Research Update:
Vitamin D and falls in older people
Fall prevention in hospitals

Stephen Lord

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Vitamin D insufficiency, physiological and cognitive functioning and falls in older people

Jasmine Menant, Jacqueline Close, Kim Delbaere, Daina Sturnieks and Stephen Lord


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Skin

Vitamin D3 (cholecalciferol)

Liver

25-hydroxy vitamin D₃ (calcidiol or serum 25OHD)

Parathyroid Glands

Kidney

1,25-dihydroxy vitamin D₃ (calcitriol)

Bone
Vitamin D insufficiency

- Common in older people
- Associated with fall risk factors
  - muscle weakness, poor balance and physical function *(Houston et al., 2007, J Gerontol; Gerdhem et al., 2005, Osteoporos Int)*
  - Impaired executive function & slow processing speed *(Buell et al., 2009, J Gerontol; Lee et al., J Neurol Neurosyr Psychiatry, 2009)*
- Increased risk of falls and fractures *(Flicker et al., 2003, JAGS; Cauley et al., 2008, Ann Intern Med)*
Research aims

- Relationship between serum Vit D and:
  - Neuropsychological and neuromuscular function, balance and stepping performance in older people
  - Prospective falls
Protocol

463 community-living older people
Aged 78.0 4.6 years – (248 women & 215 men)

Bloods: Serum 25-hydroxyvitamin D (25OHD)

Neuropsychological tests

Fall risk and balance assessment

Monthly falls questionnaires for 12 months

Fallers: at least 1 injurious fall or multiple falls in the follow-up period
Prevalence of Vit D insufficiency

Gender effect: p<0.001
## Demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Vit D Sufficient N=309</th>
<th>Vit D Insufficient N=154</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>77.7 ± 4.5</td>
<td>78.6 ± 4.8 *</td>
</tr>
<tr>
<td>Comorbidity score (out of 9 system-related conditions)</td>
<td>2.81 ± 1.34</td>
<td>2.96 ± 1.49</td>
</tr>
<tr>
<td>BMI</td>
<td>27.0 ± 4.4</td>
<td>28.3 ± 5.2 *</td>
</tr>
<tr>
<td>Diabetes</td>
<td>31 (10%)</td>
<td>27 (17.5%) *</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>53 (17.7%)</td>
<td>39 (27.7%) *</td>
</tr>
<tr>
<td>Planned exercise (hrs/wk)</td>
<td>1.3 (0.3-3.4)</td>
<td>0.8 (0.0-2.5) *</td>
</tr>
<tr>
<td>Four plus medications</td>
<td>209 (67.4%)</td>
<td>108 (70.1%)</td>
</tr>
<tr>
<td>On vitamin D supplementation</td>
<td>16 (5.2%)</td>
<td>5 (3.2%)</td>
</tr>
</tbody>
</table>

* p<0.05
Executive function – Trails making B test

- Insufficient (serum 25OHD ≤ 50nmol/L)
- Sufficient (serum 25OHD > 50nmol/L)

* p<0.05
Visuo-spatial domain - Block design test

Block design test score

Men | Women | All
---|---|---
Insufficient (serum 25OHD ≤ 50nmol/L) | Sufficient (serum 25OHD > 50nmol/L)

* p<0.05 ; # p<0.05 after adjusting for age
Quadriceps strength

6-metre walking test

* p<0.05 ; # p<0.05 after adjusting for age
Leaning balance

![Anterior-posterior distance chart]

<table>
<thead>
<tr>
<th></th>
<th>Insufficient (serum 25OHD ≤ 50nmol/L)</th>
<th>Sufficient (serum 25OHD &gt; 50nmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>![Bar chart for Men]</td>
<td>![Bar chart for Men]</td>
</tr>
<tr>
<td>Women</td>
<td>![Bar chart for Women]</td>
<td>![Bar chart for Women]</td>
</tr>
<tr>
<td>All</td>
<td>![Bar chart for All]</td>
<td>![Bar chart for All]</td>
</tr>
</tbody>
</table>

![Coordinated stability chart]

<table>
<thead>
<tr>
<th></th>
<th>Coordinated stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>![Bar chart for Men]</td>
</tr>
<tr>
<td>Women</td>
<td>![Bar chart for Women]</td>
</tr>
<tr>
<td>All</td>
<td>![Bar chart for All]</td>
</tr>
</tbody>
</table>

