
Foreword One

Snoring during childhood may be clinically important, though it is often underappreciated. In particular, snoring in children may be missed if they snore only intermittently, or if the child sleeps separately from parents. In its 2002 Clinical Practice Guideline on the Diagnosis and Management of Childhood Obstructive Sleep Apnea, the American Academy of Pediatrics recommended that reports of habitual snoring lead to an evaluation for sleep-disordered breathing.

Evaluation does not necessarily mean systematic polysomnography as suggested in the Guideline, but it does require a good evaluation of the upper airway. In our experience, the most difficult component of the airway evaluation is classification of craniofacial features, in particular the nasomaxillary complex, the mandible, and the relationship between these two bone structures. Orthodontists learn to recognize the different clinical signs that indicate whether facial structures are developing normally and harmoniously, or whether there is deviation from normal development. Techniques include inspection and characterization of craniofacial anatomy from frontal and lateral views, evaluation of the relative positions of the upper and lower canines, and paying attention to the hard palate, dental crowding, and positions of the upper and lower teeth. These assessments assist in creating a clinical impression regarding the possibility of a narrow upper airway. In such a “narrow upper airway”, the tonsils may not be abnormal in size per se, yet they may occupy an important fraction of available space when pharyngeal muscles relax during sleep - particularly during REM sleep. Additionally, narrow, collapsible, or malpositioned nasal structures may create increased resistance to airflow as well as airflow turbulence, physical phenomena that may produce airflow limitation in the upper airway. A good understanding of the growth of maxilla and mandible and a thorough clinical evaluation of the structures forming the upper airway are critically important elements in the evaluation of the child with chronic snoring. Finally, “chronic snoring” suggests that the mouth is persistently open during sleep. Research dating back as far as the 1970s has suggested that chronic mouth breathing is detrimental to appropriate maxillo-mandibular development during early childhood. Swedish investigators have

also found that continuous exposure to nonhumidified air, as occurs in mouth-breathing, can lead to abnormal enlargement of tonsils. This seems to occur in the vertical rather than the horizontal dimension, so again, tonsillar size may not appear much larger in a routinely conducted two-dimensional assessment. Perhaps a history of chronic snoring should systematically lead to careful history-taking for associated features such as mouth-breathing during sleep, and to a thorough clinical evaluation of craniofacial anatomy.

To construct valid health recommendations, epidemiological information is always needed. To gather such information, there must be agreement on how to approach the considered problem. The work of the “ Hong-Kong snoring group ” is an important first step. The presented consensus statement will not only help practitioners in their daily practice, but it will allow having a standardized approach in diagnostic and treatment. Systematic reviews of the outcome of the recommendations made in the consensus statement will lead to pediatric health policy based on data. This is a very important goal that should be supported by all. This well-thought consensus statement should be largely distributed to the pediatric community and receive its support considering the long term gain to pediatric health-care.

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Foreword Two

Childhood Sleep-related disordered breathing is an under-recognized, under-investigated and under-managed area. Increasing evidences suggested that sleep-related disordered breathing (SDB) is an important public health problem with a series of negative consequences on cardiovascular, growth and neuro-cognitive aspects in children.

With the rapid expansion of the knowledge and understanding of childhood SDB, the development of consensus is paramount and challenging. This consensus statement of management of children with snoring is a timely guidance for clinical practice in Hong Kong. This consensus covers the advanced and imperative evidence-based materials on childhood SDB, including the demarcation between primary snoring and sleep apnea, clinical features, diagnostic criteria, and management aspects of childhood snoring issue. This comprehensive consensus serves as an updated reference for clinical practitioners and researchers. Nonetheless, like every consensus and guideline, periodical update of the information, especially in this rapid developing field of sleep medicine, will be needed and foreseen.

I would also like to take this opportunity to express my earnest congratulation and gratitude to the Hong Kong Society of Paediatric Respiriology for its effort in the implementation of this tremendous task. This consensus serves as a fundamental step in the development and promotion of paediatric sleep medicine.

