BTS Guideline for diagnosing and monitoring paediatric sleep disordered breathing

Online Appendix 11 Question 11 Evidence Review and Protocol

Q11 For children with sleep disordered breathing, does oxygen saturation monitoring before tonsillectomy (with or without adenoidectomy) improve clinical outcomes?

Contents

Question Evidence Review

Q11 For children with sleep disordered breathing, does oxygen saturation monitoring before tonsillectomy (with or without adenoidectomy) improve clinical outcomes?

Background

Current UK ear, nose and throat (ENT) guidelines (Safe Delivery of Paediatric ENT Surgery in the UK: A National Strategy[1]) advise that pre-operative obstructive sleep apnoea (OSA) testing is not always necessary if a child presents with a history of, and evidence of, adenotonsillar hypertrophy. However, adenotonsillectomy in children is sometimes associated with post-operative complications such as respiratory compromise and bleeding, which can require one-to-one nursing in the hours after surgery, or, in some cases, admission to high dependency units (HDU) or paediatric intensive care units (PICU). Pulse oximetry may predict those at increased risk of peri-operative complications and this review aims to investigate if oxygen saturation monitoring before ENT surgery improves clinical outcomes.

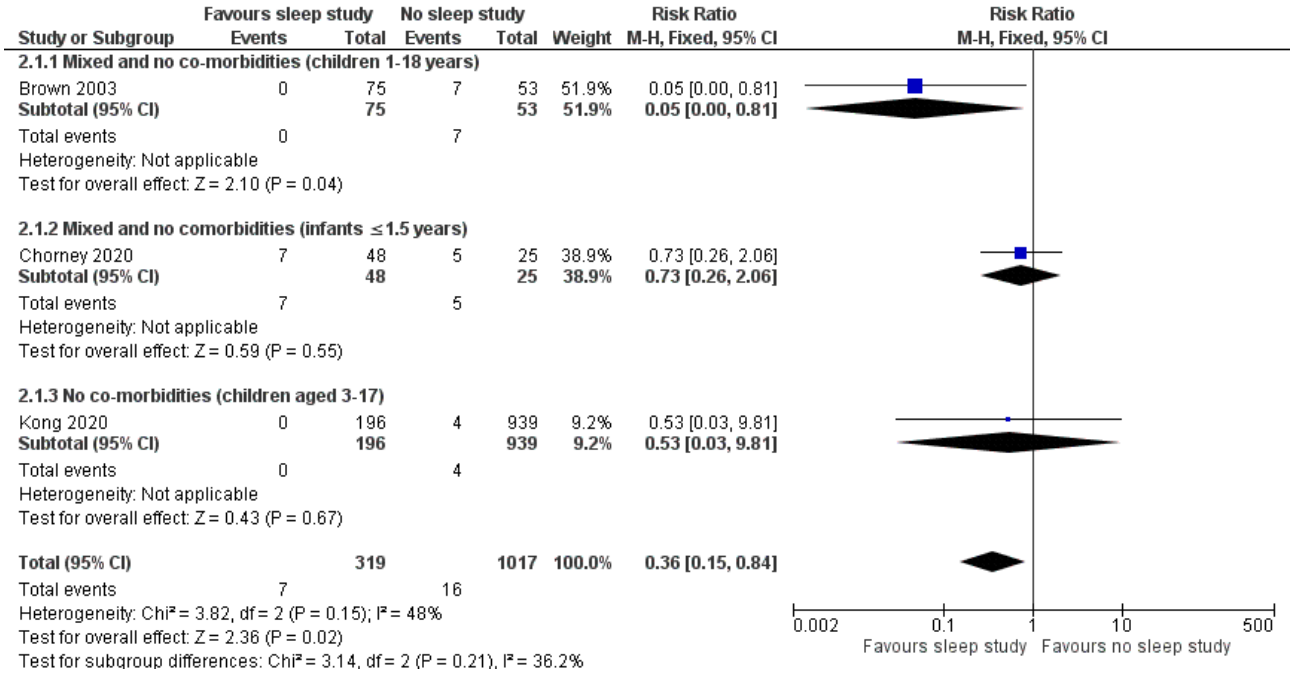
Outcomes

Unscheduled admissions to PICU/HDU/overnight inpatient stays

Evidence Review

The literature search identified 67 papers, of which 17 were deemed relevant[2-18] and all but three[3,6,12] of these studies were retrospective. Although five studies reported on unscheduled hospital stays following ENT surgery after pre-operative sleep monitoring (pulse oximetry and/or polysomnography (PSG)) and ENT surgery without pre-operative sleep monitoring[3,4,13,15,16], one study had no unscheduled hospital stays in both experimental arms[3] and one study focused pre-operative scans only in those with suspected OSA[16], which resulted in only three studies being included in the meta-analysis.[4,13,15] Meta-analysis suggested a minor reduction in peri-operative complications following a pre-operative sleep study (6 patients per 1000 patients (2 to 13)) when compared with no pre-operative sleep study (16 per 1000 patients), but the limited datasets included a mix of age groups and a mix of individuals with/without comorbidities (Figure 11a).

Figure 11a: Unscheduled admissions to PICU/HDU/overnight inpatient stays



The remaining studies also reported the number of unscheduled stays following ENT surgery with[2,3,5,6,8-12,16-18], or without pre-operative sleep monitoring[7,14,16] and a summary of all results is shown in Table 11a. Individual

study data from all studies assessing the effect of pre-operative sleep monitoring data is shown in supplementary table 11a-1 and all studies not using pre-operative sleep monitoring in supplementary table 11a-2.

Table 11a: Summary of unscheduled admissions to PICU/HDU/overnight inpatient stays following ENT surgery with, or without pre-operative sleep monitoring

