The Journal of Laryngology & Otology (2016), ***130***, *482–489*.

doi:10.1017/S0022215116000980

MAIN ARTICLE

Latest trends in the assessment and management of paediatric snoring and sleep apnoea

S D SHARMA, H KANONA, G KUMAR, B KOTECHA

Department of Otorhinolaryngology, Queen's Hospital, Romford, UK

Abstract

Objective: To investigate the assessment and management of paediatric snoring and obstructive sleep apnoea in UK otolaryngology departments.

Method: A telephone questionnaire survey of UK otolaryngology departments was conducted over a 16-week period.

Results: The response rate was 61 per cent (85 out of 139 trusts). Use of pre-operative pulse oximetry was reported by 84 per cent of respondents, mainly to diagnose obstructive sleep apnoea (73 per cent) or stratify post-operative risk (46 per cent). Thirty-one per cent of respondents reported using post-operative pulse oximetry. Twenty-five per cent of respondents have a dedicated management protocol for paediatric obstructive sleep apnoea and snoring. Thirty-four per cent require prior clinical commissioning group approval before performing surgery. Fifty-eight per cent of respondents reported following up their obstructive sleep apnoea patients after surgery. The mean follow-up period (±standard deviation) was 6.8 ± 1.2 weeks.

Conclusion: There is variation in the assessment and management of paediatric snoring and obstructive sleep apnoea across the UK, particularly in the use of pre- and post-operative pulse oximetry monitoring, and further guidelines regarding this are necessary.

Key words: Obstructive Sleep Apnea Syndrome; Pediatrics; Pulse Oximetry

Introduction

Snoring in the paediatric population is a common reason for referral to ENT surgeons from primary care physicians. This can range from simple snoring to more severe obstructive sleep apnoea (OSA). Obstructive sleep apnoea is defined as a 'disorder of breathing during sleep characterised by prolonged partial upper airway obstruction and/or intermittent complete obstruction that disrupts normal ventilation during normal sleep patterns'.[1] Studies suggest that 6–12 per cent of children have significant snoring and 1–3 per cent have OSA.[2,3]

Adenotonsillectomy often improves OSA in children, but it must be borne in mind that other factors such as obesity, poor neuromuscular tone of the upper airways, and craniofacial abnormalities, can also affect this condition.[4] The American Academy of Pediatrics has published a group of signs and symptoms associated with paediatric OSA, which can help to identify patients at risk of OSA who may require further investigation.[5]

There is still controversy over the best way to manage children with suspected OSA. There are clear guidelines regarding the management of children deemed 'at risk' of post-operative cardiorespiratory complications (e.g. age less than two years, weight less than 15 kg, significant co-morbidities and severe OSA) and the need for the availability of paediatric intensive care facilities, drawn up by a UK multidisciplinary working party.[6] However, there are still variations in practice across the UK in terms of the investigations and management of 'healthy' children with suspected OSA. The American Academy of Pediatrics has suggested that all children with suspected OSA should undergo polysomnography as a 'gold standard', but this is expensive and not readily available in many UK institutions.[5] One alternative is overnight pulse oximetry, but this test has a low negative predictive value (47 per cent), so some children with severe OSA may be missed.[7,8] The aforementioned UK multidisciplinary working party and American Academy of Otolaryngology – Head and Neck Surgery Foundation have suggested reserving polysomnography for higher risk patients only.[6,9]

There is also controversy regarding the post-operative management of these patients with pulse oximetry and whether an overnight stay is necessary for all children with OSA.[10]

Accepted for publication 13 January 2016

Based on anecdotal evidence from colleagues, we found that there were wide variations in practice with regard to the management of paediatric OSA, both within our department and in other institutions across the country. With this in mind, we set out to investigate the current trends of assessment and management of children with snoring and OSA in ENT departments across the UK, and to identify variations in practice. In particular, we aimed to investigate: the use of pulse oximetry by clinicians, the influence of a clinical commissioning group on funding for surgical interventions, the presence of formal protocols for the management of paediatric OSA and follow-up arrangements for these patients. These particular aspects have not been assessed formally in previous similar studies.[10,11]

Based on our findings, we have developed recommendations for a protocol for the management of children with snoring and OSA who present to our department.

Materials and methods

This study was approved by the Barking, Havering and Redbridge University Hospitals NHS Trust Clinical Governance Department.

