

The use of a mobile-phone-based E-diary for evaluation of patient-reported outcomes and adherence to treatment of patients with Multiple Sclerosis

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Background

Little is known regarding the applicability of smartphone technology to promote clinical care of patients with Multiple Sclerosis (PwMS).

Aim

To assess the usefulness of a smartphone-based e-diary to the estimation of adherence to disease modifying drugs (DMDs), as well as to the collection of patient-reported outcomes (PROs).

Methods

Patients downloaded our MS tailored e-diary (*Carmel Diary*) into their personal smartphones. The application prompted patients to take their DMDs and recorded their adherence. Report of PROs was conveyed once monthly through the application, using previously validated tools (Multiple Sclerosis Quality of Life inventory, Neuro-QoL short forms and CNS lability scale). Adherence data from the e-diary was compared to medication pack collection. PROs gathered by the e-diary were compared to corresponding functional system scores, determined by neurologic examination, as well as to patients' subjective reports during routine follow up visits, as documented in their electronic medical record (EMR).

Results

Data from 83 PwMS was used in this analysis [Female: 54 (65%), EDSS 3.4±2.1]. Patients were using the e-diary for a median duration of 17 weeks [range:4-29 weeks]. Only 7 patients (8%) dropped out and another 3 (3%) did not agree to participate in PRO survey but continued to report their medication intake. Adherence to DMDs as reported in the e-diary was 87.1±17.8% compared to 84 ±19.2% according to pack collection. E-diary derived PROs were significantly correlated with the corresponding functional system scores (0.47< r <0.8, P<0.0001).

Table 1: Patients' characteristics:

| | |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| Recruited | 83 |
| Enrolment date | 11.4.2016 - 30.11.2016 (Last patient: 26.12.2016) |
| Duration of follow up (median, range) | 17 weeks [0-29] |
| Age (years) | 40.4 ± 11.3 |
| Gender | F=54 (65%) |
| Employed | 48 (58%) |
| Time since MS diagnosis (years) | 9.1 ± 7.8 |
| EDSS at baseline | 3.4 ± 2.1 |
| Disease activity (1y before baseline) | 33 (40%) |
| DMD at baseline | Fingolimod 39 (46%) DMF 22 (27%) IFN beta 1a 10 (12%) Copaxone 8 (10%) Teriflunomide (4%) Natalizumab (1%) |
| Time since DMD start (years) | 2.3 ± 2.9 [0-18] |
| % with follow up clinic visit | 25 (30%) |
| Time to follow up visit (median, range) | 16 weeks [7-26] |

Table 2: Adherence to the E-diary:

| | |
|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Complete drop outs (PROs+Adherence) | 7 (8%) Smartphone failure – 3 Anxiety induced by E-diary-2 Language difficulties -1 Too much effort -1 |
| PRO collection only drop outs | 3 (3%) Anxiety induced by E-diary-3 |
| Adherence to 'body function' collection | 90 ± 16% [range: 33%-100%] |
| Adherence to 'cognitive function' collection | 83 ± 18% [RANGE: 33%-100%] |
| Adherence to medication intake collection | 88 ± 18% [RANGE:33%-100%] |
| Administrator prompting to submit surveys (# reminders per patient) | 2 ± 0.8 [range :0-9] |
| Administrator prompting to submit medication intake (reminders per patient) | 1.5 ± 0.5 [range: 0-3] |

The E-diary captured more MS related symptoms than documented in the EMR . In patients with a relapse we noted increased PRO scores, which decreased following remission.

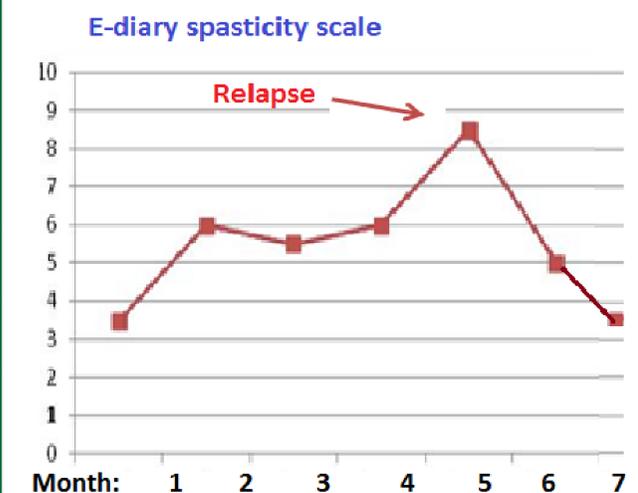
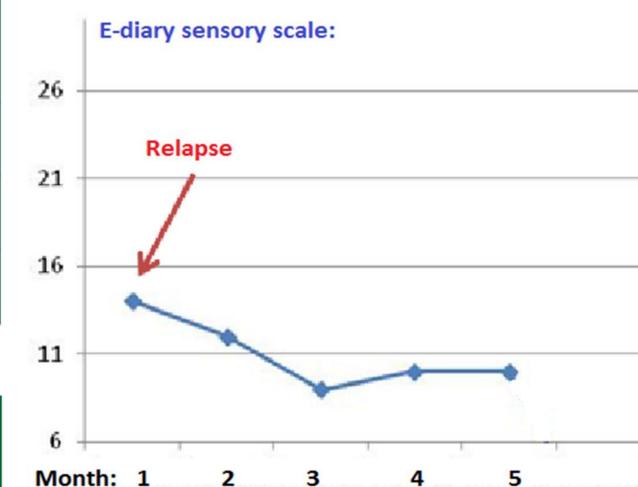
Table 3: Construct Validity (baseline)

| PRO E-diary | Neurostatus | Pearson r | P value |
|---------------------|-------------|-----------|---------|
| Lower limb | Pyramidal | 0.8 | <0.0001 |
| Sum 'Body function' | EDSS | 0.73 | <0.0001 |
| Spasticity | Pyramidal | 0.69 | <0.0001 |
| Upper limb | Pyramidal | 0.59 | <0.0001 |
| Pain | Sensory | 0.52 | <0.0001 |
| Eyes | Visual | 0.47 | <0.0001 |

Table 4: Patient-reported outcomes in electronic medical record vs. E-diary:

| PRO | EMR | E-diary |
|-------------------------------|----------|----------|
| Fatigue | 19 (35%) | 36 (65%) |
| Pain and dysaesthesia | 31 (53%) | 36 (61%) |
| Poor Sleep | 3 (5%) | 29 (49%) |
| Lower limb dysfunction | 30 (51%) | 29 (49%) |
| Subjective cognitive problems | 6 (11%) | 25 (45%) |
| Spasticity | 8 (14%) | 20 (34%) |
| Sphincter control | 16 (27%) | 18 (31%) |
| Anxiety | 0 | 15 (27%) |
| Depression | 6 (11%) | 10 (18%) |
| Problems with vision | 6 (10%) | 10 (17%) |
| Pseudo bulbar symptoms | 2 (3%) | 10 (17%) |
| Upper limb dysfunction | 2 (3%) | 6 (10%) |

Figure 1: Relapse detection by the E-diary



Conclusions

• Smartphone-based e-diary seems suitable for PwMS and can provide useful information regarding PROs and adherence to DMDs.

• Integration of smartphone-based E-diary, among spectrum of digital health tools, would promote patient-centric approach to improve care of PwMS.

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