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Clinical outcomes in a high nursing ratio ward setting for children with obstructive sleep apnea at high risk after adenotonsillectomy

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ABSTRACT

Background: In 2012 clinical management of children having adenotonsillectomy (AT) for suspected obstructive sleep apnea (OSA) at our tertiary centre changed based on previous research: children with severe obstructive sleep apnea (OSA) at increased risk of post-operative respiratory adverse events (AE) identified using home overnight oximetry or polysomnography (PSG) were managed post-operatively in a high nurse/patient ratio unit in the ward (high acuity unit, HAU) rather than in the intensive care unit (ICU) as previously.
Objectives: To examine the post-operative respiratory AE post AT in HAU.
Methods: A retrospective audit was performed of children having AT on the HAU list from Oct 2012–Sept 2014, identifying clinical information, pre-operative testing for OSA and post-operative course.
Results: 343 children underwent elective adenotonsillectomy at our tertiary centre in the study period, of whom 79 had surgery on the HAU list (16F; median age 4.2 year (range 1.2–14.7); median weight-for-age centile 77.9% (IQR 44–98.7%)). 75 had moderate/severe OSA by oximetry ($n = 44$) or PSG ($n = 31$) criteria. 77 of 79 children had oxygen therapy in the recovery room (median 20 min, IQR 15–40 min). 18 (23%) had at least one AE outside the recovery room, which were observed ($n = 2$) or treated with oxygen therapy ($n = 14$) or repositioning ($n = 2$). Obesity increased the risk of an AE (10/25 obese vs 8/54 non obese, $p = 0.01$), as did the presence of a major comorbidity (5/9 with comorbidity vs 13/70 without, $p = 0.03$). There were no admissions from the HAU to ICU. 63 patients (83%) stayed only one night in hospital (median 1 d, range 1–5 d).
Conclusions: In a cohort of children with known moderate-severe OSA, post-operative AE after AT were all managed in the HAU. Post-operative care in HAU provides safe and effective care for high-risk children post-AT, minimizing admissions to ICU.

1. Introduction

In the pediatric population, obstructive sleep apnea (OSA) is estimated to have a prevalence of 2–3% [1], and is the most frequent indication for adenotonsillectomy (AT) in children. OSA is associated with considerable morbidity, including neurocognitive and behavioural disturbances, systemic and pulmonary hypertension, endothelial dysfunction, enuresis and failure to thrive [2]. Several studies have demonstrated resolution or improvement of symptoms such as snoring, restless sleep and enuresis following AT [3–6]. It has also been demonstrated that children who no longer have OSA post AT have improved quality of life [3–5].

AT itself is usually well tolerated [2], but does carry the risk of complications such as post operative respiratory compromise, adverse anesthetic events and hemorrhage [7]. Post operative respiratory complications include desaturation secondary to immediate post-operative airway irritability and laryngospasm, continuing upper airway obstruction [8], apneic events, and

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pulmonary edema [9]. Respiratory complications are more common in those with severe OSA [10]. Other recognized risk factors for respiratory compromise include age <3 years, weight <3rd centile for age, craniofacial anomaly, cardiac disease, prematurity and hypotonia [5–14]. It is estimated that more than 20% of children with OSA have respiratory compromise requiring medical or nursing intervention in the postoperative period [10,15]. For this reason, children with moderate to severe OSA are usually observed in hospital for one night post-operatively [15], but there is little agreement as to whether children can be safely observed in a pediatric ward or if they are better served in the pediatric intensive care unit (PICU) or a monitored step-down unit.

In 2012 clinical management of post-operative care of children with severe OSA changed in our institution based on previous research [16]. All children on the waiting list for AT had pre-operative testing using home oximetry or polysomnography (PSG), with the goal of identifying children at higher risk of post-operative respiratory adverse events. Oximetry was used in this context due to the limited availability of PSG. An abnormal oximetry defined by the presence of three or more clusters of desaturation and more than 3 dips in SpO_2 below 90% has a positive predictive value of 97% for the presence of OSA in this population, with the median obstructive apnea hypopnea index for those with an abnormal oximetry being 16 h^{-1} [12,17]. Children with an abnormal oximetry or severe OSA on PSG with an oxygen saturation nadir on pre-operative testing of <80% were given increased priority on the waiting list and scheduled for surgery on a dedicated operating list (high acuity unit, HAU list), with post-operative management in a new unit in the ward with high nurse/patient ratio (1:2) (HAU) rather than in the intensive care unit as previously. The supervising anesthetist (NR) still had the discretion in planning post-operative care to refer children with very severe comorbidities (e.g. cerebral palsy, morbid obesity) or those aged <2 years with severe and frequent desaturation on pre-operative testing to ICU. We aimed to review the safety of this model of care by examining the post-operative course of children managed in this way. A secondary aim was to review the efficacy of the model of care by determining the waiting time for surgery in this high-risk group. In doing so, we aimed to evaluate the safety and efficacy of a ward setting with high nurse-patient ratio for the post-AT care of children with severe OSA, reducing non-elective admissions to ICU.

