

ASERNIP/S



Australian Safety

and Efficacy

Register of New

Interventional

Procedures - Surgical

Rapid Review

Tonsillectomy, Adenoidectomy and Adenotonsillectomy for Obstructive Sleep Apnoea: Review of Clinical Evidence and Guidelines

March 2015

**Australian Safety & Efficacy Register of
New Interventional Procedures - Surgical**

The Royal Australasian College of Surgeons

This report has been produced for the Victorian Government Department of Health

March 26, 2015

Please note that this brief report, while broad in some aspects of systematic review methodology, should not be considered a comprehensive systematic review. Rather, this is a rapid review in which the methodology has been limited in one or more of the following areas to shorten the timeline for its completion: search strategy, inclusion criteria, assessment of study quality and data analysis. This report also contains non-systematic elements, such as qualitative information gathered from local surgeons. However, it is considered that these amendments would not significantly alter the overall findings of the rapid review when compared to a full systematic review.

The methodology used for the rapid review is described in detail, including the limits for this particular topic. These limits were applied following the requirements of the specific review topic, in consultation with the requester.

For a more comprehensive understanding of this topic, a broader analysis of the literature may be required. As such, all readers of this document should be aware of the limitations of this review.

This brief was prepared by Ms Lynda McGahan and Dr Ann Scott from the Australian Safety and Efficacy Register of New Interventional Procedures – Surgical (ASERNIP-S).

Declaration of competing interest:

The authors of this publication claim no competing interests.

Table of Contents

Scope of the Report.....	iv
Executive Summary	v
Abbreviations.....	x
1. Context and Policy Issues.....	1
Research questions	3
2. Methodology.....	4
Literature review	4
Literature search strategy	4
Study selection criteria and methods.....	4
Exclusion criteria.....	4
Data extraction and analysis	5
Critical appraisal of included studies	5
Data analysis	5
Expert opinion	5
3. Studies Included in the Review.....	7
Literature search results	7
Description of studies	7
Appraisal of study quality	9
4. Literature Review Results	12
Indications for tonsillectomy in Australia.....	12
Threshold of pathology for tonsillectomy, adenoidectomy or adenotonsillectomy	12
Developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy.....	14
Effectiveness of tonsillectomy, adenotonsillectomy or adenoidectomy for sleep apnoea	16
Clinical testing for tonsillectomy, adenotonsillectomy or adenoidectomy candidates .	17

Techniques for reducing secondary bleeding following tonsillectomy, adenotonsillectomy or adenoidectomy.....	19
5. Expert Opinion.....	21
6. Discussion.....	25
Findings.....	25
Limitations of the evidence.....	28
7. Conclusions and Implications for Policy.....	30
Acknowledgements.....	32
References	33

List of Tables

Table 1: Study selection criteria	4
Table 2: Summary of indications for tonsillectomy and adenotonsillectomy	12
Table 3: Summary of evidence on threshold of pathology for tonsillectomy, adenoidectomy or adenotonsillectomy	14
Table 4: Summary of evidence on developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy	15
Table 5: Summary of evidence on effectiveness of tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea	17
Table 6: Summary of evidence on clinical testing for tonsillectomy, adenotonsillectomy or adenoidectomy candidates	18
Table 7: Summary of evidence on techniques for reducing secondary bleeding following tonsillectomy, adenotonsillectomy or adenoidectomy.....	20

List of Appendices

Appendix A: Literature Search and Retrieval.....	42
Appendix B: Evidence Hierarchy	46
Appendix C: Excluded Studies.....	47
Appendix D: Summary of Evidence	51

Scope of the Report

The objective of this rapid systematic review is to facilitate the appropriate use of tonsillectomy, adenoidectomy and adenotonsillectomy for obstructive sleep apnoea in children and adults by providing a synthesis of the evidence on the following research questions.

1. Are there specific clinical or pathological features of sleep apnoea that indicate a threshold below which tonsillectomy, adenoidectomy or adenotonsillectomy is of low clinical value in children and adults?
2. Are there specific developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy in children and adults with sleep apnoea?
3. Is tonsillectomy, adenoidectomy or adenotonsillectomy an effective treatment for sleep apnoea or snoring in children and adults?
4. Is there evidence of clinical examinations or tests that can assist surgeons in determining which children and adults will benefit from tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea?
5. Is any one of the three commonly used surgical techniques (cold steel, coblation and diathermy) more effective than another in reducing secondary bleeding (>24 hours after surgery) in children and adults undergoing tonsillectomy, adenoidectomy or adenotonsillectomy for tonsillitis or sleep apnoea?

Executive Summary

Context and policy issues

Obstructive sleep apnoea (OSA) is the most common form of sleep disordered breathing (SDB). Affected individuals commonly experience snoring, restless sleep, daytime sleepiness and fatigue. In children, SDB is associated with deficits in cognition, language, learning, memory, attention, poor school performance, behavioural abnormalities and bedwetting. Sleep apnoea is often diagnosed based on clinical symptoms and laboratory-based polysomnography (PSG) where disease severity is quantified as the number of apnoeic events per hour of sleep or apnoea-hypopnoea index (AHI). In children, mild, moderate and severe OSA are signified by an AHI of 1 to 5 per hour, 5 to 10 per hour and more than 10 per hour, respectively. OSA affects between two and four per cent of adults and is prevalent in up to five per cent of children.

Surgical treatments for OSA include removal of the tonsils, adenoids or both, which is referred to as tonsillectomy, adenoidectomy and adenotonsillectomy, respectively. While these are some of the most common surgical procedures performed, uncertainty exists regarding their effectiveness for treating sleep apnoea. Further information is needed to identify which patients derive clinical benefit in relation to their age and development. Secondary haemorrhage after tonsillectomy may require further surgical intervention, especially in children where a significant portion of their blood volume may be lost. While several surgical techniques have been developed in an attempt to reduce pain and bleeding, unplanned readmission rates remain high. Further information is needed to determine which surgical technique results in the lowest rate of secondary bleeds in patients undergoing tonsillectomy, adenotonsillectomy or adenoidectomy for tonsillitis and sleep apnoea.

The objective of this rapid systematic review (SR) is to facilitate the appropriate use of tonsillectomy, adenotonsillectomy or adenoidectomy for sleep apnoea in children and adults by providing a synthesis of the evidence on the following research questions.

1. Are there specific clinical or pathological features of sleep apnoea that indicate a threshold below which tonsillectomy, adenoidectomy or adenotonsillectomy is of low clinical value in children and adults?
2. Are there specific developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy in children and adults with sleep apnoea?
3. Is tonsillectomy, adenoidectomy or adenotonsillectomy an effective treatment for sleep apnoea or snoring in children and adults?
4. Is there evidence of clinical examinations or tests that can assist surgeons in determining which children and adults will benefit from tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea?

5. Is any one of the three commonly used surgical techniques (cold steel, coblation and diathermy) more effective than another in reducing secondary bleeding (>24 hours after surgery) in children and adults undergoing tonsillectomy, adenoidectomy or adenotonsillectomy for tonsillitis or sleep apnoea?

Methods

A systematic search of MEDLINE, EMBASE, *The Cochrane Library*, the NHS Centre for Reviews and Dissemination databases and the websites of international health technology assessment agencies and clinical practice guideline (CPG) clearinghouses was conducted to identify relevant research published in English from January 2005 (January 2009 for guidelines) to December 2014. A focused internet search was also conducted to identify grey literature. Study selection, data extraction and quality appraisal were undertaken by one reviewer. Two ear, nose and throat surgeons (one from Melbourne, Victoria and one from Adelaide, South Australia) who work in public and private facilities were surveyed to characterise current surgical practice in Australia with respect to the use of tonsillectomy in patients with OSA.

Key results

The evidence regarding the clinical or pathological features of sleep apnoea that indicate a threshold below which surgery is of low clinical value may not have included all potentially relevant populations. While risk factors for OSA include adenotonsillar hypertrophy, obesity, craniofacial anomalies and neuromuscular disorders, only the first two factors were considered in developing the CPGs and SRs. Evidence regarding specific developmental and social indicators for therapy was limited in terms of quantity and scope. Evidence on the effectiveness of tonsil and/or adenoid removal for treating sleep apnoea pertains primarily to treating uncomplicated OSA in children with SDB and tonsillar hypertrophy. SRs reported a lack of high-quality RCTs and showed significant heterogeneity. Included studies contained a mix of populations and defined OSA based on both subjective clinical symptoms and PSG. Evidence regarding clinical testing to identify surgical candidacy is limited in that while PSG is considered gold standard for diagnosing and classifying OSA, the clinically significant level of obstructive events on PSG is not known. SRs on the effectiveness of surgical techniques for reducing postoperative secondary haemorrhage suggested that included studies were too small and heterogeneous to formulate recommendations. Also, this report was limited in that no relevant studies were found regarding the use of tonsillectomy, adenotonsillectomy or adenoidectomy for treating sleep apnoea in adults. Expert opinion suggested that adult OSA is primarily managed using CPAP, tracheostomy, uvulopalatopharyngoplasty, tongue base reduction or genioglossus advancement.

Threshold of pathology for tonsillectomy, adenotonsillectomy or adenoidectomy

Treatments other than tonsillectomy should be considered if a child has OSA without

tonsillar hypertrophy. The benefits of adenotonsillectomy should be compared with other treatments for obese children with varying degrees of adenotonsillar hypertrophy; approximately 60 to 88 per cent of children have persistent SDB following therapy. Adenotonsillectomy is contraindicated in patients with small or no adenotonsillar tissue, morbid obesity (body mass index >95th percentile for age and gender) and small tonsils and/or adenoids, refractory bleeding disorders, a submucous cleft palate and conditions that preclude them from having surgery.

Developmental or social indications for tonsillectomy, adenotonsillectomy or adenoidectomy

Children who snore and have symptoms of OSA should undergo PSG, alternative diagnostic tests or evaluation by a specialist. Caregivers should be questioned regarding school performance, enuresis and behavioural problems that may improve following tonsillectomy. Children with sleep disturbance, symptoms of attention deficit hyperactivity disorder (ADHD), nocturnal enuresis or physical suffering may experience significant improvements in quality of life, ADHD symptoms and enuresis following adenotonsillectomy.

Effectiveness of tonsillectomy, adenotonsillectomy or adenoidectomy for sleep apnoea

Adenotonsillectomy effectively resolved between 60 and 83 per cent of uncomplicated cases of childhood OSA and is recommended as the primary treatment for children with adenotonsillar hypertrophy. Tonsillectomy was of clinical benefit in controlling SDB in 60 to 70 per cent of children with significant tonsillar hypertrophy. While tonsillectomy resolved SDB in approximately 10 to 25 per cent of obese children, between 60 and 88 per cent experienced persistent SDB after surgery.

Clinical testing for surgical candidacy

PSG should be performed in: children who snore and have symptoms of OSA; children with SDB and complex medical conditions; and children with SDB without complexities in whom the need for surgery is uncertain or there is a discrepancy between tonsillar size and SDB severity. Alternative diagnostic testing or evaluation by a specialist should be considered if PSG is unavailable. Body mass index (BMI) is also important considering that the majority of obese children have persistent OSA following surgery.

Techniques for reducing secondary bleeding following tonsillectomy, adenotonsillectomy or adenoidectomy

There was inadequate evidence to determine whether coblation, diathermy or cold dissection tonsillectomy offered the greatest reduction in the rate of secondary haemorrhage.

Conclusions and policy implications

In Australia, adenotonsillectomy is recommended as first-line therapy for: childhood OSA; episodes of recurrent acute tonsillitis; peritonsillar abscess; suspected neoplasm; and certain uncommon indications such as chronic diphtheria carrier status after failed antibiotics, recurrent large tonsilloliths or tonsillar cysts and recurrent tonsillar haemorrhage. All children who have their tonsils removed for the treatment of moderate or severe OSA should be monitored as inpatients after surgery.

There was consensus in the evidence that approximately 74 per cent of uncomplicated cases of moderate to severe childhood OSA derived clinical benefit from first-line adenotonsillectomy. There was evidence suggesting that children with OSA-related cardiac morbidity should be treated early with adenotonsillectomy to reverse potentially serious cardiovascular sequelae. Evidence suggested that children with sleep disturbance, symptoms of ADHD, nocturnal enuresis or physical suffering, may experience significant improvements in quality of life, ADHD symptoms and enuresis following adenotonsillectomy. Tonsillectomy was of clinical benefit in controlling SDB in approximately 60 to 70 per cent of children with significant tonsillar hypertrophy, although the level of hypertrophy that constituted clinical significance was not defined. While tonsillectomy resolved SDB in approximately 10 to 25 per cent of obese children (BMI > 95th percentile for age and gender), between 60 and 88 per cent of patients had persistent SDB following surgery. The benefits of adenotonsillectomy should be compared with other treatments for obese children with varying degrees of adenotonsillar hypertrophy. Adenotonsillectomy is contraindicated in patients with small or no adenotonsillar tissue, morbid obesity and small tonsils and/or adenoids, refractory bleeding disorders, a submucous cleft palate and conditions that make them unstable for surgery.

CPGs recommended that PSG be performed in: children who snore and have symptoms of OSA; children with SDB and complex medical conditions involving obesity, Down syndrome, craniofacial abnormalities, neuromuscular disorders, sickle cell or mucopolysaccharidoses; and children with SDB without complexities in whom the need for surgery is uncertain or there is a discrepancy between tonsillar size and SDB severity. Alternative diagnostic testing or evaluation by a specialist should be considered if PSG is not available. BMI is also an important factor to consider as approximately 88 per cent of obese children have persistent OSA following adenotonsillectomy. According to Australian experts, OSA is currently diagnosed by directed questioning and upper airway examination, aided by endoscopy and radiology. There is no place for routine use of PSG in children, but selected patients would benefit when there is diagnostic uncertainty.

There was no conclusive evidence to determine which of coblation, diathermy and cold dissection tonsillectomy offered the lowest rate of secondary haemorrhage. The majority of the evidence suggested there was insufficient data to make specific recommendations regarding surgical technique.

The findings suggested that adenotonsillectomy was an effective treatment for children with moderate to severe OSA. Expert opinion suggested that childhood OSA is commonly diagnosed based on history and clinical examination and that milder cases of OSA may benefit from treatment. While PSG is considered the gold standard for diagnosing OSA, it was most useful for complex cases involving craniofacial anomalies, syndromes and for patients whose symptoms do not resolve following adenotonsillectomy. The evidence suggested that most cases of uncomplicated childhood OSA (74%) would benefit from adenotonsillectomy in terms of improvements in OSA and ADHD symptoms, cardiovascular parameters and quality of life. Caregivers should be informed about the benefits and risks associated with surgery and that SDB may persist or recur, necessitating further management.

There was insufficient evidence to recommend a specific surgical technique to reduce the rate of secondary haemorrhage. Clinicians who perform tonsillectomy should determine their rates of primary and secondary post-tonsillectomy haemorrhage at least annually. All children who undergo adenotonsillectomy for the treatment of moderate or severe OSA should be monitored as inpatients postoperatively. Clinicians should reassess all patients with OSA for persisting symptoms following surgery to determine whether further treatment is required.

While it appears that adenotonsillectomy can be an effective treatment for OSA in children, it is currently unclear whether the use of this procedure for OSA is suboptimal in Victoria. Data on the number of adenotonsillectomy procedures performed for childhood OSA and the prevalence rate of SDB in the Victorian population need to be compared before any judgement could be made on this aspect of healthcare delivery. The factors affecting the utilisation of this service, including parental understanding of the consequences of childhood OSA and clinician knowledge of and compliance with current CPG recommendations would also need to be considered.

Important note:

The information contained in this report is a synthesis of the best available evidence located at the time the searches were completed.

Abbreviations

AAO-HNS	American Academy of Otolaryngology-Head and Neck Surgery
AAP	American Academy of Pediatrics
ADHD	attention deficit hyperactivity disorder
AGREE	Appraisal of Guidelines for Research and Evaluation
AHI	apnoea-hypopnoea index
AMSTAR	Assessment of Multiple Systematic Reviews
ASO-HNS	Australian Society of Otolaryngology-Head and Neck Surgery
BMI	body mass index
CI	confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CPAP	continuous positive airway pressure
CPG	clinical practice guideline
GDG	guideline development group
HTA	health technology assessment
MA	meta-analysis
NE	nocturnal enuresis
OSA	obstructive sleep apnoea
OSA-18	OSA-18 quality-of-life questionnaire
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSG	polysomnography
QOL	quality of life
RACP	Royal Australasian College of Physicians
RCT	randomised controlled trial
RDI	respiratory disturbance index
SD	standard deviation
SDB	sleep disordered breathing
SR	systematic review

1. Context and Policy Issues

Sleep apnoea is a sleep disorder characterised by pauses in breathing, or shallow or infrequent breathing during sleep. Each apnoea, or pause, can last from seconds to minutes and may recur over 30 times per hour. The carbon dioxide that accumulates in the blood stream during sleep apnoea triggers chemoreceptors that signal the brain to wake up and breathe—sleep resumes once oxygen levels are restored.

Obstructive sleep apnoea (OSA), the most common form of sleep disordered breathing (SDB), occurs when the tongue and soft tissues relax and the collapsible walls of the throat obstruct breathing during sleep (Epstein et al. 2009; Marcus et al. 2012). Affected individuals experience repeated cycles of sleep, obstructive choking and gasping arousal from sleep. Common symptoms include snoring, restless sleep, daytime sleepiness and fatigue. OSA is more likely to occur in small children with enlarged tonsils and adults who are elderly or obese or who have diabetes, congestive heart failure, narrow airways or low muscle or soft tissue tone. Tonsils provide defence against infection and are at their largest between the ages of 4 and 7 years (Better Health Channel 2013). Indicators of OSA include a large neck circumference or tongue volume, enlarged tonsils, a small lower jaw, morning headaches, depression and irritability and learning or memory difficulties. SDB is associated with an increased risk of cardiovascular disease, stroke, high blood pressure, arrhythmias, diabetes and accidents due to sleep-deprived driving (Epstein et al. 2009). In children, SDB is associated with deficits in cognition, language, learning, memory, attention and school performance, as well as behavioural abnormalities, bedwetting and daytime sleepiness (Jeyakumar et al. 2012; Marcus et al. 2012).

Sleep apnoea is often diagnosed based on clinical symptoms and overnight laboratory-based polysomnography (PSG) or home portable monitoring. A PSG, or sleep study, quantifies the number of apnoeic events per hour of sleep, reported as the apnoea hypopnoea index (AHI) or respiratory disturbance index (RDI). This provides an indication of the severity of the sleep apnoea, which is quantified as mild (5 to 15 apnoeic events/hour), moderate (15 to 30 events/hour) or severe (>30 events/hour) in adults (Epstein et al. 2009). Other body functions are also measured during PSG, including brain activity (electroencephalogram), eye movement (electroculogram), chin muscle activity (electromyogram), heart rate and rhythm (electrocardiogram), airflow, blood oxygen levels and respiratory effort. Due to the variability in symptoms and nature of apnoeic events, clinical practice guidelines (CPGs) use a multi-criteria decision rule to define apnoeic events. Apnoea in adults is defined as a minimum 10-second interval between breaths, with either neurological arousal or a blood oxygen desaturation of at least three to four per cent, or both arousal and desaturation (Ruehland et al. 2009). In children, mild, moderate and severe OSA are signified by an AHI of 1 to 5 per hour, 5 to 10 per hour and more than 10 per hour, respectively (Sedky et al. 2014). OSA affects

between two and four per cent of adults and is prevalent in up to five per cent of children (Epstein et al. 2009; Marcus et al. 2012).

There are behavioural, medical and surgical treatments for OSA. Behavioural interventions include avoiding the use of alcohol and muscle relaxants, losing weight, ceasing smoking and re-positioning the body to prevent gravitational collapse of the airway during sleep. Oral appliances may improve airway patency for patients with mild OSA, while those with moderate OSA may benefit from continuous positive airway pressure (CPAP). Surgical procedures, including tonsillectomy and adenoidectomy, uvulopalatopharyngoplasty, palatal pillars and maxillomandibular advancement can be used to resolve pharyngeal obstruction. Tonsillectomy, removal of the tonsils and their capsule, is typically performed in patients with recurrent tonsillitis or OSA.

Adenoidectomy, removal of the adenoids, is usually performed in children and is termed adenotonsillectomy when the tonsils are removed concurrently. Pain and bleeding are associated with tonsil and adenoid removal. Primary (within 24 hours of surgery) and secondary haemorrhage (>24 hours after surgery) may require further surgical intervention, especially in children where a significant portion of their blood volume may be lost. Several tonsillectomy techniques have been developed in an attempt to limit these complications, including dissection with cold steel, diathermy, radiofrequency ablation, coblation, harmonic scalpels, thermal welding, lasers and microdebridors (Omran et al. 2012; Shapiro and Bhattacharyya 2007).

In Victoria, the main surgical techniques used to remove tonsils or adenoids are cold steel, diathermy and coblation. Traditional cold steel tonsillectomy involves cutting the mucosa with scissors, separating the tonsil from its bed using gauze and dissecting forceps, placing pressure on the tonsil bed using a swab and controlling residual bleeding with ligatures, sutures or diathermy. In diathermy tonsillectomy, electric current is used to incise the mucosa, dissect the tonsil from the pharyngeal wall and coagulate the blood vessels. During coblation tonsillectomy, radiofrequency energy is passed through ionised saline; the resulting charge-carrying ions disintegrate the tonsillar tissue at low temperature, with minimal damage to surrounding structures (Savin & Cingi 2012).

In Australia, sleep apnoea was the fourth principal diagnosis between 2012 and 2013 and accounted for 55,139 overnight acute separations: 6,446 (12%) from public hospitals and 48,693 (88%) from private hospitals. OSA accounted for 51,628 (81%) of all cases (63,723) of sleep apnoea identified between 2011 and 2012 (AIHW 2014). Mild and moderate to severe OSA occur in approximately 20 per cent and 5 per cent of individuals, respectively. The prevalence of mild and moderate to severe OSA is 15 per cent and 3 per cent in men and 5 per cent and 1 per cent in women, respectively (Merlin et al. 2010). Of the 52,297 tonsillectomies conducted between 2012 and 2013 in Australia, 12,705 (24%) were performed in Victoria (AIHW 2014). Between 2012 and 2013, the rate of unplanned readmissions within 28 days of surgery in public hospitals was 33 per 1,000 separations for tonsillectomy and adenoidectomy (AIHW 2014). The incidence of haemorrhage is 0.6% for children aged 0 to 4 years, 3.7 per cent for those

aged 5 to 9 years, 5.5 per cent for children aged 10 to 17 years and 10.1 per cent for adults (RACP-ASOHNS 2008). In Australia, the overall rate of adenotonsillectomy is between 3 and 7 per 1,000 people—the rate in the public system is less than 4 per 1,000.

While tonsillectomy is one of the most frequently performed surgical interventions, there is some uncertainty regarding the effectiveness of tonsillectomy, adenoidectomy and adenotonsillectomy for the treatment of sleep apnoea. Further information is needed to identify which patients derive clinical benefit from these procedures. While several surgical techniques have been developed in an attempt to reduce pain and bleeding, unplanned readmission rates between 2012 and 2013 were highest for tonsillectomy and adenoidectomy, compared with appendectomy, cataract extraction, hip replacement, hysterectomy, knee replacement and prostatectomy (AIHW 2014). Further information is needed to determine which surgical technique affords the lowest rate of secondary bleeds in children and adults undergoing tonsillectomy, adenoidectomy or adenotonsillectomy for tonsillitis or sleep apnoea.

