Monitoring Manual Wheelchair Use

Ricardo A. Lopez, MS, Sharon E. Sonenblum, PhD, Stephen Sprigle, PhD, PT

Introduction
In this study, a method for the robust detection of manual wheelchair movement with accelerometer-based data logging is used to obtain metrics of wheelchair mobility that complement mean and total distance-based measurements. These metrics, that include distance, time and number of bouts, are shown to provide a better understanding of everyday use of manual wheelchairs (MWC).

Methodology

Subjects
- 12 adults, ages 23 to 68 (median 39.5), with some affiliation to the local spinal cord injury (SCI) rehabilitation center
- Diagnoses: SCI (n=10), ataxia (n=1), transverse myelitis (n=1)
- Manual wheelchair is the primary mobility device
- IRB approval
- Data collection period varied between 2 and 12 days per subject (80 days total)

Variables and Data Processing
- Data processing:
  - Acceleration is used to detect wheel motion
  - The rate of change of wheel revolutions is used to compute speed
- Variables:
  - Bouts of wheelchair activity
  - Distance wheeled
  - Time wheeling
  - Wheelchair speed
  - Non-movement durations
- Bout detection accuracy exceeds 90% (1)

Protocol
- Acceleration logger (solid-state, triaxial, MEMS-based acceleration sensor with a ±2g range) was mounted on one of the wheels (see picture below)
- Radial and tangential components of acceleration (along Y and X in the figure below, resp.) were used for movement detection
- Sampling rate: 10 Hz

Conclusions and Future Work
- A single measure of mobility, such as distance, cannot convey a full description of MWC usage
- Daily wheelchair usage varies greatly within and between subjects
- Idiosyncrasy of usage can be better understood by analyzing bouts in addition to other measures
- Future research should look into studying larger population samples and methods of combining the additional metrics presented here in a way that facilitates manufacturing, prescription and dosage

Results
- 66% of bouts are shorter than 50 seconds and 50 meters
- 14% of bouts last more than 1.5 minutes
- Subjects averaged 60 minutes and 2.2 miles of wheeling a day

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