Testing for Pediatric Obstructive Sleep Apnea When Health Care Resources Are Rationed

Linda Horwood, MSc; Robert T. Brouillette, MD; Christine D. McGregor, RRT; John J. Manoukian, MD; Evelyn Constantin, MD, MSc(Epi)

IMPORTANCE Evaluation of pediatric obstructive sleep apnea in resource-limited health care systems necessitates testing modalities that are accurate and more cost-effective than polysomnography.

OBJECTIVE To trace the clinical pathway of children referred to our sleep laboratory for possible obstructive sleep apnea who were evaluated using nocturnal pulse oximetry and the McGill Oximetry Score.

DESIGN, SETTING, AND PARTICIPANTS This was a retrospective cohort study of children 2 to 17 years old with suspected obstructive sleep apnea due to adenotonsillar hypertrophy, conducted at a Canadian pediatric tertiary care center.

INTERVENTIONS Nocturnal pulse oximetry studies scored using the McGill Oximetry Score.

MAIN OUTCOMES AND MEASURES For children who underwent adenotonsillectomy we determined the length of time from oximetry to surgery, postoperative length of stay, postoperative readmissions, and emergency department visits in the month following surgery and major surgical complications. We analyzed these outcomes by oximetry result. We compared the cost savings of our diagnostic approach with those of other diagnostic models.

RESULTS Among 362 children, the median age was 4.8 years (interquartile range, 3.3-6.7), and 61% were male. Two-hundred-sixty-six (73%) and 96 (27%), respectively, had inconclusive and abnormal oximetry results. Eighty of 96 children with abnormal oximetry results (83%) and 81 of 266 children with inconclusive oximetry results (30%) underwent adenotonsillectomy. Thirty-three of 266 children (12%) underwent further evaluation with polysomnography; of 14 diagnosed as having OSA, 12 underwent adenotonsillectomy. Children with abnormal oximetry results were operated on soonest after testing and triaged based on oximetry results. No child with an inconclusive oximetry result required hospitalization for more than 1 night postoperatively; 14% of children (11 of 80) with an abnormal oximetry result required hospitalization for 2 or 3 nights ($\chi^2 = 12.0; P = .001$). Rates of readmissions and emergency department visits were low, irrespective of oximetry results (whether inconclusive or abnormal). We show that our oximetry-based diagnostic approach results in considerable cost savings compared with a polysomnography-for-all approach.

CONCLUSIONS AND RELEVANCE Oximetry studies evaluated with the McGill Oximetry Score expedite diagnosis and treatment of children with adenotonsillar hypertrophy referred for suspected sleep-disordered breathing. When resources for testing for sleep-disordered breathing are rationed or severely limited, our proposed diagnostic approach can help maximize cost-savings and allows sleep laboratories to focus resources on medically complex children requiring polysomnographic evaluation of suspected sleep disorders.

Author Affiliations: Department of Pediatrics, Montreal Children's Hospital, McGill University Health Centre, Montreal, Quebec, Canada (Horwood, Brouillette, McGregor, Constantin); Department of Otolaryngology, Montreal Children's Hospital, McGill University Health Centre, Montreal, Quebec, Canada (Manoukian).

Corresponding Author: Evelyn Constantin, MD, MSc(Epi), Montreal Children's Hospital/McGill University Health Centre, 2300 Tupper St, Room C-508, Montreal, QC H3H 1P3, Canada (evelyn.constantin@mcgill.ca).


Published online May 22, 2014.
In children, obstructive sleep apnea (OSA) is estimated to have a point prevalence of 1% to 5%. Pediatric OSA has important short- and long-term adverse effects, including failure to thrive and cardiovascular and neurodevelopmental sequelae. Although pediatric OSA can be a feature of craniofacial, genetic, neurologic, and other complex disorders, most often it is due to adenotonsillar hypertrophy. Adenotonsillectomy is the usual first-line treatment for pediatric OSA, and OSA is the indication for most of the over 500,000 adenotonsillectomies performed yearly in the United States. Despite the prevalence and importance of OSA to child health, controversy persists about diagnostic testing for sleep-related breathing obstruction. Studies have shown that physician assessment of OSA based on patient history and physical evaluation alone are imprecise. However, 2 recent series have reported that practice patterns among otolaryngologists are such that most adenotonsillectomies (ie, >90%) are performed without benefit of laboratory confirmation of the diagnosis or severity of OSA. In-laboratory attended polysomnography (PSG) is recognized as the most accurate and comprehensive method of assessing breathing, upper airway obstruction, and gas exchange during sleep. Although considered the gold standard for diagnosis of OSA, PSG is expensive and is often unavailable outside of specialized pediatric centers. These facts necessitate an approach to better identify those patients who most require evaluation with PSG and to develop more accessible and cost-effective approaches to the diagnosis of OSA in children.

