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Obstructive Sleep Apnoea: Diagnosis and Management in Children

Link to Algorithm for Investigation of suspected OSA

Aim

The aim of these Guidelines is to:

- Increase the recognition of Obstructive Sleep Apnoea (OSA) by clinicians in order to expedite the diagnosis and avoid serious sequelae of OSA.
- To describe the optimum diagnostic tests, treatment options and appropriate patient follow-up.

Definition

Obstructive Sleep Apnoea (OSA) is defined as disorder of breathing during sleep characterised by prolonged partial and/or intermittent complete airway obstruction that disrupts normal ventilation during sleep and/or normal sleep architecture**.**

Target patient population

Children at risk for or suspected to have OSA.

Target users

All clinicians tasked with the care of children.

Background

OSA is a common condition in childhood. It is commonly under recognised due to lack of awareness among healthcare professionals. Untreated OSA can lead to significant neurocognitive deficits, poor school performance and long term cardiac sequelae. Children with OSA demonstrate an increased utilisation of healthcare resources that reverses upon successful treatment.

The prevalence of reported snoring most or every night in 4-5 year old children in the UK is 12%. Using a variety of definitions, not all based on formal polysomnography, the prevalence of obstructive sleep apnoea in the general population is between 0.7% and 2.9%. Although it affects children of all ages, the peak incidence is between 2 and 6 years of age. The presence of adenotonsillar hypertrophy is the main risk factor for OSA in otherwise healthy children. The prevalence of OSA is higher in children who are overweight or obese, ex-premature infants and children with asthma. OSA is more common in children of African origin and children from lower socio-economic groups.

Children with certain medical conditions have a particularly high prevalence of OSA. In some of these children symptoms of OSA can be difficult to identify, and testing should be considered in these children, even if apparently asymptomatic:

- Down syndrome
- Neuromuscular Disease
- Craniofacial abnormalities
- Achondroplasia
- Mucopolysaccharidoses
- Prader-Willi syndrome

Assessment

History

The diagnosis of OSA is based on history, clinical examination and an appropriate diagnostic test. A comprehensive clinical history is not sufficient to make a diagnosis of OSA. Parental questionnaires of various different types on their own have shown poor sensitivity in detecting OSA in children. The primary symptom of OSA in children is snoring, however OSA can be present in the absence of snoring, particularly in infants. The presence of daytime symptoms suggests significant disturbance of sleep quality and increases the likelihood of OSA. Children with obvious day time symptoms require more urgent assessment. The following are the commonest symptoms of OSA.

***Night time Symptoms**:*

- History of Frequent snoring (≥3 nights/wk)
- Laboured breathing during sleep
- Gasping, observed episodes of apnoea
- Nocturnal enuresis (especially secondary enuresis)
- Sleeping in a seated position or with the neck hyper extended
- Restless sleep
- Excessive sweating

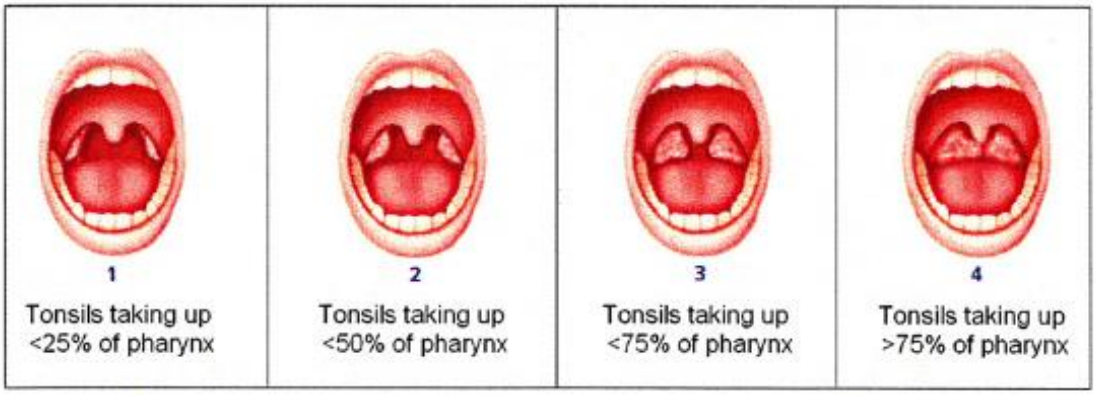
Daytime Symptoms:

- Daytime sleepiness
- Hyperactivity
- Poor concentration and attention
- Behavioural problems
- Learning difficulties
- Headaches on awakening
- Mouth breathing

Examination

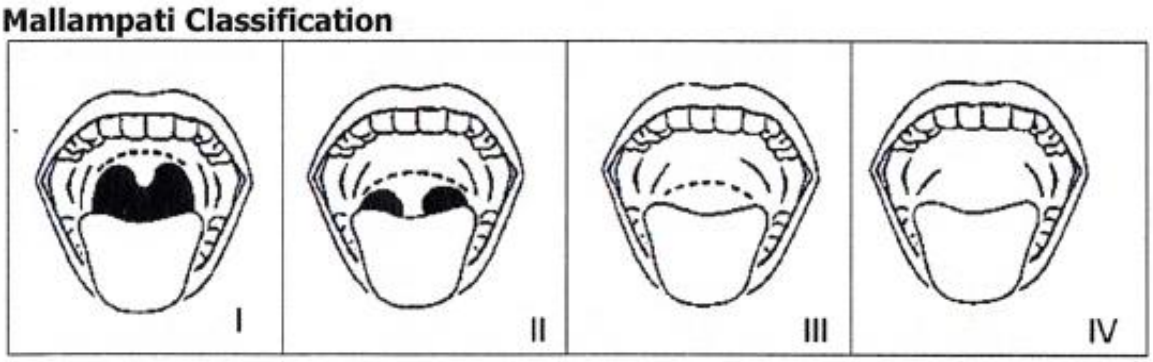
Examination is mainly focused on the head and neck. It is important to plot the child's height and weight on a centile chart as OSA can be associated with both obesity and failure to thrive. When examining the mouth and pharynx, particular note should be made of the tonsil size and the shape of the oropharynx.

Figure 1: Tonsillar Size



The Mallampati score is assessed by asking the child to open his/her mouth as wide as possible and protrude the tongue. Higher Mallampati scores are associated with an increased risk of OSA. Scores are assessed as follows (see figure 2).

Figure 2: Mallampati Classification



- Class I: Soft palate, uvula, fauces, pillars visible.
- Class II: Soft palate, uvula, fauces visible.
- Class III: Soft palate, base of uvula visible.
- Class IV: Only hard palate visible

The following are key features on examination that increase the risk of OSA:

- Obesity
- Tonsillar hypertrophy
- Adenoidal facies (inability to breathe through nose)
- Micrognathia/retrognathia
- High-arched palate
- Nasal Obstruction

Investigations

The main purpose of investigation is to either exclude or confirm the clinical suspicion of OSA, and to aid in the assessment of severity in order to inform therapeutic options. Diagnostic sleep tests measure some aspect of ventilation, assess its possible compromise by upper airway obstruction and determine any possible consequences on sleep quality. There are many ways to assess these aspects of OSA and the choice of diagnostic sleep test depends on many factors including previous studies, the age of the child and the child's underlying condition.

Studies can be performed with varying degrees of complexity, from simple overnight oximetry to full polysomnography. A diagnostic algorithm can be found in appendix 3 to this document. There are several diagnostic tests that can be used to make a diagnosis of OSA:

Full Polysomnography (PSG). This involves a supervised overnight study performed in the hospital setting. The following parameters are measured: Abdominal and thoracic effort, pulse oximetry, ECG, oronasal flow (thermistor), nasal pressure, chin EMG, limb EMG. Measurement of CO_2 levels by nasal $EtCO_2$ or transcutaneous CO_2 may be included. A limited EEG montage is recorded. Video recording is performed throughout. Full sleep staging is performed and all studies are manually scored by sleep physiology technicians. The scoring severity of OSA on a PSG is measured by the obstructive apnoea hypopnoea index (OAHI), the number of obstructive events and hypopnoeas per hour of sleep.

Cardiorespiratory Polysomnography. This usually also involves a supervised overnight study in hospital, however home studies are possible in some circumstances. The following parameters are measured: Abdominal and thoracic effort, pulse oximetry, oronasal flow and some measure of movement such as actigraphy. Measurement of CO_2 levels can be included. EEG is not recorded and sleep is not staged. The scoring of obstruction on a cardiorespiratory PSG is measured by the OAHI.

