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Utility of screening questionnaire and polysomnography to predict postoperative outcomes in children



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ABSTRACT

Introduction: The prevalence of pediatric obstructive sleep apnea (OSA) has increased concurrently with the increasing prevalence of obesity. We have previously validated a short questionnaire predicting the occurrence of OSA on polysomnography (PSG). This follow-up study assessed the utility of the questionnaire in predicting postoperative outcomes.

Methods: Children undergoing surgery and completing a sleep study were prospectively screened for OSA using a short questionnaire. Procedures within 1 year of PSG were included in the analysis. Questionnaires were scored according to a cutoff previously deemed optimal for predicting OSA (apnea-hypopnea index ≥ 5) on the sleep study. Postoperative outcomes included prolonged (>60 min) length of stay (LOS) in the post-anesthesia care unit (PACU) and oxygen requirement in the PACU.

Results: The study cohort included 185 patients (100/85 male/female) age 8 ± 4 years, undergoing adenotonsillectomy ($n = 109$), other ear, nose, and throat (ENT) procedures ($n = 18$), or non-ENT procedures ($n = 58$). There were 45 patients with OSA documented by PSG and 122 patients identified as likely to have OSA according to questionnaire responses (89% sensitivity, 41% specificity). PACU LOS was prolonged in 55/181 (30%) cases and supplemental oxygen was used in the PACU in 29/181 (16%) cases. In separate multivariable models, supplemental oxygen use in the PACU was more common if a patient scored $\geq 2/6$ points on the short questionnaire scale (OR = 5.0; 95% CI: 1.3, 19.9; $p = 0.023$) or if the patient was diagnosed with OSA on PSG (OR = 4.6; 95% CI: 1.6, 13.5; $p = 0.005$). Neither OSA on PSG nor questionnaire score $\geq 2/6$ were associated with prolonged PACU stay.

Conclusion: Both OSA diagnosis based on the AHI and the questionnaire scale achieved comparable predictive value for the need for oxygen use in the PACU. The utility of the questionnaire in predicting rare adverse events (e.g., unplanned admission or rapid response team activation) remains to be determined. Our preliminary results support using a brief questionnaire scale for preoperative risk stratification among children with suspected OSA who have not had a formal sleep study.

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1. Introduction

Pediatric obstructive sleep apnea (OSA) has increased concurrently with increases in the prevalence of obesity in children [1,2]. Children with OSA have a greater risk of intraoperative and

postoperative respiratory complications [3–5]. Additionally, patients with severe OSA have been reported to have a heightened sensitivity to the respiratory depressant effects of opioids potentially due to the effect of chronic hypoxia and opioid receptor upregulation [6–8]. Consequently, the standard dose of opioid may actually result in respiratory depression in a child with OSA thereby causing postoperative respiratory complications. Therefore, identification of the presence of OSA in the surgical patient is important as adjustment in clinical care, including modification of opioid

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dosing and the postoperative disposition with inpatient admission for postoperative monitoring, may need to be altered to limit perioperative morbidity. While the existence of OSA in patients undergoing surgical procedure may influence our clinical practice, outside of those scheduled for adenotonsillectomy, the majority of pediatric surgical patients present for surgical procedures without a definitive diagnosis of OSA.

Preoperative identification of OSA would allow for anticipation of OSA-associated respiratory problems and help to determine which patients require overnight monitoring and observation. After investigating 111 adverse events in children who underwent tonsillectomy, Cote et al. noted that at least 16 children could have been rescued from death or neurologic injury due postoperative respiratory depression or compromise if respiratory monitoring had been continued during the postoperative period [9]. While polysomnography (PSG) continues to be the gold standard in determining the presence and severity of OSA in children, it is costly to obtain and its results may be inconclusive due to the high variability depending on the operator and the diagnostic criteria of each sleep lab [10]. Obtaining preoperative PSGs may be limited due to time constraints, local availability, access, and cost to families. At our institution, less than 10% of patients undergoing adenotonsillectomy have a preoperative PSG. This number is further reduced in other surgical populations. Our surgical colleagues determine whether these patients can be operated on safely in an ambulatory setting, or need extended postoperative monitoring. Thus, there is a significant clinical need for a simple OSA screening tool to help predict the findings on the PSG, the potential for postoperative complications, and the patient's postoperative disposition [11]. Several groups have investigated the utility of caregiver questionnaires in classifying children referred for surgery as likely to have OSA or likely to experience postoperative adverse events [11–13]. We have previously developed and validated a questionnaire adapted from the Pediatric Sleep Questionnaire Sleep Related Breathing Disorder Questionnaire, which was able to predict the presence of moderate or severe OSA as determined by PSG [11,14]. In the current exploratory study, we assessed if the 6 questions identified as predictive of OSA from our previous study could be used to predict postoperative adverse outcomes, and whether the use of predicted OSA on a questionnaire achieved comparable predictive value to using available data on OSA from PSG.

