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Clinical usefulness

The Clinical Usefulness of Sleep Studies in Children

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EDUCATIONAL AIMS

The reader will come to appreciate that:

- Polysomnography is the gold standard for diagnosis and management of sleep disordered breathing in infants and children.
- There are respiratory and non-respiratory indications for performing polysomnography.
- Polysomnography is an important tool in the diagnostic work-up of children with excessive daytime sleepiness.

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SUMMARY

Sleep disordered breathing is common in children and has the potential to have a significant impact on cognition, activity and social interaction. The overnight in-laboratory polysomnography (PSG) continues to be the gold standard instrument for the investigation of sleep-disordered breathing in children. It has the ability to rule in or rule out the need for intervention for common conditions such as obstructive sleep apnoea, assess the role of sleep quality in children and adolescents with hypersomnolence, provide physiologic data in children with hypoventilation as may be seen in neuromuscular disease and assist in the assessment of children with structural airway and lung abnormalities.

Polysomnography is valuable and the only reliable method to differentiate habitual snoring from many levels of sleep apnoea syndrome [1]. The American Academy of Paediatrics recommends that, in order to diagnose and manage OSA syndrome, all children should be screened for snoring and complex cases should be referred to a specialist. PSG is the diagnostic gold standard and adenotonsillectomy is the first line of treatment [2]. There is no evidence to support nap studies or ambulatory sleep studies in children [3]. With adequate staffing, expertise, and a child and family-friendly environment, children of any age can undergo a sleep study.

VARIABLES MEASURED BY POLYSOMNOGRAPHY

Sleep architecture, gas exchange, respiratory events, snoring, arousals, limb movements, heart rate and body position are the variables measured in the PSG (Figure 1 – sleep study epoch). The sleep study set up consists of nasal and oral flow measurements, continuous electroencephalogram (EEG) and electrocardiogram (ECG), as well as bilateral electro-oculography (EOG); oxyhaemoglobin saturation and transcutaneous or end-tidal carbon dioxide; continuous electromyography of the genioglossus, diaphragm and abdominal muscles, plethysmography bands for chest and abdominal movements; microphone for sound recording and monitoring of airway noises and video recording (Figure 2).

After the study is performed and scored, the study report should contain information regarding sleep architecture and efficiency (percentage of recording time spent in sleep); central and obstructive apnoea and hypopnoea index, oxygen distribution and saturation nadir, carbon dioxide distribution and periodic limb movement index [4]. Sleep studies in children are generally performed and interpreted according to the American Academy of Sleep Medicine guidelines, but often with some modifications

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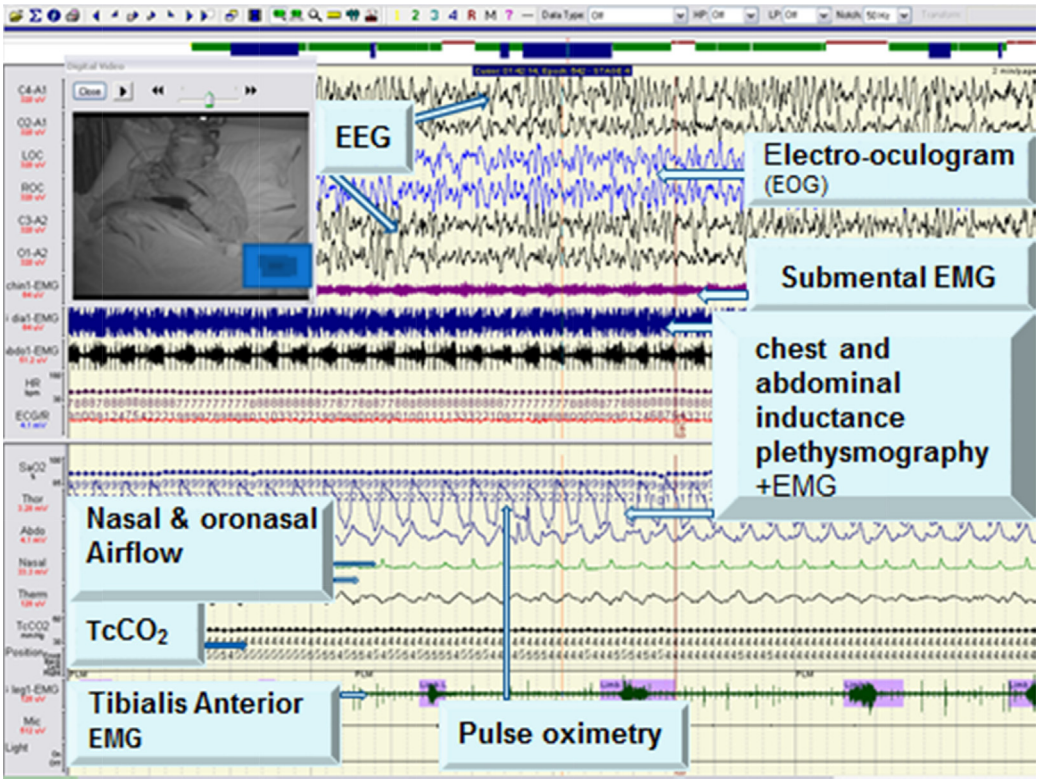