Overnight Oximetry. This involves the use of a single probe that analyses real time oxyhaemoglobin saturations. This does not require inpatient admission and can be performed at home. Data is stored on the device and subsequently downloaded and analysed. Ward or home based saturation monitors have long averaging times built in to avoid nuisance alarms (and hence are not of use in the diagnosis of OSA).

Downloadable overnight oximeters should have as low an averaging time as possible. The test can be performed over a number of nights to improve reliability. The key findings on oximetry are the mean saturations, the desaturation index (the number of desaturations >4% per hour of sleep) the desaturation nadir and the frequency of desaturation to <80%.

Overnight oximetry can be very helpful as a screening test for OSA and is being increasingly utilised internationally. If oximetry is abnormal in a predictable manner (clusters of desaturation) in a patient with a history consistent with OSA it has a high sensitivity to detect OSA and no further testing is required (See appendix 2). Oximetry will be informative if obstructive events are associated with oxyhaemoglobin desaturation, however it is well described that obstructive events may be associated with arousal as opposed to desaturation. This can only be detected with PSG. **Therefore normal oximetry does not exclude OSA.**

Overnight Oximetry/Capnography. This involves the use of a single probe that analyses real time oxyhaemoglobin saturations and transcutaneous CO_2. This usually requires inpatient admission. This test is particularly useful to determine if hypoventilation is present, but is technically inferior to overnight oximetry as a screening tool for OSA.

The choice of diagnostic test for OSA is informed by the clinical picture. In general terms the least invasive and expensive test that adequately meets the patient need should be selected. In the majority of children, overnight oximetry is a suitable first line test.

The following basic criteria apply:

- Overnight oximetry has an excellent positive predictive value for OSA if certain criteria are met (Appendix 2).
- Overnight oximetry is superior to oximetry/ capnography as a screening test for OSA.
- A normal oximetry or oximetry/ capnography **does not exclude OSA**.

- Cardiorespiratory PSG can detect changes in airflow and therefore has a greater sensitivity than oximetry. It may not, however, detect obstructive events that result in arousal (as opposed to desaturation).
- Full PSG can measure arousal and is the gold standard test for OSA. Full PSG may be required even if cardiorespiratory PSG is within normal limits.
- If polysmonography is required, the most suitable type of polysomnography should be determined by a consultant in paediatric respiratory/ sleep medicine on a case by case basis.

The core requirements for diagnostic tests for children with suspected OSA are:

1. To establish a definitive diagnosis of OSA
2. To aid in the judgement of peri-operative risk (for adenotonsillectomy)

A subgroup of children with OSA can have very abnormal overnight oximetry with persistent desaturation to less than 80% (See appendix 1b and 1d). This is not easy to detect on the basis of clinical symptoms and has been linked with peri-operative morbidity. It is recommended therefore that all children should be screened with oximetry prior to adenotonsillectomy.

For otherwise healthy children with symptoms of OSA, and without failure to thrive, co-morbidities or risk factors for peri-operative morbidity, it has long been accepted practice to proceed to adenotonsillectomy on the basis of presenting symptoms and examination, without diagnostic testing. It is acknowledged that the prevalence of OSA in the general population is high, and that available ENT services are limited with long waiting times for adenotonsillectomy in many areas. In situations where undue delays are experienced in obtaining oximetry leading to further delay in scheduling of the procedure in this group, and where there is ongoing morbidity, it may be reasonable in this group to proceed to surgery without oximetry.

For younger children or children with co-morbidities or risk factors for peri-operative morbidity (see Table 2 below) oximetry is strongly recommended as an aid in planning for adenotonsillectomy.

Severity Rating

The severity rating of OSA in children **is inexact** and is **not well correlated to important clinical outcomes.** Severity should be determined by a combination of the child's clinical symptoms and the results of formal testing as opposed to being based solely on polysomnographic/oximetry findings. When reporting a diagnostic study, the clinician should specifically comment on key severity markers such as OAHI, desaturation index, saturation nadir and frequency of desaturation <80%.

The following factors should be taken into account when determining severity:

Table 1: OSA Severity Assessment

Factor	Scoring on Formal Testing	Oxyhaemoglobin Desaturation	Daytime Symptoms	OSA Consequences
Outcome	Obstructive AHI, desaturation index.	Desaturation nadir, frequency of desaturation <80%.	Excessive fatigue, sleepiness, behavioural problems.	Pulmonary hypertension, failure to thrive.