A questionnaire was devised based on our experience and knowledge of the management of snoring and sleep apnoea in the paediatric population. This included questions on various aspects of evaluation and management, both surgical and non-surgical, that individual departments are able to provide for these patients. There was particular emphasis in the questionnaire on the investigations offered to these patients and the reasons for performing them. The questionnaire was initially piloted within our ENT department, and a revised version was used for the main study (Figure 1).

A telephone survey was conducted of 139 otolaryngology departments in acute National Health Service trusts in the UK over a period of 16 weeks, from January 2015 to April 2015.

We separated the questionnaire results into those that represented responses from district general hospitals and those that represented responses from tertiary referral centres.

The responses to the questionnaire were tabulated and analysed using Microsoft Excel (Seattle, Washington, USA). Statistical analyses and comparisons were carried out with the Fisher's exact test using GraphPad Software (La Jolla, California, USA);[12] significance was set at $p < 0.05$. Confidence interval (CI) levels were set at 95 per cent.

Results

The response rate was 61 per cent (85 out of 139 trusts). All 85 of the respondents undertake paediatric surgery within the trusts. All 85 trusts (100 per cent) receive their referrals from primary care, and 54 (64 per cent (95 per cent CI = 54–74)) also receive referrals from the paediatric team. A small number of respondents also reported referrals from respiratory medicine ($n = 4$, 5 per cent) and from other ENT departments ($n = 8$, 9 per cent (95 per cent CI = 3–15)).

All respondents (100 per cent) reported receiving referrals for simple snoring and OSA. A smaller number of respondents (12 out of 85, 14 per cent (95 per cent CI = 7–21)) reported receiving referrals for exacerbations during tonsillitis. Interestingly, 29 out of 85 respondents (34 per cent (95 per cent CI = 24–44)) reported the need for prior clinical commissioning group approval, before proceeding with surgery.

Seventy-one of the 85 respondents (84 per cent (95 per cent CI = 76–92)) reported the use of pre-operative pulse oximetry. Interestingly, 17 out of 71 respondents who do request pre-operative pulse oximetry (24 per cent (95 per cent CI = 14–34)) reported that this was a mandatory requirement by anaesthetists for all children undergoing adenotonsillectomy. Fifty-two of the 71 respondents (73 per cent (95 per cent CI = 63–83)) reported that pre-operative pulse oximetry was utilised to diagnose OSA, whilst 33 of the respondents (46 per cent (95 per cent CI = 34–58)) utilised pre-operative pulse oximetry to detect OSA for post-operative management, and 6 of the respondents (8 per cent (95 per cent CI = 2–14)) utilised it to reassure parents that there was no OSA (i.e. to discharge the child from ENT) (Figure 2).

Twenty-six of the 85 respondents (31 per cent (95 per cent CI = 21–41)) reported the use of post-operative pulse oximetry. Within this group, 23 respondents (88 per cent (95 per cent CI = 76–100)) reported that this was to monitor immediate problems in recovery, whilst 5 respondents (19 per cent (95 per cent CI = 4–34)) utilised post-operative pulse oximetry to detect residual problems (Figure 3).

Of the 72 respondents who use pulse oximetry, 42 (58 per cent (95 per cent CI = 47–69)) reported that it is utilised at the patient's home, as compared to 30 (42 per cent (95 per cent CI = 31–53)) who utilise it on the paediatric ward with an overnight stay.

Twenty-one of the 85 respondents (25 per cent (95 per cent CI = 16–34)) performed polysomnography pre-operatively, whilst 2 (2 per cent (95 per cent CI = 0–5)) performed polysomnography post-operatively. Twenty-four of the 85 respondents (28 per cent (95 per cent CI = 18–38)) had paediatric intensive therapy unit facilities available at the trust, although more trusts had paediatric high dependency unit facilities available at the hospital.

When respondents were asked which patients they would consider high risk, warranting a referral to a hospital with paediatric intensive therapy unit facilities, 71 out of 85 (84 per cent (95 per cent CI = 76–92)) reported that they would refer children aged less than 2 years, 82 respondents (96 per cent (95 per cent CI = 92–100)) would refer children weighing less than 15 kg, 80 respondents (94 per cent (95 per cent CI = 89–99)) would refer a child with a syndrome,

https://doi.org/10.1017/S0022215116000980 Published online by Cambridge University Press

