

# **Usability Evaluation of a Smartwatch Heart Rate Monitor for Subjects with Acquired Brain Injury**

**Morten Pallisgaard Støve , Birgit Tine Larsen**

*Department of Physiotherapy, University College of Northern Denmark.*

## **Introduction**

Cardiorespiratory exercise at specific heart rate reserve intensity levels is recommended in the national Danish clinical guideline for rehabilitation of acquired brain injury [1].

Traditional pulse rate monitors utilizing chest-straps are used in clinical practice, but they cannot be worn for extended periods [2]. They may also be inconvenient to use [3] and hemiplegic patients may require therapeutic assistance to apply the chest-strap.

New consumer-based wrist-worn activity monitors that utilize photoplethysmography technology to measure heart rate demonstrate good potential to overcome the limitations of the traditional chest-strap monitors in rehabilitation settings [4]. However, the usability for patients with acquired brain injury is currently unknown, hence the purpose of this study was to examine the usability of heart rate measurements using a smartwatch for patients with acquired brain injury.

## **Materials and Methods**

Twenty-five subjects with acquired brain injury were enrolled in the second week following admittance to an inpatient rehabilitation clinic. Subjects wore a smartwatch (Garmin Forerunner 235) during daily rehabilitation activities for a period of three weeks.

Two Likert scale-based questionnaires were used to elicit both the subject's assessment of their own ability to handle the watch and the nature and severity of difficulty the subject demonstrated while handling the watch evaluated by the physio- or occupational therapists. Field observations, recorded by the therapists as field notes using a standardised observation log, were used to record the interactions between the subjects and the smartwatch and to identify key usability problems during rehabilitation activities.

Normality of the data was assessed by the Shapiro-Wilks test. Participants were ranked into three groups according to Functional Independence Measure (FIM) scores to make comparisons between groups. Participant and therapist ratings were

analysed using descriptive statistical methods and the statistical difference between groups of different items was tested using Wilcoxon signed rank sum tests. The findings from the observations were summarized into themes using an inductive thematic approach.

## **Results**

Quantitative data showed that most subjects were able to put on the watch, read the pulse indicator and charge the watch independently, however, only a few subjects were able to start and stop pulse recordings independently.

Qualitative observations revealed; 1) That only a few subjects operated the watch at their own initiative, hence most of the subjects had to be reminded by the therapist to do so, daily, during the three-week period. 2) Subjects were more often baffled by the many functionalities of the watch and generally found the interface unintuitive and confusing.

Subjects with severe motor and cognitive impairment had significantly more difficulty in putting on the watch compared with subjects with less impairment ( $p < 0.039$ ). There was no difference between the subject's own assessment of their ability to handle the watch and the therapeutic assessments of the subject's ability to handle the watch ( $p > 0.555$ ).

## **Discussion**

Based on the results of the present study the usability of the Garmin Forerunner 235 for patients with acquired brain injury proved relatively low as most participants were unable to independently operate the watch during the three-week period.

The main finding was that most subjects, although physically capable, did not independently operate the watch during rehabilitation activities. This may be attributed to the nature and severity of the injuries and a reduced ability to develop automated responses which may have been exacerbated by the unintuitive watch interface.

It should, however, be noted, that  $n = 17$  subjects had moderate to severe impairments of memory, understanding and problem-solving domains of the cognitive FIM which could affect the results of this study.

## Acknowledgements

The authors wish to thank Helle Rovsing Møller Jørgensen and the staff of Neuroenhed Nord for their contribution to the study.

## References

- [1] Sundhedsstyrelsen (2014) National klinisk retningslinje for fysioterapi og ergoterapi til voksne med nedsat funktionsevne som følge af erhvervet hjerneskade, herunder apopleksi : 8 udvalgte indsatser
- [2] Fallow AB, Tarumi T, Tanaka H (2013) Influence of skin type and wavelength on light wave reflectance. *J Clin Monit Comput* 313–317 .
- [3] Spierer DK, Rossen Z, Litman LL, Fuji Kenji (2015) Validation of photoplethysmography as a method to detect heart rate during rest and exercise. *J Med Eng Technol* 264–271 .
- [4] Hickey AM, Freedson PS (2016) Utility of Consumer Physical Activity Trackers as an Intervention Tool in Cardiovascular Disease Prevention and Treatment. *Prog Cardiovasc Dis* 58:613–619 .

## Address for correspondence

Morten Pallisgaard Støve: [mps@ucn.dk](mailto:mps@ucn.dk)