

**BEST PRACTICE EVIDENCE BASED
GUIDELINE**

**ASSESSMENT OF SLEEP-
DISORDERED BREATHING IN
CHILDHOOD**

2005



PAEDIATRIC SOCIETY OF NEW ZEALAND

HEALTH OF OUR CHILDREN: WEALTH OF OUR NATION

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STATEMENT OF INTENT

Clinical guidelines are produced to assist health professionals and consumers make decisions about health care in specific clinical circumstances. Research has shown that if properly developed, communicated and implemented, guidelines can improve care. While guidelines represent a statement of best practice based on the latest available evidence (at the time of publishing), they are not intended to replace the health professional's judgment in each individual case.

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Where guidelines are modified for local circumstances, significant departures from these national guidelines must be detailed with reasons for the departure. The Paediatric Society Guidelines group cannot be held responsible for such changes.

This Guideline has a currency of 3 years from date of publication unless superseded.

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As this guideline was developed by the Paediatric Society under contract with the Ministry of Health the review of the guideline remains the responsibility of the Ministry.

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ENDORSEMENTS

Endorsements for this guideline were received from:



Endorsed by NZGG as a best-practice guideline



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PURPOSE

This guideline addresses the assessment, diagnosis and treatment of children and young people with sleep disordered breathing.

The guideline summarises the latest international literature and combines this with New Zealand expertise. The purpose is to assist informed decision making by parents/caregivers and their health care providers in order to improve the health outcomes for children and young people with sleep disordered breathing.

The guideline does not address management of sleep-disordered breathing in adults, nor does it intend to provide detailed management of respiratory disorders of neonates or infants.

FOREWORD

The Paediatric Society of New Zealand Inc (PSNZ) is a not-for-profit charitable organisation. It was founded in 1947 in recognition of the special developmental and health needs of children. Until 2000 it remained largely a professional support organisation for paediatricians. In 2000 it moved to become a multidisciplinary organisation in recognition of the crucial role played by all groups of child health professionals in achieving its mission. PSNZ is committed to improving the health of children and young people. As a multi-disciplinary Society we are able to develop and influence pathways for improvement.

“HEALTH OF OUR CHILDREN: WEALTH OF OUR NATION”

The PSNZ is a national organisation working to:

- be consistent with the UN Convention on the Rights of the Child
- advocate for the health, well-being and social environment of children and young people
- plan for the development of all aspects of children and young peoples’ health care and consider how services inter-link with each other
- promote quality health care and disease prevention initiatives for children and young people
- establish standards, guidelines and position statements
- provide and publish information for health care professionals and the public on matters that concern the health and welfare of children and young people

In 2001 the PSNZ received a contract from the Ministry of Health requiring various outputs including the development of evidence-based guidelines for common conditions. The Society undertook an internal prioritisation process and the guideline for assessment of children with sleep disordered breathing was identified as one of the five to be developed.

The National Review of Sleep Services for Children and Young People in New Zealand: Facilities and Expertise (PSNZ, May 2002) detailed the diagnostic and treatment services available around the country to children with suspected sleep disorders. While these services have grown substantially over recent years, they remain inadequate to address the needs of New Zealand children to an international standard. While considerable efforts to improve this situation continue, both in individual centres and nationally, the following statement aims to provide guidance to general practitioners and paediatricians in New Zealand regarding investigation of sleep-disordered breathing in childhood at the current time.

INTRODUCTION

In 1889, Hill described snoring and restlessness at night as a cause of “backwardness and stupidity in children”¹, but nearly 100 years passed before the first case series of children with obstructive sleep apnoea (OSA) was published². Since that time, it has been recognised that OSA is one of the most common respiratory disorders of childhood, affecting an estimated 1-2% of normal children³⁻⁶. In 1982, Brouillette et al published a case series of 22 infants and children with severe complications of OSA such as cor pulmonale and failure to thrive⁷. In recent years, research in this condition has mushroomed, bringing increasing recognition that OSA may have significant adverse consequences even in milder cases^{3,8-11}. In children, episodes of upper airway obstruction during sleep may lead to brief arousal from sleep without desaturation. These arousals can be associated with increases in heart rate and blood pressure which may have long term cardiovascular implications¹², and may also be the mechanism by which OSA affects learning and behaviour during the day^{8,9,13-16}.

In addition to the emerging research in OSA, there is increasing recognition in the literature of disorders of breathing during sleep in children with medical disorders such as neuromuscular disease, craniofacial syndromes and lung disorders. This guideline provides a brief overview of the evidence in this emerging field, to provide guidance for general practitioners and paediatricians caring for children with these conditions.

In developing this guideline it has become apparent that there is increasing evidence for the management of adults with OSA but many questions remain unanswered for children and further research for children is required.

Terminology

The obstructive sleep apnoea syndrome (OSAS) in children was defined by the American Academy of Pediatrics as a disorder of breathing during sleep characterised by prolonged partial upper airway obstruction (obstructive hypopnoea) and/or intermittent complete obstruction (obstructive apnoea) that disrupts normal ventilation during sleep and normal sleep patterns¹⁷. In this document we use the term obstructive sleep apnoea, or OSA, to refer to this spectrum of severity of obstructive events during sleep and its consequences. The term “sleep-disordered

breathing” is used as an umbrella term for all conditions where ventilation or sleep patterns are disturbed by abnormalities of breathing, including for example OSA or hypoventilation related to neuromuscular diseases or other disorders.

Maori Health Issues

There are no published data of the prevalence of snoring, sleep disordered breathing or OSA in the New Zealand paediatric population. Two studies have looked at the prevalence and ethnic differences of OSA symptoms in New Zealand adults. The first involved a population based survey and was sent to 10,000 New Zealanders (5,500 of Maori descent and 4,500 non-Maori) aged 30-60 years selected at random from the electoral roll. Results showed that symptoms of OSA are common in a New Zealand adult population and that Maori were significantly more likely to ‘always snore’, have ‘observed apnoea’ and have daytime sleepiness than non-Maori¹⁸. The second study involved home based cardio-respiratory sleep studies in Maori and non-Maori aged 30-60 years, randomly selected from the electoral roll. Results indicate that Maori had higher rates of sleep disordered breathing than non-Maori¹⁹. These studies suggest that the prevalence of OSA is likely to be higher amongst Maori than non-Maori but this data cannot necessarily be extrapolated to the paediatric population. No studies have addressed the prevalence of sleep-disordered breathing in the Pacific Island population in New Zealand.