Figure 1. A two-minute "Epoch" from a Sleep Study showing Stage 3 (N3) (Deep Sleep). High work of breathing is evident on Abdominal and Diaphragmatic EMG. Periodic Limb Movements are scored using tibialis anterior EMG.

[3]. It is beyond the scope of this paper to compare the differences in scoring respiratory events. A good summary of this can be found in a review of primary snoring by Biggs et. al recently [5].

Sleep stages

EEG, EOG and observation of genioglossus or chin muscle tone are the main defining parameters to scoring sleep stages. Sleep stages can be divided into REM and non-REM Sleep. Non-REM sleep is further divided into light sleep (N1 and N2) and deep sleep (N3). In infants under 12 months of age, sleep stages are usually divided into quiet (deep) sleep, active (REM) sleep and indeterminate sleep (where parameters of the preceding are not met).

Scoring Respiratory Events

Oxyhaemoglobin saturation, nasal and oral airflow and continuous electromyography are the parameters in the sleep study used for scoring respiratory events. An obstructive apnoea is scored where there is >90% drop in airflow compared to pre-event baseline for >90% of the duration of the event, lasting at least two missed breaths, with continued effort in chest and abdomen. A central apnoea is defined as cessation of airflow with cessation of respiratory effort. Central apnoeas are considered abnormal if lasting for more than 20 seconds and they are also scored if two or more breaths are missed with an associated drop in oxygen saturation [SpO_2] of more than 3% or an arousal. An obstructive hypopnoea is a partial obstructive event defined as a 50% drop in airflow for at least 90% of the duration of the event, lasting at least two missed breaths and associated with an arousal or a >3% SpO_2 desaturation [6]. In children an obstructive apnoea index greater than one per hour is considered abnormal [4].

RESPIRATORY INDICATIONS FOR POLYSOMNOGRAPHY IN CHILDREN

Sleep-related Breathing Disorders

Sleep studies are frequently requested for children suspected of having obstructive sleep apnoea (OSA). OSA is defined as a disorder of breathing during sleep characterized by prolonged partial upper airway obstruction and/or intermittent complete obstruction (obstructive apnoea) that disrupts normal ventilation during sleep and normal sleep patterns [4].

Adenotonsillectomy (AT) is the first line of treatment for most children [1]. Polysomnography is indicated in children being considered for adenotonsillectomy, not only to confirm the diagnosis but to prioritise the timing of the procedure and to help predict the risk of post-operative complications. Depending on the severity of the OSA, children might require peri-operative respiratory support and high-dependency care. It has been shown that history is a poor predictor of OSA [7]. PSG not only diagnoses, but helps prioritise children on the waiting list for AT. PSG is recommended for children who are at high risk of residual OSA post-adenotonsillectomy. These are children who are already at risk of post-AT compromise such as those with neuromuscular disorders, craniofacial anomalies, obesity and other risk factors [3].

Hypoventilation Syndromes

The hypoventilation disorders in children may initially be asymptomatic, progressing to physical signs of respiratory failure, such as nocturnal arousals, awkward sleeping positions, night sweats, morning headaches, irritability, daytime drowsiness or daytime hyperactivity, behavioural and cognitive problems, failure to thrive, recurrent airway infections and cor pulmonale (late