Analysis of intensive care admissions among paediatric obstructive sleep apnoea referrals

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ABSTRACT

INTRODUCTION The aim of this study was to identify the proportion of children referred to a paediatric tertiary referral centre who required admission to the paediatric intensive care unit (PICU) following surgery for obstructive sleep apnoea (OSA) and to establish risk factors for these admissions.

METHODS Retrospective review of case notes and the operative database was performed for all children undergoing adenotonsillectomy for sleep disordered breathing and OSA symptoms in Great Ormond Street Hospital over a 10-year period.

RESULTS Overall, 1,328 children underwent adenotonsillectomy for sleep disordered breathing and OSA. The mean age was 3.1 years (standard deviation [SD]: 1.7 years). A total of 37 (2.8%) were admitted to the PICU postoperatively (mean length of PICU stay: 1.2 days, standard deviation [SD]: 0.6 days) and 282 (21.2%) required nasopharyngeal airway (nasal prong) insertion intraoperatively. The mean length of stay on the ward following surgery was 1.4 days (SD: 0.8 days). Patients with severe OSA (apnoea–hypopnoea index [AHI] >10) and ASA (American Society of Anesthesiologists) grade ≥3 were more likely to require postoperative PICU admission (22/37 vs 381/1,291 [$p<0.001$] and 29/37 vs 660/1,291 [$p=0.001$] respectively). Severe OSA was also more common in children who required nasal prong insertion intraoperatively (186/282 vs 217/1,046, $p<0.001$).

CONCLUSIONS Very few children referred to a paediatric tertiary referral centre actually require PICU admission following surgery. This may be in part due to the use of a nasopharyngeal airway in patients where postoperative obstruction is anticipated. In children with severe OSA (AHI >10) and an ASA grade of ≥3, nasopharyngeal airway insertion and potential admission to the PICU should be considered.

KEYWORDS

Obstructive sleep apnoea syndrome – Paediatric – Sleep disordered breathing – Adenoidectomy – Tonsillectomy

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Sleep disordered breathing comprises a spectrum of conditions from simple snoring to obstructive sleep apnoea (OSA), which carries the highest perioperative risk.¹ OSA is defined as ‘a disorder of breathing during sleep characterized by prolonged partial upper airway obstruction and/or intermittent complete obstruction (obstructive apnea) that disrupt normal ventilation during sleep and normal sleep patterns’.² Studies suggest that 6–12% of children have significant snoring and 1–3% have OSA.^{3,4}

The pathophysiology of OSA in children is often multifactorial with contributions from adenotonsillar hypertrophy, obesity, poor neuromuscular tone of the upper airways and craniofacial abnormalities.⁵ Adenotonsillectomy has become the most common first-line management for paediatric OSA, and it has been shown to greatly improve quality of life in many children and prevent cardiorespiratory complications.⁶

Adenotonsillectomy carries significant risks including haemorrhage, pain, vomiting and dehydration.⁷ In children undergoing adenotonsillectomy for OSA, the rate of respiratory complications postoperatively requiring medical intervention is reported to range from 21% to 36%.⁸ Identifying those at risk can therefore aid planning in terms of the most suitable location for postoperative care.

In 2009 a UK multidisciplinary consensus statement noted that children with OSA should be considered ‘high risk’ if they are younger than 2 years old, weigh less than 15kg, have syndromes associated with airway problems, severe co-morbidities (ASA [American Society of Anesthesiologists] grade ≥3) or severe OSA (apnoea–hypopnoea index [AHI] >10) and their surgery should be performed in a centre with paediatric intensive care unit (PICU) facilities because of a greater risk of postoperative respiratory complications.⁹ The American Academy of Pediatrics has also 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.¹⁰ These include disturbed sleep, daytime neurobehavioural problems, failure to thrive and hypertension.

The aim of this study was to identify the proportion of children referred to a paediatric tertiary referral centre who required admission to the PICU following surgery for OSA and to establish risk factors leading to these admissions.