The objective of this rapid systematic review (SR) is to facilitate the appropriate use of tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea in children and adults by providing a synthesis of the evidence on the following research questions.

Research questions

1. Are there specific clinical or pathological features of sleep apnoea that indicate a threshold below which tonsillectomy, adenoidectomy or adenotonsillectomy is of low clinical value in children and adults?
2. Are there specific developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy in children and adults with sleep apnoea?
3. Is tonsillectomy, adenoidectomy or adenotonsillectomy an effective treatment for sleep apnoea or snoring in children and adults?
4. Is there evidence of clinical examinations or tests that can assist surgeons in determining which children and adults will benefit from tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea?
5. Is any one of the three commonly used surgical techniques (cold steel, coblation and diathermy) more effective than another in reducing secondary (>24 hours after surgery) bleeding in children and adults undergoing tonsillectomy, adenoidectomy or adenotonsillectomy for tonsillitis or sleep apnoea?

2. Methodology

Literature review

Literature search strategy

A limited systematic search of MEDLINE, EMBASE, *The Cochrane Library*, the NHS Centre for Reviews and Dissemination databases and the websites of international health technology assessment (HTA) agencies and CPG clearinghouses was conducted to identify relevant research published in English from January 2005 (January 2009 for guidelines) to December 2014. A focused internet search was also conducted to identify grey literature. Filters were applied to limit the retrieval to SRs, HTAs, meta-analyses, guidelines and randomised controlled trials (RCTs). Details of the search strategies are provided in Appendix A.

Study selection criteria and methods

One reviewer screened all citations and selected studies. On initial screening, titles and abstracts were reviewed for relevance. Full-text publications were retrieved and assessed for inclusion based on the criteria in Table 1. Only studies conducted in Australia, Canada, Japan, New Zealand, the United States and European countries (except for those with transitional economies) were included for review. These countries, which have developed economies as defined by the United Nations, are likely to have populations whose health status, cultural norms, access to health care and disease burden are comparable to those in Australia (United Nations 2009).

Table 1: Study selection criteria

Population	Research questions 1 to 4: Children and adults with sleep apnoea Research question 5: Children and adults with sleep apnoea or tonsillitis
Intervention	Tonsillectomy, adenoidectomy or adenotonsillectomy
Comparator	Non-surgical interventions (including watchful waiting)
Outcomes	Including, but not limited to, pain, symptom recurrence, primary and secondary bleeding, morbidity, absenteeism and quality of life
Study design	Research questions 1, 2 and 4: HTA, SR, MA and CPG Research questions 3 and 5: HTA, SR, MA, CPG and RCT

CPG: clinical practice guideline; HTA: health technology assessment; MA: meta-analysis; RCT: randomised controlled trial; SR: systematic review

Exclusion criteria

Studies were excluded if they: did not meet the selection criteria; were included in a selected SR; were duplicate or preliminary results; had incomplete or inappropriate methods; or were an ineligible study design. RCTs published prior to the literature search end date reported in the most recent, eligible SR were also excluded.

Data extraction and analysis

One reviewer extracted data on patient characteristics, clinical benefits and harms and guideline recommendations on the use of tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea.

Critical appraisal of included studies

One reviewer evaluated the methodological quality of the included studies. SRs were evaluated using the 11-item Assessment of Multiple Systematic Reviews (AMSTAR) checklist (Shea et al. 2007), while the Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument was used to appraise CPGs (Brouwers et al. 2010). The domains assessed by AMSTAR include design, study selection and data extraction, literature searching, study characteristics, quality assessment, methods used to combine findings, publication bias and conflict of interest. The domains assessed by AGREE II include scope and purpose, stakeholder involvement, rigour of development, clarity and presentation, applicability and editorial independence. Instead of calculating numeric scores, the strengths and weaknesses were described narratively for each study. The evidence presented in the selected studies was classified, where possible, using the levels of evidence defined by the National Health and Medical Research Council (Merlin et al. 2009) (Appendix B).

Data analysis

Study design, quantity of evidence, heterogeneity of interventions and populations and the short review timeline prevented formal meta-analysis. Study characteristics, quality assessment and results were summarised narratively in relation to the research questions. The results of the RCTs published after the most recent, eligible SR were described narratively in relation to those of existing SRs. Formal data extraction and quality assessment was not performed for the RCT evidence because of the short timeline for review and the volume and consistency of data from the included SRs.

Expert opinion

Two ear, nose and throat surgeons, one from Melbourne, Victoria and one from Adelaide, South Australia, were identified through personal referrals. The following set of five questions, developed in consultation with the Victorian Government Department of Health, was emailed to each surgeon.

1. Are there specific clinical or pathological features of sleep apnoea that indicate a threshold below which tonsillectomy, adenoidectomy or adenotonsillectomy is of low clinical value in children and adults?
2. Are there specific developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy in children and adults with sleep apnoea?
3. Is tonsillectomy, adenoidectomy or adenotonsillectomy an effective treatment for sleep apnoea or snoring in children and adults?

4. Are there any clinical examinations or tests that can assist surgeons in determining which children and adults will benefit from tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea?
5. Is one surgical technique more effective than another in reducing secondary (>24 hours after surgery) bleeding in children and adults undergoing tonsillectomy, adenoidectomy or adenotonsillectomy for tonsillitis or sleep apnoea?

Responses were de-identified, grouped into themes and reported narratively.

3. Studies Included in the Review

Literature search results

The literature search yielded 378 citations. After screening titles and abstracts, 37 potentially relevant articles were retrieved for full-text review. Reviewing the reference lists of studies and searching the grey literature identified 15 additional potentially relevant reports. Of the 52 potentially relevant reports, one contained an irrelevant population, nine contained an irrelevant intervention, 17 contained irrelevant comparators, three contained irrelevant outcomes, three had incomplete or unreported methods, and one was a study protocol. Fourteen studies (9 SRs and 5 RCTs) and four guidelines were included in this review (Baldassari et al. 2008; Baugh et al. 2011; Brietzke and Gallagher 2006; Burton and Doree 2007; Costa and Mitchell 2009; Friedman et al. 2009; Gustavii et al. 2010; Jeyakumar et al. 2012; Marcus et al. 2012; Marcus et al. 2013; Omrani et al. 2012; Paramasivan et al. 2012; Pinder et al. 2011; RACP-ASOHNS 2008; Roland et al. 2011; Sedky et al. 2014; Shapiro and Bhattacharyya 2007; Teo and Mitchell 2013). The study selection process is outlined in Appendix A (Figure A.1) and the excluded studies are listed in Appendix C.

Description of studies

The indications for performing tonsillectomy in Australia were identified from one CPG (RACP-ASOHNS 2008). Evidence regarding the specific clinical or pathological features of sleep apnoea that indicate a threshold below which surgery is of low clinical value was derived from four CPGs (Baugh et al. 2011; Marcus et al. 2012; RACP-ASOHNS 2008; Roland et al. 2011) and three SRs (Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013). Specific developmental or social indications for tonsillectomy were identified from two CPGs (Baugh et al. 2011; Marcus et al. 2012) and three SRs (Baldassari et al. 2008; Jeyakumar et al. 2012; Sedky et al. 2014). The effectiveness of surgery for sleep apnoea was reported in two CPGs (Baugh et al. 2011; Marcus et al. 2012), four SRs (Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013) and one RCT (Marcus et al. 2013). Three CPGs (Marcus et al. 2012; RACP-ASOHNS 2008; Roland et al. 2011) and a SR (Friedman et al. 2009) provided evidence regarding clinical examinations and tests to assist surgeons in identifying appropriate candidates for surgical treatment of sleep apnoea. Information regarding the effectiveness of surgical techniques in reducing secondary bleeding following tonsillectomy for tonsillitis or sleep apnoea was derived from two CPGs (Baugh et al. 2011; Marcus et al. 2012), two SRs (Burton and Doree 2007; Pinder et al. 2011) and four RCTs (Gustavii et al. 2010; Omrani et al. 2012; Paramasivan et al. 2012; Shapiro and Bhattacharyya 2007).

While these sources provided information regarding the treatment of sleep apnoea in children, no relevant studies were identified regarding the use of tonsillectomy, adenoidectomy or adenotonsillectomy for the treatment of sleep apnoea in adults. The

clinical experts consulted for this review stated that these surgical techniques are not appropriate for treating sleep apnoea in adults.

Clinical practice guidelines

The recommendation and evidence grading categories used in the CPGs are summarised in Appendix D (Table D.1).

The American Academy of Pediatrics (AAP) guideline (Marcus et al. 2012) provided an update of recommendations on the diagnosis and management of childhood OSA. The guideline focused on otherwise healthy children with adenotonsillar hypertrophy or obesity as an underlying risk factor for OSA. Complex populations, including infants and children with craniofacial anomalies, genetic or metabolic syndromes, neuromuscular disease, laryngomalacia or sickle cell disease, were excluded. The updated guideline included literature published between 1999 and 2008.

The American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) provided evidence-based recommendations to assist clinicians in identifying which children are the best candidates for tonsillectomy and to optimise clinical management (Baugh et al. 2011). The guideline was intended to reduce inappropriate variation in clinical care, optimise outcomes and minimise harms. The guideline development group (GDG) formulated the recommendations based on a SR of literature published between 1995 and 2010.

The AAO-HNS also published evidence-based recommendations for otolaryngologists regarding the use of PSG in assessing children aged 2 to 18 years with SDB who are candidates for tonsillectomy, with or without adenoidectomy (Roland et al. 2011).

Guidance was formulated based on a SR of literature published up to 2010.

Recommendations were graded as “strong recommendation, recommendation, option or no recommendation” based on perceived benefits and harms and the quantity and quality of the evidence.

The Royal Australasian College of Physicians (RACP) and the Australian Society of Otolaryngology-Head and Neck Surgery (ASO-HNS) formulated recommendations on the indications for tonsillectomy and adenotonsillectomy in children to address concerns regarding the rate of tonsillectomy among children in Australia and New Zealand (RACP-ASOHNS 2008). Members of the GDG searched the literature for evidence describing the indications for tonsillectomy and adenotonsillectomy in children and applied grades to all of the included studies for each recommendation.

Systematic reviews

The characteristics of the included SRs are summarised in Appendix D (Table D.4).

The nine SRs (level I evidence), which comprised between four and 23 studies involving 110 to 6,901 participants, provided information about the indications and effectiveness of adenoidectomy, tonsillectomy and adenotonsillectomy (Baldassari et al. 2008; Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Jeyakumar et al.

2012; Sedky et al. 2014; Teo and Mitchell 2013), clinical examinations and tests to identify appropriate candidates for surgery (Friedman et al. 2009) and techniques for reducing secondary haemorrhage (Burton and Doree 2007; Pinder et al. 2011) (Appendix D, Table D.4). Seven SRs on the surgical treatment of sleep apnoea in children were conducted in the United States (Baldassari et al. 2008; Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Jeyakumar et al. 2012; Sedky et al. 2014; Teo and Mitchell 2013), whereas those reporting on tonsillectomy in adults and children were performed in the United Kingdom (Burton and Doree 2007; Pinder et al. 2011).

The SRs included studies of children with adenotonsillar hypertrophy or obesity as the underlying risk factor for OSA. Studies involving complex populations, including infants and children with craniofacial anomalies, genetic or metabolic syndromes, neuromuscular disease, laryngomalacia or sickle cell disease, were typically excluded. Most reviews included children aged from 0 to 18 years who had a diagnosis of OSA based on PSG and clinical findings. The length of follow-up ranged from 4 weeks to 13 months in some cases, but was often not reported.

The effectiveness of adenotonsillectomy in resolving OSA based on PSG parameters was evaluated in a SR of 23 studies by Friedman et al. (2009) and a review of 14 studies by Brietzke and Gallagher (2006). The effectiveness of adenotonsillectomy for treating OSA in obese children was evaluated in a meta-analysis by Costa et al. (2009). Teo and Mitchell (2013) reviewed 14 studies and reported on cardiovascular parameters after adenotonsillectomy in children diagnosed with OSA based on PSG. Sedsky et al. (2014) meta-analysed 12 studies to evaluate the effect of adenotonsillectomy on the symptoms of attention deficit hyperactivity disorder (ADHD) 13 months after surgery in children diagnosed with SDB based on PSG. Jeyakumar et al. (2012) reviewed seven studies and reported on rates of enuresis following adenotonsillectomy in 1,360 children with SDB. Baldassari et al. (2008) evaluated the effect of adenotonsillectomy on quality of life (QOL) through a meta-analysis of studies.

Secondary haemorrhage was evaluated in two SRs. Pinder et al. (2011) systematically reviewed two studies that compared bleeding rates in adults and children undergoing dissection or diathermy tonsillectomy in an inpatient setting for tonsillitis or OSA. Burton and Doree (2007) reviewed eight studies reporting haemorrhage rates following coblation or other surgical techniques in adults and children undergoing tonsillectomy for tonsillitis or OSA.

Appraisal of study quality

Summaries of the appraisals of the CPGs and SRs are provided in Appendix D (Tables D.2 and D.5).

Clinical practice guidelines

The AAP guideline (Marcus et al. 2012) provided an update of recommendations on the diagnosis and management of childhood OSA (Appendix D, Table D.2). Relevant

literature published between 1999 and 2011 was identified by searching multiple medical literature databases. While two committee members selected studies, a single committee member reviewed and graded articles. Due to the large volume of articles, trainees were recruited to assist with review, which could have led to inconsistencies in article selection and data extraction. Evidence was appraised and summarised, and key actions were formulated as recommendations. While the guideline recommendations reflected the quality of the evidence and considered benefits and harms, the preferences of the target population and caregivers were not sought. Barriers to use, implementation strategies and monitoring and audit criteria were not reported. The CPG authors filed conflict of interest statements with the AAP, and industry was not involved in guideline development.

The AAO-HNS developed evidence-based recommendations to assist clinicians in identifying children who would be the best candidates for tonsillectomy and to optimise the management of OSA (Baugh et al. 2011). Evidence was identified by systematically searching selected databases for CPGs, SRs and RCTs published between 1995 and 2010. Guidelines were developed during a series of conference calls and meetings, with internal electronic review and feedback on each guideline draft. The Guideline Implementability Appraisal tool was used to assess adherence of the draft guideline to methodological standards, improve recommendation clarity and predict obstacles to implementation (Shiffman et al. 2005). The guideline was piloted prior to publication by a multidisciplinary group of external reviewers who were representative of the target users. The cost and resource implications of applying the recommendations were considered, and the guideline is scheduled for review five years after publication, or sooner if warranted. The cost of developing the guideline, including travel expenses, was covered by the AAO-HNS Foundation. Potential conflicts of interest for all panel members were compiled before the first conference call. Individuals with potential conflicts could remain involved if they reminded the panel of potential conflicts before discussion and recused themselves from these discussions if asked to do so by the panel.

The AAO-HNS also provided evidence-based recommendations to otolaryngologists on the use of PSG for assessing children with SDB who are candidates for tonsillectomy, with or without adenoidectomy (Roland et al. 2011). The recommendations were based on the best available evidence published up to 2010, which was identified by a systematic search of selected databases for relevant CPGs, SRs and RCTs. Results of the literature search were distributed to GDG members. In a series of conference calls, the GDG defined the scope and objectives of the guideline and devoted 10 months to guideline development; internal electronic review and feedback was incorporated in each draft to ensure accuracy of content. The Guideline Implementability Appraisal tool was used to improve the clarity of recommendations and to predict potential obstacles to implementation (Shiffman et al. 2005). The CPG was peer reviewed and approved by the GDG prior to publication. Implementation strategies included publishing supplements in journals, presenting the CPG at meetings and providing free access to the full-text

version of the guideline. The guidelines were funded by the AAO-HNS Foundation and three authors reported competing interests.

The RACP and the ASO-HNS formulated recommendations on the indications for tonsillectomy and adenotonsillectomy in children (RACP-ASOHNS 2008). Members of the GDG searched the literature for evidence describing indications for tonsillectomy or adenotonsillectomy in children, but detailed systematic search criteria were not provided. The methods used to select studies, appraise study quality and formulate recommendations were not reported. The key recommendations of the guideline were explicitly linked to supporting evidence and took into consideration the health benefits and risks associated with the procedures. Barriers to implementation, resource implications and monitoring and audit criteria were not reported, nor were funding sources or conflicts of interest.

Systematic reviews

Most SRs were based on comprehensive literature searches using predefined criteria (Brietzke and Gallagher 2006; Burton and Doree 2007; Friedman et al. 2009; Pinder et al. 2011; Sedky et al. 2014). However, relevant literature may have been missed in four reviews because the searches were limited to one (Baldassari et al. 2008; Teo and Mitchell 2013) or two electronic databases (Costa and Mitchell 2009; Jeyakumar et al. 2012). With the exception of Sedky et al. (2014), grey literature searching was seldom performed even though it would have minimised the likelihood of source bias. Study selection, data extraction and quality assessment were conducted by two independent reviewers in most SRs (Baldassari et al. 2008; Burton and Doree 2007; Costa and Mitchell 2009; Friedman et al. 2009; Jeyakumar et al. 2012; Pinder et al. 2011; Sedky et al. 2014; Teo and Mitchell 2013). Six SRs depicted the process of study selection using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Baldassari et al. 2008; Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Jeyakumar et al. 2012; Teo and Mitchell 2013). While many reviews provided reasons for excluding studies (Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Sedky et al. 2014; Teo and Mitchell 2013), only two reviews provided a list of excluded studies (Burton and Doree 2007; Pinder et al. 2011). Owing to study heterogeneity, five of the reviews meta-analysed extracted data using a random-effects model (Baldassari et al. 2008; Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Sedky et al. 2014). Publication bias was assessed in four SRs using a funnel plot or Begg and Mazumdar or Egger's test (Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Pinder et al. 2011). It was unclear whether the quality of the included studies was assessed or used in formulating the conclusions of three SRs (Baldassari et al. 2008; Costa and Mitchell 2009; Jeyakumar et al. 2012). Three reviews did not report their source of funding (Brietzke and Gallagher 2006; Friedman et al. 2009; Sedky et al. 2014) and one failed to report conflicts of interest (Brietzke and Gallagher 2006).

4. Literature Review Results

Indications for tonsillectomy in Australia

A joint position paper by the RACP and ASO-HNS listed five indications for performing tonsillectomy and adenotonsillectomy in Australia (RACP-ASOHNS 2008) (Table 2).

Table 2: Summary of indications for tonsillectomy and adenotonsillectomy from the RACP and ASO-HNS guideline (RACP-ASOHNS 2008)

Intervention	Evidence Statement/Recommendation on Indications*
Tonsillectomy or adenotonsillectomy	<ol style="list-style-type: none"> 1. Adenotonsillectomy is the first-line of therapy after diagnosis of significant upper airway obstruction in children with SDB. [Grade B recommendation] It is recommended that all children who have surgical removal of tonsils for moderate or severe OSA be monitored as inpatients postoperatively. [Grade C recommendation] 2. Episodes of recurrent acute tonsillitis: seven episodes in the preceding year, or five in each year for 2 years or three per year for 3 years, taking into consideration the severity of episodes. [Grade B recommendation] 3. Peritonsillar abscess based on past history of recurrent tonsillitis and comorbidities. [Grade C recommendation] 4. Suspected neoplasm. [Grade B recommendation] 5. Uncommon indications: chronic diphtheria carrier status after failed antibiotic eradication; recurrent large tonsilloliths or tonsillar cysts; and recurrent tonsillar haemorrhage. [Grade D recommendation]

OSA: obstructive sleep apnoea; SDB: sleep disordered breathing

*See Appendix D (Table D.1) for an explanation of the recommendation and evidence grading categories

The guideline recommended increasing access to adenotonsillectomy for children with moderate to severe OSA in an effort to avert permanent long-term adverse effects in children younger than five years of age. The funding of RCTs was recommended to improve epidemiological data on the outcomes of adenotonsillectomy for moderate to severe OSA and of tonsillectomy for recurrent sore throat (RACP-ASOHNS 2008).

Threshold of pathology for tonsillectomy, adenoidectomy or adenotonsillectomy

Evidence from four CPGs (Baugh et al. 2011; Marcus et al. 2012; RACP-ASOHNS 2008; Roland et al. 2011) and three SRs (Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013) provided information about specific clinical or pathological features of sleep apnoea that indicate a threshold below which tonsillectomy, adenoidectomy or adenotonsillectomy is of low clinical value in children (Table 3).

Clinical practice guidelines

Guidelines by the AAP recommended that a treatment other than adenotonsillectomy should be considered for an otherwise healthy child who has OSA without adenotonsillar hypertrophy (Marcus et al. 2012) (Appendix D, Table D.3). For obese children (body mass index [BMI] >95th percentile for age and gender) with varying degrees of

adenotonsillar hypertrophy, the benefits of adenotonsillectomy must be compared with other treatments. High-risk patients undergoing adenotonsillectomy, including patients younger than three years of age and those with severe OSA, cardiac complications, failure to thrive, obesity, craniofacial anomalies, neuromuscular disorders or respiratory infections, should be monitored as inpatients postoperatively. If symptoms persist after adenotonsillectomy, or adenotonsillectomy is not performed, patients should be referred for CPAP. Adenotonsillectomy is contraindicated in patients with small or no adenotonsillar tissue, morbid obesity and small tonsils or adenoids, refractory bleeding disorders, submucous cleft palate and conditions that increase their surgical risk.

The AAO-HNS recommended that caregivers of children with SDB and tonsillar hypertrophy be asked about comorbid conditions that might improve after tonsillectomy, including growth retardation (Baugh et al. 2011). Caregivers of children with tonsillar hypertrophy and abnormal PSG results should be counselled about tonsillectomy as a means of improving health. Tonsillectomy is of clinical benefit for controlling SDB in 60 to 70 per cent of children with significant tonsillar hypertrophy. However, between 60 and 80 per cent of obese children have persistent SDB following tonsillectomy (Baugh et al. 2011; Roland et al. 2011).

Guidelines by the RACP and AAO-HNS recommended adenotonsillectomy as the first-line of therapy for moderate to severe OSA in children with SDB (RACP-ASOHNS 2008). While PSG data are used to classify OSA, the number of apnoeic events that constitute clinical significance is not known.

Systematic reviews

Three SRs (level I evidence) provided evidence about specific clinical or pathological features of sleep apnoea that inform a threshold below which tonsillectomy, adenoidectomy or adenotonsillectomy is of low clinical value in children (Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013) (Table 3) (Appendix D, Table D.6). Teo and Mitchell (2013) reviewed 14 studies involving 418 children with OSA and concluded that children with cardiac morbidity associated with OSA should be treated early with adenotonsillectomy to reverse potentially serious cardiovascular sequelae. A meta-analysis by Friedman et al. (2009) evaluated the rate of cure in children with OSA following tonsillectomy and adenoidectomy. The decrease in mean AHI of 11.7 in uncomplicated children was significantly lower than the decrease in mean AHI of 22.0 in complicated children who were obese or had severe OSA (19 studies, $n=867$; $P<0.0001$). The cure rate was 74% in uncomplicated patients, which was significantly higher than of the rate of 39% in complicated patients (9 studies, $n=340$; $P<0.0001$). A meta-analysis of four studies involving 110 participants reported that while sleep quality improved after adenotonsillectomy, up to 88% of obese children had persistent OSA following surgery (Costa and Mitchell 2009).