Reporting

The physician reporting the diagnostic sleep test should make particular note of the mean oxyhaemoglobin saturations, the desaturation index, the saturation nadir, the frequency of desaturation <80% and/or the obstructive apnoea/hypopnoea index (OAHI). On the basis of the clinical information available at the time of reporting and the findings, if the reporter feels that the child will require HDU admission post-operatively, this should be clearly stated in the report. See below for details of HDU criteria.

Recommendations for the diagnosis of OSA in children:

1. A sleep history should be taken as part of the systems review in paediatric patients
2. Children with symptoms of OSA, particularly those with day time symptoms or children in high risk group should be referred for clinical assessment and/or diagnostic testing.
3. The first line diagnostic test is overnight oximetry. If overnight oximetry is diagnostic of OSA (Appendix 1), no further testing is required.
4. If overnight oximetry is normal or not diagnostic of OSA, clinical concern persists and a diagnostic test is required, polysomnography is the investigation of choice.
5. It is desirable that all children have overnight oximetry prior to adenotonsillectomy to stratify perioperative risk. It is recognised that this presents a significant resource challenge and may not be feasible in all situations, but is strongly recommended in all cases where other co-morbidities or peri-operative risk factors exist (see below).

Management

The management of children with OSA is a complex area. A diagnosis of OSA per se does not necessitate the institution of treatment in all cases, and the severity of OSA and potential consequences of non-treatment must be balanced against the burden and potential risks of treatment. This should be discussed openly with the child's parents. Once a diagnosis of OSA has been made, it is important to consider whether the condition may be partially or fully surgically reversible. Partial correction of OSA may be sufficient to improve quality of life and improve outcomes, especially in those children intolerant of non-surgical treatments. Assesment of surgical reversibility usually involves determining whether adenotonsillar hypertrophy is present and will usually require referral to an ENT surgeon.

Surgical

Adenotonsillectomy. A recent large randomised trial of adenotonsillectomy in OSA demonstrated improvements in behaviour, quality of life and polysomnographic indices following adenotonsillectomy. Previous studies suggested that adenotonsillectomy results in improved growth in infants and older children with OSA and improved behaviour and attention even when including children with very mild degrees of upper airway obstruction. Adenotonsillectomy is not without risk however. Children with severe oxyhaemoglobin desaturation pre-operatively are at increased risk of post-operative complications.

In most children adenotonsillectomy is the procedure of choice when OSA is present, however this depends on the relative hypertrophy of the tonsils and adenoids and the surgical risk in the individual child. Adenoidal tissue, even if removed, can grow back. Tonsil re-growth after a tonsillectomy is <1% with extracapsular tonsillectomy (historically the first line approach) and 1-5% with intracapsular tonsillectomy (tonsillotomy). Intracapsular tonsillectomy is increasingly performed as a first line procedure in children because of the decreased post-operative risk of tonsillar bed bleeding.

Craniofacial Surgery. Craniofacial surgery to advance the mandible or maxilla has been successful in some case series at improving OSA as judged by the avoidance of tracheostomy. No controlled trials exist in this area. Careful case selection and mutidisciplinary discussion are very important here.

Tracheostomy. Tracheostomy has been used when other medical and/or surgical interventions are ineffective or impossible, and results in complete resolution of symptoms. This is the treatment of last resort and is associated with significant risks in its own right.

Surgical Risk

Children requiring surgical intervention for OSA may be at risk for post-operative airway or pulmonary problems as a result of the relief of longstanding obstruction and the effects of anaesthetic agents and airway manipulation on control of airway patency. Certain children are at significantly increased risk – see table 2. Where there is any question of perioperative risk a pre-operative anaesthetic review is indicated. Recently the criteria for post-operative HDU admission were reviewed and suggestions made to raise the threshold (Walker 2013). The evidence suggests a combination of a marked abnormality on oximetry/PSG **and** clinical risk factors in a child is the best predictor of the need for HDU facilities.

Table 2: Criteria for HDU admission post-adenotonsillectomy
(Adapted from *Walker et al. 2013*)

Severe oxyhaemoglobin desaturation or extremely high OAHI on PSG **with** an opinion from the reporting physician recommending HDU post-op care

or

Oxyhaemogblobin saturations <80% or OAHI >20/hr **and** consideration of

- Syndrome* likely to be complicated by airway obstruction
- Age <2 years
- Weight <3rd centile
- Significant cardiac, respiratory or neuromuscular compromise
- Children with sickle cell disease
- Children with pulmonary hypertension
- Significant central component on PSG
- Morbid obesity

*Examples include, but are not limited to craniofacial abnormalities, trisomy 21, achondroplasia, mucopolysaccharidoses.