GAPS BETWEEN EVIDENCE AND CURRENT PRACTICE

In developing this guideline the team faced the challenge of reconciling previously published guidelines with current New Zealand practice, and finding a way to bridge the gaps. Recommending adoption of the American Academy of Pediatrics Guideline for the Diagnosis And Management Of Childhood Obstructive Sleep Apnoea Syndrome¹⁷, with minor modifications from more recent publications, is impractical, as an exorbitant number of children would need to be referred for polysomnography and other work-up. Restricting the guideline to resources currently available in New Zealand is inappropriate and would ignore the real burden of ill health from sleep disordered breathing in children.

The combined expertise of the team, following many iterations of clinical questions and resource implications, identified gaps between evidence and current practice. It

is anticipated that through rational implementation of evidence based recommendations there will be improvement in clinical practice in New Zealand.

What are the gaps?

The principal gaps between evidence based recommendations and current practice in the field of sleep-disordered breathing in childhood in New Zealand are:

- clinical recognition of children at risk of sleep disordered breathing
- availability of appropriate investigations, particularly polysomnography (PSG), and
- provision of timely treatment.

While the literature “gold standard” for diagnosing OSA is PSG⁶², this New Zealand guideline attempts to balance this with what is practically achievable within current clinical resources.

The guideline also indicates where efforts should be directed over the next five years to improve the equity of access for children to expertise in the recognition, appropriate investigation, and timely treatment for sleep disordered breathing.

How much effort will it take to close the gaps?

Initially this guideline will help to rationalise the assessment and management of children with sleep disordered breathing, and coordinate the limited resources to identify those in need of investigation and treatment.

Primary care will continue to be the first point of contact for many children with suspected sleep-disordered breathing. Direct referral by a general practitioner to an otorhinolaryngologist (ear, nose and throat surgeon) for consideration of adenotonsillectomy will be appropriate in many cases.

Secondary care, provided by general and regional paediatricians, will be sought when there is doubt about the diagnosis, or in situations where a child has significant co-morbidity such as Down Syndrome or spina bifida. Paediatricians will also play a key role in the education of general practitioners and promotion of child health in their regions.

Tertiary care will provide diagnostic investigation and implementation of treatment for those children referred from secondary care services.

Once the guideline is in use, the nationwide burden of need and problems of access to services will be better identified. This will help to develop a more robust understanding of the gaps between evidence based guidelines and practice.

This guideline is therefore intended for both general practitioners and general paediatricians, as well as otorhinolaryngologists who treat children. Full implementation of the recommendations depends on widespread circulation of the guideline to general practitioners and paediatricians, which will be co-ordinated by the Paediatric Society of New Zealand.

Is there a reasonable likelihood that the recommended changes could be implemented?

In developing this guideline we have sought advice from key professional and lay groups to determine, as far as possible, that the implementation of these recommendations is within reach of current services, or at least feasible to be achieved with modest increases in services. The key impacts of this guideline are likely to be changes in the investigation and management of children with suspected sleep-disordered breathing. Implementing these changes may have the following impacts:

1. Increased recognition of the symptoms of OSA, and consequences of this condition if not treated, may lead to increased referral to otorhinolaryngologists for adenotonsillectomy. Some increase in ENT resources may be required to meet this need.
2. The more widespread use of overnight oximetry as a tool for the assessment of a child with suspected sleep-disordered breathing will likely increase demand for this test. Many regional paediatric centres and some general practitioners are already undertaking this type of testing. Because of resource implications we have intentionally restricted our recommendation of its use to try and limit this increase in demand. A degree of up-skilling may be required, both in the limitations of this technology and in interpretation of test results.
3. Increased availability of comprehensive sleep studies (polysomnography) will be required to meet international standards for certain conditions. The provision of

such services for children lags considerably behind that provided to adults with similar conditions around New Zealand. The reader is referred to the document “National Review of Sleep Services for Children and Young People in NZ: Facilities and Expertise (2002)” (available on the PSNZ website: www.paeditrics.org.nz) for more detailed information about the level of services that is likely to be required. For the purposes of this guideline, we have intentionally limited the recommendation for this type of study to those children for whom no other simpler form of testing provides comparable information, plus for those in whom the result of such testing may significantly alter treatment decisions for the future e.g. the initiation of non-invasive ventilation.

These potential impacts may be associated with additional costs. These costs should be balanced, with evidence from the literature, of benefits and cost savings in the following areas:

- **Decreased use of health services.** Children with OSA are high users of health services in the year before OSA is diagnosed, implying that earlier recognition and treatment will result in cost savings^{20,21}.
- **Decreased use of special educational services.** Behavioural problems and deficits in mental functioning have been well documented in children with OSA^{8,10,11,13-16}. Treatment of OSA leads to improvements in quality of life^{13,22-24}, and improvements in behaviour and mental functioning in children^{13,25}. Thus, diagnosis of the condition and appropriate treatment both impact positively on learning and school performance.
- **Decreased use of hospital services.** Institution of non-invasive ventilation in children with chronic respiratory failure secondary to neuromuscular disease leads to decreased hospital admissions, reduced hospital days, and reduced intensive care days^{26,27}.
- **Decreased use of support services.** Non-invasive ventilation in children with chronic respiratory failure secondary to neuromuscular disease is associated with improvements in quality of life²⁸⁻³¹.

Closing the gaps

To improve the wellbeing of individual children there is a need for equity of access and fair distribution of resources, including access to effective treatment. For some

children this will mean adenotonsillectomy. Others (eg those at increased risk of co-morbidity or of post surgical complications) would benefit from limited investigation in secondary services, and yet others from tertiary workup including PSG.