NATIONAL PAEDIATRIC OSA & SNORING AUDIT PROFORMA

1. Area: □ England □ Wales □ Scotland □ Northern Ireland

2. Trust Name: ………………………………………… Hospital: ……………………………………

3. Paediatric surgery undertaken at Trust? □ Yes □ No

4. Source of paediatric OSA & snoring referrals: □ GP □ Paediatrics □ ENT □ Respiratory □ Other

5. Are referrals for children for: □ Simple snoring □ Obstructive sleep apnoea □ Exacerbations during tonsillitis

6. Prior PCT approval for surgery required? □ Yes □ No

7. Investigations performed:

a) **Pulse oximetry**: □ Pre-op □ Post-op □ At home □ On ward

i) If pre-op, why?
- □ To diagnose sleep apnoea
- □ To detect OSA for post-op recovery and management
- □ To reassure parents no OSA (to discharge child)
- □ Other
  Please specify……………………………………………………

ii) If post-op, why?
- □ To monitor post-operatively
- □ To detect residual problems
- □ Other
  Please specify……………………………………………………

b) **Polysomnography**: □ Pre-op □ Post-op

8. Do you have paediatric ITU facilities? □ Yes □ No

9. Which patients do you consider high risk warranting referral to a hospital with paediatric ITU facilities?

□ Age <2 years □ Weight <15kg □ Syndromic child □ Sickle cell
□ Significant co-morbidities □ Other Please specify………………………………………

10. Do you have a management protocol of paediatric OSA & snoring? □ Yes □ No

11. Surgery offered: □ Adenotonsillectomy □ Microlaryngoscopy (<2 years) □ Adenoidectomy (and grommets)

12. What proportion are followed up? □ None □ <50% □ >50% □ All
If patients are followed up, when? ……………….. weeks

13. Estimate of cost, at your centre, of: polysomnography £………………..
home sleep study £…………………

FIG. 1

Telephone questionnaire on the assessment and management of paediatric obstructive sleep apnoea and snoring. OSA = obstructive sleep apnoea; GP = general practitioner; PCT = primary care trust; pre-op = pre-operative; post-op = post-operative; ITU = intensive therapy unit

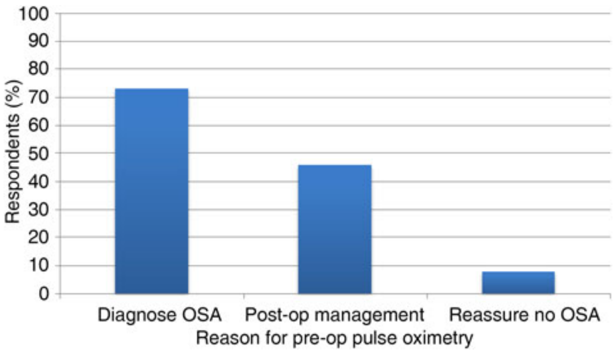

FIG. 2

Respondents' reasons for organising pre-operative pulse oximetry. OSA = obstructive sleep apnoea; post-op = post-operative; pre-op = pre-operative

72 (85 per cent (95 per cent CI = 77–93)) would refer children with sickle cell anaemia, and 82 (96 per cent (95 per cent CI = 92–100)) would refer children with significant co-morbidities (Figure 4).

Twenty-one of the 85 respondents (25 per cent (95 per cent CI = 16–34)) reported having a dedicated management protocol for paediatric OSA and snoring.

In terms of the surgery offered for management of OSA and snoring in the paediatric population, all 85 respondents (100 per cent) offered adenotonsillectomy, 65 (76 per cent (95 per cent CI = 67–85)) offered adenoidectomy, and 17 (20 per cent (95 per cent CI = 12–29)) offered microlaryngoscopy (if aged less than 2 years).

In terms of post-surgical intervention follow up, 36 out of 85 respondents (42 per cent (95 per cent CI = 32–52)) do not follow up OSA patients routinely, 14 (16 per cent (95 per cent CI = 8–24)) follow up less than 50 per cent of patients, 18 (21 per cent (95 per cent CI = 12–30)) follow up 50–99 per cent, and 17 (20 per cent (95 per cent CI = 12–29)) follow up all patients after surgery. For those patients who were followed up, the mean (±standard deviation) follow-up duration was 6.8 ± 1.2 weeks (95 per cent CI = 6.5–7.0).

None of the respondents were able to estimate the cost of polysomnography and home sleep study.