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Preface

Snoring occurs from early infancy through adolescence. It is a rather common symptom as more than 10% of children snore regularly, i.e. habitual snorer. It may signify the presence of obstructive sleep apnoea syndrome (OSAS) that requires more intensive treatment. Unfortunately, the approach to childhood snoring has not been standardized in Hong Kong. The publication of the guideline to management of childhood snoring by the Hong Kong Society of Paediatric Respiriology serves as an important first step to a structured approach to childhood snoring in Hong Kong.

It is worth remembering that childhood OSAS is associated with hypertension, ventricular hypertrophy, depressed vagal tone, increased vascular tone and increased systemic inflammation. All these would of course lead to morbidities and mortalities in adulthood that would not be known to the paediatricians who in some cases would hand over the management to physicians but in most cases the patients might well decide that they are old and well enough to be free of any medical supervision. Hence, paediatricians might well offer the last chance to catch the OSAS early, quantify the severity of OSAS and its complications and hopefully offer treatment that will alter the natural course of the disease. It is this structured approach that might prevent the untimely death of an otherwise productive adult whose proverbial death spiral was started when he was a 5-year-old kid with habitual snoring.

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Introduction

According to the current standard, all children with habitual snoring should be properly investigated by sleep study, to look for evidence of obstructive sleep apnoea. In practice, however, the availability of sleep study service is limited. Various alternative practices exist, based on the practitioners' background, training, and beliefs.

The aim of this consensus statement is to provide practitioners with a standardised approach to children presented with snoring, based on the available data and consensus.

This consensus statement is applicable to all prepubertal children older than 2 years of age. Children presented with habitual snoring or suspected apnoea at younger than 2 years of age should preferably be referred to specialists with specific experience in paediatric sleep medicine for assessment.

What is known about snoring in children?

Snoring is a common symptom of obstructive sleep apnoea syndrome (OSAS) in children. Snoring is described as a distinct coarse vibratory respiratory sound produced by vibration of the soft tissue of the oropharyngeal segment of the upper airway during sleep. Snoring typically occurs during inspiration, but may occur during expiration.

Snoring should be distinguished from the much lower intensity breathing noise produced by airflow across the nasal valves and nasal turbinates during sleep. It should also be distinguished from the noise produced by sleep-related laryngospasm, sleep talking, and sleep related groaning.

Habitual snoring refers to snoring occurring nightly or almost nightly. In most clinical research, habitual snoring is defined as presence of snoring in 3 or more nights per week. The prevalence of habitual snoring in children is 10 to 15%. The prevalence of OSAS in children is around 2 to 5%.

OSAS is known to occur in preschool children as young as 2 years old. Some children under the age of 2 years are clearly diagnosed to have OSAS, although it is relatively uncommon. Children with OSAS at younger age group tend to exhibit more cognitive behavioural disturbance and disturbed night time sleep, rather than daytime sleepiness.

In children, OSAS is commonly associated with adenotonsillar hypertrophy. However, the presence of enlarged tonsils and/or adenoid does not necessarily imply that the patient has OSAS. Other common risk factors for OSAS in children include allergy, obesity, family history of OSAS, craniofacial anomalies, and neuromuscular diseases such as Down syndrome.

OSAS in children is a treatable disease. Proper treatment should be given to these children after confirming the diagnosis, before they develop significant morbidities.

Clinical entities

Children with snoring could be diagnosed as having primary snoring or OSAS based on sleep study findings and daytime symptoms.

Primary snoring (PS)

Primary snoring refers to a condition with snoring during sleep and absence of significant obstructive respiratory events (i.e. apnoea-hypopnoea index < 1 per hour), sleep disruption, and gaseous exchange abnormality.

The diagnosis implies a benign clinical entity. However, it is now believed to be a heterogeneous group. Children with PS may develop consequences similar to that found in OSAS, e.g. high blood pressure.

Obstructive sleep apnoea syndrome (OSAS)

OSAS is a disorder of breathing during sleep characterised by intermittent complete obstruction and/or prolonged partial upper airway obstruction that disrupts normal sleep ventilation and/or normal sleep patterns.