Performance measures

The following are proposed as potential performance measures to evaluate the impact of the Guideline:

- Reduced waiting time for sleep studies (both hospital/sleep laboratory studies and home overnight oximetry)
- Reduced waiting times for adenotonsillectomy
- Total numbers of adenotonsillectomy by indication
- Total numbers of sleep studies for children aged under 14 years
- Feedback from consumer groups about the availability of paediatric sleep medicine services
- Complications following routine ENT surgery

Recommendation

That consistent access to an integrated paediatric nation-wide service for investigation and management of sleep disordered breathing is established in New Zealand.	✓
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EVIDENCE GRADING SYSTEM

Evidence and guideline recommendation grading system used for this guideline:

The guideline group agreed to use the New Zealand Guidelines Group (NZGG) grading system for recommendations. More information on the grading system can be found on www.nzgg.org.nz

TABLE 1: NZGG Levels of Evidence

NZGG Levels of Evidence	
+	assigned when all or most of the criteria are met.
∅	assigned when some of the criteria are met and where unmet criteria are not likely to affect the validity, magnitude or applicability of the results markedly.
-	assigned when few or none of the criteria are met.

TABLE 2: NZGG grading of recommendations

Grade	Details
A	The recommendation is supported by good evidence.
B	The recommendation is supported by fair evidence.
C	The recommendation is supported by expert opinion only and or limited evidence.
I	No recommendation can be made because the evidence is insufficient Evidence is lacking, of poor quality or conflicting and the balance of benefits and harms cannot be determined.

Good Practice Points	
☑	<p>Recommended best practice based on the clinical experience of the guideline development group and where guidance is needed.</p> <p>Note: Good practice points have also been assigned where the evidence has been reviewed but not formally graded.</p>

SECTION 1

1. Snoring and OSA

1.1 Screening by history and examination- “The question of snoring”

OSA is a common condition in childhood: several large epidemiologic studies in western societies have found that about 1 in 10 preschoolers snore, and 10% of those (about 1% of the population) have OSA³⁻⁶. OSA is associated with significant morbidity, including failure to thrive, daytime behavioural problems, cognitive impairments, cor pulmonale, right ventricular hypertrophy and systemic hypertension.

Habitual snoring (snoring every night, even when the child is otherwise well) is the cardinal clinical feature of OSA^{2,3,5-7,10,32-42}. The diagnosis is unlikely in children who do not snore³⁴. Snoring should not be assumed to be normal in childhood and may indicate OSA requiring treatment. “Noisy breathing during sleep” may be a better screening question, as children often do not have the vibratory type of snoring seen in adults. All children should be screened for a history of OSA at clinical visits by asking about a history of snoring or noisy breathing during sleep.

Within the group of children who snore, the literature would suggest that other aspects of the history, and features on clinical examination, have poor specificity for the presence of OSA^{4,10,32,34,41-46}. However, certain symptoms increase likelihood of significant OSA in children who snore:

- witnessed obstructive apnoea (odds ratio 3.3³²)
- frequent daytime mouth breathing (OR 3.7³²)
- parent afraid/wakes child because of breathing (OR 4.4³²)
- difficulty breathing while asleep (OR 5.54³²)
- frequent waking from sleep in a child who has previously slept through⁴⁷
- secondary enuresis^{2,48,49}
- daytime behavioural problems^{8,10,11,13-16}
- failure to thrive or slowing of weight gain⁵⁰⁻⁵⁴.

The use of a structured questionnaire improves the specificity of the history for OSA by combining many of these symptoms into a total score³⁵.

Excessive daytime sleepiness is not predictive of the presence of OSA in young children³², but is a cardinal feature of the OSA syndrome in adults, and thus this symptom should be sought, particularly in adolescents.

It should be noted that the size of the tonsils or adenoids on clinical examination is not linearly correlated with the presence or severity of OSA^{10,40,42,44,46,55-61}, so small tonsils should not exclude the diagnosis if other features are present. Other examination features such as obesity, neuromuscular disorders, cranio-facial abnormalities and atopy increase the likelihood of OSA but their absence does not exclude it.

Recommendation	Grade
OSA is a common condition in childhood, and is associated with significant morbidity.	A
All children should be routinely assessed for sleep disordered breathing, particularly habitual snoring.	☑
In children with habitual snoring, a history of other associated symptoms (witnessed apnoea etc, see list above) should be sought, because their presence increases the likelihood of OSA.	A
Small tonsillar size does not exclude OSA, and therefore children with small tonsils and habitual snoring plus other features suggestive of OSA on history or examination should be referred for assessment by a paediatrician for consideration of adenotonsillectomy or sleep studies.	B
Children with symptoms of OSA and significant co-morbidity such as obesity, neuromuscular disorders, or craniofacial abnormalities should be assessed by a paediatrician. Consideration of adenotonsillectomy and/or sleep studies is important because of the high incidence of OSA in these groups.	B

1.2 Treatment with adenotonsillectomy without sleep studies

As history and clinical examination findings are poorly specific for OSA, the current gold standard for making the diagnosis is multi-channel physiologic recordings during sleep (polysomnography, PSG)⁶². Currently we do not have the resources in New Zealand to provide polysomnography to confirm the diagnosis of OSA in the large group of children who snore, have adenotonsillar hypertrophy, but are otherwise normal. If the associated factors mentioned in the previous section are present, consideration of adenotonsillectomy is warranted without sleep studies.

In most cases of OSA in childhood, adenotonsillectomy is a highly effective treatment, leading to the resolution of abnormal respiration during sleep, and improvements in growth, restless sleep and daytime behaviour^{11,13,14,20,22-25,34,41,50,51,53,54,63-76}. One study has suggested that removal of either the tonsils or the adenoids alone carries a significant risk of persistence or recurrence of OSA⁴¹, and thus both tissues should be removed at the same surgery, unless contraindicated, to reduce the likelihood of recurrence of OSA. Children who have had adenotonsillectomy remain at increased risk of OSA in later life, **especially children who are obese or who have a family history of OSA**⁷⁷.

