The Development of a Clinical Applicable E-health Application for Measuring Myoclonus

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Introduction

Movement disorders are neurological conditions in which patients are suffering from abnormal movements. Myoclonus is a rare type of movement disorder in which patients experience repetitive brief involuntary twitching of a muscle or a group of muscles. In severe cases, myoclonus patients can be treated with 'Deep Brain Stimulation' (DBS). Although the clinical benefit of DBS is established, optimal stimulation settings are difficult to acquire and differ between patients. Furthermore, previous research has shown that the visual characterization of myoclonus is difficult and unreliable[1]. Since it is of crucial importance to objectively characterize the severity of myoclonus for titrating DBS stimulation settings, there is a big unmet clinical need.

" Develop an objective, comfortable and instantaneous method for measuring myoclonus severity "

Materials and methods

Measuring myoclonus severity was done using the accelerometer and gyroscope in the Apple Watch. This device is controlled by an iPhone custom made application which both processes the data and visualizes the results. The key result of the application is a 'severity score'. This score is an approximation of the traveled distance in centimeters and represents symptom severity. For a detailed workflow, see Fig 3.

The accuracy of the accelerometer was tested by moving the Apple Watch over a known distance and comparing this with the calculated distance. Furthermore, the accuracy of the Apple Watch accelerometer was compared with the accuracy of another commercially available accelerometer already applied in movement disorder research: the Shimmer. Finally, the Apple Watch's ability to distinguish between different severities of myoclonus was assessed. This was done by measuring ten volunteers that simulated myoclonus with three different severity levels. The data was analyzed using the 'minimum-distance-to-means' classifying method.

Results

The accelerometer of the Apple Watch was able to predict the traveled distance with an 96% accuracy. This did not differ significantly from the Shimmer (with 99% accuracy, $p = 0.74$, $\alpha = 0.05$, Fig 1). The Apple Watch's application was able to correctly classify myoclonus severity in 93% of the cases (Fig 2).

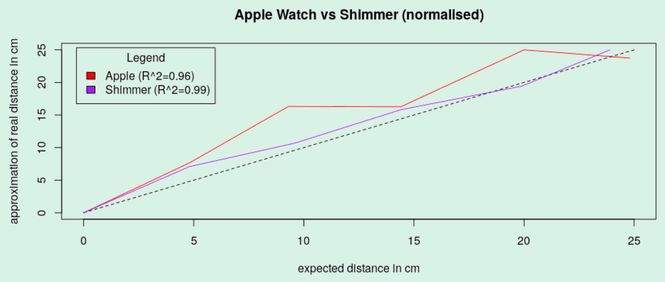


Figure 1. *Apple Watch compared to the Shimmer. Both devices are moved a known distance over a straight line and the resulting distance is compared to the actual distance. Both datasets are normalized between 0-25.*

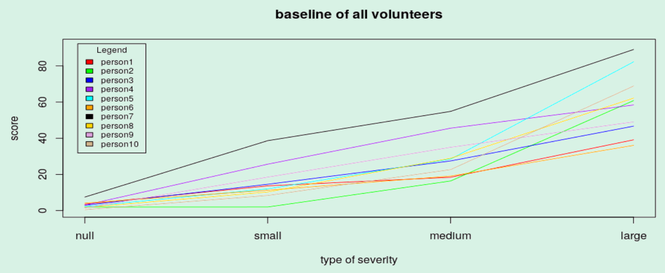
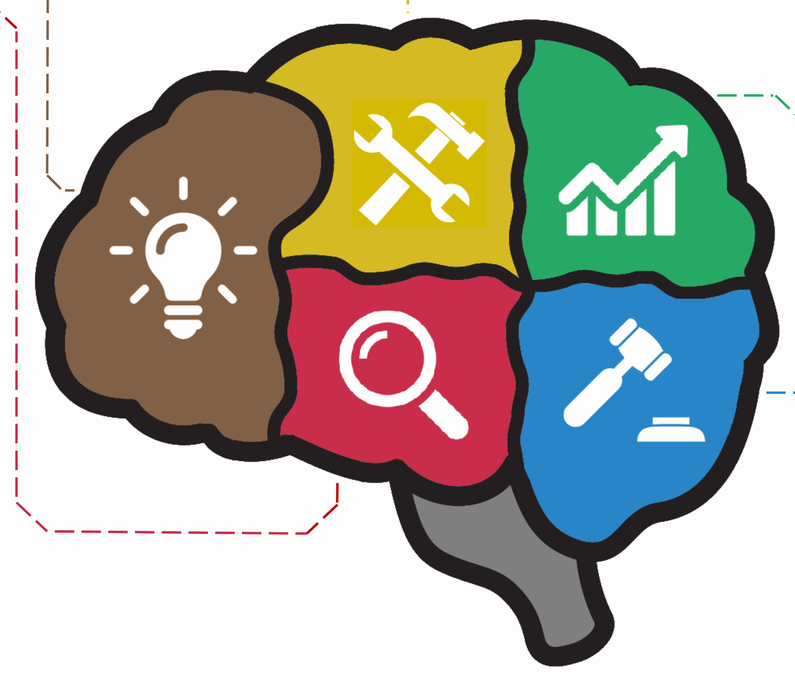