Sleep monitoring technique	**No. datasets**	**Unscheduled stays per 1000 patients** (Mean ± SD)
Pulse oximetry	4	10 ± 15
PSG	10	47 ± 62
Pulse oximetry and PSG	1	0
With sleep monitoring *	15	34 ± 54
Without sleep monitoring	8	52 ± 76
p		**0.254**†

* Combined data across all pre-operative sleep monitoring techniques (pulse oximetry and PSG)
† Independent t-test between 'With sleep monitoring' and 'Without sleep monitoring'

Cohorts within the presented data included children with or without OSA or sleep disordered breathing (SDB) and without comorbidities ('No comorbidities')[2,5,7,9,15], children with severe obstructive sleep apnoea (OSA) without comorbidities ('Severe OSA')[10,18], mixed groups of children with or without OSA or SDB and with or without comorbidities ('Mixed')[3,4,8,11,12,14,16,17] and children with OSA or SDB and obesity ('Obese')[6,7]. Comorbidities across the 'Mixed' groups included neurological disorders, Down syndrome, obesity, respiratory disorders, asthma, developmental disorders and craniofacial disorders. A summary of the subgroup data is shown in Table 11b and individual study data are shown in supplementary table 11b-1. Within the 'Mixed' groups, two studies linked the need for unscheduled admissions to PICU/HDU/overnight inpatient stays to the presence of comorbidities[14,17] and four commented on a link between unscheduled admissions and severity of OSA/SDB[4,8,10,13].

Table 11b: Summary of unscheduled admissions to PICU/HDU/overnight inpatient stays following ENT surgery, with, or without pre-operative sleep monitoring, in children with and without comorbidities

	Unscheduled stays per 1000 patients (Mean ± SD) (no. studies)		
Study cohorts	**With sleep monitoring**	**Without sleep monitoring**	***p***†
No comorbidities (Mixed SDB)	14 ± 16‡ (4)	35 ± 43 (2)	0.205
No comorbidities (Severe OSA)	117 ± 130‡ (2)	-	-
Mixed	14 ± 17 (8)	33 ± 66 (4)	0.240
Obese*	29 (1)	200 (1)	-

* Reported data from two different studies

† Independent t-tests between mean data across studies

‡ $p = 0.743$ between 'No comorbidities (Mixed SDB)' and 'No comorbidities (Severe OSA)' 'With sleep monitoring' data (Table 11b-1)

Mixed – mixed groups of children with SDB and with or without comorbidities; No comorbidities – children with SDB without comorbidities; Obese – children with SDB and obesity

One study within the 'Mixed' group also reported on three subsets within their study population: i) Children ≤1.5 years, ii) Children between >1.5 and 2.5 years; and iii) Children between >2.5 and 3.5 years.[13] A summary of the results is shown in Table 11c. Although the study found no significant difference in the rate of significant admission events between the three age groups ($p = 0.67$, Table 11c), multivariate logistical analysis showed that children under the age of 1.5 years were at a significantly higher risk of peri- or post-operative admission

events (OR 13.7 [6.5–29.0], *p* <0.001, Table 11d)[13]. This result was echoed in two further studies, where age <2 years[8] and age <3 years[17] were deemed higher risk factors of peri- or post-operative complications (Table 11d).

