A Clinically Applicable Interactive Micro and Macro-Sleep Staging Algorithm for Elderly and Patients with Neurodegeneration

Elderly and patients with neurodegenerative diseases (NDD) often complain about sleep problems and show altered sleep structure. Automated algorithms for efficient and specific sleep staging are needed. We propose a new algorithm using only one electroencephalographic and two electrooculographic channels to score wakefulness, rapid eye movement (REM) sleep and non-REM sleep in a cohort of elderly healthy controls (HC), patients with Parkinson’s disease (PD), isolated REM sleep behavior disorder (iRBD), considered the prodromal stage of PD, and patients with PD and RBD (PD+RBD). The proposed method scores both standard 30-s epochs (macro-staging) and 5-s mini-epochs (micro-staging), whose evaluation may help to better understand sleep microstructure. Moreover, the algorithm is interactive, as it labels the classified sleep epochs as either certain or uncertain, so that experts can manually review the uncertain ones. The algorithm performances were evaluated for macro-sleep staging, where it achieved overall accuracies of 0.87±0.05 in 41 HC, 0.86±0.10 in 57 PD, 0.76±0.10 in 31 iRBD and 0.77±0.10 in 30 PD+RBD patients when all 30-s epochs were considered. The accuracies increased to 0.91±0.05, 0.90±0.08, 0.85±0.09, 0.88±0.08 respectively when considering only the certain ones. The epochs labeled as uncertain were 9.95±4.15%, 11.13±7.86%, 18.39±7.38% and 18.90±8.00% in HC, PD, iRBD and PD+RBD respectively. The proposed interactive micro and macro sleep staging algorithm can be used in clinics to reduce the burden of manual sleep staging in elderly and patients with NDD.