (compared to 30/30)
• Appears to be a linear relationship between loss of point on the MMSE and increased rate of falls in the mildly impaired ranges
Preclinical Alzheimer disease is associated with increased falls risk

- Sample with mean MMSE of 28-29, mean age 74
- Falls rate increased as amyloid amount increased (by PiB imaging)
- Falls rate increased as CSF biomarkers increased.

— Stark et al, Neurology, 2013
## Institutional population

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<tr>
<th>Study</th>
<th>Setting</th>
<th>Dementia status</th>
<th>Rate of falls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Doorn, 2003</td>
<td>Nursing Home</td>
<td>Without dementia</td>
<td>2.33 falls/year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>With dementia</td>
<td>4.55 falls/year</td>
</tr>
<tr>
<td>Van Dijk, 1993</td>
<td>Nursing Home</td>
<td>With dementia</td>
<td>4.1 falls/year</td>
</tr>
<tr>
<td>Jensen, 2002</td>
<td>Group Home</td>
<td>With dementia</td>
<td>4.3 falls/year</td>
</tr>
</tbody>
</table>
Association of falls with severity of dementia and physical impairment

Rate of falls increased as severity of dementia and physical impairment increased, but decreases with most severe dementia or physical impairment

-Van Dijk, 1993
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Outcomes associated with falls and dementia

Buchner, Larsen, 1987

• 157 patients with Alzheimer’s Disease; three year follow-up after initial evaluation

• Fracture rate = 69/1000y

• More than 3 times the age-and-sex adjusted fracture rate in general population

• At 3 year follow-up 33% were classified as non-ambulatory
Fracture risk in patients with Alzheimer’s Disease

Melton, 1994

- 543 Rochester, MN residents with Alzheimer’s Disease, with age-and-sex matched controls

- In 10 year follow-up after onset, 23% of cases compared with 9% of controls suffered hip fracture (p<0.001).
Survival of Outpatients with Alzheimer-type Dementia

• Prospective cohort of 126 patients diagnosed with Alzheimer-type dementia

Walsh, Welch, Larson, 1990

Median Survival

<table>
<thead>
<tr>
<th>Wandering &amp; falling</th>
<th>From Entry</th>
<th>From symptom onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>3.0 years</td>
<td>5.4 years</td>
</tr>
<tr>
<td>No</td>
<td>6.2 years</td>
<td>9.3 years</td>
</tr>
</tbody>
</table>
## Loss to the Community

- Three year follow-up of 113 community-living patients with Alzheimer’s dementia \textit{Buchner, Larson, 1988}

Outmigration due to death or NH placement

<table>
<thead>
<tr>
<th></th>
<th>Cumulative Incidence</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Falls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild dementia</td>
<td>33%</td>
<td>1.8 (.96-3.4)</td>
</tr>
<tr>
<td>Severe</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td><strong>Falls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild dementia</td>
<td>79%</td>
<td>2.4 (1.3-4.4)</td>
</tr>
<tr>
<td>Severe</td>
<td>92%</td>
<td>2.8 (1.6-4.9)</td>
</tr>
</tbody>
</table>
Outline

• Cognitive impairment and risk of falling
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• Potential mechanisms
• Reducing falls risk
Walking and cognition

• Walking relies on multiple cognitive domains
  – executive function
  – Attention
  – visuospatial abilities
  – working memory
  – Information processing
  – Reaction time
Clearing obstacles and Alzheimer’s disease

- 17 patients with probable AD, and 2 groups of healthy older adults

- AD patients placed heel closer to obstacle ($p<.01$)

- AD patients more likely to hit obstacle ($p<.005$)

Alexander, 1995
Dual Task Paradigms

Walking without a cognitive demand vs.
Walking with cognitive demand (Dual task)

Look for markers of altered gait (e.g., swing time variability, gait variability, stopping, slowing)
Postural sway in older adult fallers with lower MMSE – effect of dual task

