Who are the most challenging people to work with?
Falls in different groups

Lord et al, 1993; Forster & Young, 1995; Hill, 1998; Hill & Stinson, 2004
Does cognitive impairment double the risk of falls and fracture?

Yes

No
Epidemiology of Falls in Dementia

• 60-90% of older people with dementia (twice the rate of older people without cognitive impairment)

• Approx. 3 times increased fracture risk

• Fallers with dementia are 5 times more likely to be institutionalized

DEMENTIA

• Those with dementia:
  – 320,000 Australians
  – 42,000,000 worldwide

(Alzheimer’s Australia, Ferri et al 2005)

• Main types
  – Alzheimer’s Disease
  – Vascular Dementia
  – Lewy Body Disease
Alzheimer’s disease (AD)

• Most common type of dementia
• >60% of people with dementia have Alzheimer’s
  – Deficits in 2 or more areas of cognition (e.g. language, motor skills, perception, attention, judgement)
  – Progressive worsening of memory and other cognitive functions
  – Impaired activities of daily living and altered patterns of behaviour
Clinical features AD

• Depression, sleep deficits
• Incontinence
• Delusions/hallucinations
• Aggression
• Sexual disorders
• Weight loss
• In more advanced disease, motor signs
  – Increased muscle tone
  – Gait disorders
Vascular dementia (VaD)

• Second most common form of dementia
• 10-20% of people with dementia have VaD
  – Dementia with evidence of 2 or more ischaemic strokes, at least one outside cerebellum
  – Deficits in orientation, attention, language, visuospatial, executive functions, motor control/praxis
  – Multiple infarcts, multiple TIAs
  – Early gait changes/incontinence
Clinical features VaD

- Gait disturbance: small stepping gait, parkinsonian type gait
- Balance impairment
- Frequent falls
- Early urinary frequency, urgency
- Mood changes
- Subcortical deficits: psychomotor slowing, abnormal executive functioning
Lewy body disease

• Common condition, possibly 10-20% of clinical cases (McKeith et al 2005)
• Neurodegenerative condition, with build up of protein (alphasynuclein) in brain cells (=Lewy bodies)
• Overlapping conditions
  – Dementia with Lewy bodies
  – Parkinson’s disease
  – Parkinson’s disease dementia
Lewy body disease (LBD)

Parkinson’s disease (PD)

PD dementia (PDD)

Lewy body dementias (LBDs)

Dementia with Lewy bodies (DLB)

(Adapted from McKeith, 2010)
Clinical features DLB

• Cognitive impairment, especially increased variability and fluctuation
• Visual hallucinations very common
• Parkinson’s motor symptoms
• Sleep disturbance, excessive movement during REM sleep
• Syncope, loss of consciousness
• Autonomic dysfunction:
  – Orthostatic hypotension
  – Urinary retention, constipation
  – Carotid sinus hypersensitivity
And also......

- Frontotemporal dementia
- Early onset dementia
- Mild cognitive impairment
Incidence and Prediction of Falls in Dementia: A Prospective Study in Older People

Louise M. Allan, Clive G. Ballard, Elise N. Rowan, Rose Anne Kenny

1 Institute for Ageing and Health, Wolfson Research Centre, Newcastle General Hospital, Newcastle upon Tyne, United Kingdom, 2 Wolfson Centre for Age Related Disorders, King's College London, London, United Kingdom, 3 Trinity College Institute of Neuroscience, Trinity College Dublin, Dublin, Ireland
### Incidence and Prediction of Falls in Dementia: A Prospective Study in Older People