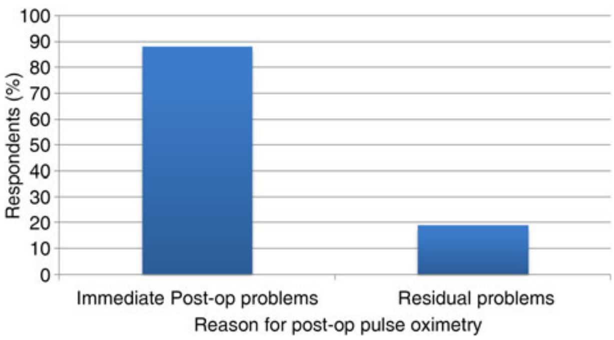

FIG. 3

Respondents' reasons for organising post-operative pulse oximetry. Post-op = post-operative

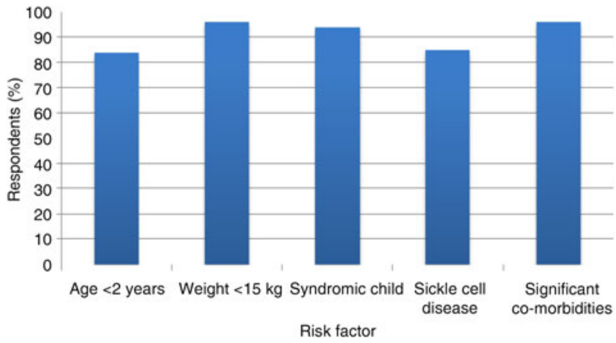

FIG. 4

Factors considered by respondents to necessitate referral of child to hospital with paediatric intensive therapy unit facilities.

When we separated the responses into those from district general hospitals ($n = 66$) and those from tertiary referral centres ($n = 19$), we found that tertiary referral centres were significantly more likely to: perform pulse oximetry pre-operatively (19 out of 19 *vs* 52 out of 66, $p = 0.03$), perform polysomnography pre-operatively (9 out of 19 *vs* 12 out of 66, $p = 0.02$) and follow up patients post-operatively (15 out of 19 *vs* 34 out of 66, $p = 0.04$).

Discussion

The management of paediatric snoring and OSA is variable across the UK. There is some inconsistency with regard to the assessment of paediatric snoring and OSA. Eighty-four per cent of our respondents performed pre-operative evaluation with pulse oximetry. Only 25 per cent performed polysomnography prior to surgical intervention, mainly in the larger tertiary paediatric referral centres. This is interesting as the American Academy of Pediatrics recommends the use of polysomnography as the gold standard for pre-operative investigation for all children with OSA.[5] A previous survey of American ENT surgeons found that only 5 per cent of ENT surgeons arranged for polysomnography prior to surgical intervention.[11] A previous survey of UK ENT surgeons found this figure to be even lower, at 2 per cent.[10] However, the low number of pre-operative polysomnography ordered by our respondents is in line with the UK multidisciplinary working party guidelines, which advise that children with mild-to-moderate OSA and no other risk factors can be investigated in terms of patient history and examination alone.[6]

Pre-operative pulse oximetry was utilised by 84 per cent of the respondents in our study. This is probably because pulse oximetry is much more readily available within most hospitals, and does not have the inherent costs and technical expertise associated with polysomnography. The most common reason for using pre-operative pulse oximetry was for diagnosing OSA (73 per cent), but, as per the UK multidisciplinary working party guidelines, the diagnosis of OSA can be made clinically through history and examination

https://doi.org/10.1017/S0022215116000980 Published online by Cambridge University Press

alone; it is the severity of OSA that pre-operative pulse oximetry can be useful in determining.

A smaller percentage of respondents used pre-operative pulse oximetry to detect OSA for post-operative recovery and management (i.e. to screen for patients with severe OSA), which is the most appropriate use as per the UK multidisciplinary working party guidelines. The concerns are that children undergoing adenotonsillectomy may have altered neuromuscular tone of upper airway patency, making them prone to post-operative respiratory complications. Perhaps surprisingly, papers have reported high rates of post-operative complications (e.g. oxygen desaturations, atelectasis, pneumonia, pulmonary oedema, pneumothorax and stridor), of 5–25 per cent.[13] Interestingly, 20 per cent of respondents reported the use of pre-operative pulse oximetry in all children as a mandatory requirement by anaesthetists, and this may reflect concerns regarding post-operative complications.

Very few respondents (8 per cent) used pre-operative pulse oximetry to reassure patients that there was no OSA (to facilitate discharge). The increased use of pre-operative pulse oximetry in our questionnaire study, when compared to previously published similar questionnaire studies, may be the result of increasing pressure from anaesthetists for mandatory documented evidence of the presence and severity of OSA, to enable appropriate post-operative management planning.[10]

The definition of OSA in children is not clear. Polysomnography, which is accepted as the gold standard investigation, involves measuring markers of sleep quality, including brain activity, oxygen saturation, heart rate, breathing, and eye and limb movements. If polysomnography results are available, the presence and severity of OSA is determined using the apnoea-hypopnoea index (a score of less than 1 indicates no OSA, 1–5 indicates mild OSA, 5–10 indicates moderate OSA and more than 10 indicates severe OSA).[14] However, as we have demonstrated in this questionnaire, polysomnography is rarely used. Polysomnography was only used in tertiary referral centres where sleep research was being undertaken, and, hence, pre- and post-operative polysomnography was encouraged.