2. Methods

The study was reviewed and approved by the Institutional Review Board of Nationwide Children's Hospital, Columbus, Ohio (IRB13-00338 and IRB17-00478) and registered at clinicaltrials.gov (NCT01914198). Informed consent was waived by the IRB due to the observational nature of the study. The need for formal consent was replaced by discussing the purpose of the study and its intent with the parents prior to their agreement to complete the questionnaire. Patients who completed PSG and underwent a surgical procedure within 1 year after the PSG, ranging in age from 3 to 18 years, were included in the analysis. The apnea-hypopnea index (AHI) from the earliest PSG data, age at the procedure, questionnaire responses, body mass index (BMI), American Society of Anesthesiologists' (ASA) physical status, preoperative administration of midazolam, and intraoperative dosing of opioids in mg of morphine equivalent were collected. It is our standard practice for albuterol to be used for treatment of bronchospasm symptoms and racemic epinephrine to be used for treatment of post-extubation stridor.

The 6-item scale used for this study was constructed from questions adapted from the Pediatric Sleep Questionnaire-Sleep-Related Breathing Disorder Questionnaire, as previously described

by our group (Table 1), and dichotomized at a value (2 out of 6) deemed optimal for predicting OSA on the PSG [4]. Each question was equally weighted. Binary questions were coded as 1 = yes; and 0 = any other response or no response. Categorical items from the questionnaire were dichotomized as 1 = Yes or sometimes; 0 = No, unsure, or no response. OSA on PSG was defined in the following clinically accepted ranges of the AHI: none/mild (AHI < 5) and moderate/severe (AHI ≥ 5). As this was an exploratory study, no *a priori* sample size calculation or adjustment for multiple comparisons were performed.

Study outcomes included prolonged (>60 min) length of stay (LOS) in the post-anesthesia care unit (PACU) and postoperative oxygen requirement. Secondary study outcomes included albuterol use, racemic epinephrine use, or Rapid Response Team (RRT) activation after PACU discharge and while patients were on the ward. Outcomes were compared between patients with and without OSA (according to the questionnaire and PSG findings) using Chi square tests or Fisher's exact tests (where cell counts were <5). Multivariable logistic regression models of each PACU outcome were fitted to cases with complete data on covariates. Model fit was summarized using the area under the curve (AUC) on a receiver operating characteristics (ROC) analysis; AUC values were compared between models including the measure of diagnosed OSA, and models including the questionnaire-based measure of predicted OSA. Confounding variables included in multivariable models were patient age, sex, BMI-for-age percentile, American Society of Anesthesiologists' (ASA) status, procedure (tonsillectomy, other ear-nose-throat [ENT] procedure, or other procedures), preoperative use of midazolam, and intraoperative narcotic dose, expressed as equivalents of intravenous morphine (mg/kg). Statistical analyses were performed using Stata/IC 13.1 (StataCorp, LP, College Station, Texas, USA). $P < 0.05$ was considered statistically significant.

3. Results

The study cohort included 185 patients (100/85 male/female) aged 8 ± 4 years, undergoing adenotonsillectomy ($n = 109$) or other procedures ($n = 76$), of whom 176 had complete data on covariates for multivariable analysis. Four patients were missing data on PACU LOS and were excluded from analysis of this outcome. Patient characteristics are summarized in Table 2. There were 45 patients with OSA on a sleep study and 122 patients identified as likely to have OSA according to questionnaire responses (89% sensitivity, 41% specificity). PACU LOS was prolonged in 55/181 (30%) cases; and supplemental oxygen was used in the PACU in 29/185 (16%) cases. On the ward, 36 patients required albuterol (19%) and 3 patients required racemic epinephrine (2%). No patients required supplemental oxygen or RRT activation while on the ward. The scheduled admission status was outpatient in 65 cases, outpatient with bed (observation) in 98 cases, and inpatient in 22 cases; there were no unplanned admissions in the study cohort.

PACU and ward outcomes are compared according to OSA on PSG and according to questionnaire responses in Table 3. Scoring $\geq 2/6$ points on the short questionnaire scale was associated with a greater need for oxygen in PACU (26/122, 21% vs. 3/63, 5%;

Table 1
Caregiver questionnaire.

1	While sleeping, does your child snore more than half the time?
2	While sleeping, does your child always snore?
3	Have you ever seen your child stop breathing during the night?
4	Does your child occasionally wet the bed?
5	Did your child stop growing at a normal rate at any time since birth?
6	Is your child overweight?

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