

Reading between the lines: an algorithm for electroencephalogram (EEG) analysis in horses

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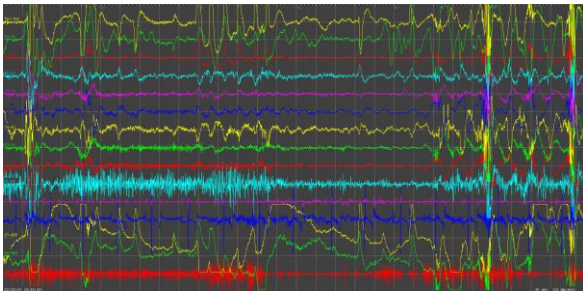


Figure 1 - Detail of a 30-second epoch illustrating wave patterns consistent with wakefulness.

Electroencephalography (EEG) is a standard method for sleep studies [1, 2]. However, although widely used in human medicine, its application to sleep analysis in veterinary medicine remains limited. One major concern of EEG is the time required for the analysis. In human sleep research, several algorithms have been developed to improve scoring efficiency [3, 4]. Therefore, the objective of this study was to analyze equine EEG recordings and develop an algorithm for sleep staging in the horse. For this purpose, a healthy 8-year-old mare underwent continuous EEG recording for 18 hours. Electrode placement followed a protocol described previously in the literature [5]. Surface electrodes were positioned at 19 predetermined sites on the equine head, including

two electrooculographic (EOG) electrodes. One electromyography (EMG) electrode, the only needle electrode used, was placed in the right trapezius muscle. Recordings were obtained using a BW Mini EEG system (Neurovirtual). Data acquisition was performed in a stall, with the device secured to the halter to allow the horse to move freely. EEG, EOG, and EMG signals were acquired at 300 Hz and down sampled to 100 Hz, preserving the spectral content of interest while reducing computational burden. To minimize the influence of pre-sleep wakefulness, sensor-settling effects, and transition-related artifacts, the first 30 min of recording were excluded. The remaining data were segmented into 30s epochs, and spectral features were extracted using the Welch method. Relative sigma and delta power were computed by normalizing EEG sigma (12–15 Hz) and delta (0.5–4 Hz) power to total EEG power in the 0.5–35 Hz range, averaged across central and frontal derivations. Band-limited power was also computed for EOG and EMG signals and subsequently log-transformed to improve the robustness of percentile-based thresholding. All preprocessing, feature extraction, and rule-based staging procedures were implemented in Python. Sleep stages were assigned using physiologically grounded decision rules and recording specific percentile thresholds derived from EMG, EOG, and EEG spectral features, followed by temporal smoothing. In the 20% validation set ($n = 406$ epochs), the method achieved an overall accuracy of 82.0%, with class-wise recall of 68.7% for N1, 70.8% for N2, 14.3% for N3, 84.6% for REM, and 88.5% for wakefulness. The low recall observed for N3 likely reflects the limited representation of this stage in the validation set. Although these findings remain preliminary, as they derive from a single-horse recording and therefore do not provide clinical validation, they support the feasibility of this approach and encourage further evaluation in a larger equine cohort.

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