In Canada, a publicly funded health care system is available to all citizens and permanent residents. Provincial governments provide funding to individual hospital administrations who in turn determine the distribution of funds toward hospital resources. It has been our experience that adequate hospital resources are not available for the in-laboratory PSG diagnosis of most children with suspected OSA. Therefore, we have had to develop an alternative diagnostic approach. Over the past several years, we have been using home-based nocturnal pulse oximetry for the evaluation of children with suspected OSA due to adenotonsillar hypertrophy. We developed the McGill Oximetry Score (MOS), which was originally validated in 349 children 6 months to 18 years of age referred for possible OSA. Figure 1 depicts the 4 oximetry scores in increasing severity (MOS 1-4). Abnormal oximetry had a 97% positive predictive value for diagnosis of OSA compared with PSG; however, sensitivity was 43%, indicating that patients with an inconclusive oximetry (MOS 1) could have milder OSA not associated with repetitive desaturation. Inter-rater reliability for scoring oximetries with the MOS was excellent (κ = 0.80). Pavone et al recently reported that nighttime consistency was excellent (Spearman correlation coefficient = 0.90) in 148 children tested on 2 nights. The MOS correlates with well-accepted PSG metrics for OSA severity. The MOS and other oximetry metrics predict the likelihood of having adverse perioperative respiratory events. This information is useful in planning perioperative care, in particular, the requirements for a tertiary care setting and overnight

![Representative Pulse Oximetry Tracings From Children in Our Study Cohort Illustrating McGill Oximetry Scores (MOS) 1 Through 4](image-url)
postoperative monitoring. The MOS can help determine the appropriate postoperative narcotic dosage, as it has been shown that repetitive hypoxemia lowers the opioid requirement for postoperative pain control.\(^{18-22}\) In our setting, children younger than 3 years and/or having an MOS of 4 (and often those with an MOS of 3) are kept overnight in hospital with close perioperative monitoring in the pediatric intensive care unit or postanesthesia care unit. Finally, the MOS has been used to prioritize the most severely affected children for expeditious adenotonsillectomy.\(^{12}\)

In our resource-limited setting, otherwise healthy children with adenotonsillar hypertrophy referred for suspected OSA are evaluated with nocturnal pulse oximetry. In these children, PSG is used only if the sleep specialist or referring physician determines that the information potentially provided by PSG would be important for clinical decisions, specifically treatment with adenotonsillectomy. We have now used this MOS-based system in over 4000 patients.

In the current study, we trace the clinical pathway of children referred for possible OSA using our diagnostic approach. The purpose of our study was to demonstrate the utility of our approach to the diagnosis of pediatric OSA as carried out within our Canadian health care system. Specifically, we aimed to (1) confirm prior data indicating that children with more abnormal MOS values have more timely access to adenotonsillectomy; (2) evaluate by MOS result postoperative length of stay, readmissions and emergency department visits in the month following surgery, and major perioperative complications; and (3) compare the potential cost savings of our diagnostic approach with one in which all referred children are evaluated with PSG.

Methods

As required by provincial (Quebec) law, our study received research ethics board approval from the director of professional services of the Montreal Children’s Hospital (MCH), who acts on behalf of the MCH research ethics board. Data from the MCH Sleep Laboratory and MCH administrative databases formed the basis of this retrospective cohort study.

Sleep Laboratory Data

The MCH Sleep Laboratory database contains demographic (parental/caregiver questionnaire) and clinical (pulse oximetry, PSG) information on all children who underwent sleep testing from March 2005 to March 2009. We included in our study all children aged 2 to 17 years without prior adenotonsillar surgery who were referred by the hospital’s otolaryngology service for oximetry testing for suspected OSA during March 2005 to March 2007. This period was chosen so that children would have a minimum of 2 years of follow-up data in our sleep laboratory database (up to March 2009). Children were excluded if they had craniofacial, genetic, neurological, neuromuscular, cardiopulmonary conditions (other than asthma), or global developmental delay.