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<table>
<thead>
<tr>
<th></th>
<th>Control (39)</th>
<th>AD (38)</th>
<th>VAD (32)</th>
<th>DLB (30)</th>
<th>PDD (40)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incidence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>number of falls/1000 person years</td>
<td>1023</td>
<td>2486</td>
<td>3135</td>
<td>9087</td>
<td>19 000</td>
</tr>
<tr>
<td>Incidence density ratio (95% CI) c.f. control group</td>
<td>1</td>
<td><strong>1.95 (1.01–3.78)</strong></td>
<td><strong>1.77 (1.17–2.69)</strong></td>
<td><strong>6.06 (3.53–10.4)</strong></td>
<td><strong>20.5 (10.4–40.2)</strong></td>
</tr>
<tr>
<td>Incidence density ratio (95% CI) c.f. AD group</td>
<td>1</td>
<td>0.907 (0.504–1.63)</td>
<td></td>
<td><strong>3.10 (1.16–8.28)</strong></td>
<td><strong>10.5 (3.32–33.1)</strong></td>
</tr>
<tr>
<td>Incidence density ratio (95% CI) c.f. VAD group</td>
<td>1</td>
<td></td>
<td>3.41 (1.96–5.95)</td>
<td></td>
<td>11.6 (5.73–23.3)</td>
</tr>
<tr>
<td>Incidence density ratio (95% CI) c.f. DLB group</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>3.38 (2.66–4.31)</td>
</tr>
<tr>
<td><strong>Fractures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>number of fractures recorded during study</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

doi:10.1371/journal.pone.0005521.t002

Allan et al, 2009, PLoS One
### Behavioural and psychological symptoms of dementia

#### Behaviour
- Aggression
- Agitation
- Aberrant motor behaviour e.g. wandering, repetitive movements
- Sleep/nighttime behaviour
- Appetite/eating
- Hoarding

#### Personality alteration
- Disinhibition
- Passivity
- Apathy/indifference
- Attention seeking
- Irritability
- Lability

#### Mood
- Depression
- Anxiety
- Elation/euphoria

#### Thought content/perception
- Hallucinations
- Delusions
Physical Comorbidities of Dementia (Kurrle 2012)

- Falls
- Epilepsy
- Delirium
- Fraility
- Malnutrition
- Gum Disease/dental disease
- Visual Impairment
- Sleep Disorders
- Incontinence
Falls risk factors

- Previous falls
- Previous injurious falls
- Medications: psychotropics, sedatives, antidepressants
- Medical conditions e.g. stroke
- Dizziness, postural hypotension
- Visual/somatosensory deficits
- Gait/balance impairment
- Foot problems
- Footwear
- Cognition
- Continence problems
- Loss of appetite/weight
- Alcohol intake
- Environment
- Risk taking
- Function
Predictors of falls in people with dementia

- Diagnosis of LBD
- Longer duration of dementia
- Previous history of falls/recurrent falls
- Cardioactive medications
- Autonomic symptoms
- Symptomatic orthostatic hypotension
- Depression
- Physical activity limitation

Allan et al, 2009
Cumulative effect.....

Risk factors:
- Antidepressant use
- Increased sway eyes closed
- Attention & orientation issues
- Anxiety

Whitney et al 2012
What about wandering?

• Wandering associated with nearly 2x higher falls risk (Whitney et al 2012)

• Wandering associated with increased falls risk but complex interaction with medications: those with high levels of wandering benefit from 1mg /day risperidone compared to placebo, but risperidone increases falls for those with low levels of wandering at baseline (Katz et al 2004)

• Why is wandering associated with falls risk?
What are your observations of

- Gait
- Balance

in people with cognitive impairment?
Gait and balance changes with dementia

Table 2

<table>
<thead>
<tr>
<th>Gait impairments in older people with dementia*</th>
<th>Balance impairments in older people with dementia*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slower walking speed</td>
<td>Increased double support time</td>
</tr>
<tr>
<td>Reduced step frequency</td>
<td>Increased sway path</td>
</tr>
<tr>
<td>Shorter step length</td>
<td>Increased unsteadiness</td>
</tr>
<tr>
<td>Increased postural flexion</td>
<td>Impaired one/two leg balance, eyes open/closed</td>
</tr>
</tbody>
</table>

*Compared with age- and sex-matched controls/corrected for age and sex.