Table 3: Summary of evidence on threshold of pathology for tonsillectomy, adenoidectomy or adenotonsillectomy

Intervention	Evidence Statement/Recommendation
Tonsillectomy or adenotonsillectomy is of low clinical value	<ul style="list-style-type: none"> Other treatments should be considered if a child has OSA without adenotonsillar hypertrophy. [1 CPG] The benefits of adenotonsillectomy should be compared with other treatments in obese children (BMI>95th percentile for age and gender) with varying degrees of adenotonsillar hypertrophy. [3 CPGs, 2 SRs] High-risk patients (<3 years of age, severe OSA, cardiac complications, failure to thrive, obesity, craniofacial anomalies, neuromuscular disorders, respiratory infection) undergoing adenotonsillectomy should be monitored as inpatients postoperatively. [1 CPG] Following therapy all OSA patients should be reassessed for persisting signs and symptoms to determine whether further treatment is required. [2 CPGs] If symptoms persist after adenotonsillectomy, or if adenotonsillectomy is not performed, patients should be referred for CPAP management. [1 CPG] Adenotonsillectomy is contraindicated in patients with small or no adenotonsillar tissue, morbid obesity and small tonsils/adenoids, refractory bleeding disorders, submucous cleft palate and conditions that increase surgical risk. [1 CPG]
Tonsillectomy or adenotonsillectomy is of clinical benefit	<ul style="list-style-type: none"> Caregivers of children with SDB and tonsillar hypertrophy should be asked about comorbid conditions that might improve after tonsillectomy, including growth retardation. [1 CPG] Caregivers of children with tonsillar hypertrophy and abnormal polysomnography should be counselled about tonsillectomy as a means of improving health. [1 CPG] Tonsillectomy is of clinical benefit for controlling SDB in 60% to 70% of children with significant tonsillar hypertrophy. [1 CPG] Adenotonsillectomy is the first-line of therapy for moderate to severe childhood OSA; 74% of uncomplicated OSA cases benefit from adenotonsillectomy. [2 CPGs, 1 SR] Children with cardiac morbidity associated with OSA should be treated early with adenotonsillectomy to reverse potentially serious cardiovascular sequelae. [1 SR]

CPAP: continuous positive airway pressure; CPG: clinical practice guideline; OSA: obstructive sleep apnoea, SDB: sleep disordered breathing; SR: systematic review

Developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy

Specific developmental or social indications for tonsillectomy were identified from one CPG (Baugh et al. 2011) and three SRs (Baldassari et al. 2008; Jeyakumar et al. 2012; Sedky et al. 2014) (Table 4).

Clinical practice guidelines

The AAP guideline recommended that caregivers of children with SDB and tonsillar hypertrophy be asked about comorbid conditions that may improve following tonsillectomy, including poor school performance, enuresis and behavioural problems (Baugh et al. 2011).

Systematic reviews

Three SRs (level I evidence) provided evidence about specific developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy (Baldassari et al. 2008; Jeyakumar et al. 2012; Sedky et al. 2014) (Table 4) (Appendix D, Table D.6). Sedky et al. (2014) conducted a meta-analysis of 12 studies involving 529 children to determine the relationship between ADHD and SDB in children and adolescents.

Adenotonsillectomy was associated with a decrease in ADHD symptoms between 2 and 13 months after surgery (Hedges' g 0.43, 95% CI 0.30 to 0.55; $P < 0.001$). These findings suggested that ADHD symptoms are related to SDB and improve after adenotonsillectomy. Therefore, patients with ADHD symptomatology should be screened for SDB. Treatment of comorbid SDB should be considered before offering medication for ADHD symptoms (Sedky et al. 2014).

Jeyakumar et al. (2012) systematically reviewed seven studies involving 1,360 children with nocturnal enuresis who underwent adenotonsillectomy for SDB. The preoperative prevalence of enuresis was 31% (426/1,360). A total of 587 children were followed up for six months after adenotonsillectomy, at which time the prevalence of enuresis was 16% (95/587; $P < 0.002$ two-tailed).

Table 4: Summary of evidence on developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy

Indications	Evidence Statement/Recommendation
Snoring, school performance, enuresis, behavioural problems, ADHD, sleep disturbance, physical suffering, emotional distress	<ul style="list-style-type: none"> Children with snoring and symptoms or signs of OSA should undergo polysomnography, alternative diagnostic tests or evaluation by a specialist. [1 CPG] Caregivers of children with SDB should be asked about comorbid conditions (poor school performance, enuresis, behavioural problems) that may improve following tonsillectomy. [1 CPG] Children with ADHD symptoms should receive SDB screening. Treatment of comorbid SDB should be considered before offering medication for ADHD symptoms. [1 SR] Adenotonsillectomy is associated with a significant improvement in enuresis in children with SDB. [1 SR] Children with sleep disturbance and physical suffering, and whose caregivers are concerned, may show significant improvements in QOL following adenotonsillectomy. [1 SR]

ADHD: attention deficit hyperactivity disorder; CPG: clinical practice guideline; OSA: obstructive sleep apnoea, QOL: quality of life; SDB: sleep disordered breathing; SR: systematic review

Baldassari et al. (2008) meta-analysed seven studies involving 369 children to determine whether adenotonsillectomy improved QOL. The mean total OSA-18 quality-of-life questionnaire (OSA-18) score and scores for all symptom domains improved significantly after adenotonsillectomy ($P < 0.0001$). The subsets of sleep disturbance, caregiver concerns and physical suffering featured the greatest improvements in QOL. The domain with the least postoperative change was emotional distress. Long-term follow-up was reported for 91 children with OSA at lengths ranging from 6 to 16.4 months; the mean OSA-18 scores were significantly improved at long-term follow-up. The mean total OSA-18 change score was a positive value of 36.2 points.

Effectiveness of tonsillectomy, adenotonsillectomy or adenoidectomy for sleep apnoea

The effectiveness of surgery for sleep apnoea was reported in two CPGs (Baugh et al. 2011; Marcus et al. 2012), four SRs (Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013) and one RCT (Marcus et al. 2013) (Table 5).

Clinical practice guidelines

Guidelines by the AAP recommended adenotonsillectomy as the primary treatment for OSA in children with adenotonsillar hypertrophy who do not have contraindications for surgery (Marcus et al. 2012) (Table 5) (Appendix D, Table D.3). All patients with OSA should be reassessed for persistent signs and symptoms after surgery to determine whether further treatment is required. If symptoms of OSA remain after adenotonsillectomy, patients should be referred for CPAP.

The AAO-HNS stated that while tonsillectomy is effective in controlling the symptoms of SDB in 60% to 70% of children with significant tonsillar hypertrophy, clinicians should counsel caregivers that SDB may persist or recur following tonsillectomy and that further treatment may be required (Baugh et al. 2011).

Systematic reviews

Four SRs (level I evidence) provided evidence regarding the effectiveness of tonsillectomy, adenoidectomy or adenotonsillectomy for treating sleep apnoea in children (Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013) (Table 5) (Appendix D, Table D.6). Teo and Mitchell (2013) reviewed 14 studies involving 418 children with OSA and demonstrated that adenotonsillectomy may reverse the cardiovascular sequelae of OSA. All studies reported improvements in blood pressure, heart rate, cardiac morphology, cardiac function and PSG-based OSA symptoms following adenotonsillectomy. The results suggested that children with cardiac morbidity associated with OSA should be treated early with adenotonsillectomy to reverse potentially serious cardiovascular consequences (Teo and Mitchell 2013).

Friedman et al. (2009) compared PSG parameters before and after adenotonsillectomy to determine the rate of cure. The treatment success of adenotonsillectomy was 66 per cent when cure was defined per each individual study. When cure was defined as an AHI of less than one (9 studies), the random-effects estimate for OSA treatment success with adenotonsillectomy was 60 per cent; the mean postoperative AHI was significantly lower than the preoperative measurement.

A SR and meta-analysis by Costa and Mitchell (2009) suggested that adenotonsillectomy improved, but did not resolve, OSA in most obese children. Up to 88 per cent of obese children had persistent OSA after adenotonsillectomy. The mean preoperative and postoperative AHI was 29.4 (range 22.2 to 34.3) and 10.3 (range 6.0 to 12.2), respectively (mean difference -18.3 events/hour, 95% confidence interval [CI] 11.2 to 25.5). The

mean preoperative and postoperative oxygen saturation nadir was 78.4 per cent (range 73.9% to 81.1%) and 85.7 per cent (range 83.6% to 89.9%), respectively (mean difference 6.3%, 95% CI 3.9 to 8.7). Forty-nine per cent of children had a postoperative AHI of less than five, 25 per cent of children had a postoperative AHI of less than two and 12 per cent of children had a postoperative AHI of less than one (Costa and Mitchell 2009).

Brietzke and Gallagher (2006) pooled data from 14 case series studies involving 342 children in a meta-analysis to determine the effectiveness of adenotonsillectomy in treating OSA. The mean AHI was reduced by 13.9 events per hour (random-effects model, 95% CI 10.05 to 17.79; $P < 0.001$) after adenotonsillectomy. The overall success rate of adenotonsillectomy in normalising PSG was 82.9 per cent (random-effects model, 95% CI 76.2 to 89.5; $P < 0.001$). Adenotonsillectomy was effective in reducing the severity of objectively measured OSA. This finding was consistent despite significant heterogeneity in patient populations and PSG diagnostic criteria—paediatric adenotonsillectomy was successful in normalising PSG measurements in the majority of patients (Brietzke and Gallagher 2006).

Findings of the CPGs and SRs were supported by a recent RCT (level II evidence) involving 464 children. Normalisation of PSG measurements was observed in a larger proportion of children undergoing early adenotonsillectomy (79%) than in those undergoing watchful waiting (46%) (Marcus et al. 2013).

Table 5: Summary of evidence on effectiveness of tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea

Intervention	Evidence Statement/Recommendation
Tonsillectomy or adenotonsillectomy	<ul style="list-style-type: none"> Adenotonsillectomy is recommended as the primary treatment for OSA in children with adenotonsillar hypertrophy without contraindications for surgery. [1 CPG] Tonsillectomy is effective in controlling SDB in 60% to 70% of children with significant tonsillar hypertrophy; SDB may persist or recur, requiring further treatment. [1 CPG] Children with cardiac morbidity associated with OSA should be treated early with adenotonsillectomy to reverse potentially serious cardiovascular consequences. [1 SR] Adenotonsillectomy is effective in resolving 66% to 83% of uncomplicated childhood OSA. [2 SRs] Adenotonsillectomy improves, but does not resolve, OSA in the majority of obese children; approximately 88% have persistent OSA following adenotonsillectomy. [1 SR]

CPG: clinical practice guideline; OSA: obstructive sleep apnoea, SDB: sleep disordered breathing; SR: systematic review

Clinical testing for tonsillectomy, adenotonsillectomy or adenoidectomy candidates

Three CPGs (Marcus et al. 2012; RACP-ASOHNS 2008; Roland et al. 2011) and one SR (Friedman et al. 2009) (Table 6) provided evidence regarding clinical examinations and tests to assist surgeons in identifying appropriate candidates for surgical treatment of sleep apnoea.

Clinical practice guidelines

According to guidelines by the AAP, PSG should be performed in children or adolescents with snoring and symptoms or signs of OSA (Marcus et al. 2012) (Table 6) (Appendix D, Table D.3). If PSG is not available, alternative diagnostic tests or evaluation by a specialist may be considered. Clinicians should reassess all patients with OSA after therapy for persisting signs and symptoms to determine whether further treatment is required (Marcus et al. 2012). Guidelines by the RACP and AAO-HNS suggested that while PSG data are used in the diagnosis and classification of OSA, the clinically significant level of obstructive events is unknown (RACP-ASOHNS 2008).

The AAO-HNS stated that children with SDB should be referred for PSG if they exhibit complex medical conditions such as obesity, Down syndrome, craniofacial abnormalities, neuromuscular disorders, sickle cell disease or mucopolysaccharidoses (Roland et al. 2011). Clinicians should use PSG prior to tonsillectomy for SDB when there is discordance between tonsillar size and the reported severity of SDB or when the need for surgery is uncertain in children who do not have comorbidities. In children for whom PSG is indicated to assess SDB prior to tonsillectomy, clinicians should obtain laboratory-based PSG when possible (Roland et al. 2011).

Systematic reviews

One SR (level I evidence) provided evidence suggesting that BMI and preoperative AHI are important factors in identifying appropriate candidates for tonsillectomy, adenoidectomy or adenotonsillectomy (Friedman et al. 2009) (Table 6) (Appendix D, Table D.6).

Table 6: Summary of evidence on clinical testing for tonsillectomy, adenotonsillectomy or adenoidectomy candidates

Intervention	Evidence Statement/Recommendation
PSG, diagnostic tests, specialist evaluation	<ul style="list-style-type: none"> PSG should be performed in children or adolescents with snoring and symptoms or signs of OSA. [1 CPG] Alternative diagnostic tests or evaluation by a specialist may be considered if PSG is unavailable. [1 CPG] Children with SDB should be referred for PSG if they exhibit complex medical conditions (obesity, Down syndrome, craniofacial abnormalities, neuromuscular disorders, sickle cell disease or mucopolysaccharidoses). [1 CPG] PSG should be performed prior to tonsillectomy for SDB when there is discordance between tonsillar size and severity of SDB or when the need for surgery is uncertain in children without complexities. [1 CPG] BMI percentile and preoperative apnoea-hypopnoea index are important factors to be considered in the diagnosis and treatment of paediatric patients. [1 SR]

BMI: body mass index; CPG: clinical practice guideline; OSA: obstructive sleep apnoea; PSG: polysomnography; SDB: sleep disordered breathing; SR: systematic review

Techniques for reducing secondary bleeding following tonsillectomy, adenotonsillectomy or adenoidectomy

Information regarding the effectiveness of surgical techniques in reducing secondary bleeding following tonsillectomy for tonsillitis or sleep apnoea was derived from two CPGs (Baugh et al. 2011; Marcus et al. 2012), two SRs (Burton and Doree 2007; Pinder et al. 2011) and four RCTs (Gustavii et al. 2010; Omrani et al. 2012; Paramasivan et al. 2012; Shapiro and Bhattacharyya 2007).

Clinical practice guidelines

According to guidelines by the AAP, data are insufficient to recommend specific surgical techniques (Marcus et al. 2012) (Table 7) (Appendix D, Table D.3).

The AAO-HNS recommended that clinicians performing tonsillectomy should determine their rates of primary and secondary haemorrhage annually. This approach was preferable to specific recommendations regarding choice of surgical technique because prospective trials were not available to support strong guidance (Baugh et al. 2011).

Systematic reviews

Two SRs (level I evidence) provided evidence regarding the rate of haemorrhage following cold steel, diathermy and coblation techniques (Burton and Doree 2007; Pinder et al. 2011) (Table 6) (Appendix D, Table D.6). According Pinder et al. (2003), the rate of secondary haemorrhage was low in two studies comparing cold steel dissection with diathermy tonsillectomy in children and adults. One study (Kujawski et al. 1997) reported 11 patients who had bleeding after discharge (three after diathermy and eight after dissection). Of these, seven patients were hospitalised and one patient from the dissection group required transfer to theatre. In the other study (Nunez et al. 2000), three patients had secondary haemorrhage (two after diathermy and one after cold steel dissection), but none required hospitalisation. Combined data from both studies showed no difference between diathermy and dissection tonsillectomy in terms of secondary haemorrhage rates (Peto odds ratio 0.56, 95% CI 0.19 to 1.63; n=250). However, the studies were insufficiently powered to pick up small differences in haemorrhage rates.

A SR by Burton and Doree (2007) evaluated rates of secondary haemorrhage following coblation and other tonsillectomy techniques based on eight studies involving 6,901 adults and children. One study reported a significant difference in secondary haemorrhage rates between coblation (13.6%) and cold steel dissection (2.1%; P=0.001) (Anthony et al. 2006). Seven other studies reported no significant difference in haemorrhage rates after coblation and other techniques (Back et al. 2001; Jayasinghe et al. 2005; Philpott et al. 2005; Shah et al. 2002; Sobol et al. 2006; Stoker et al. 2004; Temple and Timms 2001). There was insufficient evidence to determine whether coblation was better or worse than other methods of tonsillectomy with respect to preventing secondary haemorrhage. Data from a large prospective audit showed that, of all the

surgical techniques, only coblation was associated with a higher, statistically significant risk of returning to theatre for haemorrhage.

The findings of the CPGs and SRs were supported by four recent RCTs (level II evidence) that compared adenotonsillectomy with coblation or cold steel dissection in children with OSA (Gustavii et al. 2010; Omrani et al. 2012; Paramasivan et al. 2012; Shapiro and Bhattacharyya 2007). In two RCTs involving a total of 194 patients, the rate of postoperative haemorrhage was low and was not significantly different between the treatment groups (Omrani et al. 2012; Paramasivan et al. 2012). Two other RCTs involving 103 patients reported a total of three hospital readmissions in patients treated with coblation (Gustavii et al. 2010; Shapiro and Bhattacharyya 2007).

Table 7: Summary of evidence on techniques for reducing secondary bleeding following tonsillectomy, adenotonsillectomy or adenoidectomy

Intervention	Evidence Statement/Recommendation
Cold steel, diathermy or coblation tonsillectomy or adenotonsillectomy	<ul style="list-style-type: none"> • Data are insufficient to recommend specific surgical techniques. [2 CPGs] • Rates of secondary haemorrhage are similarly low following diathermy and cold steel dissection tonsillectomy; however studies were insufficiently powered to pick up small differences in haemorrhage rates. [1 SR] • While the majority of evidence suggested no significant difference in haemorrhage rates following coblation versus other techniques, evidence from a large prospective audit suggested that coblation may result in greater postoperative bleeding. Evidence may be inadequate to determine whether coblation tonsillectomy is better or worse than other methods of tonsillectomy. [1 SR]

CPG: clinical practice guideline; SR: systematic review

5. Expert Opinion

Responses were received from two ear, nose and throat surgeons (one from Melbourne, Victoria and one from Adelaide, South Australia) working in public and private facilities who were asked to provide their expert opinion on the five questions below.

The comments below pertain to the use of tonsillectomy and adenoidectomy in children only. Both surgeons stated that there is no reason to consider tonsillectomy or adenotonsillectomy as a sole treatment in adults with sleep apnoea. OSA is usually more complicated in adults than in children and requires more complex surgical techniques (e.g. tongue base reduction, genioglossus advancement and uvulopalatopharyngoplasty). CPAP is always trialled first in adults before surgery is considered.

Question 1: Are there specific clinical or pathological features of sleep apnoea that indicate a threshold below which tonsillectomy, adenoidectomy or adenotonsillectomy is of low clinical value in children (and adults)?

The main clinical features are a strong history of snoring with evidence of obstructive episodes as described by parents. Risk factors associated with SDB include snoring, witnessed apnoeas, being male, age younger than five years, adenotonsillar hypertrophy, chronic nasal congestion, family history of snoring, exposure to cigarette smoke and obesity (Kaditis et al. 2004; Vasquez et al. 2004). In children with relatively small natural airway volume, even small to moderate tonsil and adenoid enlargement may be critical. Generally, snoring and sleep-related breathing difficulties are under reported because their pathological consequences are not recognised by the general population (Pijpers et al. 2004).

OSA is diagnosed with PSG, but there is no established threshold for disease severity with regard to the development of complications. Even mild disease is associated with adverse neurocognitive, behavioural and cardiovascular changes.

Question 2: Are there specific developmental or social indications for tonsillectomy, adenoidectomy or adenotonsillectomy in children (and adults) with sleep apnoea?

SDB is a spectrum of disorders ranging in severity from primary snoring to OSA. Up to 40 per cent of children with clinically diagnosed SDB exhibit behavioural problems, including: attention deficit syndrome; poor socialisation and school performance; deficits in memory, learning and problem solving skills; enuresis; aggression; anxiety; depression; and somatisation (Basha et al. 2005; Goldstein et al. 2000; Mitchell 2005).

Question 3: Is tonsillectomy, adenoidectomy or adenotonsillectomy an effective treatment for sleep apnoea or snoring in children (and adults)?

The following comments were made:

- The primary treatment option for most children is adenotonsillectomy—adenoidectomy alone may not be sufficient. In very young children, adenoidectomy alone may be used if there is no significant tonsillar hypertrophy.
- If adenoidectomy or tonsillectomy is performed alone, there is a high likelihood that airway obstruction will recur (Kennedy and Waters 2005)
- Adenotonsillectomy is not usually performed in syndromic children with facial abnormalities as they generally require additional facial reconstruction or repair.
- A large number of studies has shown adenotonsillectomy to be effective in improving or resolving SDB in up to 95 per cent of children, resulting in improvements in sleep quality, voice clarity, growth, nocturnal enuresis, behavioural parameters, school performance, overall QOL and factors affecting long-term cardiovascular health (Baldassari et al. 2008; Brietzke and Gallagher 2006; Friedman et al. 2009).
- Symptoms of OSA persist in up to 20 per cent of non-syndromic children after adenotonsillectomy, particularly in children who are obese or who have craniofacial anomalies (Kennedy and Waters 2005).

One surgeon stated that while obesity may be a risk factor for SDB, it is also an outcome in some children. Daytime fatigue may cause children with SDB to exercise less. In addition, airway obstruction may result in children choosing foods that are easy to swallow—usually energy-dense, nutrient-poor foods—because they are unable to breathe and chew food concurrently. Any improvement in SDB will improve sleep quality and reduce daytime somnolence, leading to increased activity and better dietary patterns.

Question 4: Are there any clinical examinations or tests that can assist surgeons in determining which children (and adults) will benefit from tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea?

The preoperative assessment of children presenting with SDB includes:

- a thorough clinical and sleep history—the use of questionnaires on sleep disturbance significantly increases the diagnostic capture of patients with OSA (Pijpers et al. 2004);
- a physical examination (a complete head and neck examination, assessment of overall body stature to detect delayed growth, measurement of blood pressure and assessment of heart and lung sounds);
- an upper airway examination, aided by endoscopy—the use of lateral airway X-ray is helpful when an endoscopic examination is not possible.

PSG is the gold standard for diagnosing the severity of OSA because it records all elements of cardiorespiratory and cerebral activity. However, PSG is not cost-effective, and there are limited paediatric sleep units in Australia to screen all snoring children. In

addition, case selection based on PSG would exclude from treatment the majority of patients who are classified as having mild OSA but have sleep fragmentation that is causing neurocognitive disorders. Consequently, there is no place for the routine use of PSG in this population, but selected patients may benefit from PSG and it is useful when there is diagnostic uncertainty.

In lieu of PSG, continuous recording of pulse oximetry alone may be a helpful screening tool, although a negative finding does not exclude SDB. In addition, the failure of equipment to reliably record oxygen levels and the lack of correlation to airflow, cerebral activity and chest wall movements can limit the benefit of these studies (Kennedy and Waters 2005).

In summary, standard history taking, objective examination findings and the use of validated sleep questionnaires can provide reasonable confidence in diagnosing SDB, thereby avoiding the need for PSG, except in cases of diagnostic difficulty or treatment failure.

Question 5: Is one surgical technique more effective than another in reducing secondary (>24 hours after surgery) bleeding in children (and adults) undergoing tonsillectomy, adenoidectomy or adenotonsillectomy for tonsillitis or sleep apnoea?

Both surgeons agreed that the bleed rates are comparable for both cold dissection and diathermy, although one surgeon noted that the advantage of diathermy is a lower intraoperative blood loss, which can be important in small children.