* p<0.05 ; # p<0.05 after adjusting for age
**Reaction time**

- **Insufficient (serum 25OHD \(\leq\) 50nmol/L)**
- **Sufficient (serum 25OHD > 50nmol/L)**

* \(p<0.05\); # \(p<0.05\) after adjusting for age
Falls

- 35% fallers (33% men & 36% women)
- No increase in risk of falling for vitamin D insufficiency group (RR=1.21, 95% CI=0.94–1.57)
- **Increased risk of falling for men with vitamin D insufficiency** (RR=1.63, 95% CI=1.10–2.40)
Vitamin D insufficiency

- 30% prevalence among community living older people
- Small association with cognitive function
- Strongly related with poorer neuromuscular function and balance
- Associated with increased injurious and multiple falls in men only
Preventing falls in hospitals
Cochrane Review

Interventions for preventing falls in older people in nursing care facilities

Cover sheet
Title
Interventions for preventing falls in older people in nursing care facilities and hospitals

Reviewers
Cameron ID, Murray GR, Gillespie LD, Cumming RG, Robertson MC, Hill KD, Kerse N

Dates
Date edited: 22/06/2008
Date of last substantive update: 25/02/2008
Multifactorial interventions

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Intervention</th>
<th>Intervention</th>
<th>Usual care</th>
<th>N</th>
<th>Usual care</th>
<th>N</th>
<th>log [Rate ratio] (SE)</th>
<th>Rate ratio IV,Random,95% CI</th>
<th>Weight</th>
<th>Rate ratio IV,Random,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Supervised exercises + environment/assistive technology + knowledge interventions vs usual care</td>
<td>Cumming 2008</td>
<td>2047</td>
<td>1952</td>
<td></td>
<td></td>
<td></td>
<td>0.04 (0.15)</td>
<td></td>
<td></td>
<td>34.5%</td>
</tr>
<tr>
<td></td>
<td>Haines 2004</td>
<td>310</td>
<td>316</td>
<td></td>
<td></td>
<td></td>
<td>0.36 (0.13)</td>
<td></td>
<td></td>
<td>36.9%</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>71.3%</td>
</tr>
</tbody>
</table>

Heterogeneity: $\text{I}^2 = 0.03$; $\text{Chi}^2 = 2.60$, df = 1 ($P = 0.11$); $I^2 = 62$
Test for overall effect: $Z = 1.31$ ($P = 0.19$)

2 Medication (drug target) + environment/assistive technology + other interventions vs usual care | Healey 2004 | 749 | 905 | | | | 0.53 (0.42) | | | 12.2% | 0.59 [0.26, 1.34] |
| Subtotal (95% CI) | | | | | | | | | | 12.2% | 0.59 [0.26, 1.34] |

Heterogeneity: not applicable
Test for overall effect: $Z = 1.26$ ($P = 0.21$)

3 Medication (drug target) + social environment + knowledge + other interventions vs usual care | Stenvall 2007 | 102 | 97 | | | | 0.97 (0.34) | | | 16.4% | 0.38 [0.19, 0.74] |
| Subtotal (95% CI) | | | | | | | | | | 16.4% | 0.38 [0.19, 0.74] |

Heterogeneity: not applicable
Test for overall effect: $Z = 2.85$ ($P = 0.0043$)

Total (95% CI) | | | | | | | | | | | 100.0% | 0.69 [0.49, 0.96] |

Heterogeneity: $\text{I}^2 = 0.06$; $\text{Chi}^2 = 7.39$, df = 3 ($P = 0.06$); $I^2 = 59$
Test for overall effect: $Z = 2.17$ ($P = 0.030$)
Supervised exercise

Review: Interventions for preventing falls in older people in nursing care facilities and hospitals
Comparison: 9 Supervised exercises vs usual care (hospitals)
Outcome: 1 Number of fallers