The McGill oximetry scoring system was developed as a way to estimate the severity of OSA pre-operatively. It uses both the number of desaturations and the clusters that occur as a means to prioritise surgery for children with OSA.[7] Other cheaper alternatives (compared with polysomnography) for measuring paediatric OSA severity have been developed, including symptom questionnaires (e.g. the OSA-18 quality of life questionnaire). However, these have limited sensitivity, of 40 per cent, and they are not accurate at detecting OSA.[15,16]

Fewer of our respondents (31 per cent) utilise post-operative pulse oximetry monitoring compared to pre-operative pulse oximetry. The most common reason for its use was for overnight monitoring in the immediate post-operative period (88 per cent). Very few respondents used post-operative pulse oximetry as a method for detecting residual problems (19 per cent). Previously published guidelines provide no clear recommendations for post-operative pulse oximetry, and the UK multidisciplinary working party does not mention the use of post-operative pulse oximetry.[6] One could argue that the use of post-operative pulse oximetry should not be necessary, as patients who are deemed 'high risk' would be initially screened prior to surgery and therefore referred to the appropriate centre. Nonetheless, if clinicians have any concerns regarding the post-operative period, they tend to keep patients in overnight rather than arrange specific post-operative pulse oximetry.[10]

The use of sleep nasendoscopy has been described in previous literature. It is particularly useful for those patients who continue to have upper airway obstruction despite adenotonsillectomy, and in those patients with airway obstruction due to cerebral palsy, syndromes and craniofacial malformations.[16,17] However, in the UK it is rarely performed, and where it is used, it is reserved for those patients who have already had surgery or have upper airway obstruction secondary to a syndrome or craniofacial malformation.[17] There are also concerns about subjecting children to sedation for sleep nasendoscopy as a first-line investigation. For these reasons, we did not include it in our questionnaire.

There is an increasing trend in the UK for paediatric ENT surgery only to be performed after funding has been confirmed from the clinical commissioning group. This was reflected in our questionnaire by the fact that 34 per cent of our respondents required prior clinical commissioning group approval. Indeed, it is possible that in the future, clinical commissioning groups may demand mandatory pulse oximetry or polysomnography to prove that there is OSA present, before funding is approved. However, some clinicians would argue that overnight pulse oximetry provides a snapshot of 1 night, and therefore will not accurately diagnose all children with OSA, as reflected by its low negative predictive value of 47 per cent.

In children, the most common cause for OSA is enlarged adenotonsillar tissue relative to the upper airway size.[18] All of the respondents in our questionnaire offer adenotonsillectomy in the management of children with snoring and OSA, in common with previously published questionnaire studies.[10] A smaller number of respondents offer adenoidectomy for snoring symptoms (76 per cent). Only 20 per cent offer microlaryngoscopy combined with adenotonsillectomy (for those aged less than two years), probably because only specialist centres will anaesthetise children under the age of two years.

Adenotonsillar hypertrophy is responsible for the majority of upper airway obstructions in children. However, other causes, such as cerebral palsy, craniofacial malformations and syndromes, can lead to the