One surgeon provided the following comments:

- An Australian study reported the following rates for secondary haemorrhage after tonsillectomy: 0.6 per cent in 0- to 4-year-olds, 3.7 per cent in 5- to 9-year-olds, 5.5 per cent in 10- to 17-year-olds and 10 per cent in adults (Walker and Gilles 2007). Monopolar diathermy dissection had a lower rate of secondary postoperative haemorrhage requiring readmission (2.1%) than blunt dissection and diathermy haemostasis (4.2%), but these differences were not statistically significant.
- Most secondary bleeds are tonsillar rather than adenoidal.
- There appears to be no relationship between grade of surgeon and risk of secondary bleeding (Tomkinson et al. 2011).
- The risk of haemorrhage increases sharply with age such that patients older than 12 years have an increased risk of a secondary bleed (Royal College of Surgeons of England 2005; Tomkinson et al. 2011). As most children who undergo adenotonsillectomy for airway problems are younger than 12 years, they have a relatively low risk of secondary bleeding.

Additional comments

The following additional comments were provided by one surgeon in relation to the use of adenotonsillectomy for OSA.

- SDB is a common and under reported problem in the paediatric population.
- When left untreated, paediatric SDB can result in morbidity and mortality in the adult population, including cardiovascular and oncologic sequelae, and increased healthcare costs.
- Most children with OSA can be effectively treated with adenotonsillectomy. When selecting patients for surgery, consideration should be given to obese and syndromic children with craniofacial anomalies.
- OSA is currently under treated and the rate of adenotonsillectomy should be increased to adequately manage this patient population. The cost savings to the health system and the reduced morbidity vastly outweigh the costs involved in offering adenotonsillectomy to children with OSA.

6. Discussion

Findings

This rapid review summarised evidence on patients with OSA regarding: the threshold of pathology below which tonsil or adenoid removal is of low clinical value; the specific developmental and social indications for tonsil or adenoid removal; the effectiveness of tonsillectomy, adenoidectomy and adenotonsillectomy for treating the symptoms of sleep apnoea; the clinical tests that can be used to identify appropriate candidates for tonsil or adenoid removal; and the best surgical techniques for reducing secondary haemorrhage following tonsil or adenoid removal. The indications for tonsillectomy recommended by the relevant Australian surgical societies were also summarised.

Indications for tonsillectomy in Australia

A joint position paper by the RACP and the ASO-HNS (RACP-ASOHNS 2008) identified five indications for tonsillectomy. Adenotonsillectomy was recommended for childhood OSA, recurrent acute tonsillitis, peritonsillar abscess, suspected neoplasm and certain uncommon indications (chronic diphtheria carrier status following failed antibiotic eradication, recurrent large tonsilloliths or tonsillar cysts and recurrent tonsillar haemorrhage) (RACP-ASOHNS 2008). Increased access to adenotonsillectomy for children with moderate to severe OSA was recommended (RACP-ASOHNS 2008).

Threshold of pathology for tonsil or adenoid removal

Evidence was derived from four CPGs (Baugh et al. 2011; Marcus et al. 2012; RACP-ASOHNS 2008; Roland et al. 2011) and three SRs (Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013). When adenotonsillectomy was used as a first-line therapy for moderate to severe childhood OSA, 74 per cent of uncomplicated cases showed benefit (Friedman et al. 2009; Marcus et al. 2012; RACP-ASOHNS 2008). Tonsillectomy relieved the symptoms of SDB in 60 to 70 per cent of children with significant tonsillar hypertrophy (Baugh et al. 2011). Other treatments should be considered when a child has OSA but does not have adenotonsillar hypertrophy (Marcus et al. 2012). Caregivers of children with SDB due to tonsillar hypertrophy should be asked about comorbid conditions that may improve following tonsillectomy (Baugh et al. 2011). Evidence from a SR suggested that children with OSA-related cardiac morbidity should be treated early with adenotonsillectomy to reverse potentially serious cardiovascular sequelae (Teo and Mitchell 2013).

While tonsillectomy resolved SDB in approximately 10 to 25 per cent of obese children (BMI > 95th percentile for age and gender), up to 88 per cent of these children had persistent symptoms following therapy (Costa and Mitchell 2009). The benefits of adenotonsillectomy should be compared with other treatments for obese children with varying degrees of adenotonsillar hypertrophy (Marcus et al. 2012).

Patients younger than three years of age and those with severe OSA, cardiac

complications, failure to thrive, obesity, craniofacial anomalies, neuromuscular disorders or respiratory infections should be monitored as inpatients following adenotonsillectomy. Adenotonsillectomy is contraindicated in patients with: small or no adenotonsillar tissue; morbid obesity and small tonsils or adenoids; refractory bleeding disorders; submucous cleft palate; and conditions that increase their surgical risk (Marcus et al. 2012).

Experts suggested that SDB was associated with snoring, witnessed apnoeas, being male, age younger than five years, adenotonsillar hypertrophy, chronic nasal congestion, family history of snoring, exposure to cigarette smoke and obesity. While OSA is diagnosed with PSG, there is no established threshold for disease severity and development of complications.

Developmental or social indications for tonsillectomy, adenotonsillectomy or adenoidectomy

Evidence regarding specific developmental or social indications for tonsillectomy was identified from one CPG (Baugh et al. 2011) and three SRs (Baldassari et al. 2008; Jeyakumar et al. 2012; Sedky et al. 2014). Those who care for children with SDB should be questioned regarding school performance, enuresis and behavioural problems that may improve following tonsillectomy (Baugh et al. 2011). Children with sleep disturbance and physical suffering and whose caregivers are concerned, experience significant improvements in QOL following adenotonsillectomy (Baldassari et al. 2008).

Adenotonsillectomy was associated with a significant improvement in enuresis in children with SDB (Jeyakumar et al. 2012). Evidence also suggested that adenotonsillectomy reduced the symptoms of ADHD, and that the treatment of comorbid SDB should be considered prior to offering medication for ADHD symptoms (Sedky et al. 2014).

According to expert opinion, up to 40 per cent of children with clinically diagnosed SDB exhibit behavioural problems, including: ADHD; poor socialisation and school performance; deficits in memory, learning and problem solving; enuresis; aggression; anxiety; depression; and somatisation.

Effectiveness of tonsillectomy, adenoidectomy or adenotonsillectomy for sleep apnoea

Evidence on the effectiveness of tonsillectomy, adenotonsillectomy and adenoidectomy for the treatment of sleep apnoea was derived from two CPGs (Baugh et al. 2011; Marcus et al. 2012), four SRs (Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013) and one RCT (Marcus et al. 2013). Adenotonsillectomy effectively resolved between 66 and 83 per cent of uncomplicated cases of childhood OSA (Brietzke and Gallagher 2006; Friedman et al. 2009). A recent RCT reported that more of the children who received early adenotonsillectomy achieved normalisation of PSG findings, compared with those who underwent watchful waiting (79% versus 46%) (Marcus et al. 2013). According to guidelines by the AAO-HNS, tonsillectomy was effective in controlling the symptoms of SDB in 60 to 70 per cent of

children with significant tonsillar hypertrophy (Baugh et al. 2011). While tonsillectomy resolved SDB symptoms in approximately 10 to 25 per cent of obese children, up to 88 per cent of these patients still experienced SDB after surgery (Costa and Mitchell 2009). It was recommended that all OSA patients be reassessed for persisting symptoms following surgery to determine whether they should be referred for CPAP (Marcus et al. 2012). There was also evidence to suggest that adenotonsillectomy improved cardiac parameters and may reverse OSA-related cardiovascular sequelae (Teo and Mitchell 2013).

Experts stated that adenotonsillectomy is the primary treatment for most children with OSA. Adenotonsillectomy is effective in improving or resolving SDB in most children, resulting in improvements in sleep quality, voice clarity, growth, nocturnal enuresis, behavioural parameters, school performance, QOL and long-term cardiovascular health.

Clinical testing for tonsillectomy, adenoidectomy or adenotonsillectomy candidacy

Evidence regarding clinical testing was reported in three CPGs (Marcus et al. 2012; RACP-ASOHNS 2008; Roland et al. 2011) and one SR (Friedman et al. 2009). One CPG recommended that PSG be performed in children or adolescents with snoring and symptoms or signs of OSA. If PSG is unavailable, alternative diagnostic testing or evaluation by a specialist should be considered (Marcus et al. 2012). Children with SDB should be referred for PSG if they have complex medical conditions, including obesity, Down syndrome, craniofacial abnormalities, neuromuscular disorders, sickle cell disease or mucopolysaccharidoses (Roland et al. 2011). PSG may also be conducted in children without comorbidities when the need for surgery is uncertain or when there is a discrepancy between tonsillar size and the severity of SDB (Roland et al. 2011). BMI and preoperative AHI are important factors to consider in the treatment of childhood OSA as approximately 88 per cent of obese children have persistent OSA following adenotonsillectomy (Friedman et al. 2009).

According to expert opinion, OSA is generally diagnosed in Australia by directed questioning and general physical and upper airway examination, aided by endoscopy and radiology. There is no place for routine use of PSG in children, but selected patients may benefit when there is diagnostic uncertainty.

Techniques for reducing secondary bleeding following tonsillectomy, adenoidectomy or adenotonsillectomy

Evidence on the effectiveness of surgical techniques in reducing secondary bleeding was reported in two CPGs (Baugh et al. 2011; Marcus et al. 2012), two SRs (Burton and Doree 2007; Pinder et al. 2011) and four RCTs (Gustavii et al. 2010; Omrani et al. 2012; Paramasivan et al. 2012; Shapiro and Bhattacharyya 2007).

There was inadequate evidence to determine whether coblation, diathermy or cold dissection tonsillectomy differ in terms of the rate of secondary haemorrhage (Baugh et al. 2011; Burton and Doree 2007; Marcus et al. 2012; Pinder et al. 2011). It was

recommended that clinicians who perform tonsillectomy should determine their rates of primary and secondary haemorrhage after tonsillectomy at least annually (Baugh et al. 2011).

Expert opinion suggested that coblation may be associated with an increased risk of secondary bleeding, compared with cold steel, and that secondary bleed rates are related to surgical technique and patient factors but not to surgical experience.

Limitations of the evidence

A joint position paper by the RACP and the ASO-HNS reported five indications for the use of tonsillectomy in Australia (RACP-ASOHNS 2008). However, the evidence on which these indications are based may be outdated as the shelf life of many CPGs is less five years (Alderson et al. 2014). Relevant studies may have been missed due to a lack of systematic searching of electronic databases and grey literature sources were not systematically searched, resulting in possible source and time lag bias.

Relevant populations may have been missed in the evidence base on specific clinical or pathological features of childhood sleep apnoea that indicate a threshold below which surgical removal of tonsils or adenoids is of low clinical value. While risk factors for OSA include adenotonsillar hypertrophy, obesity, craniofacial anomalies and neuromuscular disorders, only the first two factors were considered in developing the included CPGs (Baugh et al. 2011; Marcus et al. 2012; RACP-ASOHNS 2008; Roland et al. 2011), and studies included in the SRs typically excluded patients with comorbidities other than obesity (Costa and Mitchell 2009; Friedman et al. 2009; Teo and Mitchell 2013). The studies included in some reviews had small sample sizes and many were not RCTs. Few studies used PSG, the gold standard for diagnosing and quantifying OSA, although the clinically significant level of obstructive events index on PSG is unknown (RACP-ASOHNS 2008). None of the CPGs sought patient or caregiver preferences in formulating their recommendations.

Findings on the specific developmental or social indications for tonsillectomy were limited in scope as they did not take into consideration the unique developmental and social factors related to complex cases involving comorbidities, craniofacial syndromes, morbid obesity and neuromuscular disorders (Baldassari et al. 2008; Baugh et al. 2011; Jeyakumar et al. 2012; Marcus et al. 2012; Sedky et al. 2014). This may have resulted in the exclusion of a population of interest for OSA and factors that could be important in relation to this patient population. The evidence was also limited in terms of quantity and scope. While SRs were identified in relation to the effect of adenotonsillectomy on ADHD symptoms, nocturnal enuresis and QOL, no further information was found regarding other potential factors of interest such as behavioural abnormalities, daytime sleepiness or deficits in cognition, language, learning, memory or school performance.

Information on the effectiveness of tonsillectomy, adenoidectomy and adenotonsillectomy for the treatment of sleep apnoea pertained primarily to the treatment of uncomplicated OSA in children with SDB and tonsillar hypertrophy

without comorbid conditions (Baugh et al. 2011; Brietzke and Gallagher 2006; Costa and Mitchell 2009; Friedman et al. 2009; Marcus et al. 2012; Marcus et al. 2013; Teo and Mitchell 2013). Most of the CPGs and SRs excluded studies involving complex populations with diabetes mellitus, craniofacial disorders, congenital anomalies, sickle cell disease, coagulopathies or immunodeficiency disorders. Some SRs included few studies, and there was a lack of RCTs and significant heterogeneity among the published studies. The populations included in the reviews were diverse in demographic and physical characteristics and there were few established PSG scoring criteria for paediatric patients. Many of the patients included in the studies were diagnosed with OSA based on more subjective clinical symptoms.

Evidence regarding clinical testing to determine candidacy for surgical treatment of sleep apnoea was reported in three CPGs (Marcus et al. 2012; RACP-ASOHNS 2008; Roland et al. 2011) and one SR (Friedman et al. 2009). While laboratory-based PSG was considered the gold standard for diagnosing and classifying OSA, the technique is hampered by a lack of measurement standards and consensus on their interpretation (RACP-ASOHNS 2008). In Australia, a diagnosis of childhood OSA is typically made based on history and clinical examination, supplemented with endoscopy and radiology as needed.

The authors of the SRs assessing the effectiveness of surgical techniques in reducing postoperative secondary bleeding following tonsillectomy suggested that their results should be interpreted with caution because they are mostly based on small, poorly reported studies of low methodological quality that had large losses to follow-up. In addition, many of the studies used different methods of diathermy, particularly first generation equipment that frequently required additional haemostasis, and were not sufficiently powered to identify small differences between groups.

This report was limited in that, even after systematically searching the literature and contacting clinical experts, no relevant studies were found regarding the use of tonsillectomy, adenoidectomy or adenotonsillectomy for the treatment of sleep apnoea in adults. Experts report a clear distinction between children and adults in managing OSA. Tonsillectomy, adenoidectomy and adenotonsillectomy are not indicated in adults because the causes of OSA in this group are more complex than in children. Expert opinion suggested that adult OSA is primarily managed using CPAP. When this treatment fails, surgical methods such as tracheostomy, uvulopalatopharyngoplasty, tongue base reduction and genioglossus advancement are used to manage OSA in adults.

7. Conclusions and Implications for Policy

In Australia, adenotonsillectomy is recommended as first-line therapy for: childhood OSA; episodes of recurrent acute tonsillitis; peritonsillar abscess; suspected neoplasm; and uncommon indications such as chronic diphtheria carrier status after failed antibiotics, recurrent large tonsilloliths or tonsillar cysts and recurrent tonsillar haemorrhage. All children who have tonsils removed for the treatment of moderate or severe OSA should be monitored as inpatients postoperatively.

There was consensus in the evidence that approximately 74 per cent of uncomplicated cases of moderate to severe childhood OSA derive clinical benefit from first-line adenotonsillectomy. There was evidence to suggest that children with OSA-related cardiac morbidity should be treated early with adenotonsillectomy to reverse potentially serious cardiovascular sequelae. Evidence suggested that children with sleep disturbance, symptoms of ADHD, nocturnal enuresis or physical suffering may experience significant improvements in QOL, ADHD symptoms and enuresis following adenotonsillectomy. Tonsillectomy is of clinical benefit in controlling SDB in approximately 60 to 70 per cent of children with significant tonsillar hypertrophy. While tonsillectomy resolves SDB in approximately 10 to 25 per cent of obese children (BMI > 95th percentile for age and gender), between 60 and 88 per cent of patients have persistent SDB following surgery. The benefits of adenotonsillectomy should be compared with other treatments for obese children with varying degrees of adenotonsillar hypertrophy. Adenotonsillectomy is contraindicated in patients with small or no adenotonsillar tissue, morbid obesity and small tonsils and/or adenoids, refractory bleeding disorders, submucous cleft palate and conditions that make patients unstable for surgery.

CPGs recommended that PSG be performed in children: who snore and have symptoms of OSA; with SDB and complex medical conditions involving obesity, with Down syndrome, craniofacial abnormalities, neuromuscular disorders, sickle cell or mucopolysaccharidoses; or with SDB without complexities when the need for surgery is uncertain or when there is a discrepancy between tonsillar size and SDB severity. Alternative diagnostic testing or evaluation by a specialist should be considered if PSG is not available. BMI is also an important factor to consider as approximately 88 per cent of obese children have persistent OSA following adenotonsillectomy. According to expert opinion, OSA is currently diagnosed by directed questioning, physical examination and upper airway examination aided by endoscopy and radiology. There is no place for the routine use of PSG in children, but it is helpful in selected patients when there is diagnostic uncertainty.

There is inadequate evidence to determine whether coblation, diathermy or cold dissection tonsillectomy offers the greatest reduction in the rate of secondary haemorrhage. The majority of the evidence suggested that there was insufficient data to make specific recommendations regarding surgical technique. It was recommended that

clinicians performing tonsillectomy determine their rates of primary and secondary haemorrhage on an annual basis.

The findings suggested that adenotonsillectomy is an effective treatment for children with moderate to severe OSA. Expert opinion suggested that childhood OSA is commonly diagnosed based on history and clinical examination and that milder cases of OSA may benefit from treatment. While PSG is considered the gold standard for diagnosis of OSA, it may be most useful for complex cases involving craniofacial anomalies and syndromes and for patients whose symptoms do not resolve following adenotonsillectomy. The evidence suggested that most cases of uncomplicated childhood OSA (74%) would benefit from adenotonsillectomy in terms of improvements in the symptoms of OSA, cardiovascular parameters, ADHD and QOL. All children who undergo adenotonsillectomy for the treatment of moderate or severe OSA should be monitored as inpatients postoperatively. Clinicians should reassess all patients with OSA for persisting symptoms following surgery to determine whether further treatment is required. Caregivers should be informed about the benefits and risks associated with surgery and that SDB may persist or recur, requiring further management. There was insufficient evidence to recommend a specific surgical technique to reduce the rate of secondary haemorrhage.

Clinical experts have suggested that the use of adenotonsillectomy for treating OSA in Victorian children is suboptimal. If so, this may be due, in part, to: parents being unaware of the symptoms and long-term consequences of childhood OSA; milder cases of OSA going undiagnosed or untreated; and a lack of understanding that an absence of significant tonsillar hypertrophy does not necessarily mean an absence of SDB. However, data on the number of adenotonsillectomy procedures performed for childhood OSA and the prevalence rate of SDB in the Victorian population need to be compared before any judgement could be made on whether the rates of adenotonsillectomy are suboptimal for this indication.

Acknowledgements

The authors wish to acknowledge the following people for their valuable assistance during the preparation of this report:

- Dr Yasoba Atukorale, Research Officer, ASERNIP-S, Adelaide, South Australia
- Dr David Tivey, Senior Research Officer, ASERNIP-S, Adelaide, South Australia

We are also grateful for the valuable input received from two senior ear, nose and throat surgeons, one from Melbourne, Victoria and one from Adelaide, South Australia, who kindly provided comments on and detailed expert opinion for this report.

References

- Alderson, LJ, Alderson, P & Tan, T 2014, 'Median life span of a cohort of National Institute for Health and Care Excellence clinical guidelines was about 60 months', *Journal of Clinical Epidemiology* 2014, vol.67(1), pp. 52-5.
- Australian Institute of Health and Welfare (AIHW) 2014, *Australian hospital statistics 2012–13*, AIHW, Canberra, viewed February 2015, <<http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129547000>>.
- Amin, R, Anthony, L, Somers, V, Fenchel, M, McConnell, K, Jefferies, J, Willging, P, Kalra, M & Daniels, S 2008, 'Growth velocity predicts recurrence of sleep-disordered breathing 1 year after adenotonsillectomy', *American Journal of Respiratory & Critical Care Medicine*, vol.177(6), pp. 654-9.
- Anthony, R, Wallace, H, Frewer, J, Varlow, J & Smelt, GJC 2006, 'Coblation tonsillectomy compared with conventional dissection and tie techniques- a randomized trial', unpublished draft paper.
- Apostolidou, MT, Alexopoulos, EI, Damani, E, Liakos, N, Chaidas, K, Boultsadakis, E, Apostolidis, T, Gourgoulis, K & Kaditis, AG 2008, 'Absence of blood pressure, metabolic, and inflammatory marker changes after adenotonsillectomy for sleep apnea in Greek children', *Pediatric Pulmonology*, vol.43(6), pp. 550-60.
- Atiq, M, Masood, F, Ikram, M & Haqque, R 2004, 'Reversible obstructive sleep apnea and right heart failure due to massive tonsillar hypertrophy', *Journal of Ayub Medical College Abbottabad*, vol.16(1), pp. 66-8.
- Avelino, MAG, Pereira, FC, Carlini, D, Moreira, GA, Fujita, R & Weckx, LLM 2002, 'Avaliação polissonográfica da síndrome da apnéia obstrutiva do sono em crianças, antes e após adenoamigdalectomia', *Revista Brasileira de Otorrinolaringologia*, vol.68(3), pp. 308-11.
- Aydil, U, Iseri, E, Kizil, Y, Bodur, S, Ceylan, A & Uslu, S 2008, 'Obstructive upper airway problems and primary enuresis nocturna relationship in pediatric patients: reciprocal study', *Journal of Otolaryngology: Head and Neck Surgery*, vol.37(2), pp. 235-9.
- Back, L, Paloheimo, M & Ylikoski, J 2001, 'Traditional tonsillectomy compared with bipolar radiofrequency thermal ablation tonsillectomy in adults: a pilot study', *Archives of Otolaryngology - Head and Neck Surgery*, vol.127(9), pp. 1106-12.
- Baldassari, CM, Mitchell, RB, Schubert, C & Rudnick, EF 2008, 'Pediatric obstructive sleep apnea and quality of life: a meta-analysis', *Otolaryngology - Head and Neck Surgery*, vol.138(3), pp. 265-73.
- Bar, A, Tarasiuk, A, Segev, Y, Phillip, M & Tal, A 1999, 'The effect of adenotonsillectomy on serum insulin-like growth factor-I and growth in children with obstructive sleep apnea syndrome', *Journal of Pediatrics*, vol.135(1), pp. 76-80.
- Basha, SBC, Ende, K & Szeremeta, W 2005, 'Effectiveness of adenotonsillectomy in the resolution of nocturnal enuresis secondary to obstructive sleep apnea', *Laryngoscope*, vol.115(6), pp. 1101-3.
- Baugh, RF, Archer, SM, Mitchell, RB, Rosenfeld, RM, Amin, R, Burns, JJ, Darrow, DH, Giordano, T, Litman, RS, Li, KK, Mannix, ME, Schwartz, RH, Setzen, G, Wald, ER, Wall, E, Sandberg, G & Patel, MM 2011, 'Clinical practice guideline:

- tonsillectomy in children', *Otolaryngology - Head and Neck Surgery*, vol.144(1 Suppl), pp. S1-30.
- Better Health Channel 2013, *Tonsillectomy*, State Government of Victoria, viewed February 2015, <[http://www.betterhealth.vic.gov.au/bhcv2/bhcpdf.nsf/ByPDF/Tonsillectomy/\\$File/Tonsillectomy.pdf](http://www.betterhealth.vic.gov.au/bhcv2/bhcpdf.nsf/ByPDF/Tonsillectomy/$File/Tonsillectomy.pdf)>.
- Brietzke, SE & Gallagher, D 2006, 'The effectiveness of tonsillectomy and adenoidectomy in the treatment of pediatric obstructive sleep apnea/hypopnea syndrome: a meta-analysis', *Otolaryngology - Head and Neck Surgery*, vol.134(6), pp. 979-84.
- Brouwers, M, Kho, ME, Browman, GP, Cluzeau, F, Feder, G, Fervers, B, Hanna, S & Makarski, J on behalf of the AGREE Next Steps Consortium 2010, 'AGREE II: Advancing guideline development, reporting and evaluation in healthcare', *CMAJ*, vol.182(18), pp. E839-42.
- Burton, MJ & Doree, C 2007, 'Coblation versus other surgical techniques for tonsillectomy', *Cochrane Database of Systematic Reviews*, vol.3, CD00461.
- Chervin, RD, Ruzicka, DL, Hoban, TF, Fetterolf, JL, Garetz, SL, Guire, KE, Dillon, JE, Felt, BT, Hodges, EK & Giordani, BJ 2012, 'Esophageal pressures, polysomnography, and neurobehavioral outcomes of adenotonsillectomy in children', *Chest*, vol.142(1), pp. 101-10.
- Chervin, RD, Weatherly, RA, Garetz, SL, Ruzicka, DL, Giordani, BJ, Hodges, EK, Dillon, JE & Guire, KE 2007, 'Pediatric sleep questionnaire: prediction of sleep apnea and outcomes', *Archives of Otolaryngology - Head and Neck Surgery*, vol.133(3), pp. 216-22.
- Cinar, U, Vural, C, Cakir, B, Topuz, E, Karaman, MI & Turgut, S 2001, 'Nocturnal enuresis and upper airway obstruction', *International Journal of Pediatric Otorhinolaryngology*, vol.59(2), pp. 115-8.
- Cohen, S, Springer, C, Perles, Z, Koplewitz, BZ, Avital, A & Revel-Vilk, S 2010, 'Cardiac, lung, and brain thrombosis in a child with obstructive sleep apnea', *Pediatric Pulmonology*, vol.45(8), pp. 836-9.
- Constantin, E, McGregor, CD, Cote, V & Brouillette, RT 2008, 'Pulse rate and pulse rate variability decrease after adenotonsillectomy for obstructive sleep apnea', *Pediatric Pulmonology*, vol.43(5), pp. 498-504.
- Costa, DJ & Mitchell, R 2009, 'Adenotonsillectomy for obstructive sleep apnea in obese children: a meta-analysis', *Otolaryngology - Head and Neck Surgery*, vol.140(4), pp. 455-60.
- Dillon, JE, Blunden, S, Ruzicka, DL, Guire, KE, Champine, D, Weatherly, RA, Hodges, EK, Giordani, BJ & Chervin, RD 2007, 'DSM-IV diagnoses and obstructive sleep apnea in children before and 1 year after adenotonsillectomy', *Journal of the American Academy of Child & Adolescent Psychiatry*, vol.46(11), pp. 1425-36.
- Duman, D, Naiboglu, B, Esen, HS, Toros, SZ & Demirtunc, R 2008, 'Impaired right ventricular function in adenotonsillar hypertrophy', *The International Journal of Cardiovascular Imaging*, vol.24(3), pp. 261-7.
- Eliaschar, I, Lavie, P, Halperin, E, Gordon, C & Alroy, G 1980, 'Sleep apneic episodes as indications for adenotonsillectomy', *Archives of Otolaryngology*, vol.106(8), pp. 492-6.