Figure 2. *Baseline measurements of ten volunteers. Each line is created by measuring a simulation of four types of myoclonus severities repeated three times. After baseline creation, three random severities are simulated which are classified to the closest distance class. Resulting accuracy is 93%.*

Discussion

Although accelerometers are able to reliably detect movements and movement disorders in patients, their application in clinical practice is still limited. The usage of this application has shown promising results so far. Fast, comfortable and objective measurements of myoclonus and related movement disorders are made possible. The limitations of the visual characterization can be overcome by using this application and is therefore of clinical relevance. The hardware used in this project has minor shortcomings preventing the usage of these devices to their highest potential. Limitations in the connectivity and a static sensor range could be improved. Finally, the application has not yet been tested on patients with actual myoclonus. For this reason further clinical research is needed to fully determine the clinical applicability of this application.



Conclusion

- First objective, comfortable and instantaneous E-health application for measuring myoclonus severity
- Excellent performance in classification of myoclonus severity in pilot setting

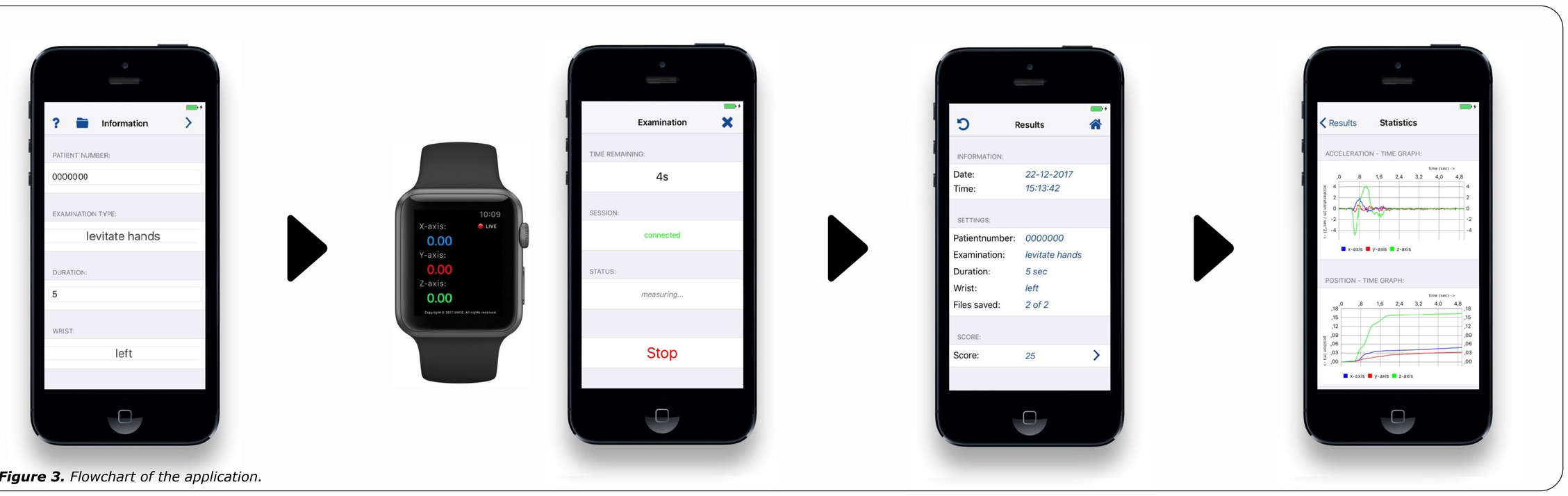


Figure 3. *Flowchart of the application.*

References

1 J. C. Van Zijl *et al.*, "Brief Reports The Inter-rater Variability of Clinical Assessment in Post-anoxic Myoclonus," *Tremor and Other Hyperkinetic Movements*, pp. 1–6, 2017.

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