Polysomnographically, it is defined by apnoea-hypopnoea index of greater than 1 per hour, regardless of sleep disruption or gaseous exchange abnormality.

Diagnostic modalities

History, physical examination, radiological tests

The first step in diagnosis is to enquire about the nature of the snoring. Parents often misinterpret other noise during sleep as snoring.

Children with allergic rhinitis often have intermittent and non-habitual snoring. These children do not need to undergo diagnostic evaluation for OSAS. However, parents may not be able to give a reliable history as to whether the snoring is habitual or non-habitual.

All children with habitual snoring should be properly worked up for suspected OSAS. The presence of symptoms and signs of OSAS (Table 1) may indicate increased likelihood of OSAS.

Table 1. Symptoms and signs of OSAS in children

Night time symptoms and signs

- Snoring and/or snorting
- Gasps or witnessed apnoea
- Restlessness
- Unusual sleep posture (e.g. prone, sitting, extended neck)
- Laboured breathing
- Excessive sweating
- Secondary nocturnal enuresis
- Parasomnias, e.g. sleep walking

Daytime symptoms and signs

- Irritability, behavioural problem
 - Poor concentration and/or attention
 - Failure to thrive
 - Upper airway obstruction / mouth breathing
 - Harrison's sulci
 - Morning headache
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Physical examination is normal in most children with OSAS. However, the features listed in table 1 should be watched out. In addition, assessment should include body mass index, nasal patency, size of the tonsils, and size of the posterior pharyngeal space. In some rare cases, signs of pulmonary hypertension and/or cor pulmonale may be present.

An upright lateral neck X-ray may indicate hypertrophy of the tonsils and/or adenoids. But these are often not necessary.

It is clear that one cannot confidently distinguish PS from OSAS based on clinical history, questionnaire report, physical examination, radiological findings, or composite score based on the combination of the above.

Overnight polysomnography

Overnight polysomnography is the preferred standard diagnostic modality for OSAS in children. This includes an overnight monitoring of the state of being (i.e. wake, sleep stages), respiratory parameters, cardiovascular parameters, body position, and limb movements. A proper overnight polysomnogram in children should include all the mandatory leads (Appendix 1). A study with incomplete inclusion of these mandatory leads will be categorized as an “abbreviated study”. The recording should last a minimum of 6 hours, but optimally 8 hours.

Overnight polysomnography can be performed in children of any age in an appropriate facility. Recordings can be done using most standard adult polysomnographic recording systems, with minor modifications of equipment to suit the size of the child. Use of sedative/hypnotic should be avoided as they are known to affect the result.

Overnight polysomnography in children should preferably be attended by a trained technician, to ensure the quality of the study. There is no data comparing unattended study against attended study. In general, the result from an unattended study can be considered valid if the quality of the tracings is good.

Currently, even the most sophisticated systems fail to generate reliable and accurate automated summaries/reports. These reports can underestimate or overestimate the clinical severity of the child's condition. These automated summaries should not be used for making clinical decision.

Although overnight polysomnograms are often manually pre-scored by trained technician, a proper interpretation of the study should include raw data reviewing and verification of the whole study by a properly trained doctor with knowledge of paediatric sleep studies of all ages.

Polysomnographically, PS is defined by $AHI < 1$ per hour of total sleep time, AND absence of sleep disruption or gaseous exchange abnormality; OSAS is defined by $AHI \geq 1$ per hour of total sleep time. In normal children, it is common to have AHI of almost 0 per hour of total sleep time.

What is apnoea-hypopnoea index?