- Elsherif, I & Kareemullah, C 1999, 'Tonsil and adenoid surgery for upper airway obstruction in children', *Ear, Nose & Throat Journal*, vol.78(8), pp. 617-20.
- Epstein, LJ, Kristo, D, Strollo, PJ, Jr., Friedman, N, Malhotra, A, Patil, SP, Ramar, K, Rogers, R, Schwab, RJ, Weaver, EM & Weinstein, MD 2009, 'Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults', *Journal of Clinical Sleep Medicine*, vol.5(3), pp. 263-76.
- Firoozi, F, Batniji, R, Aslan, AR, Longhurst, PA & Kogan, BA 2006, 'Resolution of diurnal incontinence and nocturnal enuresis after adenotonsillectomy in children', *Journal of Urology*, vol.175(5), pp. 1885-8.
- Flanary, VA 2003, 'Long-term effect of adenotonsillectomy on quality of life in pediatric patients', *Laryngoscope*, vol.113(10), pp. 1639-44.
- Frank, Y, Kravath, RE, Pollak, CP & Weitzman, ED 1983, 'Obstructive sleep apnea and its therapy: clinical and polysomnographic manifestations', *Pediatrics*, vol.71(5), pp. 737-42.
- Friedman, M, Wilson, M, Lin, HC & Chang, HW 2009, 'Updated systematic review of tonsillectomy and adenoidectomy for treatment of pediatric obstructive sleep apnea/hypopnea syndrome', *Otolaryngology - Head and Neck Surgery*, vol.140(6), pp. 800-8.
- Galland, BC, Dawes, PJ, Tripp, EG & Taylor, BJ 2006, 'Changes in behavior and attentional capacity after adenotonsillectomy', *Pediatric Research*, vol.59(5), pp. 711-6.
- Giordani, B, Hodges, EK, Guire, KE, Ruzicka, DL, Dillon, JE, Weatherly, RA, Garetz, SL & Chervin, RD 2012, 'Changes in neuropsychological and behavioral functioning in children with and without obstructive sleep apnea following Tonsillectomy', *Journal of the International Neuropsychological Society*, vol.18(2), pp. 212-22.
- Goldstein, NA, Fatima, M, Campbell, TF & Rosenfeld, RM 2002, 'Child behavior and quality of life before and after tonsillectomy and adenoidectomy', *Archives of Otolaryngology - Head and Neck Surgery*, vol.128(7), pp. 770-5.
- Goldstein, NA, Post, JC, Rosenfeld RM & Campbell TF 2000, 'Impact of tonsillectomy and adenoidectomy on child behavior', *Archives of Otolaryngology - Head and Neck Surgery*, vol.126(4), pp. 494-8.
- Goldstein, NA, Pugazhendhi, V, Rao, SM, Weedon, J, Campbell, TF, Goldman, AC, Post, JC & Rao, M 2004, 'Clinical assessment of pediatric obstructive sleep apnea', *Pediatrics*, vol.114(1), pp. 33-43.
- Gorur, K, Doven, O, Unal, M, Akkus, N & Ozcan, C 2001, 'Preoperative and postoperative cardiac and clinical findings of patients with adenotonsillar hypertrophy', *International Journal of Pediatric Otorhinolaryngology*, vol.59(1), pp. 41-6.
- Gozal, D, Capdevila, OS & Kheirandish-Gozal, L 2008, 'Metabolic alterations and systemic inflammation in obstructive sleep apnea among nonobese and obese prepubertal children', *American Journal of Respiratory & Critical Care Medicine*, vol.177(10), pp. 1142-9.
- Guilleminault, C, Huang, YS, Glanann, C, Li, K & Chan, A 2007, 'Adenotonsillectomy and obstructive sleep apnea in children: a prospective survey', *Otolaryngology - Head and Neck Surgery*, vol.136(2), pp. 169-75.

- Guilleminault, C, Li, KK, Khamtsov, A, Pelayo, R & Martinez, S 2004, 'Sleep disordered breathing: surgical outcomes in prepubertal children', *Laryngoscope*, vol.114(1), pp. 132-7.
- Gustavii, N, Bove, M & Dahlin, C 2010, 'Postoperative morbidity in traditional versus coblation tonsillectomy', *Annals of Otolaryngology, Rhinology and Laryngology*, vol.119(11), pp. 755-60.
- Huang, YS, Guilleminault, C, Li, HY, Yang, CM, Wu, YY & Chen, NH 2007, 'Attention-deficit/hyperactivity disorder with obstructive sleep apnea: a treatment outcome study', *Sleep Medicine*, vol.8(1), pp. 18-30.
- Jeyakumar, A, Rahman, SI, Armbricht, ES & Mitchell, R 2012, 'The association between sleep-disordered breathing and enuresis in children', *Laryngoscope*, vol.122(8), pp. 1873-77.
- Jayasinghe, H, Lee, P, Williams, A & Kerr, AJG 2005, 'Randomised single blinded trial of outcome for coblation versus cold steel tonsillectomy', unpublished presentation.
- Kaditis, AG, Finder, J, Alexopoulos, EI, Starantzis, K, Tanou, K, Gampeta, S, Agorogiannis, E, Christodoulou, S, Pantazidou, A, Gourgoulis, K & Molyvdas, PA 2004, 'Sleep-disordered breathing in 3,680 Greek children', *Pediatric Pulmonology*, vol.37(6), pp. 499-509.
- Kalorin, CM, Mouzakes, J, Gavin, JP, Davis, TD, Feustel, P & Kogan, BA 2010, 'Tonsillectomy does not improve bedwetting: results of a prospective controlled trial', *Journal of Urology*, vol.184(6), pp. 2527-31.
- Kennedy, JD & Waters, KA 2005, 'Investigation and treatment of upper- airway obstruction: childhood sleep disorders I', *The Medical Journal of Australia*, vol.182(8), pp. 419-23.
- Kujawski, O, Dulguerov, P, Gysin, C & Lehmann, W 1997, 'Microscopic tonsillectomy: a double-blind randomized trial', *Otolaryngology - Head and Neck Surgery*, vol.117(6), pp. 641-7.
- Lewin, DS, Rosen, RC, England, SJ & Dahl, RE 2002, 'Preliminary evidence of behavioral and cognitive sequelae of obstructive sleep apnea in children', *Sleep Medicine*, vol.3(1), pp. 5-13.
- Li, HY, Huang, YS, Chen, NH, Fang, TJ & Lee, LA 2006, 'Impact of adenotonsillectomy on behavior in children with sleep-disordered breathing', *Laryngoscope*, vol.116(7), pp. 1142-7.
- Marcus, CL, Brooks, LJ, Draper, KA, Gozal, D, Halbower, AC, Jones, J, Schechter, MS, Ward, SD, Sheldon, SH, Shiffman, RN, Lehmann, C & Spruyt, K 2012, 'Diagnosis and management of childhood obstructive sleep apnea syndrome', *Pediatrics*, vol.130(3), pp. e714-55.
- Marcus, CL, Moore, RH, Rosen, CL, Giordani, B, Garetz, SL, Taylor, HG, Mitchell, RB, Amin, R, Katz, ES, Arens, R, Paruthi, S, Muzumdar, H, Gozal, D, Thomas, NH, Janice Ware, DB, Snyder, K, Elden, L, Sprecher, RC, Willging, P, Jones, D, Bent, JP, Hoban, T, Chervin, RD, Ellenberg, SS & Redline, S 2013, 'A randomized trial of adenotonsillectomy for childhood sleep apnea', *New England Journal of Medicine*, vol.368(25), pp. 2366-76.
- Merlin, T, Liufu, Z & Wang, S 2010, *Unattended sleep studies in the diagnosis and reassessment of obstructive sleep apnoea. MSAC Application 1130, Assessment Report*, Commonwealth

- of Australia, Canberra, viewed February 2015,
<[http://www.msac.gov.au/internet/msac/publishing.nsf/Content/BAE45713D7D0FDEBCA257817001CB46D/\\$File/1130_MSAC_Report.pdf](http://www.msac.gov.au/internet/msac/publishing.nsf/Content/BAE45713D7D0FDEBCA257817001CB46D/$File/1130_MSAC_Report.pdf)>.
- Merlin, T, Weston, A & Tooher, R 2009, 'Extending an evidence hierarchy to include topics other than treatment: revising the Australian 'levels of evidence'', *BMC Medical Research Methodology*, vol.9(34), doi:10.1186/1471-2288-9-34.
- Mitchell, RB 2005, 'Sleep-disordered breathing in children: are we underestimating the problem?' *European Respiratory Journal*, vol.25(2), pp. 216-7.
- Mitchell, RB 2007, 'Adenotonsillectomy for obstructive sleep apnea in children: outcome evaluated by pre- and postoperative polysomnography', *Laryngoscope*, vol.117(10), pp. 1844-54.
- Mitchell, RB & Boss, EF 2009, 'Pediatric obstructive sleep apnea in obese and normal-weight children: impact of adenotonsillectomy on quality-of-life and behavior', *Developmental Neuropsychology*, vol.34(5), pp. 650-61.
- Mitchell, RB & Kelly, J 2004a, 'Adenotonsillectomy for obstructive sleep apnea in obese children', *Otolaryngology - Head and Neck Surgery*, vol.131(1), pp. 104-8.
- Mitchell, RB & Kelly, J 2004b, 'Outcome of adenotonsillectomy for severe obstructive sleep apnea in children', *International Journal of Pediatric Otorhinolaryngology*, vol.68(11), pp. 1375-9.
- Mitchell, RB & Kelly, J 2005, 'Outcome of adenotonsillectomy for obstructive sleep apnea in children under 3 years', *Otolaryngology - Head and Neck Surgery*, vol.132(5), pp. 681-4.
- Mitchell, RB & Kelly, J 2006, 'Long-term changes in behavior after adenotonsillectomy for obstructive sleep apnea syndrome in children', *Otolaryngology - Head and Neck Surgery*, vol.134(3), pp. 374-8.
- Mitchell, RB & Kelly, J 2007a, 'Outcome of adenotonsillectomy for obstructive sleep apnea in obese and normal-weight children', *Otolaryngology - Head and Neck Surgery*, vol.137(1), pp. 43-8.
- Mitchell, RB & Kelly, J 2007b, 'Outcomes and quality of life following adenotonsillectomy for sleep-disordered breathing in children', *ORL; Journal for Otorhinolaryngology and its Related Specialties*, vol.69(6), pp. 345-8.
- Mora, R, Salami, A, Passali, FM, Mora, F, Cordone, MP, Ottoboni, S & Barbieri, M 2003, 'OSAS in children', *International Journal of Pediatric Otorhinolaryngology*, vol.67 Suppl 1, pp. S229-31.
- Naiboglu, B, Devenci, S, Duman, D, Kaya, KS, Toros, S, Kinis, V, Surmeli, M, Devenci, I & Gokceer, T 2008, 'Effect of upper airway obstruction on pulmonary arterial pressure in children', *International Journal of Pediatric Otorhinolaryngology*, vol.72(9), pp. 1425-9.
- Ng, DK, Wong, JC, Chan, CH, Leung, LC & Leung, SY 2010, 'Ambulatory blood pressure before and after adenotonsillectomy in children with obstructive sleep apnea', *Sleep Medicine*, vol.11(7), pp. 721-5.
- Nieminen, P, Tolonen, U & Lopponen, H 2000, 'Snoring and obstructive sleep apnea in children: a 6-month follow-up study', *Archives of Otolaryngology - Head and Neck Surgery*, vol.126(4), pp. 481-6.

- Nishimura, T, Morishima, N, Hasegawa, S, Shibata, N, Iwanaga, K & Yagisawa, M 1996, 'Effect of surgery on obstructive sleep apnea', *Acta oto-laryngologica. Supplementum*, vol.523, pp. 231-3.
- Nunez, DA, Provan, J & Crawford, M 2000, 'Postoperative tonsillectomy pain in pediatric patients: electrocautery (hot) vs cold dissection and snare tonsillectomy-a randomized trial', *Archives of Otolaryngology - Head and Neck Surgery*, vol.126(7), pp. 837-41.
- Nuyens, MR, Vella, S & Bassetti, C 1999, 'Objektiver nutzen der adenotonsillektomie beim kind', *Praxis* vol.88, pp.893-9.
- O'Brien, LM, Sitha, S, Baur, LA & Waters, KA 2006, 'Obesity increases the risk for persisting obstructive sleep apnea after treatment in children', *International Journal of Pediatric Otorhinolaryngology*, vol.70(9), pp. 1555-60.
- Omrani, M, Barati, B, Omidifar, N, Okhovvat, AR & Hashemi, SAG 2012, 'Coblation versus traditional tonsillectomy: A double blind randomized controlled trial', *Journal of Research in Medical Sciences*, vol.17(1), pp. 45-50.
- Paramasivan, VK, Arumugam, SV & Kameswaran, M 2012, 'Randomised comparative study of adenotonsillectomy by conventional and coblation method for children with obstructive sleep apnoea', *International Journal of Pediatric Otorhinolaryngology*, vol.76(6), pp. 816-21.
- Philpott, CM, Wild, DC, Mehta, D, Daniel, M & Banerjee, AR 2005, 'A double-blinded randomized controlled trial of coblation versus conventional dissection tonsillectomy on post-operative symptoms', *Clinical Otolaryngology*, vol.30(2), pp. 143-8.
- Pinder, DK, Wilson, H & Hilton, MP 2011, 'Dissection versus diathermy for tonsillectomy', *Cochrane Database of Systematic Reviews*, vol.(3), CD002211.
- Pijpers, M, Poels, PJ, Vaandrager, JM, de Hoog M, van den Berg S, Hoeve HJ & Joosten KF 2004, 'Undiagnosed obstructive sleep apnea syndrome in children with syndromal craniofacial synostosis', *The Journal of Craniofacial Surgery*, vol.15(4), pp. 670-4.
- Roland, PS, Rosenfeld, RM, Brooks, LJ, Friedman, NR, Jones, J, Kim, TW, Kuhar, S, Mitchell, RB, Seidman, MD, Sheldon, SH, Jones, S & Robertson, P 2011, 'Clinical practice guideline: Polysomnography for sleep-disordered breathing prior to tonsillectomy in children', *Otolaryngology - Head and Neck Surgery*, vol.145(1 Suppl), pp. S1-15.
- Royal Australasian College of Physicians and The Australian Society of Otolaryngology, Head and Neck Surgery (RACP-ASOHNS) 2008, *Indications for tonsillectomy and adenotonsillectomy in children*, RACP-ASOHNS, Sydney.
- Royal College of Surgeons of England, British Association of Otorhinolaryngologists–Head and Neck Surgeons Comparative Audit Group and the Clinical Effectiveness Unit 2005, *National prospective tonsillectomy audit – final report for an audit carried out in England and Northern Ireland between July 2003 and September 2004*, Royal College of Surgeons of England, London.
- Ruehland, WR, Rochford, PD, O'Donoghue, FJ, Pierce, RJ, Singh, P & Thornton, AT 2009, 'The new AASM criteria for scoring hypopneas: impact on the apnea hypopnea index', *Sleep*, vol.32(2), pp. 150-7.

- Savin, I & Cingi, C 2012, 'Recent medical devices for tonsillectomy', *Hippokratia*, vol. 16(1), pp. 11-6.
- Sedky, K, Bennett, DS & Carvalho, KS 2014, 'Attention deficit hyperactivity disorder and sleep disordered breathing in pediatric populations: A meta-analysis', *Sleep Medicine Reviews*, vol.18(4), pp. 349-56.
- Shah, UK, Galinkin, J, Chiavacci, R & Briggs, M 2002, 'Tonsillectomy by means of plasma-mediated ablation: prospective, randomized, blinded comparison with monopolar electrosurgery', *Archives of Otolaryngology - Head and Neck Surgery*, vol.128(6), pp. 672-6.
- Shapiro, NL & Bhattacharyya, N 2007, 'Cold dissection versus coblation-assisted adenotonsillectomy in children', *Laryngoscope*, vol.117(3), pp. 406-10.
- Shea, BJ, Grimshaw, JM, Wells, GA, Boers, M, Anderson, N, Hamel, C, Porter, AC, Tugwell, P, Moher, D & Bouter, LM 2007, 'Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews', *BMC Medical Research Methodology*, vol.7(10), doi:10.1186/471-2288-7-10.
- Shiffman, RN, Dixon, J, Brandt, C, Essaihi, A, Hsiao, A, Michel, G & O'Connell, R 2005, 'The GuideLine Implementability Appraisal (GLIA): development of an instrument to identify obstacles to guideline implementation', *BMC Medical Informatics & Decision Making*, vol.5(23).
- Shine, NP, Lannigan, FJ, Coates, HL & Wilson, A 2006, 'Adenotonsillectomy for obstructive sleep apnea in obese children: effects on respiratory parameters and clinical outcome', *Archives of Otolaryngology - Head and Neck Surgery*, vol.132(10), pp. 1123-7.
- Shintani, T, Asakura, K & Kataura, A 1998, 'The effect of adenotonsillectomy in children with OSA', *International Journal of Pediatric Otorhinolaryngology*, vol.44(1), pp. 51-8.
- Sobol, SE, Wetmore, RF, Marsh, RR, Stow, J & Jacobs, IN 2006, 'Postoperative recovery after microdebrider intracapsular or monopolar electrocautery tonsillectomy: a prospective, randomized, single-blinded study', *Archives of Otolaryngology - Head and Neck Surgery*, vol.132(3), pp. 270-4.
- Sofer, S, Weinhouse, E, Tal, A, Wanderman, KL, Margulis, G, Leiberman, A & Gueron, M 1988, 'Cor pulmonale due to adenoidal or tonsillar hypertrophy or both in children. Noninvasive diagnosis and follow-up', *Chest*, vol.93(1), pp. 119-22.
- Sohn, H & Rosenfeld, RM 2003, 'Evaluation of sleep-disordered breathing in children', *Otolaryngology - Head and Neck Surgery*, vol.128(3), pp. 344-52.
- Stewart, MG, Glaze, DG, Friedman, EM, Smith, EO & Bautista, M 2005, 'Quality of life and sleep study findings after adenotonsillectomy in children with obstructive sleep apnea', *Archives of Otolaryngology - Head and Neck Surgery*, vol.131(4), pp. 308-14.
- Stoker, KE, Don, DM, Kang, DR, Hauptert, MS, Magit, A & Madgy, DN 2004, 'Pediatric total tonsillectomy using coblation compared to conventional electrosurgery: a prospective, controlled single-blind study', *Otolaryngology - Head and Neck Surgery*, vol.130(6), pp. 666-75.
- Suen, JS, Arnold, JE & Brooks, LJ 1995, 'Adenotonsillectomy for treatment of obstructive sleep apnea in children', *Archives of Otolaryngology - Head and Neck Surgery*, vol.121(5), pp. 525-30.

- Tal, A, Bar, A, Leiberman, A & Tarasiuk, A 2003, 'Sleep characteristics following adenotonsillectomy in children with obstructive sleep apnea syndrome', *Chest*, vol.124(3), pp. 948-53.
- Tal, A, Leiberman, A, Margulis, G & Sofer, S 1988, 'Ventricular dysfunction in children with obstructive sleep apnea: radionuclide assessment', *Pediatric Pulmonology*, vol.4(3), pp. 139-43.
- Tauman, R, Gulliver, TE, Krishna, J, Montgomery-Downs, HE, O'Brien, LM, Ivanenko, A & Gozal, D 2006, 'Persistence of obstructive sleep apnea syndrome in children after adenotonsillectomy', *Journal of Pediatrics*, vol.149(6), pp. 803-8.
- Temple, RH & Timms, MS 2001, 'Paediatric coblation tonsillectomy', *International Journal of Pediatric Otorhinolaryngology*, vol.61(3), pp. 195-8.
- Teo, DT & Mitchell, RB 2013, 'Systematic review of effects of adenotonsillectomy on cardiovascular parameters in children with obstructive sleep apnea', *Otolaryngology - Head and Neck Surgery*, vol.148(1), pp. 21-8.
- Tezer, MS, Karanfil, A & Aktas, D 2005, 'Association between adenoidal-nasopharyngeal ratio and right ventricular diastolic functions in children with adenoid hypertrophy causing upper airway obstruction', *International Journal of Pediatric Otorhinolaryngology*, vol.69(9), pp. 1169-73.
- Tomkinson, A, Harrison, W, Owens, D, Harris, S, McClure, V & Temple, M 2011, 'Risk factors for postoperative hemorrhage following tonsillectomy', *Laryngoscope*, vol.121(2), pp. 279-88.
- Tran, KD, Nguyen, CD, Weedon, J & Goldstein, NA 2005, 'Child behavior and quality of life in pediatric obstructive sleep apnea', *Archives of Otolaryngology - Head and Neck Surgery*, vol.131(1), pp. 52-7.
- Tunkel, DE, Hotchkiss, KS, Carson, KA & Sterni, LM 2008, 'Efficacy of powered intracapsular tonsillectomy and adenoidectomy', *Laryngoscope*, vol.118(7), pp. 1295-302.
- Ugur, MB, Dogan, SM, Sogut, A, Uzun, L, Cinar, F, Altin, R & Aydin, M 2008, 'Effect of adenoidectomy and/or tonsillectomy on cardiac functions in children with obstructive sleep apnea', *ORL; Journal for Otorhinolaryngology and its Related Specialties*, vol.70(3), pp. 202-8.
- United Nations 2009, *List of country groupings and sub-groupings for the analytical studies of the United Nations World Economic Survey and other UN reports*, United Nations, New York, NY, viewed February 2014, <<http://unpan1.un.org/intradoc/groups/public/documents/un/unpan008092.pdf>>.
- Vasquez, JC, Montes, FM, Rivera, CA, Vargas, SM & Pérez-Padilla, R 2004, 'Clinical predictors of sleep disordered breathing in children at moderate altitude', *Archives of Medical Research*, vol.35(6), pp. 524-31.
- Walker, P & Gilles, D 2007, 'Post tonsillectomy haemorrhage rates: Are they technique dependent?', *Otolaryngology - Head and Neck Surgery*, vol.136(4 Suppl), pp. S27-S31.
- Walker, P, Whitehead, B & Gulliver, T 2008, 'Polysomnographic outcome of adenotonsillectomy for obstructive sleep apnea in children under 5 years old', *Otolaryngology - Head and Neck Surgery*, vol.139(1), pp. 83-6.