Table 11c: Comparison of admission events* following ENT surgery in children ≤3.5 years old with or without pre-operative sleep monitoring (PSG)[17]

Age (years)	**No. patients**	**Admission events***	**Events per 1000 patients**
≤1.5	73	12	164
>1.5 and ≤2.5	164	7	43
>2.5 and ≤3.5	116	2	17
p			0.67

* Oxygen desaturation below 85%, admission to PICU or admission beyond 24 h after surgery

Table 11d: (Multivariate) regression analysis of age as a risk factor for significant post-operative admissions

Study	**Age** (years)	**Complication rate** (events/patients)	**OR** [CI]	***p***
Chorney 2020[13]	<1.5	12/73	13.7 [6.5-29.0]	<0.001
Hill 2011[8]	<2	-	-	<0.01
Katz 2020[17]	<3	14/39	4.1 [1.8, 9.3]*	-

* Data rounded to one decimal place

- – no data presented, CI – confidence intervals, OR – odds ratio

Evidence Statements

Based on primarily retrospective evidence:

Pre-operative sleep monitoring (pulse oximetry or polysomnography) before tonsillectomy (with or without adenoidectomy) does not appear to reduce the need for unscheduled admissions to PICU/HDU/overnight inpatient stays for most children, with or without comorbidities, and symptoms of sleep disordered breathing (**Very low**)

Diagnosing severe obstructive sleep apnoea (OSA) in children before tonsillectomy (with or without adenoidectomy) may reduce the need for unscheduled peri-operative admissions to PICU/HDU/overnight inpatient stays (**Ungraded**)

Pre-operative sleep monitoring (pulse oximetry or polysomnography) before tonsillectomy (with or without adenoidectomy) may reduce unscheduled admissions to PICU/HDU/overnight inpatient stays in children with obesity and sleep disordered breathing (**Ungraded**)

Pre-operative sleep monitoring (pulse oximetry or polysomnography) before tonsillectomy (with or without adenoidectomy) may also reduce unscheduled admissions to PICU/HDU/overnight inpatient stays in children with comorbidities if there is a clinical need (**Ungraded**)

Recommendations

- Routine pre-operative sleep monitoring as a basis for surgical decision making is not recommended in children without comorbidities who are over the age of two years, and in whom severe OSA is not suspected (**Conditional** – by consensus)
- Pre-operative sleep monitoring before tonsillectomy (with or without adenoidectomy) may be considered for children who are less than two years of age to allow pre-operative planning (**Conditional** – by consensus)

Good Practice Points

- ✓ Pre-operative cardiorespiratory sleep study monitoring before tonsillectomy (with or without adenoidectomy) may be considered for children of all ages with comorbidities (e.g. obesity, Down syndrome, cerebral palsy, neuromuscular disease) and suspected SDB to confirm a diagnosis of SDB and allow pre-operative planning
- ✓ A pre-operative pulse oximetry sleep study before tonsillectomy (with or without adenoidectomy) may be considered for children without comorbidities with suspected severe OSA
- ✓ Sleep monitoring following tonsillectomy (with or without adenoidectomy) may be also considered for children with severe OSA, with, or without comorbidities, if there is a clinical need (e.g. less than two years of age, Down syndrome, obesity, cerebral palsy, neuromuscular disease, persistent need)

Research Recommendation

- Further research is needed into assessing the effect of pre-operative sleep monitoring (pulse oximetry and polysomnography), pre-operative sleep questionnaires, or pre-operative sleep video recording before tonsillectomy, on unscheduled admissions to paediatric intensive care units (PICU), high dependency units (HDU) or overnight inpatient stays in children with sleep disordered breathing

Supplementary data tables

Table 11a-1: Comparison of unscheduled admissions to PICU/HDU/overnight inpatient stays following ENT surgery with pre-operative sleep monitoring

