Investigation of sleep disorders including home monitoring

Many children have a sleep disorder.\(^1\) Often it is sufficiently frequent or intense for it to seriously concern parents. Particularly high rates are reported for certain groups, such as children with a mental handicap,\(^2\) and many physical illnesses are likely to be complicated by sleep disruption.\(^3\)

There is, therefore, a need for comprehensive coverage of children's sleep disorders in medical education at undergraduate and postgraduate levels to ensure familiarity with the clinical features of sleep disorders, the conditions with which sleep disorders may be confused, and with the many forms of treatment that are available.

The place of special sleep studies also needs to be more widely known, including the comparatively recent availability of systems by which objective information about sleep patterns and physiology can be obtained from recordings taken at home or in other non-specialised settings.

The range of sleep problems for which such evaluation may be appropriate is wide.\(^4\) The three main types (of which there are many varieties) are: sleeplessness of one form or another,\(^5\) episodic disturbances of behaviour (parasomnias),\(^6\) and excessive sleepiness during the day.\(^7\)

**Diagnostic approach and procedures**

**CLINICAL ASSESSMENT**

Reflecting the general neglect of sleep disorders, history taking protocols usually contain few items concerning sleep and need to be supplemented with a systematic review of the 24 hour sleep-wake pattern, and sleep arrangements and environment. A sleep diary is often instructive. Important information may be available not only from parents but older children themselves and sometimes from siblings. Sleep questionnaires can provide a useful framework for detailed clinical inquiry as in recent studies of children with Down's syndrome\(^8\) or tuberous sclerosis.\(^9\)

**OBJECTIVE ASSESSMENT**

Detailed inquiry about sleep patterns and problems should be attempted but parents' recollection of their child's sleep patterns and problems may well be incomplete or distorted. Therefore, in some cases at least, more objective assessment is needed for accuracy or, alternatively, when physiological information is required.

1. **Video monitoring**

   For episodic disturbances at night, overnight video recordings alone can be highly instructive. Parents can be encouraged to use their family video systems for recordings at home. The disparities between the findings and the usual clinic descriptions of night time attacks are sometimes striking. Overnight video and sound recordings combined with oximetry may also be used (at least as a screening device) for the detection of sleep related breathing problems.\(^10\)

2. **Conventional nocturnal polysomnography**

   A major milestone in the understanding of sleep physiology was the description in the 1950s of rapid eye movement (REM) sleep and then the four stages of non-rapid eye movement (NREM) sleep, with the occurrence of about four to six NREM/REM cycles throughout the night. These phenomena are based on the recording of the electroencephalogram, electro-oculogram and electromyogram, and the definition of the different stages of sleep in terms of universally agreed criteria.\(^11\)

   Results are usually expressed in terms of (a) time spent in each stage of sleep (stages 1 to 4 of NREM sleep, REM sleep, plus time awake), (b) latencies to sleep onset, to the first period of deep NREM sleep, and to the first period of REM sleep, (c) NREM-REM cycles, and (d) the occurrence of nocturnal events. This information is presented in the form of sleep statistics and also a 'hypnogram'. Normative data are available for adults and also for children.\(^12\) In infants, sleep, described in terms of active, quiet, and indeterminate sleep states because well defined stages have not developed.\(^13\)

   For the evaluation of sleep related breathing disorders,\(^14\) additional measures are taken of respiratory effort and airflow, blood oxygenation, and possibly expired carbon dioxide and electrocardiography. Video and sound recording are also usually included. Additional electroencephalography channels can be used if nocturnal epilepsy is suspected.

   The accepted objective assessment of daytime sleepiness is the multiple sleep latency test,\(^15\) which measures the readiness with which the subject falls asleep given repeated opportunities to do so in a quiet darkened room.

**Ambulatory polysomnography**

There are few specialised sleep disorders centres outside North America. Such laboratories are very expensive to staff and run and are unacceptable to many patients, especially children. As a result, there is increasing interest in ambulatory sleep recording systems for use at home, in hospital wards, intensive care units, and other non-specialised environments.