- Wang, RC, Elkins, TP, Keech, D, Wauquier, A & Hubbard, D 1998, 'Accuracy of clinical evaluation in pediatric obstructive sleep apnea', *Otolaryngology - Head and Neck Surgery*, vol.118(1), pp. 69-73.
- Weissbach, A, Leiberman, A, Tarasiuk, A, Goldbart, A & Tal, A 2006, 'Adenotonsilectomy improves enuresis in children with obstructive sleep apnea syndrome', *International Journal of Pediatric Otorhinolaryngology*, vol.70(8), pp. 1351-6.
- Wiet, GJ, Bower, C, Seibert, R & Griebel, M 1997, 'Surgical correction of obstructive sleep apnea in the complicated pediatric patient documented by polysomnography', *International Journal of Pediatric Otorhinolaryngology*, vol.41(2), pp. 133-43.
- Yilmaz, MD, Onrat, E, Altuntas, A, Kaya, D, Kahveci, OK, Ozel, O, Derekoy, S & Celik, A 2005, 'The effects of tonsillectomy and adenoidectomy on pulmonary arterial pressure in children', *American Journal of Otolaryngology*, vol.26(1), pp. 18-21.

Appendix A: Literature Search and Retrieval

The search was developed and carried out prior to the study selection process.

Databases searched and search terms

The databases and resources searched are shown in Table A.1. Searches were restricted to studies published in English from January 2005 (January 2009 for CPGs) to December 2014. A focused internet search for HTA reports and CPGs on tonsillectomy, adenoidectomy and adenotonsillectomy in the management of sleep apnoea or tonsillitis was also conducted. In addition, the websites of relevant specialist societies were also searched (Table A.1).

Table A.1: Databases and resources searched

Database	Edition/Date Searched
Ovid MEDLINE (including In-Process & Other Non-Indexed Citations)	2005 to 2014, December 18, 2014 (RCTs) 2009 to 2014, December 18, 2014 (SRs and meta-analyses)
EMBASE	2005 to 2014, December 18, 2014 (RCTs) 2009 to 2014, December 18, 2014 (SRs and meta-analyses)
<i>The Cochrane Library</i>	Issue 7, December 2014 January 1, 2005 to December 18, 2014
NHS Centre for Reviews and Dissemination databases	January 1, 2005 to December 18, 2014
HTA agencies	
Agency for Healthcare Research and Quality (AHRQ) http://search.ahrq.gov/	December 18, 2014
Canadian Agency for Drugs and Technologies in Health (CADTH) http://www.cadth.ca/en/	December 18, 2014
Medical Services Advisory Committee (MSAC) http://www.msac.gov.au/	December 18, 2014
National Institute for Health and Care Excellence http://www.nice.org.uk/	December 18, 2014
Clinical practice guidelines	
BMJ Best Practice http://bestpractice.bmj.com	December 18, 2014
Guidelines International Network (G-I-N) http://www.g-i-n.net/library/international-guidelines-library	December 18, 2014
National Guideline Clearinghouse http://www.guideline.gov/	December 18, 2014
National Health and Medical Research Council Guidelines https://www.nhmrc.gov.au/guidelines	December 18, 2014

Table A.1: Databases and resources searched (cont'd)

Database	Edition/Date Searched
National Institute for Health and Care Excellence guidance http://guidance.nice.org.uk/	December 18, 2014
New Zealand Guidelines Group http://www.health.govt.nz/about-ministry/ministry-health-websites/new-zealand-guidelines-group	December 18, 2014
NHS Evidence in Health and Social Care https://www.evidence.nhs.uk/	December 18, 2014
Scottish Intercollegiate Guidelines Network (SIGN) http://www.sign.ac.uk/search.html	December 18, 2014
World Health Organization http://www.who.int/publications/guidelines/en/	December 18, 2014
Targeted internet search	
Academic Pediatric Association https://www. www.academicpeds.org	December 18, 2014
American Academy of Pediatrics http:// www.aap.org	December 18, 2014
American Sleep Apnea Association http://www.sleepapnea.org/	December 18, 2014
American Society of Pediatric Otolaryngologists http://www.aspo.us	December 18, 2014
Australasian Sleep Association http:// www.sleep.org.au	December 18, 2014
Australian Society of Otolaryngology Head and Neck Surgery http://www.asohns.org.au	December 18, 2014
British Association of Otorhinolaryngologists http://www.entuk.org	December 18, 2014
European Sleep Research Society http:// www.esrs.eu	December 18, 2014
Royal Australasian College of Physicians http:// www.racp.edu.au	December 18, 2014
Sleep Apnoea Trust Association (SATA) http:// www.sleep-apnoea-trust.org	December 18, 2014
VIC Health http://www.health.vic.gov.au/	December 18, 2014

RCT: randomised controlled trial; SR: systematic review

Search terms

For MEDLINE, searches on the key concepts of tonsillectomy, adenoidectomy and adenotonsillectomy as a treatment for sleep apnoea or tonsillitis are detailed in Table A.2. This search was conducted using the Ovid SP platform and was restricted by language, year and study type. The search strategy was also translated and run in EMBASE, *The*

Cochrane Library and the Centre for Reviews and Dissemination databases; searches were restricted by language, year and, where appropriate, publication type. In addition, a NOT MEDLINE limiter was applied to the EMBASE searches.

Table A.2: Ovid MEDLINE search

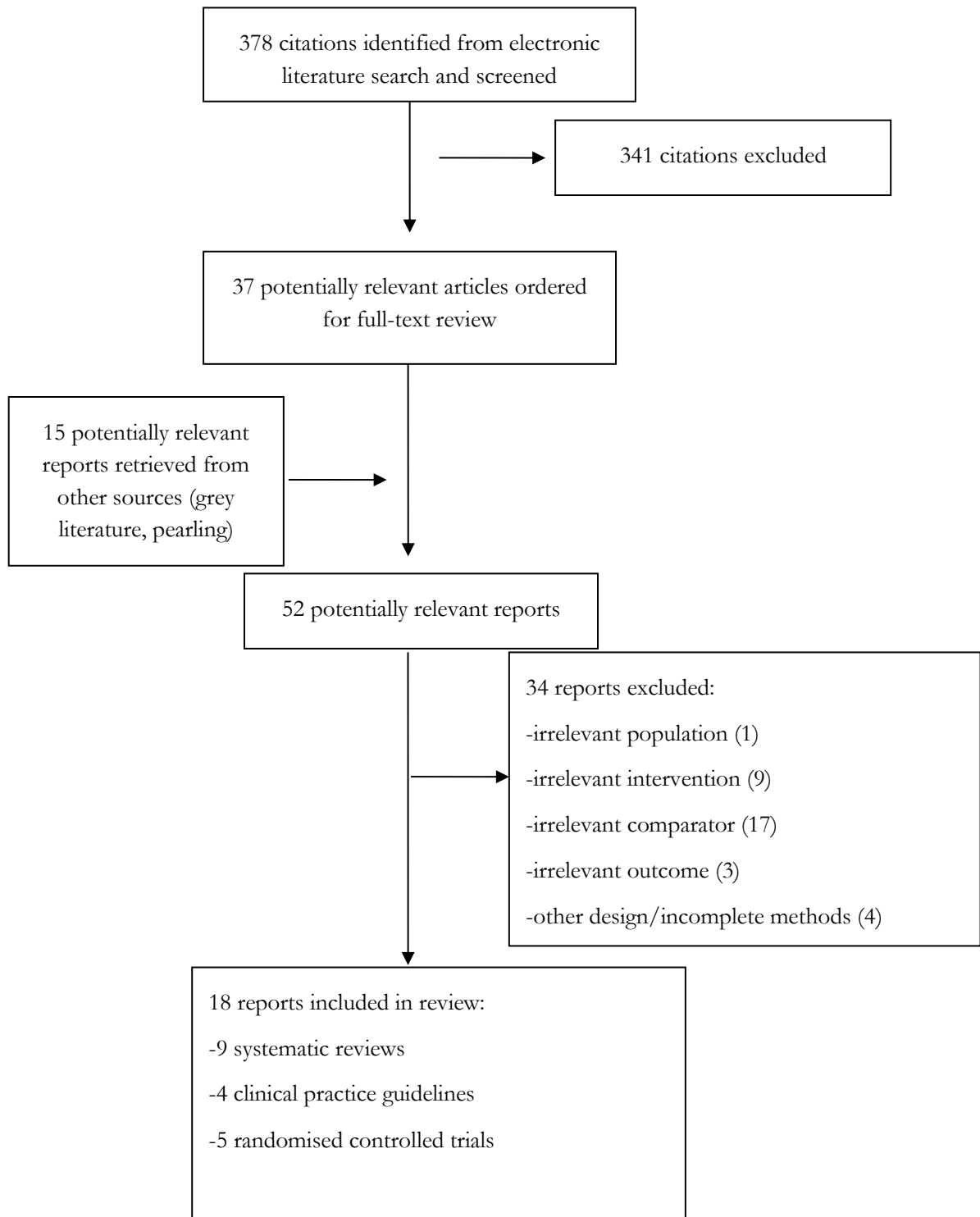
Search ID	Key Concept	Search
1	Tonsillectomy	Exp. Tonsillectomy [MeSH] OR (tonsil* AND (remove* OR surger* OR excision*))
2	Adenoidectomy	Exp. Adenoidectomy [MeSH] OR (adenoid* AND (remove* OR surger* OR excision*))
3	Adenotonsillectomy	Adenotonsil* AND (remove* OR surger* OR excision*)
4	Intervention	1 OR 2 OR 3
5	Sleep apnea	Exp. Sleep Apnea Syndromes [MeSH] OR Exp. obstructive sleep apnea [MeSH] OR Exp. syndrome, upper airway resistance, sleep apnea [MeSH] OR OSA OR (sleep AND (apnoea* OR apnea*))
6	Tonsillitis	Exp. Tonsillitis [MeSH]
7	Population	5 OR 6
8	Tonsillectomy, adenoidectomy or adenotonsillectomy for the treatment of sleep apnoea or tonsillitis	4 AND 7
9	Limited to Systematic reviews	8 restricted SRs and meta-analyses, English language, year 2005 - 2014
10	Limited to clinical trials	8 restricted to RCTs and clinical trials, English language, year 2005 - 2014
11	Limited to Guidelines	8 restricted to CPGs, English language, year 2009 - 2014
12	Combined results	9 OR 10 OR 11

CPG: clinical practice guidelines; RCT: randomised controlled trials; SR: systematic reviews

Note: Ovid SP platform was used to search MEDLINE, EMBASE, *The Cochrane Library* and the Centre for Reviews and Dissemination databases; EMBASE searches were limited to non-MEDLINE journals.

Study selection

Figure A.1: Flow diagram of the study selection process



Appendix B: Evidence Hierarchy

Table B.1: National Health and Medical Research Council evidence hierarchy (Merlin et al. 2009)

Level	Intervention	Diagnostic accuracy	Prognosis	Aetiology	Screening Intervention
I	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies
II	A randomised controlled trial	A study of test accuracy with: an independent, blinded comparison with a valid reference standard, among consecutive persons with a defined clinical presentation	A prospective cohort study	A prospective cohort study	A randomised controlled trial
III-1	A pseudo-randomised controlled trial (i.e. alternate allocation or some other method)	A study of test accuracy with: an independent, blinded comparison with a valid reference standard, among non-consecutive persons with a defined clinical presentation	All or none	All or none	A pseudo-randomised controlled trial (i.e. alternate allocation or some other method)
III-2	A comparative study with concurrent controls: <ul style="list-style-type: none"> Non-randomised, experimental trial Cohort study Case-control study Interrupted time series with a control group 	A comparison with reference standard that does not meet the criteria required for Level II and III-1 evidence	Analysis of prognostic factors amongst persons in a single arm of a randomised controlled trial	A retrospective cohort study	A comparative study with concurrent controls: <ul style="list-style-type: none"> Non-randomised, experimental trial Cohort study Case-control study
III-3	A comparative study without concurrent controls: <ul style="list-style-type: none"> Historical control study Two or more single arm study Interrupted time series without a parallel control group 	Diagnostic case-control study	A retrospective cohort study	A case-control study	A comparative study without concurrent controls: <ul style="list-style-type: none"> Historical control study Two or more single arm study
IV	Case series with either post-test or pre-test/post-test outcomes	Study of diagnostic yield (no reference standard)	Case series, or cohort study of persons at different stages of disease	A cross-sectional study or case series	Case series

Appendix C: Excluded Studies

Irrelevant population

Scottish Intercollegiate Guidelines Network (SIGN) 2010, *Management of sore throat and indications for tonsillectomy*, SIGN, Edinburgh, viewed February 2014, <<http://www.sign.ac.uk/pdf/sign117.pdf>>.

Irrelevant intervention

Aurora, RN, Casey, KR, Kristo, D, Auerbach, S, Bista, SR, Chowdhuri, S, Karippot, A, Lamm, C, Ramar, K, Zak, R & Morgenthaler, TI 2010, 'Practice parameters for the surgical modifications of the upper airway for obstructive sleep apnea in adults', *Sleep*, vol.33(10), pp. 1408-13.

Burton, MJ, Glasziou, PP, Chong, YL & Venekamp, RP 2014, 'Tonsillectomy or adenotonsillectomy versus non-surgical treatment for chronic/recurrent acute tonsillitis', *Cochrane Database of Systematic Reviews*, vol.(11), CD001802.

Epstein, LJ, Kristo, D, Strollo, PJ, Jr., Friedman, N, Malhotra, A, Patil, SP, Ramar, K, Rogers, R, Schwab, RJ, Weaver, EM & Weinstein, MD 2009, 'Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults', *Journal of Clinical Sleep Medicine*, vol.5(3), pp. 263-76.

Fleetham, J, Ayas, N, Bradley, D, Fitzpatrick, M, Oliver, TK, Morrison, D, Ryan, F, Series, F, Skomro, R & Tsai, W 2011, 'Canadian Thoracic Society 2011 guideline update: diagnosis and treatment of sleep disordered breathing', *Canadian Respiratory Journal*, vol.18(1), pp. 25-47.

Franklin, KA, Anttila, H, Axelsson, S, Gislason, T, Maasilta, P, Myhre, KI & Rehnqvist, N 2009, 'Effects and side-effects of surgery for snoring and obstructive sleep apnea: a systematic review', *Sleep*, vol.32(1), pp. 27-36.

Lim, J & McKean, MC 2011, 'Adenotonsillectomy for obstructive sleep apnoea in children', *Cochrane Database of Systematic Reviews*, vol.(2), CD003136.

National Institute for Health and Care Excellence (NICE) 2006, *Tonsillectomy using laser*, NICE, London, viewed February 2015, <<https://www.nice.org.uk/guidance/ipg186>>.

Sundaram, S, Lim, J & Lasserson, TJ 2005, 'Surgery for obstructive sleep apnoea in adults', *Cochrane Database of Systematic Reviews*, vol.(4), CD001004.

Walton, J, Ebner, Y, Stewart, MG & April, MM 2012, 'Systematic review of randomized controlled trials comparing intracapsular tonsillectomy with total tonsillectomy in a pediatric population', *Archives of Otolaryngology - Head and Neck Surgery*, vol.138(3), pp. 243-49.

Irrelevant comparator

- Attner, P, Hemlin, C & Soderman, AC 2010, 'Ligasure versus diathermy scissors tonsillectomy: A controlled randomized study', *Acta Oto-Laryngologica*, vol.130(10), pp. 1180-4.
- Babademez, MA, Yurekli, MF, Acar, B & Gunbey, E 2011, 'Comparison of radiofrequency ablation, laser and coblator techniques in reduction of tonsil size', *Acta Oto-Laryngologica*, vol.131(7), pp. 750-6.
- Clenney, T, Schroeder, A, Bondy, P, Zizak, V & Mitchell, A 2011, 'Postoperative pain after adult tonsillectomy with PlasmaKnife compared to monopolar electrocautery', *Laryngoscope*, vol.121(7), pp. 1416-21.
- D'Eredita, R 2010, 'Tonsillectomy in children: a five-factor analysis among three techniques--reporting upon clinical results, anesthesia time, surgery time, bleeding, and cost', *Laryngoscope*, vol.120(12), pp. 2502-7.
- Ericsson, E, Lundeborg, I & Hultcrantz, E 2009, 'Child behavior and quality of life before and after tonsillotomy versus tonsillectomy', *International Journal of Pediatric Otorhinolaryngology*, vol.73(9), pp. 1254-62.
- Frampton, SJ, Ward, MJ, Sunkaraneni, VS, Ismail-Koch, H, Sheppard, ZA, Salib, RJ & Jain, PK 2012, 'Guillotine versus dissection tonsillectomy: randomised, controlled trial', *Journal of Laryngology & Otology*, vol.126(11), pp. 1142-9.
- Haraldsson, PO, Attner, P, Fredelius, L & Strander, B 2011, 'Intrapersonal randomized controlled trial comparing bipolar scissors and conventional cold tonsillectomy', *Otorhinolaryngology Clinics*, vol.3(2), pp. 79-83.
- Jones, DT, Kenna, MA, Guidi, J, Huang, L, Johnston, PR & Licameli, GR 2011, 'Comparison of postoperative pain in pediatric patients undergoing coblation tonsillectomy versus cautery tonsillectomy', *Otolaryngology - Head and Neck Surgery*, vol.144(6), pp. 972-7.
- Karatzanis, A, Bourolas, C, Prokopakis, E, Panagiotaki, I & Velegrakis, G 2008, 'Thermal welding technology vs ligasure tonsillectomy: a comparative study', *American Journal of Otolaryngology*, vol.29(4), pp. 238-41.
- Kemal, O 2012, 'Harmonic scalpel versus bipolar tonsillectomy: a double-blind clinical trial', *European Archives of Oto-Rhino-Laryngology*, vol.269(5), pp. 1533-6.
- Lachanas, VA, Prokopakis, EP, Bourolas, CA, Karatzanis, AD, Malandrakis, SG, Helidonis, ES & Velegrakis, GA 2005, 'Ligasure versus cold knife tonsillectomy', *Laryngoscope*, vol.115(9), pp. 1591-4.
- Lock, C, Wilson, J, Steen, N, Eccles, M, Mason, H, Carrie, S, Clarke, R, Kubba, H, Raine, C, Zarod, A, Brittain, K, Vanoli, A & Bond, J 2010, 'North of England and Scotland Study of Tonsillectomy and Adeno-tonsillectomy in

- Children(NESSTAC): a pragmatic randomised controlled trial with a parallel non-randomised preference study', *Health Technology Assessment*, vol.14(13), pp. 1-164.
- Ozkiris, M, Kapusuz, Z & Saydam, L 2013, 'Comparison of three techniques in adult tonsillectomy', *European Archives of Oto-Rhino-Laryngology*, vol.270(3), pp. 1143-7.
- Sezen, OS, Kaytanci, H, Kubilay, U, Coskuner, T & Unver, S 2008, 'Comparison between tonsillectomy with thermal welding and the conventional 'cold' tonsillectomy technique', *ANZ Journal of Surgery*, vol.78(11), pp. 1014-8.
- Stephens, J, Singh, A, Hughes, J, Goswami, T, Ghufloor, K & Sandhu, G 2009, 'A prospective multi-centre randomised controlled trial comparing PlasmaKnife with bipolar dissection tonsillectomy: evaluating an emerging technology', *International Journal of Pediatric Otorhinolaryngology*, vol.73(4), pp. 597-601.
- Wilson, YL, Merer, DM & Moscatello, AL 2009, 'Comparison of three common tonsillectomy techniques: a prospective randomized, double-blinded clinical study', *Laryngoscope*, vol.119(1), pp. 162-70.
- Yilmaz, M, Duzlu, M, Catli, T, Ustun, S & Ceylan, A 2012, 'Thermal welding versus cold knife tonsillectomy: a prospective randomized study', *Kaohsiung Journal of Medical Sciences*, vol.28(5), pp. 270-2.

Irrelevant outcome

- Gleich, SJ, Olson, MD, Sprung, J, Weingarten, TN, Schroeder, DR, Warner, DO & Flick, RP 2012, 'Perioperative outcomes of severely obese children undergoing tonsillectomy', *Paediatric Anaesthesia*, vol.22(12), pp. 1171-8.
- National Institute for Health and Care Excellence (NICE) 2009, *Suction diathermy adenoidectomy*, NICE, London, viewed February 2015, <<https://www.nice.org.uk/guidance/ipg328>>.
- Polites, N, Joniau, S, Wabnitz, D, Fassina, R, Smythe, C, Varley, P & Carney, AS 2006, 'Postoperative pain following coblation tonsillectomy: Randomized clinical trial', *ANZ Journal of Surgery*, vol.76(4), pp. 226-9.

Other design or incomplete methods

- Isaacson, G 2012, 'Tonsillectomy care for the pediatrician', *Pediatrics*, vol.130(2), pp. 324-34.
- Mäkelä, M 2014, *Sore throat and tonsillitis*, Duodecim Medical Publications Ltd 2014, viewed February 2015, <<http://www.ebm-guidelines.com/dtk/ebmg/home>>.
- Redline, S, Amin, R, Beebe, D, Chervin, RD, Garetz, SL, Giordani, B, Marcus, CL, Moore, RH, Rosen, CL, Arens, R, Gozal, D, Katz, ES, Mitchell, RB, Muzumdar, H, Taylor, HG, Thomas, N & Ellenberg, S 2011, 'The Childhood Adenotonsillectomy Trial (CHAT): rationale, design, and challenges of a

randomized controlled trial evaluating a standard surgical procedure in a pediatric population', *Sleep*, vol.34(11), pp. 1509-17.

Surgical Speciality Associations and Royal College of Surgeons 2013, *Commissioning guide for tonsillectomy*, viewed February 2015,

<<https://entuk.org/sites/default/files/files/RCSEng%20and%20ENT-UK%20Commissioning%20Guide%20-%20Tonsillectomy%20-%20out%20for%20consultation%2017%20May%20-%2014%20June%202013.pdf>>.