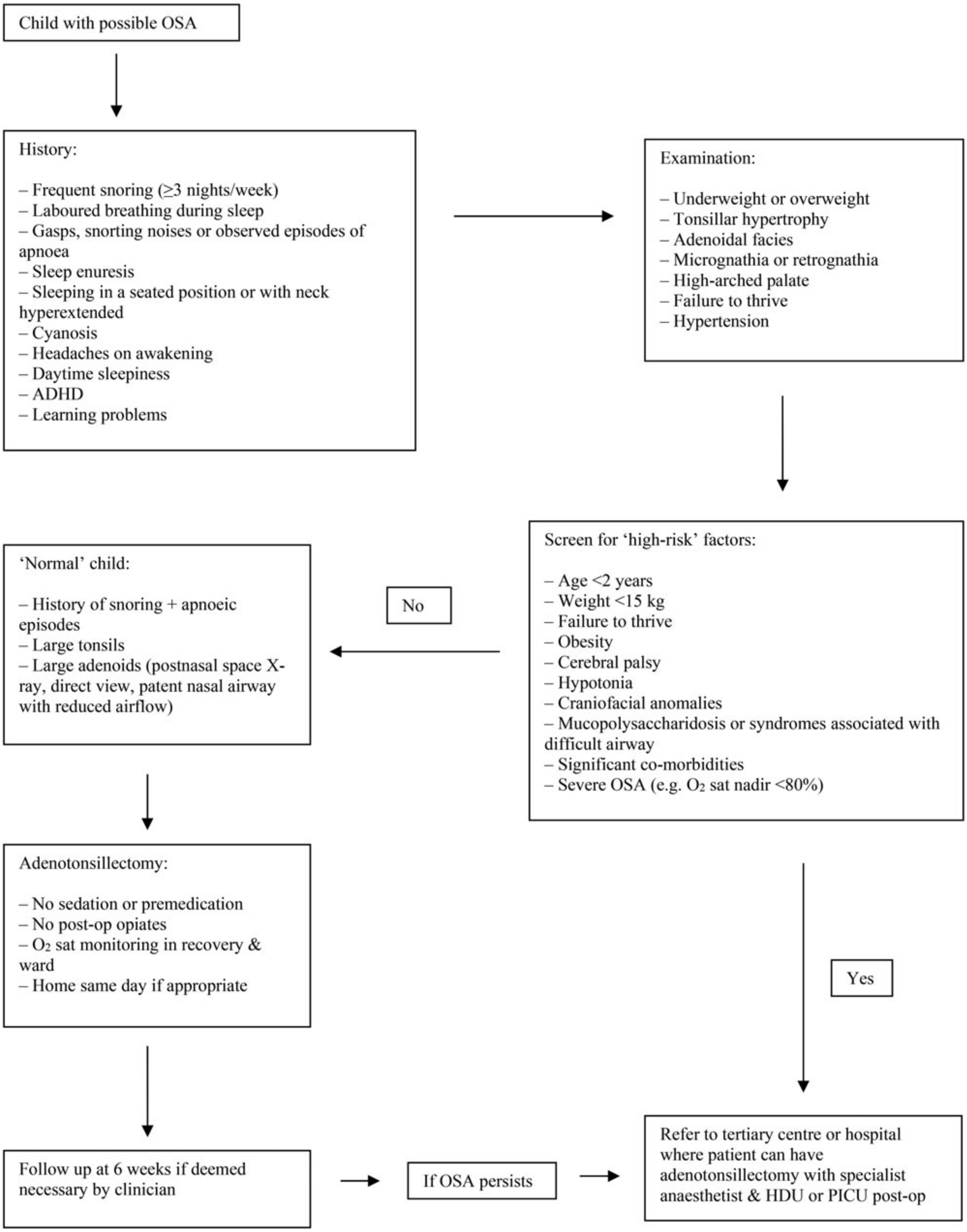

FIG. 5

Local trust protocol for management of paediatric snoring and obstructive sleep apnoea.[2] OSA = obstructive sleep apnoea; ADHD = attention-deficit hyperactivity disorder; O_2 sat = oxygen saturation; post-op = post-operative; HDU = high dependency unit; PICU = paediatric intensive care unit

https://doi.org/10.1017/S0022215116000980 Published online by Cambridge University Press

development of upper airway obstruction, as a result of factors such as poor muscle tone.[4] However, investigation of such causes is beyond the scope of this study.

Continuous positive airway pressure (CPAP) is a well-established treatment for OSA in both adults and children.[19] In children, CPAP has a useful role in those who are ineligible for surgery or awaiting an operation, in those with complex diseases, or in cases where surgery has failed to resolve symptoms.[20] We did not include this treatment in the questionnaire, as we were primarily interested in surgical interventions for paediatric OSA.

The majority of our respondents were aware of the UK multidisciplinary working party guidelines in terms of which patients should be referred on to a centre with paediatric intensive therapy unit facilities. Interestingly, when it came to the age of a child, there was some variation in practice, and some centres without paediatric intensive therapy unit facilities were operating on children younger than two years, citing that it was dependent on the anaesthetists at the hospital. All centres that responded to the questionnaire were able to refer patients to a centre with paediatric intensive therapy unit facilities, but only 28 per cent had on-site paediatric intensive therapy unit facilities. The centres with paediatric intensive therapy unit facilities were sometimes a large distance away from the referring hospital, and had limited bed availability, which influenced decision-making for surgery for children with OSA aged less than two years.

