

# A home environment test battery for status assessment in patients with motor fluctuations

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## Highlights

The test battery:

- Is designed for patients with motor fluctuations
- Captures both patients' perception of state and actual fine-motor performance
- Has good patient compliance
- Could detect treatment differences in two pilot patients, both in diary answers, tapping tests and spiral scores

## Description

This test battery is implemented on a hand unit (Figure 1) with a touch screen and built-in mobile communication. It has interfaces for the patient to answer questions and perform motor tests and gives an audible signal when it is time to enter. There is an interface for clinical staff to assign hand units to patients, define test periods and demonstrate the patient interface. There is a web application (Figure 2) that presents summaries of the test results per patient and test period graphically.

Figure 1. The hand unit.

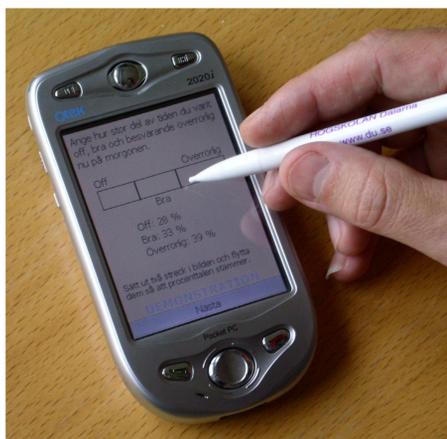
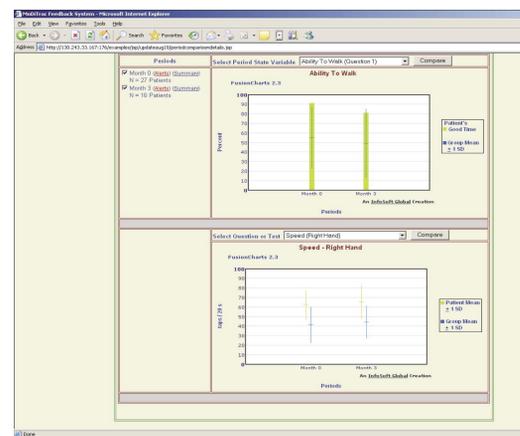


Figure 2. Sample screen from the web application.



## Usage

Typically, the test battery will be used:

- Several times daily in test periods of a week
- Before scheduled follow-up visits
- On suspicion of problems
- When treatment is changed
- In clinical studies

## Methods

Development of the user interface was done by iterating prototypes with input from pilot patients and clinicians. It was decided to implement the test battery on standard hardware (Qtek 2020i Pocket PC) with built-in mobile communication that was available at reasonable cost. The Java and to some extent the C implementation languages were used.

Selection of diary questions was based on the questions from a previous study [3]. The questions in that study were of verbal descriptive scale type with five answer alternatives ranging from 1 (worst) to 5 (best). Some strongly correlated questions were removed and, some were altered based on experiences from that study. One question about the patient's own assessment of the current state in seven steps ranging from 'very off' to 'very dyskinetic' was added. Tapping tests (with and without visual cueing) and a spiral drawing test were added. A validation algorithm for the spirals was developed and the methods by Liu et al [5] were modified and implemented to extract involuntary movements of different frequencies to compute a spiral 'score'. For the tapping tests, speed and proportion of correct taps were calculated.

An evaluation with two pilot patients was performed before and after receiving new treatments for advanced Parkinson's disease. Both patients were scheduled to receive these treatment changes. No interventions were made. Both patients approached the authors and volunteered to try out the test battery and were involved in the user interface design. One patient (A) was a 45 year-old woman who first had oral treatment in combination with deep-brain stimulation (DBS). Later she received duodenal levodopa infusion (Duodopa®), replacing the oral treatment, but keeping the DBS. The other patient (B) was a 65 year-old man who first received oral treatment and later received DBS and reduced his oral dose. The test battery was used four times per day during test periods of approximately one week. Treatment differences were evaluated using the two-sided Mann-Whitney non-parametric statistical test. Some questions were changed between the test periods and are therefore not evaluated.

The test battery is currently being used in a larger longitudinal study. In May 2006 it had been used by 33 patients. Compliance with the test battery was calculated as percentage actual entries / expected entries. Results from this study will be available in 2007.

## References

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5. Liu X, Carroll CB, Wang SY, Zajicek J, Bain PG. Quantifying drug-induced dyskinesias in the arms using digitised spiral-drawing tasks. *J Neurosci Methods*. 2005 May 15;144(1):47-52.

## Objectives

The aim of this work was to create a useful test battery for repeated status assessments in the patient's home environment, taking into account both the patient's own assessment of quality of life and symptom state in a diary, and assessments of actual motor performance, through fine motor tests such as tapping and spiral drawing.

