Quantitative Gait Analysis

**Falls, Frailty, Polypharmacy and Sarcopenia Seminar**
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"Measure what can be measured, and make measurable what cannot be measured."
Galileo Galilei (1564-1642)

How do we measure dynamic stability in gait, in a clinically meaningful way?

"Despite the extensive effort in the area there is no accepted quantitative way to judge or score the dynamic stability of human locomotion. The process of determining the stability of particular patients still hinges on the personal observations and past experience of the involved team members."


Adapted from Whittle. Gait analysis.

Spatio-temporal parameters of gait

Body worn sensor technology

3-D Laboratory Gait Modelling

Gait speed
Distance (m) / Time (sec)

• Well lit space
• Uninterrupted walkway
• Comfortable (low heel) walking shoes


**Normative values for gait speed (www.tilda.tcd.ie)**

"What gets measured gets managed."
Peter Drucker
Normative values for gait speed (www.cildt.tcd.ie)

There’s an app for that!!

GAITRite™

Measuring gait speed using floor mat technology

Gait speed and independent living


GAITRite™

**Gait Assessment – Minimum data set**

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Clinical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age:</td>
<td>Sex:                Ethnicity:</td>
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</table>

<table>
<thead>
<tr>
<th>Clinical characteristics</th>
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<tbody>
<tr>
<td>Ht:</td>
</tr>
<tr>
<td>Medications: &gt;3 (coded yes/no)</td>
</tr>
<tr>
<td>Hx of falls: (previous 12 mths coded yes/no)</td>
</tr>
<tr>
<td>Neurological disease: Dementia (yes/no)</td>
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<tr>
<td>Other (yes/no)</td>
</tr>
<tr>
<td>Depressive symptoms: (yes/no)</td>
</tr>
<tr>
<td>Anxiety symptoms: (yes/no)</td>
</tr>
<tr>
<td>Major orthopaedic diagnosis: (yes/no)</td>
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<tr>
<td>Vision disorder: (yes/no)</td>
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<tr>
<td>Lower limb proprioception disorder: (yes/no)</td>
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<tr>
<td>Muscle strength impairment: (yes/no)</td>
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<tr>
<td>Use of walking aid: (yes/no)</td>
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</tbody>
</table>

**Clinical gait characteristics**

**Spatio-temporal gait analysis**

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**Body Worn Sensor**

**Inertial Measurement Unit (IMU)**

- Miniature accelerometers
- Miniature gyroscopes
- Battery
- Sensors
- Microprocessor control
- Signal data
- Memory chip
- Wireless data streaming

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**Accelerometer**
- Responds to linear acceleration

**Gyroscope**
- Responds to rotational movement
- Angular velocity

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**Tri-axial sensors**

Sensor placement options

- What gait features are of interest in the clinical cohort
- Environmental considerations (clinic or community)
- Guidance from previous literature

Clinical Applications
Technology Research for Independent Living

- Sensor attachment
- Data streaming via bluetooth
- Free walking trials over 30 meters

Signal Analysis

- Spatio-temporal parameters
- Gait variability
- Gait complexity

- Descriptors of gait
- Ageing and neurological cohorts
- Clinic and free living home environment
- Early biomarkers of physical and cognitive decline


3-D Gait Laboratory
Lower body model of gait
Kinematics

Evolution of knee angle over the gait cycle
(Sagittal Plane)