

Sleep physiology and sleep-disordered breathing: the essentials

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ABSTRACT

Sleep is essential, but poses a risk to breathing in some children. We have outlined the developmental changes in sleep patterns and physiology, and the evidence of deleterious effects of sleep deprivation and of sleep-related breathing disorder (SRBD). Some factors increase the risk of adeno tonsillar surgery and should be excluded before contemplating surgery in a secondary care setting. Screening for SRBD is indicated in some conditions, which are discussed. Although simple studies may suffice for many patients, there are a few who need more detailed assessment with polysomnography. A managed clinical network would be the most appropriate model to ensure appropriate organisation and utilisation of scarce resources in this area.

INTRODUCTION

Sleep is something of a mystery. It is a physiological process that appears essential to all mammals, and the adverse effects of sleep deprivation are well documented, but the functional purpose of the sleep process remains poorly understood. Theories advanced to explain this include the replenishment of neurotransmitter stores, the restoration of synaptic density, the off-line housekeeping of the brain, 'exercising' underused memories and synapses, and the consolidation and integration of new learning. There are several reasons why paediatricians should have an understanding of sleep physiology: to help with the diagnosis and treatment of behavioural sleep problems; to recognise the adverse effects of sleep deprivation or poor quality sleep; and to understand the possible effects of sleep on breathing in vulnerable populations. In this article we describe the developmental physiology of sleep, and focus particularly on common problems of sleep and breathing.

Sleep services in the UK are under-developed compared to other countries in Europe, North America and Australia. A Royal College of Paediatrics and Child Health working party on sleep physiology and respiratory control disorders in children (SPARCINIC) has published a report on the subject with recommendations for clinical practice, organisation of services and quality control, and is essential reading for anyone taking an interest in this area.¹

PHYSIOLOGY

Developmental physiology

The sleep-wake rhythm alternates between the need for sleep and the need for wakefulness and is controlled by homeostatic and circadian

processes. Sleep itself is rhythmical and is divided into two states: (a) ontogenetically younger rapid eye movement (REM) sleep and (b) ontogenetically older non-REM (NREM) sleep. This organisation of sleep is determined by the ultradian REM-NREM rhythm. These biorhythmic processes alter with age due to changes in environmental cues, hormone secretion, core temperature and other physiological influences.

NREM sleep was traditionally divided into stages 1–4. Stages 3 and 4 both represent different degrees of slow wave (δ) sleep (SWS) and are now merged as stage N3.² The different stages of NREM and REM occur repeatedly over the course of a night in a rhythmical pattern known as a sleep cycle.³ Each sleep cycle is entered by stage N1 and N2 sleep, followed by a period of SWS and then transition to REM sleep, sometimes with brief periods of wakefulness interdispersed. In adults and older children each sleep cycle lasts approximately 90 min. SWS occurs in larger amounts in the first third of the night and REM predominates in the latter third of the night. Detailed sleep staging in infants is difficult due to immature EEG patterns, and sleep in this age group is often categorised into 'quiet' (NREM equivalent) and 'active' (REM equivalent) sleep. The sleep cycle changes with age, especially during the first few years of life.

Age-related differences in sleep patterns and duration

Newborns require equal amounts of active and quiet sleep⁴ alternating in 50–60 min sleep cycles, starting with an active sleep phase. The high proportion of REM sleep declines rapidly to about 25% of total sleep time at 6 months of age.⁵ A neonate sleeps for about 16 h in a day, evenly distributed in 2–4 hourly periods.⁶ During the first 2 months the sleep-wake cycle starts to mirror the light-dark cycle and becomes more organised⁷ with the infant picking up environmental cues.⁸ At 3 months of age REM sleep is still seen 50–60 min into a sleep cycle, but there is a shift towards the adult pattern of NREM (soon to be slow wave) sleep predominating in the earlier part of the night and REM sleep seen more in the later part of the night (Figure 1).⁹

By 6 months of age characteristic patterns of mature REM and NREM become classifiable.² Sleep durations and cyclical rhythms start to lengthen and by 12 months a baby is still sleeping for 14 h out of 24 but has managed to consolidate the majority of their sleep to the night time, with just one or two well-defined short naps in the daytime.¹⁰ By 5 years of age nearly all children have lost their daytime nap altogether,¹¹ although

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