Ambulatory polysomnography implies recording physiological parameters from subjects free from stationary recording devices. Probably the most widely used system of this type is the Oxford Medilog.\(^16\) The latest version provides information (recorded onto cassette tape) on basic sleep parameters plus, where necessary, the additional measures described earlier. An automated sleep staging system is available the results of which have been shown to produce acceptable correspondence with visual scoring for normal sleep patterns.\(^17\)

In addition to the lower cost compared with admission to a sleep laboratory, even a single night of home recording may provide a more representative sample of the subject's sleep because of a reduced 'first night effect', that is, sleep pattern disturbance caused by the recording procedure and laboratory environment.\(^18\) This reduction is thought to result from the subject's familiarity with his own bed, the absence of an observing technician, and adaptation to the equipment provided it is fitted well before bedtime. Long duration recordings are possible over at least one 24 hour sleep wake cycle which is of particular importance for the detection of daytime napping or other events that occur outside the usual hours of sleep. In addition, investigations of sleep wake cycle patterns are possible in naturalistic settings where the effects of sleep disturbing influences of a physical or psychological nature can be studied.
As the circumstances in which ambulatory recordings
are made are non-standardised, with limited control over
the subject’s activity levels or other factors influencing
his sleep-wake patterns, a sleep-wake log completed for
the whole recording period is desirable, combined with the
use of an event marker built into the cassette recorder.
Alternatively, combined video recordings and cassette
recordings can be used. The optimal selection of physio-
logical parameters, and number of channels devoted to
each, needs to be considered in the light of the particular
sleep problem under investigation.

An exact correspondence cannot be expected between
the results obtained by ambulatory polysomnography and
conventional polysomnography because of the different
recording environments. Indeed, for clinical purposes,
results obtained at home might well be more relevant to
diagnosis and management. Where parallel recordings
have been made, results obtained by ambulatory sleep
systems have been shown to be generally in agreement with
conventional polysomnography.

There is good evidence of the value of ambulatory
polysomnography when used with experience and convic-
tion. However, its use with children seems to have been
unnecessarily restricted and there is a need for both wider
use and further evaluation in young subjects.

Kayed has described the value of this type of
procedure in the absence of specialised sleep laboratory
facilities. McCall et al illustrate its selective use in
the insomnias, hypersomnias, parasomnias and sleep-wake
cycle disorders, while Broughton focuses on excessive
daytime sleepiness. Opinions differ about the adequacy
of home sleep recordings regarding sleep related respira-
tory problems. The general view seems to be that ambula-
tory monitoring should be restricted to screening purposes.
The place of ambulatory monitoring in the parasomnias
has not been systematically evaluated although there are
individual case illustrations. Its role in the investigation
of epilepsy, including sleep related seizures, is well
established across a wide age range from the neonatal
period onwards.

Home sleep studies are inappropriate for patients who
are uncooperative or medically ill, and in the presence of
simultaneous sleep pathologies or where the precise
relationships between pathological events and specific
stages need to be established. Wherever the sleep
recordings are performed, experienced technologists, and
staff skilled in the interpretation of the findings, are
essential.

Other recent developments
There is increasing interest in the significance for daytime
function of changes in the microstructure of sleep.
Frequent brief arousals (characterised mainly by abrupt
changes in electroencephalographic frequency, suggestive
of the awake state but without actual awakening) ‘fragment’ sleep without shortening it or changing
conventional sleep stages. These ‘microarousals’ have been associated with impaired cognitive function, mood
changes, and complaints of fatigue in a variety of clinical
disorders and experimental subjects.

At the other extreme, where a detailed account of sleep
physiology is not required or possible, monitoring of body
movements during sleep can be a simple and inexpensive
way of distinguishing between the awake and asleep states.
Of the various methods that have been devised, increasing
use is being made of small wrist worn movement sensors.
Good correspondence with polysomnographic data has been
reported at all ages including infants and young children.

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