Obese children represent a particular sub-group at risk of OSA that may require special consideration. Recent evidence would suggest that obese children with tonsils that occupy more than 50% of the pharyngeal diameter have a high prevalence of OSA⁷⁸. Adenotonsillectomy may be an effective treatment for this group as for other children, but factors other than adenotonsillar hypertrophy may contribute to OSA. Obesity places a child at increased risk of post-operative respiratory compromise (see below), and this group of children should therefore be observed closely overnight after adenotonsillectomy. Following this treatment, clinical follow-up should determine if symptoms of OSA have resolved. Children with symptoms that persist following adenotonsillectomy should be considered for sleep studies, as continuous positive airway pressure (CPAP) may be indicated. A weight control programme should always be a part of the management of this group of children.

Clinicians should be aware that children with OSA are at increased risk of respiratory complications in the post-operative period^{16,46,51,63,74,75,79-91}. Medical intervention including supplemental oxygen, CPAP and re-intubation is required for these complications in up to 25% of children with OSA.^{83,85,87,90} These high risk children should have their surgery in a hospital equipped to deal with airway emergencies in children after hours, and should stay overnight rather than have day-stay surgery^{85,90}. Within this group, children under 3 years of age, those with other medical problems (including obesity), and those with severe OSA (cor pulmonale, failure to thrive or desaturation below 80% on overnight oximetry) are at highest risk^{83,85,87,90}.

Recommendation	Grade
Adenotonsillectomy is an effective treatment for OSA in most otherwise healthy children.	A
Otherwise healthy children with habitual snoring plus other features suggestive of OSA on history or examination should be referred for consideration of adenotonsillectomy if the tonsils are enlarged.	☑
Children under 3 years of age, those with co-morbid conditions including obesity, and those with more severe OSA (see text) should remain in hospital overnight after adenotonsillectomy, with continuous oximetry monitoring, in a unit with personnel skilled in paediatric airway management.	A
Children whose symptoms of OSA persist after adenotonsillectomy, or who do not have enlarged tonsils or adenoids, should be referred to a paediatrician for consideration of a sleep study.	☑

1.3 Referral for sleep studies before adenotonsillectomy

In the ideal circumstance, OSA would be confirmed by multi-channel physiologic recording during sleep (polysomnography, PSG) prior to surgery. In New Zealand at the current time however, this test is not widely available. In most cases confirmation of the diagnosis is not critical. **However for children for whom surgery or anaesthesia involves a high risk¹⁷**, for example those with bleeding disorders or malignant hyperthermia, formal confirmation of diagnosis is important.

Possible alternatives to PSG for confirming the diagnosis include:

- a. Overnight oximetry can be useful if it shows a pattern of cyclic desaturation⁹². An example of this pattern is shown in Figure 1. However interpretation of this test involves knowledge of the performance characteristics of the oximeter being used⁹³ and the limitations of the technology⁹⁴. It may not be useful in children with co-morbidity¹⁷. A normal oximetry should not be used to exclude OSA, as it has a low negative predictive value^{81,90,92,95,96}.
- b. Daytime (nap) polysomnography has a high positive predictive value, but a low negative predictive value^{97,98}.
- c. Limited information is available to support the use of other abbreviated types of polysomnography (limited channel sleep studies) in children^{45,97,99-104}. Validation

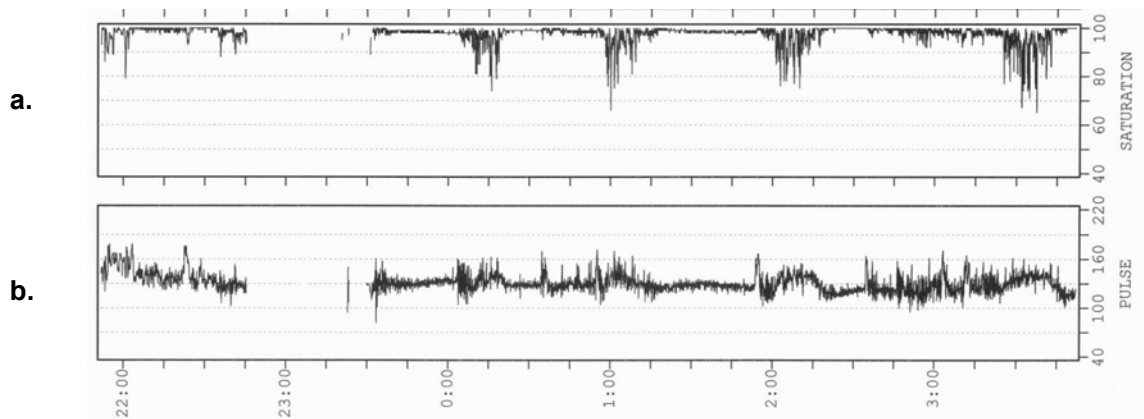
studies in adults are not sufficient, due to the different detection requirements and scoring criteria necessary for interpretation of paediatric studies¹⁰⁵.

Where doubt exists, individual patients should be discussed with a paediatric sleep centre and referral for formal polysomnography discussed.

Recommendation	Grade
Children whom the ENT surgeon or anaesthetist consider to be at high risk should have the diagnosis of OSA made formally before surgery is contemplated.	C
A characteristic overnight oximetry recording (Figure 1) in an otherwise healthy child is sufficient to confirm the diagnosis, but a normal oximetry does not exclude OSA.	B
Abbreviated sleep studies are not well validated in children and thus the need for formal sleep studies should be discussed with a referral centre.	B

Figure 1.

A section of an overnight a) oxygen saturation and b) heart rate recording demonstrating clusters of desaturation with ≥ 3 dips in oxygen saturation below 90%. This pattern has a high positive predictive value for OSA in an otherwise normal child with a history suggestive of OSA⁹².



1.4 Treatment for OSA other than adenotonsillectomy

1.4.1 CPAP

For patients with specific surgical contraindications, minimal adenotonsillar tissue, persistent OSA after adenotonsillectomy, or OSA due to obesity or craniofacial or neuromuscular conditions, continuous positive airway pressure (CPAP) may be an option. CPAP is effective and well tolerated, even in very young children^{15,106-112}. The exact threshold for the severity of OSA that should be treated with CPAP is not determined for children.