Hauer, 2003

• 40 older adults with injurious fall in past 6 months:
  • 20 without cognitive impairment (mean MMSE 28)
  • 20 with cognitive impairment defined as MMSE of 17-23 (mean 19)

• Patients without cognitive impairment had no increase in sway with dual task (serial 7s)
• With cognitive impairment had doubling of sway area with dual task
• MMSE strongly correlated with sway during dual task ($r = -.420$, $p = .007$)
Divided attention and gait variability in Alzheimer’s

- 35.8% increase in stride to stride variability with dual task (p=0.007)
- Change in stride variability with dual task correlated with MMSE (r=-0.47) and clock draw r=0.49).
- In stepwise regression, clock draw was strongest predictor of change.

Sheridan JAGS, 2003
Executive control deficits predict falls

- 262 participants with intact cognition, no falls in past year, followed for falls for 2 years

- Worst EF quartile had 3 times increased falls risk compared to best quartile

- Dual task gait variability also predicted future falls

Herman, J. Gerontol, 2010
Five year follow up for falls

- Risk for falls associated with:
  - Executive function
  - Attention
  - Dual task gait variability

Mirelman, PLoS ONE, 2012
Role of Risky Performance of Everyday Mobility Activities

• What causes increased falls risk for people with cognitive decline? How much of increased risk is due to impaired judgment affecting performance of everyday?

• Secondary analysis of Dane County SAFE Study (multifactorial falls prevention RCT)

245 older adults at risk for falls, followed for 1 year

<table>
<thead>
<tr>
<th>Behavior</th>
<th>No. of Older Adults Performing Activity&lt;sup&gt;a&lt;/sup&gt;</th>
<th>No. of Older Adults Performing Activity in Risky Manner&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Stair climbing</td>
<td>174</td>
<td>70</td>
</tr>
<tr>
<td>Laundry</td>
<td>177</td>
<td>71</td>
</tr>
<tr>
<td>Bathing</td>
<td>237</td>
<td>95</td>
</tr>
<tr>
<td>Housekeeping</td>
<td>141</td>
<td>57</td>
</tr>
<tr>
<td>Shopping</td>
<td>194</td>
<td>78</td>
</tr>
<tr>
<td>Toileting</td>
<td>239</td>
<td>96</td>
</tr>
<tr>
<td>Car transfer</td>
<td>240</td>
<td>96</td>
</tr>
<tr>
<td>Yard work</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Mail</td>
<td>216</td>
<td>87</td>
</tr>
<tr>
<td>Answering phone/door</td>
<td>239</td>
<td>96</td>
</tr>
<tr>
<td>Dressing</td>
<td>233</td>
<td>94</td>
</tr>
<tr>
<td>Meal preparation</td>
<td>208</td>
<td>84</td>
</tr>
</tbody>
</table>

<sup>a</sup> Mean number of older adults performing activity.<br>
<sup>b</sup> Mean number of older adults performing activity in risky manner.

**Table: Behavior and Risky Activity**

**Statistics:**

- **X**: Mean number of older adults performing activity
- **SD**: Standard Deviation of number of older adults performing activity

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<thead>
<tr>
<th>Behavior</th>
<th>X</th>
<th>SD</th>
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<tr>
<td><strong>Total</strong></td>
<td>9.43</td>
<td>2.51</td>
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- **X**: Mean number of older adults performing activity in risky manner
- **SD**: Standard Deviation of number of older adults performing activity in risky manner

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<td><strong>Total</strong></td>
<td>0.51</td>
<td>0.86</td>
</tr>
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</table>
Results

cognition by SPMSQ was associated with:
- number of mobility activities done riskily
- rate of falls
  - adjusted for age, sex, number of psychotropic medications, alcohol use, mood

• Declining cognition was also associated with risk of engaging in risky mobility activities.