Apnoea-hypopnoea index (AHI)

= total number of obstructive respiratory events / hour of total sleep time

Three types of obstructive respiratory events exist:

- **Obstructive apnoea:** an event with continued breathing effort lasting for longer than 2 breaths, associated with $>90\%$ airflow reduction
- **Hypopnoea:** an event with continued breathing effort lasting for longer than 2 breaths, associated with $>50\%$ but $<90\%$ airflow reduction
- **Mixed apnoea:** an event with initial absence of breathing effort, followed by an obstructive apnoea

Abbreviated study

The diagnostic value of various abbreviated studies is variable depending on the techniques used. In general, abbreviated studies have good positive predictive value, but limited sensitivity and negative predictive value. When in doubt, one should study the child by a proper overnight polysomnography, rather than trying to correlate with the “clinical features”.

The most simplistic abbreviated study is one using overnight pulse oximetry set at an averaging time of 3 seconds or shorter. In the clinical setting of otherwise healthy children who presented with habitual snoring, a positive finding in overnight pulse oximetry is highly predictive of OSAS in children. However, all the negative or suspicious findings should be interpreted as “inconclusive” rather than normal. These children should be properly studied by overnight polysomnography.

Upper airway endoscopy

Awake sitting endoscopy is a useful tool for assessment of the size of adenoid and the pharyngeal space in cooperative children. This is particularly useful in children whom the major site of obstruction is the adenoid. However, the upper airway passage is often wider while awake because of the active muscle tone. Sleep endoscopy can be performed in complicated or cases with residual or recurrence of OSAS after T&A. Sleep endoscopy allows better visualisation of the state of the upper airway during sleep. But it is still not a real representation of the muscle atonia state that occurs during the Rapid Eye Movement sleep.

Treatment

Children with PS do not require active specific treatment for the snoring. However, they may require treatment based on the indications for the underlying problem, for example, allergic rhinitis.

Children suffering from OSAS is known to be have substantial morbidities, particularly affecting cognitive behavioural functions. However, the exact threshold for treatment has not been clearly defined.

Treatment is generally recommended for children with:

- AHI \geq 5 per hour, regardless of symptoms;
- Symptomatic children with AHI between 1 and 5 per hour
- Children with AHI between 1 and 5, with significant gaseous exchange abnormality during sleep or sleep disruption

In asymptomatic children with AHI between 1 and 5 per hour, controversies exist as to when and how they should be treated.

A successful management of children with OSAS mandates a close collaboration between paediatric sleep specialists, ENT surgeons, orthodontists and maxillofacial surgeons.

Surgical treatment

In children suffering from OSAS with presence of adenotonsillar hypertrophy, tonsillectomy and adenoidectomy (T&A) is considered the first line treatment. It is important to recognise that the decision to perform T&A is not based on how large the tonsils or adenoid are, but rather on how much space in the upper airway that can be widened by the procedure. Most children with OSAS could be cured by this procedure. This is performed under general anaesthesia.

Numerous techniques are described for tonsillectomy. Classically the choice is between hot tonsillectomy during which monopolar cautery is used for dissection and haemostasis, or cold tonsillectomy during which dissection is performed by cold metal instrument like the scissors. Cold tonsillectomy in

general results in less postoperative pain and bleeding, and is the preferred choice.

Adenoidectomy is classically performed through the oral cavity by the adenoid curette or the adenotome. Newer techniques like the use of powered instrument and the endoscope facilitate a more complete resection of the adenoid.

The risk of post-T&A bleeding is around 2-5%, half of which occurs within the first postoperative day (reactionary hemorrhage) and the other half usually occurs at 7 days after surgery as a result of infection. If post-operative bleeding occurs, haemostasis under general anesthesia may be necessary.

Postoperative inpatient monitoring is required for high risk cases, e.g. young age, severe OSAS, morbid obesity, craniofacial anomalies, neuromuscular disorders, cardiac complications, etc.

Adjunctive surgical procedures may be required. Turbinate reduction procedures may be helpful in children with nasal block secondary to severe turbinate hypertrophy. Post-operative care can be challenging especially in young children. Radiofrequency reduction of the turbinate is an alternative choice.

Surgical treatment should be individualised in children with craniofacial anomaly and neuromuscular anomaly. A comprehensive radiological and endoscopic assessment is often required for these patients.

