CHEST

Pediatric Home Sleep Apnea Testing
Slowly Getting There!

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Pediatric OSA can result in significant neurocognitive, behavioral, cardiovascular, and metabolic morbidities. Prompt diagnosis and treatment are, therefore, of paramount importance. The current gold standard for diagnosis of OSA in children is in-laboratory polysomnography (PSG). Home sleep apnea testing has been considered as an alternative as it is potentially more cost effective, convenient, and accessible. This review concentrates mainly on the use of type 2 and 3 portable monitoring devices. The current evidence on the feasibility and diagnostic accuracy of home testing in the diagnosis of pediatric OSA was examined. Overall, the evidence in children is limited. Feasibility studies that have been performed have on the whole shown good results, with several reporting > 90% of their home recordings as meeting predetermined quality criteria regarding signal artifact and minimum recording time. The limited data comparing type 2 studies with in-laboratory PSG have shown no significant differences in respiratory parameters. The results pertaining to diagnostic accuracy of type 3 home sleep apnea testing devices are conflicting. Although more research is needed, home testing with at least a type 3 portable monitor offers a viable alternative in the diagnosis of otherwise healthy children with moderate to severe OSA, particularly in settings where access to polysomnography is scarce or unavailable. Of note, since most studies have been performed in habitually snoring healthy children, home sleep apnea testing may not be applicable to children with other comorbid conditions. In particular, CO_2 monitoring is important in children in whom there is concern regarding nocturnal hypoventilation, such as children with neuromuscular disease, underlying lung disease, or obesity hypoventilation, and most home testing devices do not include a transcutaneous or end-tidal CO_2 channel. CHEST 2015; 148(6):1382-1395

ABBREVIATIONS: AASM = American Academy of Sleep Medicine; AHI = apnea-hypopnea index; OAHI = obstructive apnea-hypopnea index; PAT = peripheral arterial tonometry; PSG = polysomnogram; RDI = respiratory disturbance index; RP = respiratory polygraphy; SCOPER = sleep, cardiovascular, oximetry, position, effort, and respiratory; SCS = Sleep Clinical Score; TRT = total recording time; TST = total sleep time

Pediatric OSA is characterized by intermittent partial or complete obstruction of the upper airways during sleep, with the disruption of normal ventilation and sleep patterns.[1] It can result in periodic hypoxia, hypercarbia, increases in respiratory effort,

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intrathoracic pressure changes, and sleep fragmentation.[2] OSA is now recognized as a very common childhood health problem with a reported prevalence ranging from 1% to 5%, depending on the population studied and the stringency of the diagnostic criteria used. Crucially, if left untreated, it can lead to adverse neurocognitive/behavioral, cardiovascular, and metabolic consequences.[1-5] It is, therefore, of utmost importance that accurate diagnosis is made in a timely manner so that appropriate treatment can be initiated and potential resultant morbidities minimized.

The currently accepted gold standard for diagnosis of OSA is an in-laboratory polysomnogram (PSG), as it provides an objective measure of disturbances in respiratory parameters and sleep architecture.[1] However, PSGs may not be readily available in all countries. Furthermore, PSGs have their attendant disadvantages: They are labor intensive, requiring in-laboratory monitoring of the patient by skilled staff overnight and subsequent scoring and analysis. This is expensive, both in terms of time and resources, not insignificant considerations in the current economically constrained times. Moreover, PSGs are also poorly predictive of OSA-associated morbidities.[6]

Home sleep apnea testing is, thus, of considerable interest, as it has the potential to measure a more typical night's sleep, as the child is sleeping at home, and could be substantially less expensive and potentially accessible to more children. The critical questions that need to be answered are the following: (1) Is it possible to obtain high-quality recordings from unattended home testing in children? (2) What is the diagnostic accuracy of the different types of home testing? and (3) Are there specific populations where home testing is not appropriate?

In 1994, the American Academy of Sleep Medicine (AASM) Portable Monitoring Task Force classified portable monitoring into four types, of which types 2 through 4 are applicable to home testing.[7] Type 1 studies are fully attended PSG (seven or more channels) in a laboratory setting. Type 2 studies are unattended PSG (seven or more channels). Type 3 consist of studies using more limited channel devices (usually using four to seven channels), also referred to by many as respiratory polygraphy (RP) studies. Type 4 studies include only one or two channels, with oximetry traditionally but not exclusively being used as one of the measurements. Here, we critically appraise and summarize the most recent available literature on the use of home testing in the diagnosis of pediatric OSA. As there already is extensive literature concerning overnight oximetry,[8-10] we will predominantly focus on type 2 and 3 portable monitoring devices in children. Studies that have examined pediatric home sleep apnea testing using these two types of devices are summarized in Tables 1 and 2,[11-19] including the sleep, cardiovascular, oximetry, position, effort, and respiratory (SCOPER) designations of the devices used. This refers to a more specific classification proposed in 2011 which categorizes out-of-center testing devices based on measurement of SCOPER parameters[20] (see Table 3 for explanation of the SCOPER categorization system).

Home PSG (Type 2 Portable Monitoring)

Of the first 162 children recruited for the Tucson Children's Assessment of Sleep Apnea study (TuCASA) who had home PSGs performed, 91% of the studies were technically acceptable on first pass.[11] This was defined as "respiratory channels (airflow or either band), oximetry, and one EEG were good for >4 h." This increased to 97% when nine children who failed the first night recording had it successfully repeated. These findings suggest that high-quality, unattended PSGs can be performed on children aged 5 to 12 years in the research setting. The nasal pressure transducer and thermistor signals were the ones that were most frequently lost.[11] Five children also had in-laboratory PSGs, and there was no statistically significant difference in respiratory disturbance index (RDI) between the in-laboratory and home PSGs.[11] RDI was defined by the investigators as the number of respiratory events (apneas and hypopneas) per hour of total sleep time. Apneas were scored if the amplitude of the thermistor decreased below 25% of baseline lasting for >6 s or two breaths. Hypopneas were scored if the amplitude of any respiratory signal decreased below 70% of baseline.[11]

More recently, Marcus et al[12] reported similar findings in 201 children aged 5 to 12 years from four centers in Canada and Australia who had PSGs performed at home. These studies were also conducted in the context of a research setting (the Caffeine for Apnea of Prematurity Trial). Artifact-free signals were obtained for $\geq 75\%$ of recording time in $>92\%$ of subjects. The only exception was the nasal pressure transducer signal, which was satisfactory for $\geq 75\%$ of recording time in only 67% of subjects.[12] A total of 91% of the initial studies were deemed technically satisfactory, and a further 14 studies were satisfactory when repeated (ie, overall, 98% of the studies were successful). In-laboratory PSGs were compared with home PSGs in four children.[12] The children slept longer in the home environment, with a trend toward more consolidated sleep. Respiratory