Only 58 per cent of our respondents follow up patients after surgical intervention for paediatric snoring and OSA. However, the American Thoracic Society recommends that all children with OSA should be reassessed six to eight weeks post-operatively.[1] The literature suggests that some patients may continue to have OSA despite surgery because of anatomical and neuromuscular factors that affect the size and shape of the pharyngeal airway.[21] Patients who continue to have symptoms are in the 'high risk' group and should go on to have a post-intervention sleep study.[15]

Interestingly, none of our respondents were able to provide an estimate of the costs of pulse oximetry and polysomnography. At our hospital, pulse oximetry testing using a Masimo Radical-7™ device costs approximately £150. The cost of an overnight stay on a paediatric ward is £500. In contrast, a standard polysomnography study costs approximately £820 (excluding hospital stay).

A significant proportion of respondents in our survey (75 per cent) do not have a formal management protocol for paediatric snoring and OSA. Based on the findings of our questionnaire study and a previously published study investigating the use of pulse oximetry,[2] in our local department we have developed a local trust protocol for the management of children with snoring and OSA (Figure 5).

This study had a higher response rate than any of the other previously published questionnaire studies on paediatric OSA, most likely because we obtained responses via telephone, rather than e-mail or post. However, we would have expected a higher response rate given that this was a telephone questionnaire study. The reasons for the limited response rate include an inability to contact clinicians despite repeated attempts, and the fact that some clinicians were not aware of the management guidelines at their centre for children with OSA. As there was a response rate of less than 100 per cent, this study may be susceptible to response bias. A significant proportion of the non-responders may be unable to or do not provide services for the assessment or management of paediatric snoring and OSA.

We did not survey anaesthetists, which would have been useful, particularly for establishing reasons why some centres operate on children aged less than two years or weighing less than 15 kg when paediatric intensive therapy unit facilities are not available on-site. We asked some follow-up questions not included in the questionnaire if the centre's management differed significantly from most centres, but this could have been more formally assessed. Our questionnaire was not validated and the responses can be subjective as they can represent a particular surgeon's view as opposed to that of the trust.

- **Assessment and management of snoring and obstructive sleep apnoea (OSA) in the paediatric population varies across the UK**
- **Further guidelines, particularly in terms of post-operative pulse oximetry, are necessary**
- **Pre-operative pulse oximetry is sometimes used for suspected mild-to-moderate OSA in children with no co-morbidities, contrary to guidelines**
- **This could be because of pressure from anaesthetists and clinical commissioning groups regarding documented evidence of OSA severity**
- **All UK ENT surgeons surveyed offer adenotonsillectomy to treat paediatric OSA**
- **A significant proportion of UK clinicians routinely follow up patients after surgery for paediatric OSA**

Further studies are warranted to investigate the long-term effects of untreated mild-to-moderate OSA in the paediatric population and evaluate the management of children in the immediate post-operative period.

Conclusion

There is variation in the assessment and management of snoring and OSA in the paediatric population

https://doi.org/10.1017/S0022215116000980 Published online by Cambridge University Press

across the UK. There is particular variation in the use of pre- and post-operative pulse oximetry monitoring across different centres. Further guidelines regarding this, particularly in terms of post-operative pulse oximetry, are necessary. All ENT surgeons in the UK appear to offer adenotonsillectomy to treat paediatric OSA. A significant proportion of ENT surgeons use pulse oximetry pre-operatively for suspected mild-to-moderate OSA in children with no co-morbidities, contrary to the UK multidisciplinary working party guidelines; this could be because of increasing pressure from anaesthetists and clinical commissioning groups regarding documented evidence of OSA severity. Most clinicians in the UK do not routinely follow up patients after surgery for paediatric OSA.

Acknowledgement

Grateful thanks to the administrative staff in the ENT Department at Queen's Hospital, Romford, UK.