Methods

This study was approved by the Great Ormond Street Hospital for Children NHS Foundation Trust clinical governance department. A retrospective review of case notes and the otolaryngology department operative database was performed for all children undergoing adenotonsillectomy for OSA symptoms at our institution over a ten-year period between January 2006 and December 2015. The inclusion criteria were all referrals from other institutions across the country in children who had a history suggestive of sleep disordered breathing or OSA but for whom it was deemed inappropriate to have surgery at a district general hospital (DGH).

Patient demographics, associated co-morbidities, weight, ASA grade and severity of OSA were all recorded. Outcome measures such as PICU admission, nasopharyngeal airway insertion and length of stay were also noted.

All patients who underwent adenotonsillectomy had general anaesthesia and orotracheal intubation. The majority had gas induction with short acting non-depolarising paralytic agents and narcotics, and intravenous dexamethasone at induction (to prevent postoperative nausea). Adenoidectomy was performed in the majority of patients using suction monopolar diathermy (38W, cutting or coagulation setting) and tonsillectomy by bipolar dissection (6–8W). More recently, some surgeons at our institution have begun to use Coblation® (Smith & Nephew, London, UK) intracapsular tonsillectomy and adenoidectomy (settings 7:3), and these patients were also included in our study.¹¹

The use of a customised nasopharyngeal airway is unique to our institution. The decision regarding insertion is typically taken based on preoperative factors as well as on observations made by the anaesthetist as to the level of obstruction at induction of general anaesthesia. Factors at induction such as a drop in oxygen saturations or features of respiratory distress influence the decision for use of the nasopharyngeal airway. The nasopharyngeal airway is fashioned from a paediatric endotracheal tube, cut to size with the tip of the tube positioned just below the margin of the soft palate. The endotracheal tube is then sutured to an endotracheal tube holder to act as a flange for securing the outside of the tube to the face. Once created, the nasal prong is inserted when surgery is complete and remains in situ overnight (Fig 1).

Statistical analysis was carried out using Fisher's exact test (QuickCalcs; GraphPad Software, La Jolla, CA, US). A *p*-value of <0.05 was deemed statistically significant.

Figure 1 Nasal prong, used to reduce postoperative respiratory complications in children undergoing adenotonsillectomy

Results

Overall, 1,328 children (723 male, 605 female) who underwent adenotonsillectomy for OSA were included in the study. The mean age was 3.1 years (standard deviation [SD]: 1.7 years).

Of the included patients, 324 (24.4%) were aged <2 years, 488 (36.7%) weighed <15kg, 648 (48.8%) had syndromes associated with airway problems, 689 (51.9%) had severe co-morbidities (ASA grade ≥3) and 403 (30.3%) had documented severe OSA, confirmed by a formal sleep study. A total of 814 patients (61.2%) had formal polysomnography prior to surgery because of a suspicion of severe OSA. Of these patients, 403 (49.5%) had severe OSA (AHI >10), 207 (25.4%) had moderate OSA (AHI 5–10), 92 (11.3%) had mild OSA (AHI 1–4) and 112 (13.8%) had no OSA (but a clinical history of sleep disordered breathing).

There were no perioperative mortalities in this group. Of the total 1,328 admissions, only 5 patients (0.4%) had a primary haemorrhage within 24 hours of surgery requiring a return to theatre. Secondary haemorrhage rates were not assessed in this study.

In total, 37 children (2.8%) were admitted to the PICU postoperatively (mean length of stay on PICU: 1.2 days, SD: 0.6 days) and 282 (21.2%) required nasopharyngeal airway insertion intraoperatively. The mean length of stay on the ward following surgery was 1.4 days (SD: 0.8 days).

Of the 37 patients who required a postoperative stay on the PICU, 21 (56.8%) were planned postoperative admissions and 16 (43.2%) were unplanned. The overall planned PICU admission rate was therefore 1.6% and the unplanned rate was 1.2%.