➢ *The requirement for a HDU bed should be established by the ENT surgeon in discussion with the consultant anaesthetist and/or respiratory consultant.*

What is a High Dependency Unit?

Clear and unambiguous definitions of the level of care that should be provided to children with the above peri-operative risk factors are not available. **The information provided below is for guidance only, as the definition and scope of high dependency care is outside of the remit of this document.** The purpose of step-up care for these children is to safely manage the risk of acute deterioration (including post obstructive pulmonary oedema, acute airway obstruction, acute severe bleeding and a combination of these) by ensuring at least the following:

- Close nursing supervision - a patient to nurse ratio of 2:1 or 1:1 with continuous cardiac and oxyhaemoglobin saturation monitoring

- Nursing staff trained in the management of the acutely unwell child including children with airway/respiratory compromise including the acute use of non-invasive positive pressure ventilation
- The immediate provision non-invasive positive airway pressure if required
- On site access to senior anaesthetic trainees with experience with paediatric airway management
- Urgent access to consultant anaesthetist/intensivist with experience in paediatric airway management
- The facility for urgent intubation and ventilation of children on-site
- Urgent access to ICU beds for children on site

It is acknowledged that different levels of provision of HDU type care for children exist in different regional and tertiary hospitals. In light of this, each centre performing adenotonsillectomy in children with perioperative risk factors should ensure that there is a robust local management plan in place incorporating the above requirements for escalation of care. HDU admissions (elective and emergency) post-adenotonsillectomy should be audited on a 2 yearly basis to ensure that local criteria are effective in striking the correct balance between safety and efficient resource utilisation.

Non-Surgical

Non-invasive ventilation (NIV). Continuous positive airway pressure (CPAP) has been shown to be effective in correcting the physiological disturbance in several case series of children with OSA, including infants and those with neurodisability. CPAP also improves behaviour and alertness and concentration. Compliance with treatment may prove challenging and considerable support is required for families in the initiation and maintenance of CPAP therapy at home, ideally by a nurse specialist. Between 55% and 83% of families tolerate CPAP in the longer term with support. Bi-level positive airway pressure (BiPAP) has also been used effectively in children with OSA and is generally used when use of CPAP is not effective in completely overcoming airway obstruction.

Supplemental oxygen. Supplemental oxygen reduces the severity of desaturation in OSA but does not correct the underlying problem of apnoeas or hypopnoeas. There is conflicting data on its effect on apnoea frequency, arousals and sleep quality. In a small number of children supplemental oxygen use is associated with hypercapnia. It is therefore reasonable to use this as a temporary measure provided hypercapnia is excluded by performing an overnight oximetry/capnography on oxygen prior to initiation.

Nasal Steroids. Allergic processes may be involved in adenoidal hypertrophy and OSA, and nasal steroids have been shown to reduce apnoea frequency over a 6 week treatment period; they may have a role in the milder patient group. Oral steroids appear ineffective.

Montelukast. Given the link between asthma, allergic rhinitis, nasal obstruction and OSA, montelukast can be effective in reducing the severity of OSA and can be used in combination with nasal steroids.

Nasopharyngeal airway. Nasopharyngeal airways can bypass the point of obstruction and have immediate beneficial effects on OSA. NPAs are usually only suitable in infancy given difficulties with tolerance in older children.

Orthodontic devices. In a highly selected group of children with malocclusion, oral jaw positioning devices or orthodontics were found to resolve symptoms in about 50% of children and may also be applicable for children with neurodevelopmental problems. They are unlikely to be helpful in children with adenotonsillar hypertrophy or in the case of severe craniofacial problems.

