Biomechanical differences between falls and non-falls while performing daily activities in older adults in long-term care

Olivia Aguiar, Yijian Yang, Kimberley S. van Schooten, Stephen Robinovitch

Injury Prevention and Mobility Laboratory, Simon Fraser University

Background

- Around 60% of older adults (65+) in long-term care (LTC) fall at least once every year. Most falls occur during activities of daily living (ADLs) such as standing, walking, and transferring. The same individual regularly performs the same ADLs without falling. What factors separate successful and unsuccessful performances of ADLs in frail older adults?

Purpose

- To determine, among older adults in LTC, the differences in movement patterns and environmental/situational characteristics, between falls and successfully performed ADLs in the same individuals over time.
- To link the changes in movement patterns to changes in clinical status (acute and chronic illnesses, medication use).
- This project focuses on the factors that contribute to falls during transferring and standing (gait will be addressed separately).

Methods

1. CRITERIA & VIDEO COLLECTION:

   - Inclusion criteria:
     - Current resident at partnering LTC facility
     - Consent to access medical records
     - Falls captured in the past 1-2 months that:
       - Occur in the hallway, lounge or dining hall
       - Occur during transferring or standing

   - Access surveillance cameras in common areas
   - Collect fall videos during transferring and standing
   - Analyze falls and non-falls with MPVAQ
   - Collect 2-4 non-fall videos of the same activity before the fall

   Figure 1. Flow chart of the participant inclusion criteria and data collection process. For eligible residents, video footage is captured of the resident performing activities of daily living both successfully and unsuccessfully (leading to a fall). To date, we have enrolled 18 unique residents. Here, one case study will be discussed for an 89-year-old man.

2. QUESTIONNAIRE DEVELOPMENT:

   - The Movement Pattern Video Analysis Questionnaire (MPVAQ) - designed to probe biomechanical, environmental and situational aspects of each task

   - Movements
     - Transfers
     - Standing
     - General description of the video
     - Characteristics of the chair used in transferring
     - Balance maintenance during transferring
     - Balance recovery during transferring
     - Additional notes (intrinsically environmental factors)
     - General description of the video
     - Kinematics of standing
     - Balance maintenance during standing
     - Balance recovery during standing
     - Additional notes (intrinsically environmental factors)
     - Use of assistive devices
     - Additional notes (intrinsically environmental factors)

   Figure 2. The Movement Pattern Video Analysis Questionnaire identifies key biomechanical, environmental and situational characteristics of the transferring and standing movement by structured analysis of the video. The tool supplements an existing video collection questionnaire for falls.

Results

- For each fall and non-fall activity, the MPVAQ is completed by 2 trained individuals coming to a consensus and assigning a probability to each answer being correct. We further collect information on physical and cognitive function, disease diagnoses, and use of medications from the computerized Minimum Data Set (RAI-MDS 2.0).

- Table 1. Case A’s resident’s physical and cognitive outcome scores from the RAI-MDS 2.0 assessment items

<table>
<thead>
<tr>
<th>Date</th>
<th>Cognitive Performance Scale (CPS)</th>
<th>ADL Self-Performance Hierarchy Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/22/2016</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>03/22/2017</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

- The CPS scale describes the cognitive status of the resident, ranging from 0 (intact) to 6 (severe impairment).
- The ADL self-performance scale reflects the disablement process by grouping ADL performance levels into discrete stages of loss, ranging from 0 (independent) to 6 (total dependence).
- The resident’s CPS score remained constant between Dec 22, 2016 and March 22, 2017, reflecting moderate impairment of cognitive function.
- The resident’s ADL self-performance score improved over this period, reflecting improved independence in locomotion, eating and personal hygiene. Further investigation revealed the resident has been receiving physical therapy, focusing on his walking mechanics.
- Despite this, medical charts revealed the following deteriorations over this period:
  - Increased distraction, restless, rising from wheelchair with triggers (i.e. thirsty, toilet use, boredom, itchy skin);
  - Declines in knee and hip range of motion, bed mobility and balance while standing and sitting;
  - Decline in vision secondary to macular degeneration.

- Video analysis using the MPVAQ revealed:
  - Environmental contributions: The wheelchair was on during the successful sit-to-stand performance, as illustrated by the red arrow in Figure 3f. However, as seen in Figure 4d, the brakes were not on during the fall. The chair slid back during the transfer, likely contributing to the fall.
  - Behaviour: Substantial trunk flexion is observed in both cases. Non-optimal positioning of the feet and hands may have contributed to a state of imbalance, and the generation of horizontal forces contributing to chair movement and falling.
  - It is possible that increased distraction, as noted in medical charts, contributed to an attempt to stand without locking of the wheelchair brakes. Declines in knee and hip ROM may have contributed to attempting to stand from a non-optimal starting posture.

Future Work

- Refinement and validation (tests of inter-rater reliability) of the MPVAQ questionnaire.
- Ongoing video collection and analysis.
- Comparison of successful versus unsuccessful ADL performance with repeated-measures Generalized Linear Models.

References


Acknowledgements