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Intervention N</th>
<th>Usual care N</th>
<th>log [Risk ratio] (SE)</th>
<th>Risk ratio IV,Fixed,95% CI</th>
<th>Weight</th>
<th>Risk ratio IV,Fixed,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barreca 2004</td>
<td>25</td>
<td>23</td>
<td>-0.37 (0.71)</td>
<td><strong>0.69 [0.17, 2.78]</strong></td>
<td>31.6%</td>
<td></td>
</tr>
<tr>
<td>Donald 2000</td>
<td>30</td>
<td>24</td>
<td>-1.56 (0.87)</td>
<td><strong>0.21 [0.04, 1.16]</strong></td>
<td>21.0%</td>
<td></td>
</tr>
<tr>
<td>Jarvis 2007</td>
<td>14</td>
<td>15</td>
<td>-0.78 (0.58)</td>
<td><strong>0.46 [0.15, 1.43]</strong></td>
<td>47.4%</td>
<td></td>
</tr>
</tbody>
</table>

**Total (95% CI)**
Heterogeneity: Chi² = 1.13, df = 2 (P = 0.57); I² = 0.0%
Test for overall effect: Z = 2.04 (P = 0.041)
Main results

- Multifactorial interventions reduced the rate of falls (RaR 0.69, 95% CI 0.49 to 0.96; 4 trials, 6478 participants) and risk of falling (RR 0.73, 95% CI 0.56 to 0.96; 3 trials, 4824 participants)

- Supervised exercise interventions showed a significant reduction in risk of falling (RR 0.44, 95% CI 0.20 to 0.97; 3 trials, 131 participants)
Reviewers’ conclusions

- There is evidence that multifactorial interventions reduce falls and risk of falling in hospitals
- Exercise in subacute hospital settings appears effective
- Limitations of the review: small number of studies, difficulty isolating effects of multifactorial interventions, variability of interventions
Falls Prevention in Hospitals
POPI Study 2003-2006

Randomized wards  n=24
Total patients    n=3995

12 intervention wards
2047 patients

12 control wards
1948 patients

Falls in hospital

Design and Intervention

- Research team
  - nurse and physiotherapist (25 hours per wk)
  - research assistant
- 3 month intervention period
- Intervention levels
  - patient-based
  - ward-based
Nursing Interventions

- Falls risk assessment of all patients
- Staff education: group and individual sessions
- Patient and family education
- Arrange provision of aids eg walking aids, glasses
- Environmental modification: ward and bedside
- Assessment, liaison with and referral to other staff about medications, confusion, foot problems
- Arrange increased supervision
- Foot alarms
Physiotherapy Interventions

- Exercises designed to enhance balance and functional task ability
  - for those at increased risk
  - in addition to intervention provided by ward physiotherapy staff
  - group and individual sessions
- Practice of safe mobility within ward environment
- Negotiation with staff, patient and family about safe mobility in ward
  - use of walking aids
  - amount of supervision needed
Falls and Fallers

- 9.2 falls per 1000 bed days
- Falls frequency:
  0 falls 92.5%
  1 fall 6.1%
  2 falls 1.0%
  3+ falls 0.4%
  Acute wards: 6.2% fell
  Rehab. wards: 10.9% fell

7.5% fell at least once
**RESULTS - individual level analyses**

<table>
<thead>
<tr>
<th></th>
<th>Incidence rate ratio</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted</td>
<td>1.02</td>
<td>0.70-1.48</td>
<td>0.93</td>
</tr>
<tr>
<td>Adjusted for past falls</td>
<td>0.96</td>
<td>0.72-1.28</td>
<td>0.79</td>
</tr>
</tbody>
</table>
Possible explanations for negative finding

- Extra staff are required - 24 hours a day, 7 days a week?
- Longer intervention period needed?
- Absence of sitters?
- Whole system approach, including work practice changes?
Patient Education to Prevent Falls Among Older Hospital Inpatients

A Randomized Controlled Trial

Terry P. Haines, PhD; Anne-Marie Hill, MS; Keith D. Hill, PhD; Steven McPhail, BS; David Oliver, MD; Sandra Brauer, PhD; Tammy Hoffmann, PhD; Christopher Beer, MBBS

Arch Intern Med.
Published online November 22, 2010.
Methods

Older hospital patients (n=1206) admitted to acute (orthopedic, respiratory, and medical) and subacute (geriatric and neuro-rehab) hospital wards at 2 Australian hospitals

The interventions were a multimedia patient education program based on the health-belief model combined with trained health professional follow-up (complete program), multimedia patient education materials alone (materials only), and usual care (control)

Falls data were collected by reviewing hospital incident reports, hand searching medical records, and weekly patient interviews
Main findings