Special considerations

Pre-operative assessment. All children undergoing adenotonsillectomy for OSA will have been seen by an ENT surgeon and the majority will have had a diagnostic sleep test. The ENT surgeon will review the criteria

for HDU admission and discuss if necessary with the respiratory, anaesthetic or HDU teams. If a HDU bed is required this will be stipulated by the ENT surgeon at the time of listing for the procedure. **Pre-operative cardiology review** to exclude pulmonary hypertension is not routinely required for children needing HDU admission but should be specifically organised in the following situations:

- Frequent and/or sustained desaturation to <80% on overnight oximetry (see appendix 1b and 1d) or PSG. This should be outlined in the oximetry/ PSG report
- A history of pre-existing haemodynamically significant cardiac disease
- Children with a history of ongoing significant respiratory illness, particularly those on oxygen within the last year.
- Children with trisomy 21 (should have stable echo findings excluding significant pulmonary hypertension within 1 year of the procedure)

The purpose of pre-operative echocardiography is to detect unsuspected pulmonary hypertension, a risk factor for post-operative morbidity and mortality.

Anaesthesia in children with OSA. Children with OSA are at increased risk of significant airway obstruction during or after anaesthesia **(for procedures other than adenotonsillectomy)**. Limited evidence exists to give recommendations in relation to post-anaesthesia management of children with suspected or established OSA. The following guidance is based on a common sense approach:

- Children with an established diagnosis of OSA, who have ongoing symptoms and who are not on CPAP, should be observed as inpatients overnight after general anaesthetic.
- Children with an established diagnosis of OSA, who are successfully established on CPAP treatment, usually **do not** require inpatient observation after general anaesthesia unless they had a prolonged general anaesthetic or oropharyngeal or airway surgery. This decision is at the discretion of the consultant anaesthetist on duty.
- Children with suspected OSA, or waiting evaluation or diagnostic testing, may require overnight observation as inpatients after general anaesthetic. This decision will be based on the frequency and severity of obstruction at home by history, medical and surgical co-morbidities and clinical assessment pre and/or post-operatively. This decision is at the discretion of the consultant anaesthetist on duty.

Specific guidance on anaesthetic agents, analgesia or peri-operative airway management are outside the scope of this document, although it should be noted that children with OSA can be particularly sensitive to the effects of opioids, which should be used with great care in this group.

Follow Up

In children who have low grade symptoms of OSA and/or non-severe findings on diagnostic testing and have a definitive procedure such as an adenotonsillectomy where the symptoms completely resolve, further testing is not required. Parents should be counselled, however, about the signs and symptoms of OSA and asked to return if symptoms reappear. Children with significant symptoms of OSA and/or markedly abnormal findings on diagnostic testing, particularly obese children or children with high risk conditions such as trisomy 21 require follow up review and in most cases further investigation even in the case where significant adenotonsillar hypertrophy is present and there is a significant improvement in symptoms after adenotonsillectomy.

Recommendations for the treatment and follow up of children with OSA

1. Children diagnosed with OSA should be seen by an ENT surgeon to determine whether a surgically reversible cause for OSA can be found.
2. If surgical intervention is warranted, an assessment of peri-operative risk should be performed. Children at high risk of peri-operative complications should be observed in HDU post-operatively. Refer to specific guidelines above.
3. Treatment options should be discussed with the family of children with mild manifestations of OSA. Treatment may not always be necessary but follow up is important if this is the case.
4. Children with either a marked abnormality on diagnostic testing or clinically significant consequences of OSA require treatment. Treatment options should be discussed with the family.
5. Children who are not candidates for a definitive surgical approach should be referred to a consultant in paediatric respiratory medicine to evaluate treatment options including medical treatments and CPAP.
6. Children initiating CPAP therapy require intensive support and close follow up under the supervision of a consultant in paediatric respiratory medicine
7. Children with OSA who fail or are not suitable for CPAP treatment should be offered montelukast and/or intranasal steroids as a trial.
8. Children with OSA who fail or are not suitable for CPAP and have severe oxyhaemoglobin desaturation should be treated with oxygen
9. Children who have low grade symptoms of OSA and/or mildly abnormal findings on diagnostic testing and have an adenotonsillectomy do not require follow up testing if symptoms settle completely. Parents should be alerted to the signs and symptoms to look out for.
10. Children with significant symptoms of OSA and/or markedly abnormal findings on diagnostic testing who have an adenotonsillectomy require both clinical follow up and a follow up study.
11. Children with OSA or suspected OSA may need overnight observation in hospital following general anaesthesia (for any procedure). Refer to specific guidelines above.

Companion Documents

Appendix 1: OSA Oximetry Tracings

Appendix 2: Algorithm for Interpretation of Overnight Oximetry

Appendix 3: Algorithm for Investigation of Suspected OSA

Evidence Table

Literature Search

References and Links


C H I
Children's Health Ireland