Shaw et al., 2003
Mechanism of postural control

Sensory inputs → CNS → Motor outputs

Perception → Cognition → Action

Environment / Task characteristic

Feedback control

Feedforward control

Organization

Shumway-Cook et al., 2007; Nashner, 1997, Woollacott et al., 1997; Pollock et al., 2000, Winter, 1995
Balance changes with dementia

**FIG. 1.** Typical center of pressure paths of a healthy elderly (HE) subject and an Alzheimer’s disease (AD) subject during the single and the dual tasks.
Balance changes with dementia

Mild to moderate AD (community dwellers)

Pilot data comparison of stability measures from clinical balance measure, and Falls risk score between participants with AD (n=24) and healthy controls (n=28).

Suttanon 2012
Balance changes with dementia

Physiological risk factors increase risk of falls in older cognitively impaired people
• Increased reaction time
• Increased postural sway
• Increased leaning balance
• Increased PPA falls risk score

Poorer performance by those with cognitive impairment compared to healthy controls
• Muscle strength (grip and quadriceps)
• Balance (sway on floor and foam, leaning and tandem standing)
• Mobility – sit to stand, TUG, steps to turn

Taylor 2012, Taylor 2013
Physiological Profile Assessment

- Postural Sway (Balance)
- Visual contrast sensitivity
- Reaction Time
- Leg muscle strength
- Lower limb proprioception

Kit Commercially available from Prince of Wales Medical Research Institute, Sydney
What causes balance and gait impairments in people with dementia?

- Peripheral conditions
- Central impairments
  - “Classic” motor disorders in the basal ganglia
  - Central processing problems (including attention, executive functions, processing speed)

Martin 2013, Beauchet 2008, Shaw et al., 2003; Chong et al., 1999
Stage of dementia?

LATE (More severe cognitive decline)

- Gait and balance disorders are related to severity of cognitive decline

  Motor disorders commonly described in later stages e.g. gait apraxia, bradykinesia, extrapyramidal rigidity, resting tremor, cautious gait, gait slowing
Dementia related gait changes

(All stages of dementia)

- Decrease in walking speed
- Decrease in stride length
- Increase in support phase

-parallels severity of Alzheimer’s disease
- Vascular dementia and dementia with Lewy bodies walked more slowly than AD

Beauchet 2008
EARLY (Mild or moderate cognitive impairment)

- Increase in stride-to-stride variability

Recent Studies:
- Anti dementia drugs and changes in gait
- Executive function impairment, falls and physical performance

Beauchet 2008

Beauchet 2013

Muir 2013, Mirelman 2012
What is dual task?
Walking while talking

• Interaction of cognition and gait
• Indicates a difficulty with dual task
• Predicator of falls
Stroop Walking Test

<table>
<thead>
<tr>
<th>Stimuli</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
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<tbody>
<tr>
<td>Pictogramme</td>
<td>Green/Moving</td>
<td>Red/Standing</td>
<td>Red/Moving</td>
<td>Green/Standing</td>
</tr>
<tr>
<td>Colour/Shape</td>
<td></td>
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</tbody>
</table>
Studies of dual tasks and cognitive impairment

• The effects of a concurrent motor task on walking in Alzheimer's disease.
  – Walking with a motor dual-task produced significantly slower and more variable gait and was feasible for people with severe AD.
Recent findings: what next?

• Vitamin D – its role in cognition and in gait
• Motor signature for types of MCI
• Anatomical changes
• Motor imagery times to detect MCI
Amboni 2013 (adapted from Montero-Odasso 2012)
Practical issues in Gait and Balance assessment with people with cognitive impairment

- Must include dual task analysis
- Include obstacles in gait analysis
- Include directional changes in gait analysis
- If possible, look at stride to stride variability
- Consider fatigue particularly in “wanderers”