Among those children admitted to the PICU, 18 (48.6%) required postoperative intubation and ventilation, and 11 of these (61.1%) were transferred already intubated from other centres because of severe OSA symptoms. Of these 11

patients, 6 (54.5%) had severe co-morbidities (ASA grade ≥ 3), 3 (27.3%) had syndromes associated with airway problems, 2 (18.2%) had pre-existing documented severe OSA, 1 (9.1%) was <2 years old and 1 (9.1%) weighed <15 kg. Half of the children on the PICU (19/37, 51.4%) stayed there for postoperative observation for one night without the need for intubation and ventilation.

Of the patients who were admitted to the PICU, over half had severe OSA (22/37, 59.5%). In contrast, under a third of those who did not require PICU admission had AHI >10 (381/1,291, 29.5%). This difference was statistically significant ($p<0.001$).

In terms of co-morbidities, over three-quarters of the children admitted to the PICU were classified as ASA grade ≥ 3 (29/37, 78.4%) while this applied to only half of those who did not require PICU admission (660/1,291, 51.1%). Again, this difference was statistically significant ($p=0.001$).

The presence of severe OSA was also more common in those patients who required nasopharyngeal airway insertion intraoperatively than in those who did not (186/282 vs 217/1,046, $p<0.001$). Age <2 years and weight <15 kg were not more likely to require PICU admission (6/37 vs 318/1,291 [$p=0.33$] and 12/37 vs 476/1,291 [$p=0.73$] respectively) or nasopharyngeal insertion intraoperatively (62/282 vs 262/1,046 [$p=0.31$] and 102/282 vs 386/1,046 [$p=0.84$] respectively).

Discussion

Our data suggest that very few patients who are referred to a paediatric tertiary referral centre actually require a PICU admission postoperatively (2.8%) and only 1.2% of these were unplanned PICU admissions. This is lower than the rates reported in the literature from other countries. For instance, a study from Brazil of 805 children undergoing adenotonsillectomy reported a PICU admission rate of 6.6%.⁸ Studies indicate that between 25% and 60% of those patients at 'high risk' actually develop respiratory complications postoperatively.¹²⁻¹⁴ It is interesting to note that a previous study from the same institution looking at 1,735 PICU admissions between 2003 and 2010 for children undergoing adenotonsillectomy reported a PICU admission rate of 2.4%, which shows that this has not changed significantly over a 12-year period.¹²

The UK multidisciplinary consensus statement suggests that the majority of patients who are aged <2 years, weigh <15 kg, have syndromes associated with airway problems, severe co-morbidities or severe OSA are considered at high risk of respiratory complications requiring possible PICU admission.⁹ Conversely, our data demonstrate that very few of these patients actually require admission to the PICU.

In our tertiary paediatric centre, PICU admission usually requires the child to be intubated and ventilated, and the acute surgical ward (staffed by experienced otorhinolaryngology trained nursing staff) acts as a high dependency unit (HDU). As a result, in other centres, some of our postoperative adenotonsillectomy patients would possibly need to be nursed on a paediatric HDU instead, requiring referral to a tertiary centre to obviate this. However, this implies that a

significant number of those children being referred to a tertiary paediatric centre could have surgery performed safely at a DGH (such as those <2 years of age, <15 kg in weight or ASA grade <3) and would certainly not routinely need a PICU bed booked prior to surgery.

Nevertheless, it should be borne in mind that the Royal College of Anaesthetists' guidelines for the provision of paediatric anaesthesia services comment on suitability for day case surgery at DGHs and recognise that there should be local recommendations regarding the lower age limit for elective operations at DGHs.¹⁵ This can have implications on the referral of children to tertiary paediatric centres.