Appendix D: Summary of Evidence

Table D.1: Grading of recommendations and levels of evidence in CPGs on the treatment of sleep apnoea in children

Study, Country	Recommendation Grading	Evidence Categories/Grading
AAP Marcus et al. (2012) United States	<p>A. Strong recommendation: anticipated benefits clearly exceed the harms and the quality of supporting evidence is excellent. In some circumstances, strong recommendations may be made when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh harms. Evidence quality A: well-designed RCTs or diagnostic studies in relevant population; or B: RCTs or diagnostic studies with minor limitations; consistent observational studies.</p> <p>B. Recommendation: anticipated benefits exceed the harms but the quality of evidence is not as strong. In some circumstances, recommendations may be made when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh harms. Evidence quality A: well-designed RCTs or diagnostic studies in relevant population; B: RCTs or diagnostic studies with minor limitations or consistent observational studies; or C: observational studies.</p> <p>C. Option: define courses that may be taken when either the quality of evidence is suspect or carefully performed studies show little clear advantage to one approach over another. Evidence quality D: expert opinion, case reports, reasoning from first principles.</p> <p>D. No recommendation: there is a lack of pertinent published evidence and the anticipated balance of benefits and harms is presently unclear. Evidence quality D: expert opinion, case reports, reasoning from first principles.</p>	<p>I: Evidence from a prospective study in a broad spectrum of persons with suspected condition based on gold standard diagnostic test applied blinded. All persons undergoing diagnostic test have the presence or absence of the disease determined. Level I studies have a low risk of bias.</p> <p>II: Evidence from a prospective study of a narrow spectrum of persons with suspected condition, or well-designed retrospective study of a broad spectrum of persons who have an established condition based on gold standard diagnostic test applied blinded. Level II studies have a moderate risk of bias.</p> <p>III: Evidence from a retrospective study in which either persons with the established condition or controls are of a narrow spectrum and in which the reference standard, if not objective, is applied by someone other than the person who performed (interpreted) the test. Level III studies have moderate to high risk of bias.</p> <p>IV: Any study design where the test is not applied in an independent evaluation, or evidence is provided by expert opinion alone or in descriptive case series without controls. Blinding may be inadequate and the spectrum of persons tested may be broad or narrow. Level IV studies have high risk of bias.</p>
AAO-HNS Baugh et al. (2011) United States	<p>A. Strong recommendation: benefits of recommended approach clearly exceed harms and the quality of the supporting evidence is excellent (Grade A or B). In some circumstances, strong recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and anticipated benefits strongly outweigh harms.</p> <p>B. Recommendation: the benefits exceed the harms, but the quality of evidence is not as strong (Grade B or C). In some circumstances, recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits outweigh the harms.</p> <p>C. Option: either the quality of evidence is suspect (Grade D) or the well-done studies (Grade A, B or C) show little clear advantage to one approach versus another.</p> <p>D. No recommendation: there is both a lack of pertinent evidence (Grade D) and an unclear balance between benefits and harms.</p>	<p>A: Well-designed RCTs or diagnostic studies performed on a population similar to the guideline's target population.</p> <p>B: RCTs or diagnostic studies with minor limitations; consistent evidence from observational studies.</p> <p>C: Observational studies (case-control and cohort design)</p> <p>D: Case reports, reasoning from first principles (bench research or animal studies)</p> <p>X: Exceptional situations in which validating studies cannot be performed and there is clear preponderance of benefit over harm.</p>

Table D.1: Grading of recommendations and levels of evidence in CPGs on the treatment of sleep apnoea in children (cont'd)

Study, Country	Recommendation Grading	Evidence Categories/Grading
AAO-HNS Roland et al. (2011) United States	<p>A. Strong recommendation: benefits of recommended approach clearly exceed harms and the quality of the supporting evidence is excellent (Grade A or B). In some circumstances, strong recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and anticipated benefits strongly outweigh harms.</p> <p>B. Recommendation: the benefits exceed the harms, but the quality of evidence is not as strong (Grade B or C). In some circumstances, recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits outweigh the harms.</p> <p>C. Option: either the quality of evidence that exists is suspect (Grade D) or the well-done studies (Grade A, B, or C) show little clear advantage to one approach versus another.</p> <p>D. No recommendation: there is both a lack of pertinent evidence (Grade D) and an unclear balance between benefits and harms.</p>	<p>A: Well-designed RCTs or diagnostic studies performed on a population similar to the guideline's target population.</p> <p>B: RCTs or diagnostic studies with minor limitations; consistent evidence from observational studies.</p> <p>C: Observational studies (case-control and cohort design)</p> <p>D: Case reports, reasoning from first principles (bench research or animal studies)</p> <p>X: Exceptional situations in which validating studies cannot be performed and there is clear preponderance of benefit over harm.</p>
RACP-ASOHNS (2008) Australia	<p>A. Body of evidence can be trusted to guide practice.</p> <p>B. Body of evidence can be trusted to guide practice in most situations.</p> <p>C. Body of evidence provides some support for recommendations, but care should be taken in its application.</p> <p>D. Body of evidence is weak and recommendation must be applied with caution.</p>	<p>I: Systematic review of level II studies.</p> <p>II: RCT</p> <p>III-1: Pseudo-RCT (alternate allocation or other method)</p> <p>III-2: Comparative study with concurrent controls</p> <p>III-3: Comparative study without concurrent controls</p> <p>IV: Case series with either post-test or pre-test/post-test outcomes</p>

AAP: American Academy of Pediatrics; AAO-HNS: American Academy of Otolaryngology-Head and Neck Surgery; RACP-ASOHNS: Royal Australasian College of Physicians and the Australian Society of Otolaryngology-Head and Neck Surgery; RCT: randomised controlled trial

Table D.2: Summary of critical appraisal of CPGs on the treatment of sleep apnoea in children

Study, Country	Strengths	Limitations
AAP Marcus et al. (2012) United States	<p>The objective was to update the CPG on the diagnosis and management of childhood OSA by the AAP.</p> <p>Research questions, target patient populations, users, interventions and outcomes were specified.</p> <p>The GDG included expertise in OSA, paediatrics, sleep medicine, paediatric pulmonology, paediatric otolaryngology, neonatology, clinical psychology and general paediatrics.</p> <p>Evidence was identified by systematically searching PubMed, Scopus, Ovid, PsycINFO, EBSCO (including Health Source Nursing, Child Development and Adolescent Studies) and CINAHL from 1999 to 2011.</p> <p>Evidence was graded based on a system developed by the American Academy of Neurology.</p> <p>Key action items identified, appraised and summarised with an explicit link between evidence and recommendations.</p> <p>Evidence-based recommendations reflected the quality of evidence and the balance of benefit and harm as per AAP policy.</p> <p>All working group members reviewed final recommendations.</p> <p>All authors filed conflict of interest statements with the AAP and industry was not involved in the development of the CPG.</p>	<p>Grey literature sources were not systematically searched resulting in possible publication bias and overestimation of the treatment effect in favour of the intervention.</p> <p>While risk factors for OSA included adenotonsillar hypertrophy, obesity, craniofacial anomalies and neuromuscular disorders, only the first two risk factors were considered in developing the CPG. Patient populations of potential relevance may not have been included as articles involving infants and children with craniofacial anomalies or syndromes were excluded from review.</p> <p>While two committee members screened titles and abstracts, a single committee member reviewed and graded the selected articles. Because of the large volume of articles, members recruited trainees and colleagues to assist in reviewing the articles, which may have led to inconsistencies in study selection.</p> <p>While the quality of OSA studies had improved since the original guideline, there were few randomised, blinded, controlled studies. Many studies used standard definitions for paediatric PSG scoring, but the AHI criterion used for diagnosis or to determine treatment varied widely.</p> <p>The views and preferences of the target population or caregivers were not sought.</p> <p>Key review criteria for monitoring or audit were not clearly reported.</p> <p>A procedure for updating the guideline was not reported, but the guideline expires five years after publication.</p> <p>Barriers and implementation strategies were not reported.</p>
AAO-HNS Baugh et al. (2011) United States (Cont'd over page)	<p>The purpose was to provide clinicians with evidence-based guidance in identifying children who are the best candidates for tonsillectomy, to optimise management and to reduce inappropriate variations in care.</p> <p>The CPG was developed using an a priori protocol and evidence was identified by systematically searching selected databases for CPGs, SRs and RCTs from 1995 to 2010.</p> <p>Research questions, target populations and users were specified.</p> <p>The Guideline Implementability Appraisal tool (Shiffman et al. 2005) was used to appraise adherence of the draft guideline to methodological standards, to improve the clarity of recommendations and to predict obstacles to implementation.</p> <p>The CPG was pilot tested with a multidisciplinary group of external reviewers, which was representative of the target audience, for feedback and comment prior to publication; the CPG was compared with guidelines by other groups.</p>	<p>The CPG was not intended to apply to populations excluded from most tonsillectomy research studies, such as patients with diabetes, cardiopulmonary disease, craniofacial disorders, congenital anomalies, immunodeficiency and sickle cell disease or other coagulopathies.</p> <p>The views and preferences of the target population or caregivers were not sought.</p>

Table D.2: Summary of critical appraisal of CPGs on the treatment of sleep apnoea in children (cont'd)

Study, Country	Strengths	Limitations
AAO-HNS Baugh et al. (2011) United States (cont'd)	Implementation strategy and tools were provided. Considered costs and resource implications of applying the recommendations. A scheduled review process will occur five years from publication, or sooner if new evidence warrants consideration. Funding source and conflicts of interests were provided.	
AAO-HNS Roland et al. (2011) United States	The objective was to provide otolaryngologists with evidence-based recommendations for using PSG to assess children with SDB who are candidates for tonsillectomy, with or without adenoidectomy. Research questions, target populations and users were specified. The CPG was developed using an a priori protocol and evidence was identified by systematically searching selected databases for CPGs, SRs and RCTs up to 2010. Recommendations were based on best available published data up to 2010 and the strengths and limitations of the evidence were clearly described. The CPG was peer reviewed and approved by the GDG. Implementation strategies included publishing supplements in journals, presenting the CPG at meetings, publishing brochures and providing free access to the full-text version of the CPG. A scheduled review will occur five years after publication, or sooner if new evidence warrants consideration. Funding and conflicts of interest were reported.	Grey literature sources were not systematically searched resulting in possible publication bias and overestimation of the treatment effect in favour of the intervention. Barriers to implementation were not reported. The views and preferences of the target population or caregivers were not sought.
RACP-ASOHNS (2008) Australia	The objective was to review existing literature on the indications for tonsillectomy and adenotonsillectomy and make recommendations about policy and practice in order to bring Fellows from different colleges to a common understanding of recent literature. The GDG comprised members of the RACP-ASOHNS with expertise in paediatric surgery, paediatric respiratory and sleep medicine, otolaryngology, paediatrics and infectious diseases. The research question, target population and end users were specified. Key recommendations were easily identifiable, explicitly linked to supporting evidence and considered the health benefits and risks.	While members of the GDG undertook searches of the medical literature for studies that described indications for tonsillectomy or adenotonsillectomy in children, detailed systematic search criteria were not listed. Methods regarding how studies were selected and assessed for quality were not reported. Methods by which recommendations were formulated were not reported. The views and preferences of the target population or caregivers were not sought. Facilitators and barriers to implementation were not discussed. Resource implications and audit criteria for monitoring and audit were not reported.

AAO-HNS: American Academy of Otolaryngology-Head and Neck Surgery; AAP: American Academy of Pediatrics; AHI: apnoea-hypopnea index; CINAHL: Cumulative Index to Nursing and Allied Health Literature; CPG: clinical practice guideline; GDG: guideline development group; OSA: obstructive sleep apnoea; PSG: polysomnography; SDB: sleep disordered breathing; SR: systematic review; RACP-ASOHNS: Royal Australasian College of Physicians and the Australian Society of Otolaryngology-Head and Neck Surgery; RCT: randomised controlled trial

Table D.3: CPG recommendations on the treatment of sleep apnoea in children

Guideline, Author, Year, Country	Recommendations
AAP Marcus et al. (2012) United States	<p>PSG should be performed in children or adolescents with snoring and symptoms or signs of OSA [Grade A recommendation]. If PSG is not available, alternative diagnostic tests or referral to a specialist for extensive evaluation may be considered [Grade D recommendation].</p> <p>Adenotonsillectomy is the primary treatment for OSA in children with adenotonsillar hypertrophy without contraindications for surgery. Other treatments should be considered if a child has OSA but does not have adenotonsillar hypertrophy [Grade B recommendation].</p> <p>Clinical judgement is needed to weigh the benefits of adenotonsillectomy compared with other treatments in obese children with varying degrees of adenotonsillar hypertrophy [Grade B recommendation].</p> <p>Data are insufficient to recommend specific surgical techniques; however, children undergoing partial tonsillectomy should be monitored for possible recurrence of OSA.</p> <p>High-risk patients (<3 years of age, severe OSA, cardiac complications, failure to thrive, obesity, craniofacial anomalies, neuromuscular disorders or respiratory infection) undergoing adenotonsillectomy should be monitored as inpatients postoperatively [Grade B recommendation].</p> <p>Clinicians should clinically reassess all patients with OSA for persisting signs and symptoms after therapy to determine whether further treatment is required [Grade B recommendation].</p> <p>Clinicians should refer patients for CPAP management if symptoms persist, if there is objective evidence of OSA after adenotonsillectomy or if adenotonsillectomy is not performed [Grade B recommendation].</p> <p>Adenotonsillectomy is contraindicated in patients with no adenotonsillar tissue, small tonsils/adenoids, morbid obesity and small tonsils/adenoids, bleeding disorders refractory to treatment, submucous cleft palate and conditions that make them unstable for surgery.</p>
AAO-HNS Baugh et al. (2011) United States	<p>Clinicians should ask caregivers of children with SDB and tonsillar hypertrophy about comorbid conditions that might improve after tonsillectomy, including growth retardation, poor school performance, enuresis and behavioural problems [Grade C recommendation based on observational before-and-after studies with preponderance of benefit over harm].</p> <p>Clinicians should counsel caregivers about tonsillectomy as a means to improve health in children with abnormal PSG who also have tonsillar hypertrophy and SDB [Grade C recommendation based on observational before-and-after studies with a preponderance of benefit over harm].</p> <p>Clinicians should counsel caregivers and explain that SDB may persist or recur after tonsillectomy and may require further management. Tonsillectomy is effective for control of SDB in 60% to 70% of children with significant tonsillar hypertrophy. Tonsillectomy produces resolution of SDB in only 10% to 25% of obese children [Grade C recommendation based on observational, case-control and cohort studies with a preponderance of benefit over harm].</p> <p>Clinicians who perform tonsillectomy should determine their rates of primary and secondary post-tonsillectomy haemorrhage at least annually [Grade C recommendation based on observational studies with a preponderance of benefit over harm].</p>

Table D.3: CPG recommendations on the treatment of sleep apnoea in children (cont'd)

Guideline, Author, Year, Country	Recommendations
AAO-HNS Roland et al. (2011) United States	<p>Clinicians should refer children with SDB for PSG if they exhibit complex medical conditions such as obesity, Down syndrome, craniofacial abnormalities, neuromuscular disorders, sickle cell or mucopolysaccharidoses [Grade C recommendation based on observational studies with a preponderance of benefit over harm].</p> <p>Clinicians should advocate for PSG prior to tonsillectomy for SDB in children without any of the comorbidities listed above and for whom the need for surgery is uncertain or when there is discordance between tonsillar size on physical examination and the reported severity of SDB [Grade C recommendation based on observational and case-control studies with a preponderance of benefit over harm].</p> <p>Clinicians should communicate PSG results to the anaesthesiologist prior to the induction of anaesthesia for tonsillectomy in a child with SDB [Grade C recommendation based on observational studies with a preponderance of benefit over harm].</p> <p>Clinicians should admit children with OSA documented on PSG for inpatient, overnight monitoring after tonsillectomy if they are younger than 3 years or have severe OSA (AHI >10 events/hour, oxygen saturation <80% or both) [Grade C recommendation based on observational studies with a preponderance of benefit over harm].</p> <p>In children for whom PSG is indicated to assess SDB prior to tonsillectomy, clinicians should obtain laboratory-based PSG when available [Grade C recommendation based on diagnostic studies with limitations and a preponderance of benefit over harm].</p>
RACP-ASOHS (2008) Australia	<p>Rates of adenotonsillectomy for OSA in Australia and New Zealand are currently suboptimal. An increase in access to adenotonsillectomy for children with moderate or severe OSA is urgently required. Outpatient and surgical waiting lists should reflect this priority. Given the potential for permanent, long-term adverse effects in the younger age group, children under 5 years of age should be the first target group for increased services.</p> <p>Improved epidemiological data are urgently required. Funding of appropriately randomised clinical studies that measure the outcomes from adenotonsillectomy in mild or moderate OSA and assess the role of tonsillectomy in recurrent sore throat should be a priority. These results are required before making further alterations to the recommended indications for surgery.</p> <p>Current indications for tonsillectomy or adenotonsillectomy are: upper airway obstruction in children with OSA; frequent recurrent acute tonsillitis; peritonsillar abscess; suspected neoplasm; and certain uncommon indications. Tonsillectomy should be conducted for frequent, recurrent acute tonsillitis per the Paradise criteria.</p> <p>All children who have surgical removal of tonsils for moderate and severe OSA should be monitored as inpatients postoperatively [Grade C recommendation].</p> <p>High-risk children for tonsillectomy or adenotonsillectomy should be identified and their operation should be performed in a hospital with appropriate paediatric intraoperative and postoperative airway support services.</p> <p>Adenotonsillectomy is the first-line of therapy after diagnosis of significant upper airway obstruction (moderate to severe OSA) in children with SDB [Grade B recommendation]. While PSG data are used in classification, the clinically significant level of obstructive events index on PSG is unknown.</p> <p>Tonsillectomy or adenotonsillectomy is indicated for episodes of recurrent acute tonsillitis. As a guide, seven episodes in the preceding 12 months, or five in each year for 24 months or three per year for 3 years. Account should be taken of the clinical severity of the episodes and that this may result in as little as one less episode of sore throat with fever per year [Grade B recommendation].</p> <p>Tonsillectomy in peritonsillar abscess should be based on past history of recurrent tonsillitis and co-morbidities [Grade C recommendation].</p> <p>Suspected neoplasm is an absolute indication for tonsillectomy [Grade B recommendation]. Chronic diphtheria carrier status after failed antibiotic eradication, recurrent large tonsilloliths or tonsillar cysts and recurrent tonsillar haemorrhage are also (uncommon) indications for tonsillectomy [Grade D recommendation].</p>

AAO-HNS: American Academy of Otolaryngology-Head and Neck Surgery; AAP: American Academy of Pediatrics; AHI: apnoea-hypopnea index; CPAP: continuous positive airway pressure; OSA: obstructive sleep apnoea; PSG: polysomnography; SDB: sleep disordered breathing; RACP-ASOHS: Royal Australasian College of Physicians and the Australian Society of Otolaryngology-Head and Neck Surgery

Table D.4: Summary of systematic review characteristics

Study, Country	Study Design	Patient Characteristics	Intervention	Comparator	Outcomes Measured
<i>Systematic reviews on the treatment of sleep apnoea in children</i>					
Sedky et al. (2014) United States	SR and MA of 12 studies (Chervin et al. 2012; Dillon et al. 2007; Galland et al. 2006; Giordani et al. 2012; Huang et al. 2007; Lewin et al. 2002; Li et al. 2006; Mitchell 2007; Mitchell and Boss 2009; Mitchell and Kelly 2005; Mitchell and Kelly 2006; Tran et al. 2005) Participants: 529 Literature search: up to 2012 Follow-up: 2 to 13 months post-surgery	Children aged 0 to 18 years; SDB diagnosed using PSG; ADHD symptoms based on parent and/or teacher ADHD symptom rating scale or clinician-based ADHD diagnosis Mean age: 8 years	Tonsillectomy or adenotonsillectomy	Pre-surgery	ADHD symptoms
Teo and Mitchell (2013) United States	SR of 14 studies (Amin et al. 2008; Apostolidou et al. 2008; Atiq et al. 2004; Cohen et al. 2010; Constantin et al. 2008; Duman et al. 2008; Gorur et al. 2001; Naiboglu et al. 2008; Ng et al. 2010; Sofer et al. 1988; Tal et al. 1988; Tezer et al. 2005; Ugur et al. 2008; Yilmaz et al. 2005) Participants: 418 Literature search: 1970 to 2012 Follow-up: Not reported	Children aged 2 to 10 years; OSA diagnosed by PSG or clinical criteria Mean age: 6 years (range 2 to 10)	Adenotonsillectomy	Pre-surgery	Cardiovascular parameters including blood pressure, heart rate, cardiac morphology and function
Jeyakumar et al. (2012) United States	SR of 7 studies (Aydil et al. 2008; Basha et al. 2005; Cinar et al. 2001; Elsherif and Kareemullah 1999; Firoozi et al. 2006; Kalorin et al. 2010; Weissbach et al. 2006) Participants: 1,360 Literature search: 1988 to 2010 Follow-up: 6 months	Children aged 2 to 18 years; clinical diagnosis of SDB and NE Mean age: 6 years (range 2 to 18)	Adenotonsillectomy	Pre-surgery	Prevalence of NE
Friedman et al. (2009) United States	SR of 23 studies (Bar et al. 1999; Chervin et al. 2007; Goldstein et al. 2004; Gozal et al. 2008; Guilleminault et al. 2007; Mitchell 2007; Mitchell and Kelly 2004a; Mitchell and Kelly 2004b; Mitchell and Kelly 2005; Mitchell and Kelly 2007b; Nieminen et al. 2000; Nishimura et al. 1996; O'Brien et al. 2006; Shine et al. 2006; Shintani et al. 1998; Stewart et al. 2005; Suen et al. 1995; Tal et al. 2003; Tauman et al. 2006; Tunkel et al. 2008; Walker et al. 2008; Wang et al. 1998; Wiet et al. 1997) Participants: 1,079 Literature search: up to 2008 Follow-up: Not reported	Children <20 years; OSA diagnosed by PSG Mean age: 6.5 years (range 3 to 9)	Adenotonsillectomy	Pre-surgery	Percentage of patients successfully treated based on PSG parameters showing resolution of OSA as normalised PSG

Table D.4: Summary of systematic review characteristics (cont'd)