References

1 American Thoracic Society. Standards and indications for cardiopulmonary sleep studies in children. *Am J Respir Crit Care Med* 1995;**153**:866–78
2 Kanona H, Sharma SD, Chaidas K, Kotecha B. Pulse oximetry in paediatric obstructive sleep apnoea – is it used appropriately? *J Laryngol Otol* 2015;**129**:874–81
3 Anuntaseree W, Rookkapan K, Kuasirikul P, Thongsuksai P. Snoring and obstructive sleep apnoea in Thai school-age children: prevalence and predisposing factors. *Pediatr Pulmonol* 2001;**32**:222–7
4 Brunetti L, Rana S, Lospalluti ML. Prevalence of obstructive sleep apnoea syndrome in a cohort of 1,207 children of Southern Italy. *Chest* 2001;**120**:1930–5
5 Marcus CL, Brooks LJ, Draper KA, Gozal D, Halbower AC, Jones J *et al*. Diagnosis and management of childhood obstructive sleep apnea syndrome. *Pediatrics* 2012;**130**:576–84
6 Robb PJ, Bew S, Kubba H, Murphy N, Primhak R, Rollin AM *et al*. Tonsillectomy and adenoidectomy in children with sleep-related breathing disorders: consensus statement of a UK multidisciplinary working party. *Ann R Coll Surg Engl* 2009;**91**: 371–3
7 Nixon GM, Kermack AS, Davis GM, Manoukian JJ, Brown KA, Brouillette RT. Planning adenotonsillectomy in children with obstructive sleep apnea: the role of overnight pulse oximetry. *Pediatrics* 2004;**113**:19–25
8 Brouillette RT, Morielli A, Leimanis A, Waters KA, Luciano R, Ducharme FM. Nocturnal pulse oximetry as an abbreviated testing modality for pediatric obstructive sleep apnea. *Pediatrics* 2000;**105**:405–12
9 Roland PS, Rosenfeld RM, Brooks LJ, Friedman NR, Jones J, Kim TW *et al*. Clinical practice guideline: polysomnography for sleep-disordered breathing prior to tonsillectomy in children. *Otolaryngol Head Neck Surg* 2011;**145**:S1–15
10 Pringle MB, Natesh BG, Buchanan EM. National UK survey on the assessment and surgical management of suspected paediatric obstructive sleep apnoea syndrome. *Int J Pediatr Otorhinolaryngol* 2013;**77**:1689–96
11 Weatherly RA, Mai EF, Ruzicka DL, Chervin RD. Identification and evaluation of obstructive sleep apnea prior to adenotonsillectomy in children: a survey of practice patterns. *Sleep Med* 2003;**4**:297–307
12 GraphPad Software. QuickCalcs. In: http://www.graphpad.com/quickcalcs/contingency1/ [22 November 2015]
13 McColley SA, April MM, Carroll JL, Naclerio RM, Loughlin GM. Respiratory compromise after adenotonsillectomy in children with obstructive sleep apnoea. *Arch Otolaryngol Head Neck Surg* 1992;**18**:940–3
14 Gupta S, Nicoli T, Kotecha B. Latest trends in the assessment and surgical management of snoring in England: a prospective questionnaire study. *Clin Otolaryngol* 2014;**39**:177–82
15 Constatin E, Tewfik TL, Brouillette RT. Can the OSA-18 quality-of-life questionnaire detect obstructive sleep apnea in children? *Pediatrics* 2010;**125**:162–8
16 Caulfield H. Investigations in paediatric obstructive sleep apnoea: do we need them? *Int J Pediatr Otorhinolaryngol* 2003;**67**:S107–10
17 Myatt HM, Beckenham EJ. The use of diagnostic sleep nasendoscopy in the management of children with complex upper airway obstruction. *Clin Otolaryngol Allied Sci* 2000;**25**:200–8
18 Stradling JR, Thomas G, Warley AR, Williams P, Freeland A. Effect of adenotonsillectomy on nocturnal hypoxaemia, sleep disturbance, and symptoms in snoring children. *Lancet* 1990; **335**:249–53
19 Palombini L, Pelayo R, Guilleminault C. Efficacy of automated continuous positive airway pressure in children with sleep-related breathing disorders in an attended setting. *Pediatrics* 2004;**113**:e412–17
20 Girbal IC, Goncalves C, Nunes T, Ferreira R, Pereira L, Saianda A *et al*. Non-invasive ventilation in complex obstructive sleep apnea – a 15-year experience of a pediatric tertiary center. *Rev Port Pneumol* 2014;**20**:146–51
21 Nishmura T, Morishima N, Hasegawa S, Shibata N, Iwanaga K, Yagisawa M. Effect of surgery on obstructive sleep apnea. *Acta Otolaryngol Suppl* 1996;**523**:231–3

Address for correspondence:
Mr Sunil Sharma,
Department of Otorhinolaryngology,
Queen's Hospital,
Rom Valley Way,
Romford RM7 0AG, UK

Fax: +44 (0)1708 435 096
E-mail: sunilsharma@doctors.org.uk

Mr S Sharma takes responsibility for the integrity of the content of the paper
Competing interests: None declared