Recommendation	Grade
CPAP is an effective treatment for OSA in children	B
Children with significant symptoms of OSA that persist after adenotonsillectomy, and those who do not have enlarged tonsils or adenoids, should be discussed with a paediatric sleep service for consideration of CPAP treatment.	<input checked="" type="checkbox"/>

1.4.2 Other treatments

Nasal steroids have been proposed as treatment for OSA, particularly in children with allergic rhinitis¹¹³⁻¹¹⁶. Further research is needed in this area however before a specific recommendation is made.

Mandibular distraction may be an efficacious treatment for OSA in children with craniofacial malformations¹¹⁷⁻¹²¹. Again, further research is needed, but this treatment may be considered in individual cases.

Oral appliances that fit inside the mouth and usually serve to hold the mandible forward have been suggested to treat OSA in children^{122,123}. Whereas there is some evidence suggesting that oral appliances improve OSA in adults, there is currently insufficient evidence to recommend this treatment for children.

Recommendation	Grade
Nasal steroids may be considered as treatment for symptoms of OSA in children with allergic rhinitis, with appropriate follow-up to determine the effect of treatment.	C
Mandibular distraction or other types of surgery may be considered as treatment for OSA in children with craniofacial disorders, in consultation with a paediatric sleep service and surgical specialists.	C
No recommendation can be made regarding the use of oral appliances for children.	I

1.5 Complex high-risk children

OSA should be particularly considered in the following conditions, due to the high rates of OSA in these groups:

- Down syndrome^{80,89,124-129}
- Pierre Robin sequence and other craniofacial syndromes^{118,121,130-138}
- laryngomalacia¹³⁹⁻¹⁴¹
- mucopolysaccharoidoses^{82,142}
- spina bifida^{143,144}
- achondroplasia¹⁴⁵⁻¹⁴⁷
- cerebral palsy^{148,149}
- previous palatal surgery^{131-133,135,150}
- prematurity¹⁵¹⁻¹⁵³

Children with these disorders potentially have pathophysiology in addition to adenotonsillar hypertrophy that may contribute to OSA. Therefore adenotonsillectomy may not lead to complete resolution of the problem^{89,143}, may not be indicated at all, or may even be contra-indicated e.g. Pierre Robin Sequence or laryngomalacia in an infant. Children with these conditions are also at risk of central sleep apnoea or hypoventilation, which is indistinguishable from OSA either clinically or using overnight oximetry. In children with spina bifida for example, an abnormal overnight oximetry predicts moderate to severe sleep-disordered breathing with a sensitivity of 100%, but it has a low specificity¹⁴³. Therefore a more detailed sleep study is needed to diagnose the type of sleep-disordered breathing (e.g. central vs OSA) and thus guide treatment.

Children with the above medical disorders should be referred for polysomnography or a cardiorespiratory sleep study if CPAP, tracheostomy, upper airway surgery or other treatment is being considered. The indications for such treatments will vary, but hypoxaemia or hypercapnia during sleep (risk factors for pulmonary hypertension), hypertension, or significant daytime impairments due to sleep-disordered breathing would be the main indications.

Recommendation	Grade
Children with complex medical disorders and suspected OSA should be assessed by a paediatrician and then discussed with or referred to a paediatric sleep service if necessary, for consideration of investigation and treatment.	B

SECTION 2:

2.1 Neuromuscular disease

Children with neuromuscular disease are at risk of developing both central and obstructive apnoea, and hypoventilation during normal sleep. **Non-invasive ventilation** (NIV) can be used successfully in young children, and there is increasing evidence that it can reverse ventilatory insufficiency due to neuromuscular disease, improve quality of life, and reduce hospitalisations^{26,30}. The literature suggests that NIV is frequently started for the first time for respiratory failure due to acute pneumonia²⁷. It is helpful if the possibility of such support is raised with families before an acute situation arises during routine outpatient visits, or hospitalisations for respiratory infections when NIV is not required. This may allow enough time for evaluation and consideration of NIV in an elective situation.

Daytime pulmonary function and awake blood gases can serve as guides for children most likely to have sleep-disordered breathing. The following children could be referred for sleep studies with or without institution of treatment, *if non-invasive ventilation is being considered*:

- a. Children with forced vital capacity (FVC) <40% predicted and a daytime capillary pCO₂ above 45 mmHg (6.0kPa), especially if the base excess is ≥ 4 mmol/L¹⁵⁴⁻¹⁵⁶.
- b. The possibility of sleep-disordered breathing should also be considered in children with morning headaches, excessive daytime sleepiness, unrefreshing sleep, failure to thrive or developmental delay disproportionate to their underlying disease. These symptoms are less sensitive however than daytime respiratory function (see a).

Recommendation	Grade
Lung function should be monitored on an annual basis in children with neuromuscular disease, with the aim of anticipating the onset of sleep-disordered breathing, and the risk of respiratory failure during respiratory illnesses.	☑
Referral for polysomnography should be considered in children with a forced vital capacity <40% predicted and a daytime capillary pCO ₂ above 45 mmHg (6.0kPa), or if clinical symptoms of sleep-disordered breathing are present.	☑
Non-invasive respiratory support during sleep should be considered and discussed with parents and patients after acute respiratory	

illnesses requiring oxygen, and/or when the forced vital capacity is <40% predicted, or the daytime capillary pCO ₂ above 45 mmHg (6.0kPa).	<input checked="" type="checkbox"/>
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2.2 Disorders of breathing in infants

2.2.1 Apparent life-threatening events (ALTE)

Investigation of an infant who has an apparent life-threatening event (ALTE) is beyond the scope of this document. Polysomnography is not indicated for routine evaluation in infants with an uncomplicated ALTE¹⁵⁷. If OSA is clinically suspected¹⁵⁸, bradycardia is demonstrated on cardiac monitoring in the absence of central apnoea, or if an underlying disorder of control of breathing (e.g central alveolar hypoventilation syndrome) is suspected, a referral should be discussed with a sleep centre¹⁵⁷. This recommendation also applies to infants and children on apnoea monitors for reasons other than ALTE.