Study, Country	Study Design	Patient Characteristics	Intervention	Comparator	Outcomes Measured
Costa and Mitchell (2009) United States	SR and MA of 4 studies (Mitchell and Kelly 2004a; Mitchell and Kelly 2007a; O'Brien et al. 2006; Shine et al. 2006) Participants: 110 Literature search: 1998 to 2008 Follow-up: 3 to 6 months	Children aged 0 to 18 with BMI >95 th percentile; OSA based on PSG; undergoing adenotonsillectomy Mean age range: 7 to 9 Mean BMI range: 28 to 32 kg/m ²	Adenotonsillectomy	Pre-surgery	Resolution of OSA based on PSG measures
Baldassari et al. (2008) United States	SR of 7 studies (Flanary 2003; Goldstein et al. 2002; Mitchell and Kelly 2004a; Mitchell and Kelly 2004b; Mitchell and Kelly 2005; Sohn and Rosenfeld 2003; Tran et al. 2005) Participants: 369 Literature search: 1970 to 2005 Follow-up: 4 weeks to 6 months post-surgery	Children age 0 to 18 with OSA diagnosed by PSG or clinical symptoms; Child Health Questionnaire assessment of QOL Mean age: 6.3 (range 5.3 to 7.1)	Adenotonsillectomy	Pre-surgery	QOL using the OSA-18 quality-of-life questionnaire
Brietzke and Gallagher (2006) United States	SR of 14 studies (Avelino et al. 2002; Bar et al. 1999; Eliaschar et al. 1980; Frank et al. 1983; Guilleminault et al. 2004; Mora et al. 2003; Nieminen et al. 2000; Nishimura et al. 1996; Nuyens et al. 2009; Shintani et al. 1998; Suen et al. 1995; Tal et al. 2003; Wang et al. 1998; Wiet et al. 1997) Participants: 342 Literature search: up to 2005 Follow-up: Not reported	Children aged 0 to 18 with OSA diagnosed by PSG or clinical symptoms Mean age range: 5 to 8 years	Adenotonsillectomy	Pre-surgery	Resolution of OSA based on PSG measures
Systematic reviews on tonsillectomy in adults and children					
Pinder et al. (2011) United Kingdom	SR of 2 studies (Kujawski et al. 1997; Nunez et al. 2000) Participants: 254 Literature search: up to 2010 Follow-up: Not reported	Adults and children undergoing tonsillectomy in an inpatient setting Range: ≥3 years	Dissection tonsillectomy	Diathermy tonsillectomy	Intraoperative blood loss, primary (within 24 hours of surgery) and secondary (>24 hours after surgery) blood loss
Burton and Doree (2007) United Kingdom	SR of 8 studies (Anthony et al. 2006; Back et al. 2001; Jayasinghe et al. 2005; Philpott et al. 2005; Shah et al. 2002; Sobol et al. 2006; Stoker et al. 2004; Temple and Timms 2001) Participants: 6,901 participants Literature search: up to 2006 Follow-up: Not reported	Adults and children undergoing tonsillectomy in an inpatient setting Age: 3 to 65 years	Coblation tonsillectomy	Other surgical techniques	Pain, haemorrhage

ADHD: attention deficit hyperactivity disorder; BMI: body mass index; MA: meta-analysis; NE: nocturnal enuresis; OSA: obstructive sleep apnoea; PSG: polysomnography; QOL: quality of life; SDB: sleep disordered breathing; SR: systematic review

Table D.5: Summary of critical appraisal of the included systematic reviews

Study, Country	Strengths	Limitations
<i>Systematic reviews on the treatment of sleep apnoea in children</i>		
Sedky et al. (2014) United States	Comprehensive literature search based on predefined criteria. Grey literature search for unpublished literature to minimise source bias. Study selection by two independent reviewers according to well-defined criteria. Reasons for excluding studies were reported. Data were extracted and assessed for quality using the Newcastle-Ottawa scale and verified by a second author. Study quality was considered in formulating results and conclusions. Authors reported no conflicts of interest.	A list of excluded studies was not reported. Funding source was not reported.
Teo and Mitchell (2013) United States	Inclusion and exclusion criteria were determined a priori. Two reviewers selected studies and reported the process in a PRISMA flow chart. Reasons for excluding studies were reported. Two reviewers independently extracted data and assessed study quality based on the level of evidence. Risk of bias was assessed according to method of data collection; PSG criteria used to diagnose OSA; consecutive study sampling; losses to follow-up reported and multivariate statistical data analysis used. Characteristics of included studies were provided in supplemental tables. Authors reported no funding source or conflicts of interest.	Evidence may be incomplete; only one electronic literature database was searched. Risk of source and time lag bias as the authors failed to report searching for grey literature. A list of excluded studies was not reported.
Jeyakumar et al. (2012) United States	Inclusion and exclusion criteria were predefined. Characteristics of included studies were provided. Authors reported having no funding, financial relationships or conflicts of interest to disclose.	Evidence may be incomplete; only two electronic literature sources were searched. Potential for bias in the selection of studies. Methods of study selection and data extraction were not reported. It was unclear whether the included studies were assessed for quality or risk of bias. It was unclear whether the quality of the included studies was considered in formulating conclusions.

Table D.5: Summary of critical appraisal of the included systematic reviews (cont'd)

Study, Country	Strengths	Limitations
Friedman et al. (2009) United States	<p>Comprehensive literature search of three electronic databases performed independently by two reviewers using keywords.</p> <p>Two reviewers independently selected studies based on predefined criteria.</p> <p>The quality of included articles was reviewed by the entire research group and level of evidence was determined according to the Centre for Evidence-Based Medicine guidelines.</p> <p>Data were meta-analysed using a random-effects model and heterogeneity was assessed using I^2 statistic.</p> <p>Publication bias was assessed using a funnel plot, or Begg and Mazumdar or Egger's test.</p> <p>Conflicts of interest were disclosed.</p>	<p>Funding source not reported.</p> <p>Studies on children with identified craniofacial, chromosomal or neuromuscular syndromes were excluded from the review, which may have resulted in the exclusion of a population of interest for OSA.</p>
Costa and Mitchell (2009) United States	<p>Two authors independently selected studies based on predefined criteria.</p> <p>Data were meta-analysed using a random-effects model and heterogeneity was measured in terms of the I^2 statistic.</p> <p>Publication bias was assessed using a funnel plot and calculation of the Egger's intercept to determine asymmetry.</p> <p>Authors reported no financial disclosures, but they did report a potential conflict with one authors' involvement in two studies included in the meta-analysis.</p>	<p>Relevant literature may have been missed as searching was limited to two electronic databases.</p> <p>Risk of source and time lag bias as the authors did not report searching for grey literature.</p> <p>Possible overestimate of effectiveness in favour of intervention.</p> <p>It was unclear whether the quality of the included studies was assessed or used in formulating conclusions.</p>
Baldassari et al. (2008) United States	<p>Two reviewers independently selected studies based on predefined criteria.</p> <p>Data were meta-analysed using a random-effects model.</p> <p>Authors reported no financial disclosure.</p>	<p>Relevant evidence may have been missed as searching was limited to PubMed.</p> <p>Risk of source and time lag bias as the authors did not report searching for grey literature.</p> <p>Possible overestimate of effectiveness in favour of intervention.</p> <p>It was unclear whether the quality of the included studies was assessed or used in formulating conclusions.</p>
Brietzke and Gallagher (2006) United States	<p>Comprehensive literature search of PubMed, <i>The Cochrane Library</i> and EMBASE up to 2005 using keywords.</p> <p>Selection criteria were predefined.</p> <p>Data were meta-analysed using a random-effects model due to significant heterogeneity.</p> <p>Publication bias was assessed using a funnel plot.</p>	<p>Relevant populations may not be included as studies on children with craniofacial syndromes, comorbidities, obesity or neuromuscular disorders were excluded.</p> <p>It was unclear how many reviewers selected studies, extracted data and assessed the quality of the included studies.</p> <p>Funding source and conflicts of interest were not reported.</p>

Table D.5: Summary of critical appraisal of the included systematic reviews (cont'd)

Study, Country	Strengths	Limitations
Systematic reviews on tonsillectomy in adults and children		
Pinder et al. (2011)	Update of an existing Cochrane review with well-defined research question, population, intervention, comparator and outcomes.	
United Kingdom	Comprehensive literature search strategy, including grey literature. Two reviewers independently selected studies and extracted data using standardised forms. A list of excluded studies with reasons was provided. Two authors independently assessed the risk of bias of included studies based on sequence generation, allocation concealment, blinding, completeness of outcome data, selective outcome reporting and other sources of bias. Data on secondary haemorrhage were pooled using Peto odds ratio with a fixed-effect model; statistical heterogeneity was assessed using the Chi ² and I ² statistic. Authors reported no conflicts of interest.	
Burton and Doree (2007)	Comprehensive literature search of relevant databases and <i>The Cochrane Library</i> using keywords.	
United Kingdom	Reviewers independently selected studies based on predefined criteria. Two reviewers independently extracted data using standardised forms. Two reviewers graded the quality of included studies based on adequate randomisation, allocation concealment, blinding of outcome assessors and losses to follow-up.	

OSA: obstructive sleep apnoea; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses; PSG: polysomnography;

Table D.6: Summary of findings from systematic reviews

Study, Country	Main Study Findings	Authors' Conclusions
Systematic reviews on the treatment of sleep apnoea in children		
Sedky et al. (2014) United States	<p>ADHD symptoms pre- and post-adenotonsillectomy SR of 12 studies involving 529 children (Chervin et al. 2012; Dillon et al. 2007; Galland et al. 2006; Giordani et al. 2012; Huang et al. 2007; Lewin et al. 2002; Li et al. 2006; Mitchell 2007; Mitchell and Boss 2009; Mitchell and Kelly 2005; Mitchell and Kelly 2006; Tran et al. 2005)</p> <p><i>ADHD symptoms (n=529, follow-up 2 to 13 months):</i> Adenotonsillectomy was associated with decreased ADHD symptoms post-surgery (Hedges' g 0.43, 95% CI 0.30 to 0.55; P<0.001). Studies with lower AHI cut-offs had higher effect sizes, suggesting that milder forms of OSA may be more closely related to ADHD symptoms. Higher quality studies had larger effect sizes suggesting that the relation between ADHD and SDB is not an artefact of poorer quality studies.</p>	<p>"The findings of this meta-analysis suggest that ADHD symptoms are related to SDB and improve after adenotonsillectomy. Therefore, patients with ADHD symptomatology should receive SDB screening. Treatment of comorbid SDB should be considered before medicating the ADHD symptoms if present." (p. 349)</p>
Teo and Mitchell (2013) United States	<p>Cardiovascular parameters pre- and post-adenotonsillectomy in children SR of 14 studies involving 418 participants (Amin et al. 2008; Apostolidou et al. 2008; Atiq et al. 2004; Cohen et al. 2010; Constantin et al. 2008; Duman et al. 2008; Gorur et al. 2001; Naiboglu et al. 2008; Ng et al. 2010; Sofer et al. 1988; Tal et al. 1988; Tezer et al. 2005; Ugur et al. 2008; Yilmaz et al. 2005)</p> <p><i>Blood pressure:</i> All three studies reporting blood pressure demonstrated significant improvement in mean 24-hour ambulatory blood pressure monitoring. Ng et al. (2010) noted a significant drop in mean diastolic blood pressure from 15.9 (SD 18.2) to 10.5 mmHg (SD 10.2; P=0.021) in 44 children with OSA after adenotonsillectomy. This was associated with a significant decrease in mean AHI post-surgery from 14.1 (SD 15.9) to 3.3 (SD 7.2). Apoustolidau et al. (2008) reported a reduction in diastolic blood pressure in children with complete resolution of OSA after adenotonsillectomy; mean change 6.7 mmHg (95% CI -1.2 to 1.4; P=0.2). However, no significant decrease in diastolic blood pressure was noted in controls or children with residual OSA post-surgery; mean change 2.8 mmHg (95% CI -5.5 to 11.2; P=0.48) and -2.2 mmHg (95% CI -7.2 to 2.8; P=0.37), respectively. Amin et al. (2008) demonstrated a decline in mean diastolic blood pressure 6 months post-surgery from 64 to 57 mmHg (P=0.003) in patients with AHI>3.</p> <p><i>Cardiac function:</i> Seven studies reported cardiac morphology and function detected on echocardiology. After adenotonsillectomy, Uger et al. (2008) reported a statistically significant decrease in mean pulmonary arterial systolic pressure from 31.3 (SD 4.2) to 13.1 mmHg (SD 2.3; P<0.001) and an improvement in right ventricular function as demonstrated by a change in mean tricuspid peak rapid filling velocity from 11 (SD 2.7) to 13.5 cm/second (SD 2.7; P<0.001). Duman et al. (2008) demonstrated a significant decrease in right ventricular myocardial perfusion index after adenotonsillectomy in children with OSA, compared with controls, from 0.4 (SD 0.06) to 0.3 (SD 0.03; P<0.001) based on echocardiography. Tezer et al. (2005) demonstrated normalisation in myocardial function 3 months after adenoidectomy in 21 children with OSA: the E/A ratio improved from 1.01 (SD 0.2) to 1.24 (SD 0.2; P<0.5). Tai et al. (1988) found that within 2 months of adenotonsillectomy children showed improvements in right ventricular wall motion and right ventricular ejection fraction, which rose from 24% (SD 3.6) to 47% (SD 3.4; P<0.005). Gorur et al. (2001) reported improvement in cardiac morphology and function after adenotonsillectomy; right ventricle thickness decreased from 1.6 (SD 0.3) to 1.4 cm (SD 0.2; P<0.05). Three studies demonstrated reversibility of severe cardiovascular sequelae associated with OSA (Atiq et al. 2004; Cohen et al. 2010; Sofer et al. 1988).</p>	<p>"There is evidence that cardiovascular morbidities associated with OSA are potentially reversible. Adenotonsillectomy may have a significant role in reversing the cardiovascular sequelae of OSA. There is evidence that children with cardiac morbidity associated with OSA should be treated early with adenotonsillectomy to reverse potentially serious cardiovascular sequelae." (p. 21)</p>

Table D.6: Summary of findings from systematic reviews (cont'd)

Study, Country	Main Study Findings	Authors' Conclusions
Jeyakumar et al. (2012) United States	<p>Prevalence of nocturnal enuresis pre- and post-adenotonsillectomy in children</p> <p>SR of 7 studies involving 1,360 participants (Aydil et al. 2008; Basha et al. 2005; Cinar et al. 2001; Elsherif and Kareemullah 1999; Firoozi et al. 2006; Kalorin et al. 2010; Weissbach et al. 2006)</p> <p><i>Prevalence of enuresis (n=587, follow-up 6 months):</i></p> <p>Preoperative prevalence of enuresis was 31% (426/1,360). The postoperative prevalence of enuresis was 16% (95/587; P<0.002, two-tailed). Most studies did not distinguish between primary and secondary enuresis.</p>	<p>"SDB in children is associated with nocturnal enuresis. Adenotonsillectomy is associated with a significant improvement in enuresis in children with SDB. There is a need for RCTs to look at the role of adenotonsillectomy in children with SDB and enuresis." (p. 800)</p>
Friedman et al. (2009) United States	<p>Resolution of OSA based on PSG parameters pre- and post-adenotonsillectomy in children treated for OSA</p> <p>SR of 23 studies involving 1,079 participants (Bar et al. 1999; Chervin et al. 2007; Goldstein et al. 2004; Gozal et al. 2008; Guilleminault et al. 2007; Mitchell 2007; Mitchell and Kelly 2004a; Mitchell and Kelly 2004b; Mitchell and Kelly 2005; Mitchell and Kelly 2007b; Nieminen et al. 2000; Nishimura et al. 1996; O'Brien et al. 2006; Shine et al. 2006; Shintani et al. 1998; Stewart et al. 2005; Suen et al. 1995; Tal et al. 2003; Tauman et al. 2006; Tunkel et al. 2008; Walker et al. 2008; Wang et al. 1998; Wiet et al. 1997)</p> <p>The rate of treatment success after adenotonsillectomy was 66% when cure was defined per each individual study. When cure was defined as AHI<1 (n=9 studies), the random-effects estimate for OSA treatment success rate was 60%. Postoperative mean AHI was significantly decreased from preoperative levels.</p> <p>The mean AHI decrease in uncomplicated children (19 studies, n=867) of 11.7 was significantly lower than the mean AHI decrease of 22.0 in complicated children with comorbidities (obesity, severe OSA) (P<0.0001). The cure rate was 74% in uncomplicated patients and was significantly higher than that of 39% in complicated patients (9 studies, n=340; P<0.0001). The Begg and Mazumdar test (Tau=0.373; P=0.01) and Egger's test (intercept=6.52, 95% CI 3.05 to 10.0; P=0.0008) indicated possible publication bias and an asymmetrical funnel plot.</p>	<p>"Contrary to popular belief, meta-analysis of current literature demonstrates that paediatric sleep apnoea is often not cured by adenotonsillectomy. Although complete resolution is not achieved in most cases, adenotonsillectomy still offers significant improvements in AHI, making it a valuable first-line treatment for paediatric OSA. A success rate of 66.3% indicates that a large number of children have residual disease. Fewer than half of obese children and those with severe OSA are cured of sleep apnoea by PSG criteria following adenotonsillectomy. BMI percentile and preoperative AHI are important factors to be considered in the diagnosis and treatment of paediatric patients." (p. 800)</p>
Costa and Mitchell (2009) United States	<p>Resolution of OSA based on PSG parameters pre- and post-adenotonsillectomy in obese children treated for OSA</p> <p>SR and MA of 4 studies involving 110 participants (Mitchell and Kelly 2004a; Mitchell and Kelly 2007a; O'Brien et al. 2006; Shine et al. 2006)</p> <p>The mean preoperative and postoperative AHI was 29.4 (range 22.2 to 34.3) and 10.3 (range 6.0 to 12.2), respectively. The mean difference between the preoperative and postoperative AHI was -18.3 events/hour (95% CI 11.2 to 25.5). The mean preoperative and postoperative oxygen saturation nadir was 78% (range 74% to 81%) and 86% (range 84% to 90%), respectively. The mean difference for the oxygen saturation nadir was 6.3% (95% CI 3.9 to 8.7); 49% of children had a postoperative AHI<5, 25% had a postoperative AHI<2 and 12% had a postoperative AHI<1.</p>	<p>"Sleep improves but rarely normalises after adenotonsillectomy in obese children with OSA. Up to 88% of obese children have persistent OSA after adenotonsillectomy. The efficacy and role of additional therapeutic options requires more study. The high incidence of obesity in children makes this a public health priority. Data on secondary haemorrhage rates can only adequately be obtained from prospective audit of all patients undergoing coblation tonsillectomy, whether or not this is in the context of an ongoing RCT." (p. 459)</p>

Table D.6: Summary of findings from systematic reviews (cont'd)

Study, Country	Main Study Findings	Authors' Conclusions
Baldassari et al. (2008) United States	<p>QOL pre- and post-adenotonsillectomy in children treated for OSA</p> <p>SR of 7 studies involving 369 participants (Flanary 2003; Goldstein et al. 2002; Mitchell and Kelly 2004a; Mitchell and Kelly 2004b; Mitchell and Kelly 2005; Sohn and Rosenfeld 2003; Tran et al. 2005)</p> <p>The mean total OSA-18 score and scores for all symptom domains showed significant improvement after adenotonsillectomy ($P < 0.0001$). The subsets of sleep disturbance, caregiver concerns and physical suffering featured the greatest changes in QOL. The domain with the least postoperative change was emotional distress. Long-term follow-up was reported for 91 children with OSA. Time between adenotonsillectomy and postoperative assessment was 6 to 16.4 months. The OSA-18 mean change scores for children were significantly improved at long-term follow-up. The mean total OSA-18 change score was a positive value at 36.2 points. The OSA subsets featuring the most significant improvements after surgery were sleep disturbance, caregiver concerns and physical suffering.</p>	<p>"Paediatric OSA has a significant impact on QOL. QOL in paediatric OSA is similar to that of children with juvenile rheumatoid arthritis. Large improvements in QOL occur after adenotonsillectomy, and these findings are maintained long-term. The literature lacks controlled studies on QOL in paediatric OSA." (p. 265)</p>
Brietzke and Gallagher (2006) United States	<p>Resolution of OSA based on PSG parameters pre- and post-adenotonsillectomy in children treated for OSA</p> <p>SR of 14 studies involving 342 participants (Bar et al. 1999; Eliaschar et al. 1980; Frank et al. 1983; Guilleminault et al. 2004; Avelino et al. 2002; Mora et al. 2003; Nieminen et al. 2000; Nishimura et al. 1996; Nuyens, et al. 2009; Shintani et al. 1998; Suen et al. 1995; Tal et al. 2003; Wang et al. 1998; Wiet et al. 1997)</p> <p>The summary change in AHI was a reduction of 13.9 events/hour (random-effects model, 95% CI 10.05 to 17.79; $P < 0.001$) after adenotonsillectomy; there was significant heterogeneity amongst studies ($\chi^2 = 205.7$, $P < 0.001$). The summary success rate of adenotonsillectomy in normalising PSG was 82.9% (random-effects model, 95% CI 76.2% to 89.5%; $P < 0.001$).</p>	<p>"Adenotonsillectomy is effective in reducing the severity of objectively measured OSA. This finding is consistent despite significant heterogeneity in patient populations and in PSG diagnostic criteria and technology. Paediatric adenotonsillectomy is successful in normalising PSG measurements in the majority of patients. However, given the magnitude of the problem, the presence of residual OSA after adenotonsillectomy in a large number of patients is a significant probability that urgently requires more study and intervention." (p. 984)</p>
Systematic reviews on tonsillectomy in adults and children		
Pinder et al. (2011) United Kingdom	<p>Dissection versus diathermy tonsillectomy in children and adults</p> <p>SR of 2 studies involving 254 participants (Kujawski et al. 1997; Nunez et al. 2000)</p> <p><i>Secondary haemorrhage:</i></p> <p>The rate of secondary haemorrhage was low in both studies. Kujawski et al. (1997) reported 11 patients who had bleeding after discharge (three after diathermy and eight after dissection). Of these, seven patients were hospitalised and one patient from the dissection group required transfer to theatre for control of bleeding. In Nunez et al. (2000), three patients reported secondary haemorrhage; two after diathermy and one after cold dissection, but none required hospitalisation. Combined data from both studies showed no difference between diathermy and dissection tonsillectomy in terms of secondary haemorrhage rate (Peto odds ratio 0.56; 95% CI 0.19 to 1.63).</p>	<p>"Data from RCTs to support one method of tonsillectomy over another are currently lacking, particularly regarding haemorrhage rates. The combined data suggest there is less intraoperative blood loss using diathermy dissection; this may be relevant for certain patients such as small children and infants. No differences were found in either the primary or secondary haemorrhage rate. This may reflect the fact that the studies were insufficiently powered to pick up small differences in such rates." (p. 7)</p>

Table D.6: Summary of findings from systematic reviews (cont'd)

Study, Country	Main Study Findings	Authors' Conclusions
Burton and Doree (2007) United Kingdom	<p>Coblation versus other tonsillectomy techniques in children and adults</p> <p>SR of 8 studies involving 6,901 participants (Anthony et al. 2006; Back et al. 2001; Jayasinghe et al. 2005; Philpott et al. 2005; Shah et al. 2002; Sobol et al. 2006; Stoker et al. 2004; Temple and Timms 2001).</p> <p><i>Secondary haemorrhage:</i></p> <p>Secondary haemorrhage rates varied from 0% to 50%. One study reported that secondary haemorrhage rates were 13.6% after coblation, compared with 2.1% after dissection ($P=0.001$) (Anthony et al. 2006). Seven other studies reported differences in haemorrhage rates that were not statistically significant (Back et al. 2001; Jayasinghe et al. 2005; Philpott et al. 2005; Shah et al. 2002; Sobol et al. 2006; Stoker et al. 2004; Temple and Timms 2001).</p>	<p>"In terms of postoperative pain, speed and safety of recovery, there is inadequate evidence to determine whether coblation tonsillectomy is better or worse than other methods of tonsillectomy. Evidence from a large prospective audit suggests that it has been associated with a higher level of morbidity in terms of postoperative bleeding. Large, well-designed RCTs supplemented by data from large prospective audits are needed to produce information on effectiveness and morbidity respectively." (p. 2)</p>

ADHD: attention deficit hyperactivity disorder; AHI: apnoea-hypopnoea index; BMI: body mass index; CI: confidence interval; MA: meta-analysis; OSA: obstructive sleep apnoea; OSA-18: OSA-18 quality-of-life questionnaire; PSG: polysomnography; QOL: quality of life; RCT: randomised controlled trial; SD: standard deviation; SDB: sleep disordered breathing; SR: systematic review