Non-stationarity of EEG during wakefulness and anaesthesia: advantages of EEG permutation entropy monitoring.

Abstract:
Monitors evaluating the electroencephalogram (EEG) to determine depth of anaesthesia use spectral analysis approaches for analysis windows up to 61.5 s as well as additional smoothing algorithms. Stationary EEG is required to reliably apply the index algorithms. Because of rapid physiological changes, artefacts, etc., the EEG may not always fulfil this requirement. EEG analysis using permutation entropy (PeEn) may overcome this issue, since PeEn can also be applied to practically nonstationary EEG. One objective was to determine the duration of EEG sequences that can be considered stationary at different anaesthetic levels. The second, more important objective was to test the reliability of PeEn to reflect the anaesthetic levels for short EEG segments. EEG was recorded from 15 volunteers undergoing sevoflurane and propofol anaesthesia at different anaesthetic levels and for each group 10 data sets were included. EEG stationarity was evaluated for EEG sample lengths from 4 to 116 s for each level. PeEn was calculated for these sequences using different parameter settings and analysis windows from 2 to 60 s. During wakefulness EEG can only be considered stationary for sequences up to 12 s. With increasing anaesthetic level the probability and duration of stationary EEG increases. PeEn is able to reliably separate consciousness from unconsciousness.
for EEG segments as short as 2 s. Especially during wakefulness a conflict between stationary EEG sequence durations and methods used for monitoring may exist. PeEn does not require stationarity and functions for EEG sequences as short as 2 s. These promising results seem to support the application of non-linear parameters, such as PeEn, to depth of anaesthesia monitoring.