2.2.2 Bronchopulmonary dysplasia, chronic neonatal lung disease, home oxygen dependency

Infants with chronic neonatal lung disease (CNLD, bronchopulmonary dysplasia) on home oxygen should have continuous overnight recording of oximetry for at least eight hours on a regular basis to guide reduction of oxygen prescription^{159,160}. Guidelines for weaning oxygen are available from regional level III neonatal units. Oximeters used for overnight monitoring in infants and children should have high movement resistance (ability to detect the true oxygen saturation during motion) and a low averaging time (2-3 seconds) in order to detect brief desaturation events.

Full polysomnography (i.e. with other cardiorespiratory channels and/or EEG monitoring) should be considered in this group if:

- OSA is suspected clinically
- there are clusters of desaturation on overnight oximetry (suggesting more than just CNLD),
- an underlying disorder of control of breathing (e.g central alveolar hypoventilation syndrome) is suspected¹⁵⁷.

Recommendation	Grade
Referral for polysomnography should be discussed with a sleep centre for infants who have had an ALTE or those with chronic lung disease if an underlying disorder of breathing is clinically suspected, such as OSA or central alveolar hypoventilation syndrome.	☑
Decisions about oxygen prescription for infants on home oxygen should be guided by overnight recordings of oxygen saturation, usually without more detailed studies of breathing during sleep.	☑
Oximeters used for overnight monitoring in infants and children should have high movement resistance (ability to detect the true saturation during motion) and a low averaging time (2-3 seconds) in order to detect brief desaturation events.	☑

2.3 Cystic fibrosis, bronchiectasis, other chronic lung diseases

Progressive deterioration of lung function in cystic fibrosis (CF) patients may lead to significant hypoxaemia and hypercapnia, especially during sleep¹⁶¹⁻¹⁶⁵. Sub-clinical pulmonary hypertension develops in a significant proportion of patients with CF and is strongly correlated with hypoxaemia, independent of pulmonary function¹⁶⁶. Furthermore, sub-clinical pulmonary hypertension appears to be associated with increased mortality compared to a group with a similar degree of lung function impairment without pulmonary hypertension¹⁶⁶. **Oxygen therapy at home** should be considered when the oxygen saturation is below 90% for more than 10% of the night, in a clinically stable period¹⁶⁷. Long-term oxygen therapy has been demonstrated to improve survival in people with chronic obstructive pulmonary disease¹⁶⁸, but one study would suggest that this may not be the case in CF¹⁶⁷. Supplemental oxygen therapy may lead to an increase in nocturnal pCO₂¹⁶⁹, and thus pCO₂ should also be assessed if considering this therapy.

Non-invasive ventilation, when used in addition to oxygen, may improve gas exchange during sleep to a greater extent than oxygen therapy alone in moderate to severe cystic fibrosis lung disease^{165,169-171}. Non-invasive ventilation (NIV) may also improve sleep quality, health status and may have a benefit in reducing exacerbation frequency and severity¹⁷². To date there is no firm long term evidence regarding the efficacy, safety and acceptability of non-invasive ventilation in CF¹⁷¹.

Daytime measurements of lung function have poor specificity for nocturnal hypoventilation in cystic fibrosis^{161,164,173}. A continuous overnight oximetry recording

to identify children who might benefit from nocturnal supplemental oxygen has been suggested for those with: a resting SaO₂ awake in room air of <95%¹⁵⁷ or <93%¹⁶⁴, or a FEV₁<65% predicted¹⁶⁴, during a clinically stable period.

Overnight oximetry and PSG are rarely indicated in children with asthma, unless there is clinical suspicion of OSA, morning headaches or cor pulmonale¹⁵⁷.

Recommendation	Grade
Overnight oximetry should be performed at least annually during a clinically stable period in children with cystic fibrosis who have an FEV ₁ less than 65% predicted. Supplemental oxygen should be considered for children spending more than 10% of the night with SaO ₂ below 90%.	☑
Polysomnography should be discussed with a sleep centre for children with cystic fibrosis and symptoms of sleep-related hypoventilation, if non-invasive ventilation is being considered.	☑

GUIDELINE DEVELOPMENT PROCESS

In 2000 the PSNZ received a contract from the Ministry of Health that included the development of five evidence based guidelines. The Society undertook an internal consultation and review process to select the five guidelines to be developed. Sleep disordered breathing in childhood was one of the five that met the criteria established by PSNZ and agreed to by the Ministry of Health. An expert group of paediatricians, sleep technologists and other related health professionals was convened to develop a guideline for the management of the snoring child. This group decided that the mandate should be broadened to include guidelines for the management of other disorders of breathing during sleep. The issues identified by the group addressing in the guideline were:

1. How should general practitioners and paediatricians approach the investigation of a child who snores?
2. Which children should be referred from around New Zealand to a sleep disorders centre for further evaluation?
3. What treatments are available for disorders of breathing during sleep in childhood and what are the known benefits of these treatments?

A search was performed using OVID Medline (1966 to April 2004) using the following search items: "Sleep Apnea Syndromes", with "obstructive" as a key word; and, "Sleep Apnea, Obstructive". All abstracts were then reviewed by Gillian Nixon, excluding studies that did not fit the following criteria:

1. Studies including children aged 0-18 years;
2. Studies published in the English language;
3. Studies related to the diagnosis of OSA in children
 - Including the use of history, examination and diagnostic testing of various sorts to confirm/exclude the diagnosis
 - Including studies comparing alternatives to polysomnography (PSG) e.g. oximetry vs PSG
 - Excluding central apnoea
 - Excluding literature around apparent life threatening events / sudden infant death syndrome
 - Excluding premature infants
 - Excluding studies related to other disorders of sleep
 - Excluding studies comparing methods employed in polysomnography e.g. nasal cannula vs thermistor
 - Excluding studies of the pathophysiology of children with OSA

4. Studies related to the treatment of OSA in children
 - Including the efficacy of adenotonsillectomy
 - Including the risks of adenotonsillectomy
 - Including the effects and risks of continuous positive airway pressure (CPAP) and other treatments
 - Excluding studies related to surgical method or details of perioperative care
5. Studies related to OSA in children with co-morbid conditions

A review of all included and excluded studies was subsequently performed by the entire working group. A systematic critical review of the selected literature was undertaken by Dr. Maud Meates-Dennis, Senior Lecturer in Paediatrics, Christchurch School of Medicine. Evidence tables were then reviewed by the entire working group in order to formulate recommendations based on the literature. These tables are available on the Paediatric Society of New Zealand website as background documents (<http://www.paediatrics.org.nz/>). Where evidence was available from randomised controlled trials and systematic reviews, recommendations were based on these. Where there was a lack of evidence from high quality quantitative and qualitative studies, then recommendations were based on the best available evidence or expert opinion.

