ASSISTING CLINICAL DECISION-MAKING BY PREDICTING TREATMENT RESPONSE FOR PAEDIATRIC MOVEMENT DISORDERS

Rosa MS Visscher (1,2), Julia Murer (1), Fahimi Fatemeh (1,3), Elke Viehweger (2,4), William R Taylor (1,3), Reinald Brunner (2,4), Navrag B Singh (1,3)

1. Laboratory for Movement Biomechanics, Institute for Biomechanics, ETH Zürich, Switzerland;
2. Department of Biomedical Engineering, University of Basel, Switzerland;
3. Singapore-ETH Centre, Future Health Technologies Program, Singapore;
4. Laboratory for Movement Analysis, University Children's Hospital Basel, Switzerland

Introduction

Paediatric movement disorders, like cerebral palsy, often negatively impact walking behaviour. Although clinical gait analysis is usually performed to guide treatment decisions [1], not all respond positively to their assigned treatment [2]. Identifying these individuals based on their pre-treatment characteristics could alert clinicians and allow them to possibly adapt to a more personalized intervention. This study therefore presents an approach for identifying patients at risk of negative treatment outcomes. To automate this process, we applied a standard machine learning approach to standardly collected pre-treatment gait and anthropometric features.

Methods

Observational data of 119 patients with movement disorders were retrospectively extracted from a local clinical database, comprising sagittal joint angles and spatiotemporal parameters, derived from motion capture data pre- and post-treatment (physiotherapy, orthosis, botulin toxin injections, or surgery). Participants were labelled based on their change in gait profile score (GPS, worsened vs. maintained/improved $\Delta 1.6°$, [3]). Their pre-treatment features (sagittal joint angles, spatiotemporal parameters, anthropometrics) were used to train a linear support vector machine (SVM) classifier with 5-fold cross-validation and Bayesian optimization, within MATLAB Classification Learner App.

Results

28 out of 119 patients, worsened their GPS after receiving standard treatment, while 91 showed no change or improved. No significant differences in sex, age, height, weight, diagnosis, treatment, or pre-treatment GPS were present between those who worsened and those who maintained/improved their GPS (t or fisher exact test $p>0.05$). Those who worsened, increased their GPS from 10.7±3.1 to 13.0±3.5, while the others reduced their GPS from 12.4±5.0 to 10.8±3.3. An average accuracy of 88.2±0.5% was obtained, with a 96.0±0.9% true positive rate for identifying those at risk of worsening their gait and an area under the curve of 88.0±1.0% (Figure 1, Table 1).

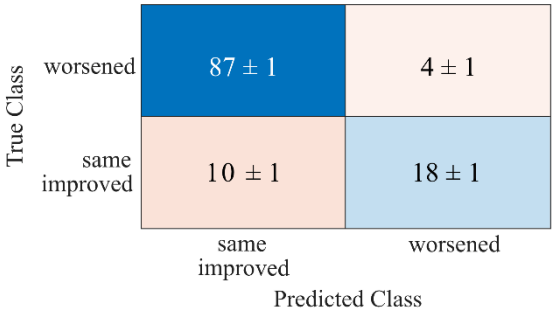

Figure 1: Confusion matrix of average SVM results, showing how many individuals were classified correctly on the diagonal.

	TPR	FNR
Worsened (%)	96.0±0.9	4.0±0.9
Maintained/Improved (%)	62.9±4.3	37.1±4.3

Table 1: Average results SVM, reporting true positive rate (TPR) and false negative rate (FNR) in percentages.

Discussion

Overall, a classical machine learning model was able to identify patients at risk of worsening their gait after treatment, based on routinely collected gait features and anthropometrics. The output of such a model could function as a method for notifying clinicians that a certain individual might not respond well to the standard of care and a more personalized intervention might be needed.

References

1. Armand et al., EFFORT OpenRev, 1(12):448-60 2016.
2. Kusumoto et al, PLoS One, 11(5):e0154749, 2016.
3. Baker et al, Gait Posture, 35(4):612-5, 2012.

Acknowledgements

The authors acknowledge the gait lab personal for their support in data collection and analysis. This work was financially supported by the Ralf-Loddenkemper Foundation (CH-270.7.002.704-3).