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Damien Bachasson, Océane Landon-Cardinal, Olivier Benveniste, Jean-Yves Hogrel, Yves Allenbach. Physical activity monitoring: A promising outcome measure in idiopathic inflammatory myopathies. *Neurology*, 2017, 89 (1), pp.101-103. 10.1212/wnl.0000000000004061 . hal-04554731

**HAL Id: hal-04554731**

**<https://hal.science/hal-04554731v1>**

Submitted on 22 Apr 2024

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# Clinical/Scientific Notes

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## PHYSICAL ACTIVITY MONITORING: A PROMISING OUTCOME MEASURE IN IDIOPATHIC INFLAMMATORY MYOPATHIES

Availability of reliable outcomes for idiopathic inflammatory myopathies (IIM) is critical to optimize treatment strategies.<sup>1</sup> The current consensus for the assessment of IIM severity and treatment efficacy relies on the evaluation of core set measures comprising manual muscle testing, muscle enzymes, extramuscular disease activity assessment, physician and patient global disease activity assessment, and patient's physical function questionnaires.<sup>2</sup> Muscle enzymes such as serum creatine kinase (CK) level are highly sensitive markers for detecting changes in disease activity though this does not correlate well with disease severity. Manual muscle testing is an operator-dependent and semiquantitative evaluation resulting in poor interrater reliability and poor sensitivity to changes. Disease burden may be imprecisely assessed when using self-reported questionnaires. Floor and ceiling effects associated with these metrics are also of major concern.<sup>1,2</sup>

Triaxial wrist-worn accelerometers are increasingly used for the objective assessment of physical activity energy expenditure (PAEE) in daily life.<sup>3</sup> Software developed by device manufacturers often use proprietary algorithms, which has led to widespread confusion among health researchers. More recently, several devices allow the computation of nonproprietary features extracted from multiday raw acceleration data. To our knowledge, there is no previous report that has investigated the potential of these new methods to evaluate and monitor patients with IIM.

**Methods.** In this pilot work, 5 patients with IIM wore a widely used device in human movement sciences (GENEActiv, Activinsights Ltd., Kimbolton, UK) on their nondominant wrist for 14 consecutive days, every month during 6 months after treatment initiation. At screening and at each follow-up visit, patients underwent the following evaluations: manual muscle testing assessed in 8 muscle groups (MMT8)<sup>4</sup>; serum CK levels; and quality of life assessed with the French version of the Short Form-36 (SF-36) (100 is the maximal score). Other International Myositis Assessment and Clinical Studies groups core set measures<sup>2</sup> required for evaluating the time to reach

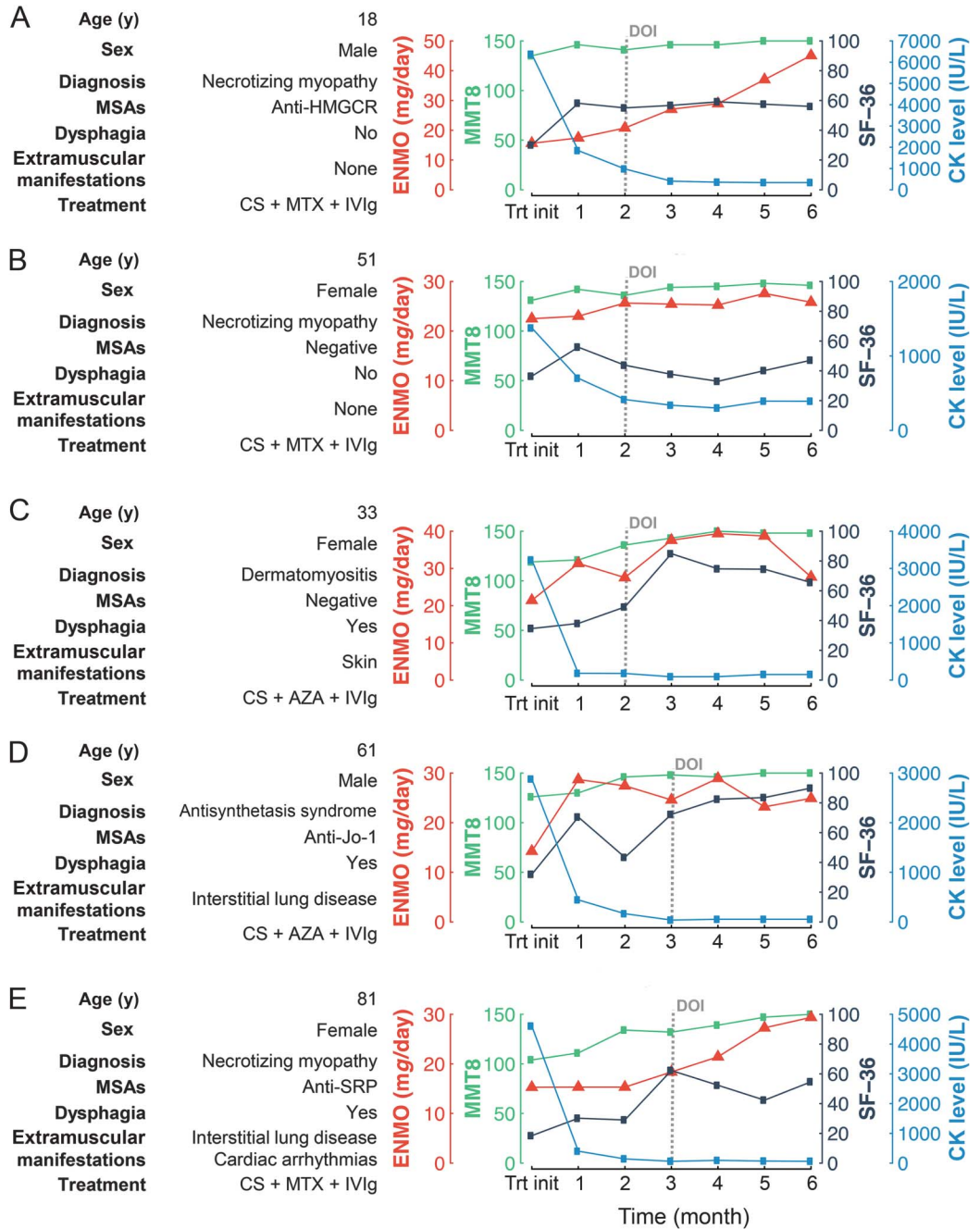
definition of improvement were also collected. Raw accelerometer data were analyzed using the open-source R-package GGIR ([cran.r-project.org/web/packages/GGIR](http://cran.r-project.org/web/packages/GGIR/)).<sup>5,6</sup> The vector magnitude from the 3 axes corrected for gravity, referred to as Euclidean norm - 1 g (ENMO), was computed.<sup>5</sup> The procedure for nonwear detection was performed as described previously.<sup>5</sup> ENMO is recognized as one of the main open-source summary metrics for raw accelerometry data and was reported to be strongly associated with PAEE.<sup>7</sup> The average daily ENMO was used as an index of physical activity.