Study	No. patients			No. Unscheduled stays	Unscheduled stays / 1000 patients			
	Ox	PSG	Ox/PSG		Ox	PSG	Ox/PSG	Combined*
Baguley 2014[2]	-	100	-	0	-	0	-	0
Blenke 2008[3]	29	-	-	0	0	-	-	0
Brown 2003[4]	-	-	75	0	-	-	0	0
Chang 2017[5]	-	610	-	15	-	25	-	25
Chorney 2020		76		7	-	92	-	92
De 2017[6]	-	34	-	1	-	29	-	29
Hill 2011[8]	-	83	-	2	-	24	-	24
Horwood 2014[9]	161	-	-	5	31	-	-	31
Katz 2020[17]	-	374	-	16	-	43	-	43
Keamy 2015[10]	-	157	-	4	-	25	-	25
Kong 2020[15]	-	196	-	0	-	0	-	0
Liu 2019[16]	271	-	-	2	7	-	-	7
Michelson 2014[11]	-	39	-	1	-	26	-	26
Molero Ramirez 2019[18]	-	158	-	33	-	209	-	209
Piumetto 2011[12]	79	-	-	0	0	-	-	0
Mean					**10**	**47**	**0**	**34**
SD					**15**	**62**	**-**	**54**

* Combined data across all pre-operative sleep monitoring techniques (pulse oximetry and PSG)
Ox – pulse oximetry; Ox/PSG – study reported a mix of pulse oximetry and PSG, but individual numbers not specified; PSG – polysomnography

Table 11a-2: Summary of unscheduled admissions to PICU/HDU/overnight inpatient stays following ENT surgery without pre-operative sleep monitoring

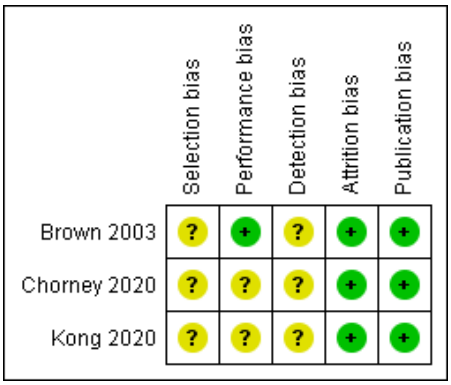
Study	No. patients	No. unscheduled stays	Unscheduled stays / 1000 patients
Brown 2003[4]	53	7	132
Blenke 2008[3]	20	0	0
Chorney 2020[13]	277	5	18
Gleich 2012[7] (obese)	100	20	200
Gleich 2012[7] (normal)	200	13	65
Kong 2020[15]	939	4	4
Liu 2019[16]	118	0	0
Moroco 2020[14]	324	0	0
Mean			**52**
SD			**76**

Table 11b-1: Subgroup comparison of unscheduled admissions to PICU/HDU/overnight inpatient stays following ENT surgery with and without pre-operative sleep monitoring

Study	Unscheduled stays / 1000 patients				
	With pre-operative sleep monitoring				No sleep monitoring
	Ox	PSG	Ox/PSG	Combined	
No comorbidities					
Baguley 2014[2]	-	0	-	0	-
Chang 2017[5]	-	25	-	25	-
Gleich 2012[7]	-	-	-	-	65
Horwood 2014[9]	31	-	-	31	-
Kong 2020[15]	-	0	-	0	4
Mean	**31**	**8**	**-**	**14**	**35**
SD	**-**	**14**	**-**	**16**	**43**
Severe OSA					
Keamy 2015[10]		25		25	-
Molero Ramirez 2019[18]	-	209	-	209	-
Mean	**-**	**117**	**-**	**117**	**-**
SD	**-**	**130**	**-**	**130**	**-**
Mixed comorbidities and no comorbidities					
Blenke 2008[3]	0	-	-	0	-
Brown 2003[4]	-	-	0	0	132
Hill 2011[8]	-	24	-	24	-
Katz 2020[17]	-	43	-	43	-
Liu 2019[16]	7	-	-	7	0
Michelson 2014[11]	-	26	-	26	-
Moroco 2020[14]	-	-	-	-	0
Piumetto 2011[12]	0	-	-	0	-
Mean	**2**	**31**	**0**	**14**	**33**
SD	**4**	**10**	**-**	**17**	**66**
Obesity					
De 2017[6]	-	29	-	-	-
Gleich 2012[7]	-	-	-	-	200
Mean	**-**	**29**	**-**	**-**	**200**

Mixed – mixed groups of children with SDB and with or without comorbidities; No comorbidities – children with SDB without comorbidities; Obese – children with SDB and obesity

Risk of bias summary



GRADE analysis

For children with sleep disordered breathing, does oxygen saturation monitoring before tonsillectomy (with or without adenoidectomy) improve clinical outcomes?