Table 2. Between-Group Comparisons on Fall-Related Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Control</th>
<th>Materials Only</th>
<th>Complete Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Sample</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falls/injurious falls/falls resulting in fracture, No.</td>
<td>81/25/2</td>
<td>96/40/2</td>
<td>70/32/1</td>
</tr>
<tr>
<td>Falls per 1000 patient-days</td>
<td>9.27</td>
<td>8.61</td>
<td>7.63</td>
</tr>
<tr>
<td>Fallers, No. (%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>54 (14)</td>
<td>56 (13)</td>
<td>44 (11)</td>
</tr>
<tr>
<td>Injurious falls per 1000 patient-days</td>
<td>2.86</td>
<td>3.59</td>
<td>3.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitively Intact Participants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falls/injurious falls/falls resulting in fracture, No.</td>
<td>46/15/2</td>
<td>61/25/1</td>
<td>25/10/0</td>
</tr>
<tr>
<td>Falls per 1000 patient-days</td>
<td>8.72</td>
<td>8.18</td>
<td>4.01</td>
</tr>
<tr>
<td>Fallers, No. (%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>30 (11)</td>
<td>32 (10)</td>
<td>20 (6)</td>
</tr>
<tr>
<td>Injurious falls per 1000 patient-days</td>
<td>2.84</td>
<td>3.34</td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitively Impaired Participants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falls/injurious falls/falls resulting in fracture, No.</td>
<td>35/10/0</td>
<td>35/15/1</td>
<td>45/22/1</td>
</tr>
<tr>
<td>Falls per 1000 patient-days</td>
<td>10.10</td>
<td>9.47</td>
<td>15.30</td>
</tr>
<tr>
<td>Fallers, No. (%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24 (24)</td>
<td>24 (22)</td>
<td>24 (26)</td>
</tr>
<tr>
<td>Injurious falls per 1000 patient-days</td>
<td>2.89</td>
<td>4.06</td>
<td>7.49</td>
</tr>
</tbody>
</table>
Conclusions

Multimedia patient education with trained health professional follow-up reduced falls among patients with intact cognitive function admitted to a range of hospital wards.
Sustained reduction in serious fall-related injuries in older people in hospital

David Fonda, Jennifer Cook, Vivienne Sandler and Michael Bailey

MJA 2006; 184 (8): 379-382
Design, setting and participants

Three-year quality improvement project comparing data at baseline (2001) and at 2-year follow-up (2003) after interventions to reduce falls. All patients admitted to the Aged Care Services wards at Caulfield General Medical Centre, Melbourne, between January 2001 and December 2003 were included.
Interventions

Multistrategy approach phased in over 3 months from September 2001 and involving data gathering, risk screening with appropriate interventions, work practice changes, environmental and equipment changes, and staff education.
Results

Over a 2-year period, there was a 19% reduction in the number of falls and a 77% reduction in the number of falls resulting in serious (P < 0.001) Staff compliance with completing the falls risk assessment tool increased from 42% to 70%, and 60% of staff indicated they had changed their work practices to prevent falls
Conclusions

A multistrategy falls prevention program in an aged care hospital setting produced a significant reduction in the number of falls and a marked reduction in serious fall-related injuries. Incorporating a falls prevention program into all levels of an organisation, as part of daily care, is crucial to the success and sustainability of falls prevention.
Translating Research Into Practice

The Prince of Wales Hospital Experience
Hypnotic use - POWH

Number of sedatives dispensed per month - POWH
Vit D use - POWH

Number of tablets of Vit D dispensed per month - POWH

- Jan-06
- Mar
- May
- Jul
- Sept
- Nov
- Jan-07
- Mar
- May
- Jul
- Sept
- Nov
- Jan-08
- Mar
- May
- Jul
- Sept
- Nov
- Jan-09
- Mar
- May
- Jul
- Sept
- Nov
- Jan-10
- Mar
- May
- Jul
- Sept
- Nov
- Jan-11

Neuroscience Research Australia
Acknowledgements

- Understanding Fear of Falling and Risk taking in Older People, NeuRA – NHMRC project Grant (No. 400941)
- Brain and Ageing Program, School of Psychiatry, UNSW-NHMRC Program Grant (No. 350833)
- NeuRA Falls and Balance Research Group
- Sydney Memory & Ageing Study team