**Results.** Characteristics of patients at baseline and changes after treatment initiation are displayed in the figure. Average wear time of the activity monitor per day was  $22.65 \pm 2.27$  hours, confirming high compliance.<sup>3</sup> At baseline, patients displayed slight to moderate impairments in muscle strength according to the MMT8 (range 104–135). Patients reported poor quality of life according to the SF-36 (range 19–36). Ranges of physical and mental components of the SF-36 summary scores were 11.5–30.3 and 30.0–65, respectively. Serum CK levels were elevated in all patients (range 1,375–6,366 IU/L). After treatment initiation, all patients exhibited an early and substantial decrease in serum CK levels, suggesting responsiveness to treatment. Panels A and E of the figure illustrate a continued increase in ENMO after plateauing of MMT8 and SF-36. Six months after treatment initiation, ranges of percentage changes in ENMO were generally much greater than percentage changes in MMT8 (i.e., up to 188% vs 44%, respectively).

**Discussion.** Our observations suggest a high potential of objective PAEE estimates as an additional tool for evaluating disease burden and treatment-induced changes in IIM, as previously reported in other medical fields. Ceiling effects associated with MMT8 are clearly highlighted. Moreover, further increase in ENMO may be observed after plateauing of MMT8 (patients A and E). Changes in SF-36 during treatment also mirrored increase in physical activity. When comparing values from each follow-up time points to values at treatment initiation, we also found a significant correlation between percentage changes in ENMO and percentage changes in SF-36 ( $r = 0.48$ ,  $p < 0.01$ ;  $n = 30$ ).

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**Figure** Clinical characteristics of patients at treatment initiation and during 6 months



Five patients with idiopathic inflammatory myopathies (3 patients with necrotizing autoimmune myopathy [A, B, E], 1 patient with dermatomyositis [C], and 1 patient with antisynthetase syndrome [D]) wore a triaxial accelerometer on the nondominant wrist for 14 days every month during 6 months after treatment initiation (Trt init). The Euclidean norm (vector magnitude expressed in milig [mg]) of the 3 raw acceleration signals minus one (to limit the confounding effect of the gravity) was used to estimate daily physical activity energy expenditure; Quality of life was assessed with the French version of the Short Form-36 (SF-36) (100 is the maximal score); muscle strength testing (MMT8) was assessed in 8 muscles using the Medical Research Council scale, in which 0 indicates no movement and 5 indicates ability to contract against full resistance (150 is the maximal score); CK level = serum creatine kinase level. Gray dashed line indicates time to reach definition of improvement (DOI; see text for details). Anti-Jo-1 = Jo-1 antibody; anti-SRP = signal recognition particle antibody; AZA = azathioprine; CS = corticosteroids; HMGCR = HMG-CoA reductase antibody; IVlg = IV immunoglobulin; MSA = myositis-specific autoantibodies; MTX = methotrexate.

A broad range of outcome variables, including activity classification, e.g., time spent to perform moderate to vigorous activity, may also be computed to provide additional information regarding activity

profile, sedentary behavior, as well as changes over time. Availability of open-source software and collaborative approaches for data analysis will facilitate the adoption of these methods.<sup>3</sup> A common effort must

be carried out to implement this low-cost approach in large-scale studies to evaluate the potential to improve the evaluation of treatment efficacy towards enhancing clinical decision-making.

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*Author contributions: D.B., O.B., J.-Y.H., and Y.A. designed and acquired data. D.B. and O.L.-C. analyzed the data. D.B., O.L.-C., O.B., J.-Y.H., and Y.A. analyzed and interpreted the results. D.B. drafted the first version of the manuscript. D.B., O.L.-C., O.B., J.-Y.H., and Y.A. critically revised the manuscript for intellectual content.*

*Study funding: This study was funded by the Association Française contre les Myopathies (AFM).*

*Disclosure: The authors report no disclosures relevant to the manuscript. Go to Neurology.org for full disclosures.*

*Received November 30, 2016. Accepted in final form March 16, 2017.*

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*Neurology* published online May 31, 2017

DOI 10.1212/WNL.0000000000004061

**This information is current as of May 31, 2017**

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