• Engaging in risky mobility activities mediated the relationship between declining cognition and falls
Implications

• Important to assess how person with cognitive impairment who has balance problems does routine mobility activities
  – In-home caregiver
  – Physical therapy assessment of activity performance

• Can’t assume that older adults living with caregiver are at reduced risk for falls by virtue of having someone to assist them.
Occupational therapy model of task performance

Potential changes:
- **Person** - reduce psychotropic medications, muscle strengthening, balance training
- **Process** - identify others to do task, provide assistive device, stand-by assist, task training?
- **Environment** - add railings, reduce glare and clutter, move items
Other mechanisms

- Some data suggest that motor changes (slowed gait) may precede cognitive changes in AD
  - Slow gait and executive dysfunction may be early indicators of combined mobility and cognitive decline, which may evolve to falls and dementia
  - Motor and executive function both involve frontal cortical structures that are in the watershed vascular distribution and may be highly sensitive to vascular micro-damage
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Kenosha County Study

- RCT
- 349 adults age 60 and older
- Enrolled based on risk for falls
  - History of 2 or more falls in past year
  - History of fall in past 2 years with unsteady gait or self-reported injury
- Participants randomized to intermediate-intensity community-based multifactorial falls intervention vs. control home safety visit
- Findings suggested a subgroup with MMSE < 28 benefited from the intervention

# Effect of a Multifactorial Falls Intervention on Fall Rate (Per 365.25 Community Days)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control Rate</th>
<th>Intervention Rate</th>
<th>RR (95% CI)</th>
<th>P-value</th>
</tr>
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<tbody>
<tr>
<td>Overall (N=349)</td>
<td>2.31</td>
<td>1.88</td>
<td>0.81 (0.57–1.17)</td>
<td>.27</td>
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<tr>
<td>Mini-Mental State Examination score</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>≥28 (n=218)</td>
<td>1.56</td>
<td>1.51</td>
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<td>Lives alone (n=131)</td>
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<td>1.44</td>
<td>0.78 (0.45–1.36)</td>
<td>.39</td>
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<tr>
<td>Lives with someone (n=87)</td>
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<td>1.59</td>
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<td>&lt;28 (n=131)</td>
<td>4.26</td>
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<td>.05*</td>
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<td>Lives alone (n=61)</td>
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<td>1.48</td>
<td>1.04 (0.56–1.96)</td>
<td>.89</td>
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<td>Lives with someone (n=70)</td>
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<td>3.10</td>
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*Statistically significant. †Borderline statistically significant  RR=rate ratio; CI=confidence interval.
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Other interventions - Exercise

- Systematic Review and Meta-analysis of 4 Exercise RCTs
  - Interventions from 3-12 months
  - Exercised 1, 2, 3, or 5 times per week
  - Strength, balance, mobility training, progressing over time
  - Group based or home
  - PT or OT supervision, caregivers helping in 2
  - 2 studies were multifactorial
  - Reduced risk of being a faller by 32%
  - Reduced mean number of falls by 1 per year
  - Burton et al, Clinical Interventions in Aging, 2015
Cognitive interventions – still experimental

- **Pharmacologic**
  - Methylphenidate – increased gait measures and EF (pre-post)
  - Donepezil – improved gait speed (small pilot)

- **Non-pharmacologic**
  - Dual-task walking training improved DT performance in people with mild to moderate dementia.
  - Computerized “mindfit”: improved gait speed during normal walking and DT walking
  - Treadmill training plus virtual reality obstacle course – improved gait speed during normal and DT walking
Conclusions

- Cognitive impairment (even mild) increases the risk of falling
- People with dementia who fall are at high risk for nursing home placement and death
- Executive dysfunction, decreased attention, decreased ability to multi-task, more risky performance of everyday activities play a role.
- Underlying mechanisms?
Conclusions

- Progressive balance and strength exercises may help reduce risk
- Multifactorial intervention working with caregiver to reduce risk factors may help reduce risk
  - Change the person: medications, vision, footwear, balance and strength training
  - Alter the environment
  - Change how the task is done
Thank you!