All children with OSAS should be re-assessed clinically after surgery. Patients who have complete resolution of symptoms and signs usually do not usually require repeat sleep study to document resolution.

Patients who have continued symptoms or signs of OSAS after surgery, or who have worsening of their obesity may require objective re-evaluation with overnight polysomnography. Objective data regarding timing of postoperative evaluation are not available. Most clinicians recommend waiting 2 to 3 months before re-evaluation to ensure that upper airway, cardiac, and central nervous system remodeling is complete.

Treatment options of residual OSAS after T&A include positive airway pressure, dental treatment, medical treatment e.g. nasal steroid, leukotriene receptor antagonist, and revision adenoidectomy for cases with adenoid regrowth. In rare complex cases, upper airway surgery, craniofacial surgery, or even tracheostomy may be considered.

Positive airway pressure

Positive airway pressure during sleep is an effective alternative treatment for children with OSAS. When it is properly used, it is highly effective.

The main problem with positive airway pressure is with the adherence to treatment. To be effective, this has to be used every night and throughout the night. The prerequisite for successful application of positive airway pressure via a nasal mask is a patent nasal airway. A systematic evaluation of the nasal airway is mandatory in all children planned for positive airway pressure. In cases with severe nasal block secondary to turbinate hypertrophy and/or adenoid hypertrophy, appropriate medical and/or surgical procedure will be required prior to introduction of positive airway pressure.

A careful choice of mask interface, education, frequent monitoring, and reassessment are crucial for its successful application. A specific behavioural desensitisation program is often required for children.

The commonly used positive airway pressure treatment in children includes continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BPAP). Both are considered equally effective. The adherence to treatment with CPAP and BPAP is similar.

A proper titration with overnight polysomnography is required, to ensure the right setting of the positive airway pressure. Settings that are too low or too high would significantly affect the adherence to treatment. The use of heated humidifier is generally advised in children.

Children on positive airway pressure should be reviewed regularly, to monitor potential adverse reactions, adequacy of mask size, infection control, and adherence to treatment. They should also be re-evaluated with overnight polysomnography (or abbreviated studies) in order to ensure the institution of the right settings.

Medical Treatment

Nasal steroid is an effective adjunctive treatment for children with OSAS. Preliminary evidence suggests that it is effective in reducing the severity of OSAS in children, and in treatment of residual OSAS after T&A. Oral leukotriene receptor antagonist has been shown to be effective in reducing the severity of OSAS in children with AHI < 5 per hour. Combination treatment with nasal steroid and oral leukotriene receptor antagonist has been shown to be effective in treatment of residual OSAS after T&A. However, it is still unknown as to how long these treatment effect may last after discontinuing the treatment.

Dental treatment

Dental surgeons, orthodontists, and maxillofacial surgeons play important roles in management of children with OSAS. When children with OSAS are suspected to have dento-facial discrepancy (e.g. narrow maxilla and retrognathic mandible with increased overjet), they should be referred for orthodontic consultation.

These children need to be assessed clinically and/or radiologically (e.g. true lateral cephalometric assessment), in order to determine the usefulness of dental and maxillofacial procedures in enlarging the relevant space of the upper airway.

Sequential cephalometric radiographic monitoring of the facial skeletal development is a useful tool for early detection of predisposing skeletal factor for OSAS, as well as for monitoring of mid-facial growth in young patients receiving long-term positive airway pressure treatment.

Various orthodontic and maxillofacial surgical procedures, for example, maxillary expansion and mandibular advancement, have been shown to be effective in appropriate patients.

Appendix 1.

Polysomnographic montage

Electroencephalogram* (1 frontal, 1 central, and 1 occipital)
Electrooculogram* (right/left)
Chin electromyogram*
Electrocardiogram*
Thoracic and abdominal excursion*
Oximetry*
Flow* (oronasal thermistor, or nasal pressure, or both)
Snoring microphone*
Body position sensor*
Limb electromyogram*
End-tidal CO₂
Oximetry waveform
Video/Audio recording
Oesophageal pressure

* Mandatory lead

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