The aim of the test battery is to provide status information in order to:

- evaluate treatment effects in clinical practice and research
- follow up treatments and disease progression
- predict outcome to optimise treatment strategy

## Background

Status assessment in patients with motor fluctuations, such as in advanced Parkinson's disease, is a difficult task. Clearly, single or a few measurements will not give full information on what state a patient is normally in, how much the state varies and how much time that is spent in different states. For the patient it can be difficult to remember the condition over past days, and repeated observations by medical staff requires hospitalisation which is expensive and may not be representative of the condition in the home environment.

Paper diaries are problematic since they may not be filled-in at designated times [1]. This is overcome by electronic diaries, which can have a good compliance in Parkinson patients [2]. However, patients' own assessment of function may not correlate well with their actual performance in motor tests. This was observed when further analysing the data from [3]. Tapping tests are widely used in assessment of motor function and have been implemented on touch screens in a test battery "neuromarker" [4]. Spiral drawings have been used for quantification of involuntary movements in [5].

## Results

Median compliance with the test battery in the ongoing study was 93%. Mean was 82%. 29 of the 33 patients had a compliance > 70%. The four patients with lower compliance could be explained by technical or study-specific reasons.

Post-treatment improvement was detected in both pilot patients in many of the test variables. Correctness in the free tapping test was significantly worse on the second treatment for patient A. All other significant differences indicate improvements. See Table 1 and Figure 3 for details.

Table 1. Results of comparison of test variables measured before and after treatment change in two patients. The Mann-Whitney test was used to calculate p-values for treatment difference.

Test variable	p-value for treatment difference	
	Patient A	Patient B
Ability to walk	<0.0001	0.1594 NS
Worst off	<0.0001	0.0212
Worst dyskinetic	<0.0001	0.0055
Satisfied with function	<0.0001	0.0097
Free tapping speed (right + left hands)	0.0001	0.0160
Free tapping correctness (right + left hands)	0.0098 *	0.6847 NS
Chase button test speed	0.0863 NS	0.6098 NS
Chase button test correctness	0.0001	0.7444 NS
Spiral score	0.0006	0.0049

\* Patient score was significantly worse on second treatment. NS = not significant.

Figure 3 (a-f). Plots of individual values for the two pilot patients for selected test variables. Lines connect mean value.

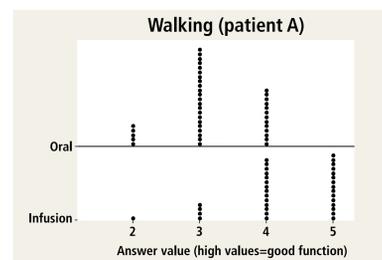


Figure 3 a. Shift is significant.

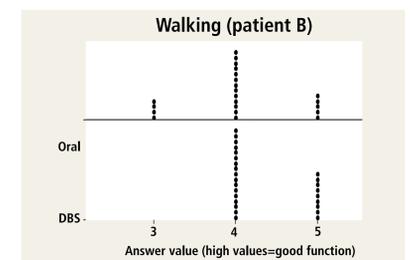


Figure 3 b. Shift is not significant.

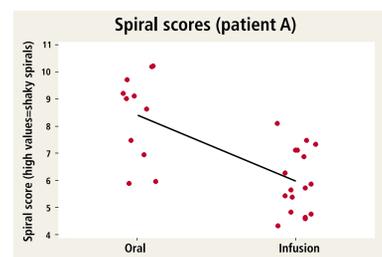


Figure 3 c. Shift is significant.

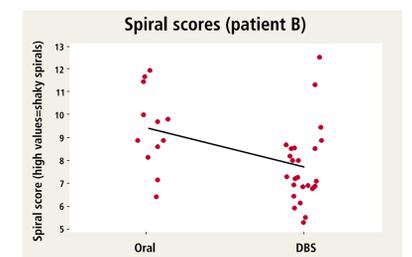


Figure 3 d. Shift is significant.

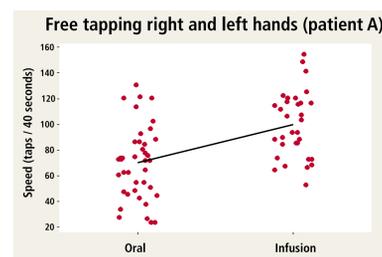


Figure 3 e. Shift is significant.

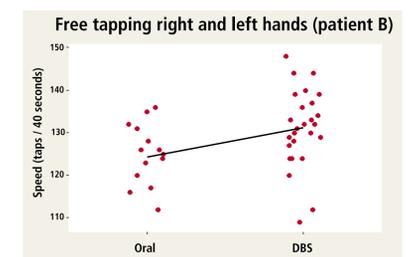


Figure 3 f. Shift is significant.