An internet search was undertaken looking for relevant existing guidelines, using the key words “sleep paediatric guidelines”, “sleep pediatric guidelines”, “obstructive sleep apnoea guidelines” and “obstructive sleep apnea guidelines”. The only positive result was the American Academy of Paediatrics Clinical Practice Guideline: Diagnosis and Management of Childhood Obstructive Sleep Apnea Syndrome (2002)¹⁷. This document, with its accompanying technical report¹⁷⁴ was selected as a base document for the New Zealand Guideline. The AAP Guideline¹⁷ was assessed by three reviewers independently using the AGREE Appraisal of Guidelines for Research & Evaluation (AGREE) Instrument (www.agreecollaboration.org), who found the following key points:

- The guideline was developed by a large group of professionals from a variety of specialties;
- The guideline is for use by primary care practitioners and the recommendations are for the diagnosis and treatment of OSA;
- The guideline is for children aged 2-18 years;
- The literature review was systematic and criteria for selection described, although there was no discussion on rejected papers;
- The recommendations are clear and are related to the evidence.

The reviewers recommended the use of the guideline for the development of a New Zealand guideline, with adaptations for use in New Zealand particularly in relation to:

- ethnic and cultural differences
- the availability of polysomnography
- an updated review of the literature including local and Australian papers to 2004
- how the diagnosis of OSA should be made in New Zealand
- the tests that are possible in regional centres as distinct from tertiary referral centres.

The New Zealand Health Technology Assessment group (NZHTA) was engaged to provide technical support for the search and critical appraisal of the literature relating to sleep-disordered breathing in neuromuscular disease. This information is summarised in Section 2.

The whole working group met on three occasions to review the guideline draft, and additional development of the guideline occurred by correspondence and teleconference.

Guideline team

Gillian Nixon (Chair):	Specialist in Paediatric Respiratory and Sleep Medicine Consultant Paediatrician, Starship Children's Hospital, Auckland. Clinical Senior Lecturer, University of Auckland.
Alex Bartle:	General Practitioner. RNZCGP representative
Angela Campbell:	Senior Lecturer, Department of Medicine, Wellington School of Medicine and Health Sciences. Manager WellSleep.
Dawn Elder:	Senior Lecturer in Paediatrics, Wellington School of Medicine and Health Sciences.
Glynn Russell:	Consultant Neonatal Paediatrician, Christchurch Women's Hospital
Janine Larkin:	Paediatric Respiratory & Sleep Technologist, Paediatric Department, Christchurch Hospital, Christchurch
Jeff Brown:	Consultant Paediatrician, Palmerston North Hospital
Elizabeth Edwards :	Specialist in Paediatric Respiratory and Sleep Medicine, Starship Children's Hospital, Auckland. Senior Lecturer, University of Auckland.
Philip Pattemore:	Senior Lecturer in Paediatrics, Christchurch School of Medicine.
Barry Taylor	Professor of Paediatrics and Child Health, Dunedin School of Medicine, University of Otago
Veronica Casey	CEO Paediatric Society of New Zealand

Sources of funding and editorial independence

The development of the guideline was funded by the Paediatric Society of New Zealand through funding from the Society contract with the Ministry of Health.

Declaration of competing interests

All working party members provide sleep services for children but, with the exception of Drs Dawn Elder and Alex Bartle, no members derive income from sleep studies for children. No other declarations of competing interest have been made by members, and thus the guideline reflect the unbiased views of the guideline team.

Consultation:

A draft guideline was circulated to approximately 60 organisations and individuals and to all members of the Paediatric Society and was made available on www.paediatrics.org.nz. Comments were received from:

Bates Lindsay,	Group Manager, MidCentral Health
Clarke Chris	CEO Hawkes Bay DHB
Cooke Dr Rob	New Zealand Guidelines Group
Davey Dr Margot	Chairperson, Paediatric Special Interest Group, Australasian Sleep Association
Dawbin Angela	Professional Nursing Advisor, NZNO
Kemphorne Dr Peter	Paediatric Specialist Anaesthetist, Christchurch Hospital
NZNO Neonatal Nurses	NZNO
Robertson Dr Christopher	MDS DSc, Department of Oral Sciences and Orthodontics, School of Dentistry, University of Otago.
Teng Dr Arthur	Medical Director & Conjoint Lecturer in Paediatrics, School of Women's and Children's Health, the University of New South Wales and Sydney Children's Hospital (at the invitation of Professor Don Robertson, President, Paediatrics & Child Health Division, Royal Australasian College of Physicians)
Mahadevan Dr Murali	Secretary, Australasian Society of Paediatric Otorhinolaryngology.

APPENDIX 1

SLEEP SERVICES FOR CHILDREN IN NEW ZEALAND

Study types

Full polysomnography includes EEG and measurements of muscle tone and eye movements, so that detailed sleep staging and scoring of arousals can be performed. This test is not ideal for looking for seizures during sleep and this specific indication should be discussed with the referral centre *before* a referral is made. It is recommended that, before full polysomnography is undertaken, a clinical opinion from a clinician with expertise in paediatric sleep medicine is obtained.

“Cardiorespiratory sleep studies” include a variety of multi-channel sleep studies without EEG, EMG or EOG. Channels may include oximetry, heart rate, measurements of respiratory effort, airflow or snoring sounds.

There are some commercially available devices for automatic detection of apnoeas and hypopnoeas. No such devices have been validated in children, and these devices employ adult criteria for the scoring of respiratory events, and may thus underestimate OSA in children¹⁰⁵.

