Comparing video actigraphy across premature infant sleep states

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COMPARING VIDEO ACTIGRAPHY ACROSS PREMATURE INFANT SLEEP STATES

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Introduction: Sleep plays important role for the development of neonates, in particular premature infants. Premature infant sleep consists of mainly active sleep and quiet sleep stages and wake state. Continuous monitoring of sleep states is indicative of their neural development over time. However, current methods of sleep monitoring in clinical practice, such as polysomnography (PSG) and behavioural observations require either attachment of electrodes to the infant's fragile skin or time-consuming effort through human scoring [1]. Therefore, there is a strong need for unobtrusive sleep state monitoring of premature infants. Video-based monitoring is considered a non-contact and unobtrusive method to capture infants' activity during sleep. By analysing body motions, we aimed at distinguishing between different sleep states automatically. Thereby, we quantified the body motion (called "video actigraphy") and compared it across sleep states.
Materials and methods: Data of 29.8 h from seven premature infants (gestational age: 29.9 ± 2.7 wk) was analysed, where near-infrared videos were recorded for each infant. Sleep states were manually scored by two trained raters individually for each non-overlapping 30-s epochs, based on an adaptation of the behavioural scoring system developed by Prechtl in 1974 [2]. Respiratory signals, collected using an unobtrusive sensor, were used to assist the behavioural scoring. A 3DRS motion estimation algorithm [3] was employed to quantify motions by characterising pixel changes of consecutive video frames. Estimated non-zero motion values were counted and then averaged over each 30 s, resulting in epoch-based video actigraphy measures. The video actigraphy measures were then compared and statistically examined over sleep states.
Results: Mean and standard deviation of video actigraphy during wake, active sleep, and quiet sleep were 0.21 ± 0.19, 0.10 ± 0.21, and 0.09 ± 0.25, respectively. During wake state, the video actigraphy was significantly larger compared with that during the two sleep stages (examined with an unpaired t-test, $p < 0.0001$). This indicates that premature infants, in general, showed remarkably more body movements in wake state than in sleep state. In addition, no significant difference ($p = 0.26$) in video actigraphy was found between active sleep and quiet sleep.
Conclusions: By analysing the body motions (quantified using video actigraphy) for premature infants during different sleep stages, we found that it is feasible to discriminate between sleep and wake states for this patient group. However, our approach seems not capable of identifying specific sleep stages (i.e. active sleep or quiet sleep) with video actigraphy. From an application perspective, future work should be focused on investigating and developing an automated sleep/wake detection algorithm based on video actigraphy.
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