2. Methods

We performed a retrospective chart review of patients aged 0–18 years who had tonsillectomy or AT on the dedicated list for higher risk patients (HAU list) at Monash Children's Hospital, a large urban tertiary centre. This list took place in the morning once a month and was intended to be reserved for children with documented severe OSA. Post-operative care location was determined at the time of surgery booking by a single pediatric anesthetist (NR) based on OSA severity, oxygen saturation nadir, age and the presence of severe comorbid conditions. To reduce ICU admissions, most children with severe OSA were triaged to receive post-operative care in a dedicated four-bed unit which served as a monitored step down unit with a high nurse to patient ratio (1:2) (herein referred to as the high acuity unit, HAU). Children were not discharged from the post-anesthetic care unit (PACU) to HAU until awake, comfortable and with stable oxygen saturation. The HAU operated for a duration of 24 h from the start of the HAU list, after which any patients who were not discharged received nursing care on the general pediatric surgical ward. In HAU, all patients received continous oximetry monitoring from the time of return from the operating room. Nursing staff responded to desaturation below 90% according to a protocol, by re-positioning the patient, more frequent observations of the patient or administering supplemental oxygen. Urgent medical review was obtained when needed, according to hospital policies. If patients required closer monitoring or the provision of non invasive ventilation or intubation for airway compromise, transfer to the pediatric ICU would be required. This project was approved as a quality assurance activity by the Monash Health Human Research Ethics Committee.

We identified all patients listed on the monthly HAU list between Oct 2012 and Sept 2014. Clinical data was extracted from the hospital records. Case records were reviewed manually. Clinical parameters collected included age, weight and height, and known risk factors for post-operative complications (recognized syndrome affecting muscle tone or airway, failure to thrive (weight < 3rd centile for age), current O_2-dependant lung disease, or cardiac abnormalities such as septal defects or pulmonary hypertension). Obesity was defined as a weight for age centile >95th centile. Asthma was not included as a co-morbidity given the limited clinical information available about the severity/nature of that condition. We collected preoperative polysomnography (PSG) or overnight oximetry data for the identified children through the Melbourne Children's Sleep Centre database.

In those cases with PSG, PSG was performed using a commercially available PSG system (E Series Sleep System, Compumedics, Melbourne, Australia) in the Melbourne Children's Sleep Centre. Recordings were scored according to standard criteria [18]. Overnight oximetry was performed at the child's home using a Masimo Radical oximeter (Masimo Corporation, Irvine, California, USA) after instructing a parent in the use of the device. Oximeters were set to 2-second averaging time.

Severity of OSA was classified on the basis of the obstructive apnea hypopnea index (OAHI) in cases where PSG was performed into the following: primary snoring (PS, OAHI <1 event/h); mild OSA (OAHI between 1 and 5 events/h); or moderate/severe OSA (OAHI > 5 events/h). For children who had oximetry but no PSG, severity of OSA was defined as either unknown (a normal or inconclusive oximetry result) or moderate/severe (including McGill scores 2, 3, and 4) [12]. The original description of the McGill Score showed that an abnormal oximetry with even a mild degree of desaturation (McGill score 2) corresponded to a mean obstructive apnea-hypopnea index (OAHI) of 12.6 h^{-1} on PSG, hence our categorization of children with abnormal oximetry as having moderate/severe OSA (an OAHI > 5 events/h by PSG criteria) [12].

Respiratory adverse events (AE) were defined from the end of the procedure. A mild respiratory AE was defined as requring supplemental O_2, stimulation, repositioning of the patient to improve the airway or increased frequency of nursing observations. A severe AE was defined as a requirement for any of: bag and mask ventilation, CPAP/non-invasive ventilation, placement of an oro-pharyngeal airway, re-intubation, or unplanned admission to the ICU.

Waiting time for surgery was determined from the date the child was added to the waiting list, established from the medical record. Length of stay was calculated from the dates of admission and discharge. Reasons for length of stay were analyzed individually from documentation in the medical records.

2.1. Data analysis

Data were analyzed using Stata 10 (StataCorp LP, College Station, USA). Risk factors for AE were assessed using Wilcoxon signed-rank test (obesity) or Fisher's exact test (age < 3 years, weight-for-age < 3rd centile, presence of major co-morbidity).