Classification of Movement States in Parkinson's Disease Using a Wearable Ambulatory Monitor

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Background

For Parkinson's patients to function at their best, the clinicians who care for them must be able to manage and offset the fluctuations in movement that occur throughout the day. Symptoms of Parkinsonism such as bradykinesia, hypokinesia and akinesia and medication-related side effects such as dyskinesia need to be reported to the clinician in a manner that accurately conveys the timing and severity of symptoms. The clinician can then tightly adjust and titrate the timing and dosing of medication, allowing the patient to function at his or her best. Patient history and patient self reporting diaries are currently used for this purpose, but they have problems with compliance, completeness and reliability. A monitor that could be worn by the patient while he or she is at home and could issue to the clinician a report of how the patient has been moving over the course of the day would be a great help to clinicians. Wearable devices have been studied for the measurement of movement in Parkinson's patients, but none have been designed in a manner that would be useful for the titration of medications [1, 2, 3].

Methods

The device we studied consisted of 5 three axis accelerometers attached to all 4 limbs as well as the hip. Two Parkinson's patients were observed by a neurologist for a total of 640 minutes. The patient's state was recorded by a neurologist using a 5 point scale for bradykinesia/hypokinesia and a 5 point scale for dyskinesia. In addition, videotapes of the sessions were reviewed by the neurologist, allowing for the neurologist to resolve the state of bradykinesia/hypokinesia and dyskinesia down to a minute by minute basis. Features were obtained from the raw accelerometric data based on the absolute of the derivative of magnitude of acceleration as well as position and magnitude correlation between sensors. The data were randomly divided into training and test sets and each of the two scales of the neurologist's annotations were dichotomized. Neural networks and classification trees were used to try and predict dykinetic vs. not-dyskinetic states as well as bradykinetic/hypokinetic vs. not bradykinetic/hypokinetic states.

Results

Neural networks were able to detect bradykinesia/hypokinesia on the test set with a c-index of 88.0-92.1% (c-index equivalent to area under the ROC curve). Dyskinesia was detected with a c-index of 91.1-94.1%. Classification trees detected bradykinesia/hypokinesia with accuracies of 74.8-85.3% and dyskinesia with accuracies of 80.6-91.6%.

Discussion

This device we used was able to characterize two different aspects of Parkinson's patient's movement with a good degree of discriminative power. Neural networks did appear to perform somewhat better. This device should be able to be improved further when more data is collected using more patients.

References

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