Population: Children (<17 years) with sleep disordered breathing

Intervention: Oxygen saturation monitoring before ENT surgery

Comparator: ENT surgery without prior oxygen saturation monitoring

Outcome	Number of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects		Quality of the Evidence (GRADE)
			No monitoring	Pre-op monitoring	
Unscheduled admissions	1336 (3 studies)	RR 0.36 (0.15 to 0.84)	**16 per 1000**	**6 per 1000** (2 to 13)	⨁◯◯◯ **VERY LOW** [a,b,c]

CI: Confidence interval

Explanations

a. High risk of bias in across studies
b. Some inconsistency and large confidence intervals
c. Some imprecision, wide CIs, crosses one MID

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Question Protocol

Field	Content
Review Question	For children with sleep disordered breathing, does oxygen saturation monitoring before ENT surgery improve clinical outcomes?
Type of review question	Intervention review
Objective of the review	There exists a UK ENT guideline that advises that testing is not necessary in some children with a convincing history and evidence of adenotonsillar hypertrophy. There are also studies, particularly with oximetry that purport to show that that test modality can allow risk stratification before surgery. This question will augment the issues tackled in Question 1 with regards to accuracy of diagnosis. • Does oximetry allow identification of those at risk of peri-operative complications such as haemorrhage, infection or HDU admission? • What components of the oximetry data are predictive of post-operative complications? • Does oximetry predict those at increased risk of a lack of symptomatic benefit?
Eligibility criteria – population / disease / condition / issue / domain	Children (<17 years) with sleep disordered breathing
Eligibility criteria – intervention(s)	Oxygen saturation monitoring before ENT surgery
Eligibility criteria – comparators(s)	ENT surgery without prior oxygen saturation monitoring
Outcomes and prioritisation	Unscheduled admissions to PICU/HDU/overnight inpatient stays
Eligibility criteria – study design	Randomised controlled trials Observational studies Case series
Other inclusion /exclusion criteria	Non-English language excluded unless full English translation Conference abstracts, Cochrane reviews, systematic reviews, reviews Cochrane reviews and systematic reviews can be referenced in the text, but **DO NOT** use in a meta-analysis

Proposed sensitivity / subgroup analysis, or meta-regression	Obese children (<17 years) Obese children <2 years Obese children 2-11 years Obese children 12-16 years Non-obese children (<17 years) Non-obese children <2 years Non-obese children 2-11 years Non-obese children 12-16 years
Selection process – duplicate screening / selection / analysis	Agreement should be reached between Guideline members who are working on the question. If no agreement can be reached, a decision should be made by the Guideline co-chairs. If there is still no decision, the matter should be brought to the Guideline group and a decision will be made by consensus
Data management (software)	RevMan5 — Pairwise meta-analyses Evidence review/considered judgement. Storing Guideline text, tables, figures, etc. Gradeprofiler — Quality of evidence assessment Gradepro — Recommendations
Information sources – databases and dates	MEDLINE, Embase, PubMED, Central Register of Controlled Trials and Cochrane Database of Systematic Reviews No date restriction
Methods for assessing bias at outcome / study level	RevMan5 intervention review template and NICE risk of bias checklist (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)
Methods for quantitative analysis – combining studies and exploring (in)consistency	If 3 or more relevant studies: RevMan5 for meta-analysis, heterogeneity testing and forest plots (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)
Meta-bias assessment – publication bias, selective reporting bias	GRADEprofiler — Intervention review quality of evidence assessment for each outcome (follow instructions in '*BTS Guideline Process Handbook – Intervention Review'*)

Rationale / context – what is known	As mentioned above there is guidance that ‘allows” surgery with no prior test and this is thought to be common UK practice. Other centres are thought to have a practice that all children must have a diagnostic test pre-operatively. Complications of surgery can be unexpected and severity of obstruction is not easy to ascertain clinically. A clearer view of the utility of oximetry in those in whom surgery is planned has the potential to harmonise practice and give clear guidance.