Definitions

- The definition of an *obstructive apnoea* in a child is an episode of reduction in airflow to less than 20% of baseline with ongoing respiratory efforts, lasting at least three seconds or two respiratory cycles.
- A *hypopnoea* consists of a reduction in airflow to 20-50% of baseline, accompanied by a desaturation of >3% and/or an arousal.
- *Normal children* should have less than one apnoea per hour of sleep¹⁷⁵, and an apnoea/hypopnoea index of less than 1.2/hour of sleep¹⁷⁶.
- *Mild OSA* is usually defined as an apnoea index of 1-4 events/hour, or a SpO2 nadir of 87-91% in association with obstruction, or hypoventilation for 10-24% of total sleep time¹⁷⁷. The benefits of treating mild OSA are not well established.
- *Moderate OSA* is usually defined as an apnoea index of 5-9 events/hour, or a SpO2 nadir of 76-85% in association with obstruction, or hypoventilation for 25-49% of total sleep time¹⁷⁷.

- *Severe OSA* is usually defined as an apnoea index of >10 events/hour, or a SpO2 nadir of <75% in association with obstruction, or hypoventilation for >50% of total sleep time¹⁷⁷.

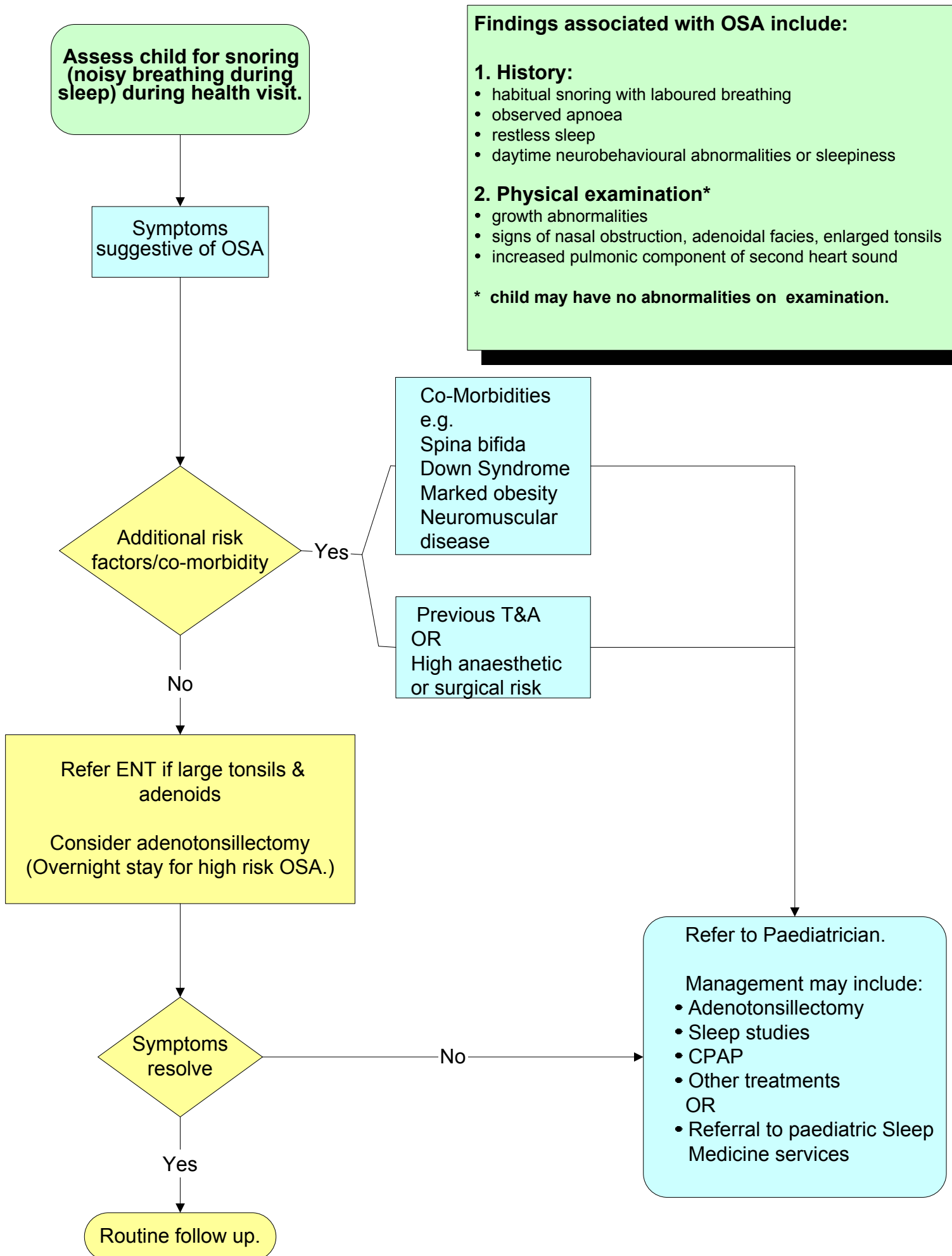
Sleep Services

Sleep services specifically for children are currently available in Dunedin, Christchurch, Palmerston North, and Starship Hospitals, and at WellSleep (Wellington School of Medicine & Health Sciences). These services are in evolution in all centres. It is therefore suggested that readers familiarise themselves with their nearest centre's resources, and contact those centres directly to discuss cases as needed.

Note:

Some adult sleep services may offer home or laboratory polysomnography for children but without paediatric assessment and the use of paediatric standards. In some circumstances they may provide a useful service but this should be combined with a clinical opinion from a clinician with paediatric sleep medicine expertise. Currently, the only paediatricians in New Zealand with formal qualifications in paediatric sleep medicine are Drs Gillian Nixon and Elizabeth Edwards at Starship Children's Hospital. Paediatricians around the country who have an interest and clinical experience in sleep medicine include: Professor Barry Taylor (Dunedin), Drs Dawn Elder (Wellington), Jeff Brown (Palmerston North, and Philip Pattermore and Glynn Russell (Christchurch).

Algorithm One: Investigation and Management of Suspected Obstructive Sleep Apnoea in Children



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