Another possible reason for reduced need for intensive care admission is the use of a customised nasopharyngeal airway for those considered at high risk of respiratory compromise following surgery. The use of a customised nasopharyngeal airway is unique to our institution, and has been shown to avoid the need for medical intervention and intensive care admission.^{16,17} On the other hand, it does require admission for a minimum of two nights as the patients are observed for a further night after the prong is removed, which slightly increases their length of stay in the hospital. There are some studies that demonstrate the relative safety of performing adenotonsillectomy as a day case on the majority of children with OSA.¹⁸

Risk factors associated with potential respiratory complications postoperatively have been reported extensively. A large analysis of 4,092 patients undergoing tonsillectomy suggested that trisomy 21, weight, coexistent syndrome, presence of OSA and significant co-morbidities were associated with an increased risk of desaturation in the first 24 hours after surgery.¹⁹ Other authors have also found that sleep studies showing a high AHI, a low peripheral oxygen saturation nadir ($<80\%$) and presence of rhinitis are associated with increased risk of postoperative respiratory complications.^{8,20} This is likely to be because these patients have greater airway collapsibility and greater sensitivity to postoperative airway swelling, and are more susceptible to the respiratory depressant effects of anaesthetics and opioids as well as taking longer for recalibration of their central hypercapnic respiratory drive.²¹

Our study has shown that children with severe OSA (AHI >10) and significant co-morbidities (ASA grade ≥ 3) are at greater risk of PICU admission, indicating that they are also at greater risk of respiratory complications. These findings are supported by studies published previously.^{12,22} Preoperative pulse oximetry or formal polysomnography may therefore be useful in children considered clinically to have severe OSA as it can help to risk stratify these patients for postoperative PICU admission.²² It is interesting that age <2 years and weight <15 kg have been shown in some other studies to be associated with greater risk of postoperative respiratory complications but this was not identified in our study.²³

It is also important to note that the criteria used to classify respiratory compromise following adenotonsillectomy in the literature are variable. Some papers describe respiratory complications as any postoperative desaturations, which may require simple repositioning, supplemental oxygen or

nebulisers, leading to a quoted incidence of up to 25%.^{14,24} Other studies define cases with respiratory complications as only those children requiring PICU admission and so their reported incidence of respiratory complications is much lower.²⁵ This distinction is important as a significant number of patients undergoing adenotonsillectomy for OSA in a tertiary centre will develop occasional desaturations and would therefore be classified in some papers as having respiratory complications when in fact they do not need PICU admission.

In our study, severe OSA was more common in those children who required nasal prong insertion intraoperatively. This has not been investigated before in the literature and has implications for intraoperative decision making regarding insertion of a nasal prong in children with severe OSA.

Owing to ease of access to polysomnography at our institution, we have a higher rate of preoperative polysomnography than at other centres. In addition, many of our patients are referred to us from other centres, having already had preoperative pulse oximetry or polysomnography to risk stratify these children.

This study was limited by the small sample size and a bias in those children who were selected for preoperative polysomnography. The study was retrospective and relied on accurate database recording. As a result, there may be an element of selection and reporting bias. This was also a heterogeneous group in terms of age and co-morbidities. Some of the patients may therefore have had multiple co-morbidities as well as severe OSA, which could influence the results. In common with other UK centres, there are significant pressures on the availability of PICU beds and this can influence the decision making process for borderline patients who may potentially require PICU admission.

Further prospective studies are warranted to look into the management of children in the immediate postoperative period in other paediatric tertiary centres. Moreover, further studies investigating outcomes with nasal prong insertion would be useful.

Conclusions

Our data suggest that very few children who are referred to a paediatric tertiary referral centre actually require a PICU admission following surgery. This could be in part due to the fact that a nasal prong is often used in 'high risk' patients where postoperative obstruction is anticipated, allowing the patient to be looked after on a paediatric acute surgical ward with experienced otorhinolaryngology trained staff, thereby avoiding an admission to the PICU. This has implications for the UK multidisciplinary consensus statement in that many of the children who are referred to tertiary centres could potentially have their surgery performed safely at a DGH. In children with severe OSA (AHI >10) and significant co-morbidities (ASA grade ≥3), nasal prong insertion and admission to PICU should be considered.

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