Pulse Oximetry

Nocturnal pulse oximetry is a simple, noninvasive method to determine the oxygen saturation of hemoglobin. Oximetry can be easily set up and used in the home by a parent or caregiver subsequent to a brief in-hospital instruction session with a sleep laboratory technician. Pulse oximetry recordings (Radical pulse oximeter, Masimo; and oximetry software, Download 2001, version 2.5.0, Stowood Scientific Instruments) are scored according to the frequency and depth of desaturation episodes and the number of clusters of desaturations.\(^{11,12}\) The pulse oximetry studies are scored using the MOS as previously described\(^{12}\); an MOS of 1 designates an oximetry result as inconclusive for OSA; an MOS of 2, 3, or 4 designates increasingly abnormal oximetry results with repetitive desaturations to less than 90%, 85%, and 80%, respectively (Figure 1). Full details regarding MOS scoring are provided in Brouillette et al\(^{11}\) and Nixon et al.\(^{12}\)

Parental/Caregiver Questionnaire

At the time that the pulse oximeter is picked up in the sleep laboratory, parents or caregivers complete a computer-based questionnaire (PHD Medical Inc) that collects demographic data and information about their child’s health, particularly his or her sleeping patterns and breathing.\(^{11,23}\) As part of this questionnaire, parents or caregivers indicate their child’s race/ethnicity by selecting from predetermined categories (“Caucasian, Black, Asian, Amerindian, Inuit, Latin American, Other”).

Polysomnography

In cases of inconclusive MOS studies, when suggested by the sleep medicine physicians or requested by the referring otolaryngologist, children are evaluated by PSG using standard techniques.\(^{24,25}\) One or more mixed obstructive apnea or hypopnea events per hour is considered abnormal and diagnostic of OSA in children.

Administrative Data and Medical Chart Reviews

Information from hospital electronic administrative databases and paper medical charts were accessed and merged with the information contained in the sleep laboratory database to trace the clinical course of children after referral for oximetry testing. For each child, administrative data were queried to (1) determine if an adenotonsillectomy followed sleep testing; (2) collect details about postoperative length of stay, emergency department visits and readmissions related to surgery; and (3) report on clinical follow-up (ie, scheduling, attendance, and outcomes of otolaryngology clinic appointments). To enumerate major perioperative complications, we performed medical chart reviews of all patients who had a prolonged length of stay (ie, admission for > 1 night), who had hospital readmission, or who visited the emergency department within 1 month of adenotonsillectomy.

Cost Estimation

For illustrative purposes, we estimated the costs of oximetry and PSG to be $100 and $1000, respectively. These values are based on the costs associated with the use of these tests in the MCH Sleep Laboratory.
Statistical Analysis
Continuous variables were assessed using t tests or Mann-Whitney tests, when normally or nonnormally distributed, respectively. Categorical variables were assessed using χ² tests. For all analyses, statistical significance was set at P < .05. We used SPSS statistical software (version 17.0; SPSS Inc) for database management and statistical analyses.

Results
Characteristics of our study population are given in Table 1. Among the 362 children who met inclusion criteria, the median age was 4.8 years (interquartile range [IQR], 3.3-6.7), and 61% (221 of 362) were male. Children's racial/ethnic groups (as identified by parental/caregiver report) were “Caucasian” (56%), “Asian” (16%), “Black” (11%), “Latin American” (9%), “Amerindian” (1%), and “Other” (7%). Parents or caregivers reported that the reasons for referral to the sleep laboratory were suspected sleep apnea or snoring (87%), adenotonsillar hypertrophy (56%), and other symptoms suggestive of OSA (11%). Almost half of all children were referred for more than 1 reason (49%).

Figure 2 shows the diagnostic pathway followed by our cohort of children. Two hundred sixty-six children (73%) had an inconclusive MOS, whereas 96 children (27%) had an abnormal MOS. Table 1 compares the characteristics of these groups; children with an abnormal MOS were younger than those with inconclusive MOS (P = .002). The groups were similar in terms of sex, race/ethnicity, and reasons for referral.

Clinical Course of Children With an Abnormal MOS
Among the 96 children who had an abnormal MOS, 14% (13 of 96) had an MOS of 4, 18% (17 of 96) had an MOS of 3, and 69% (66 of 96) had an MOS of 2. Among the 96 children who had an abnormal MOS, 83% (80 of 96) proceeded to adenotonsillectomy. Sixteen of 96 children with an abnormal MOS (17%) were not treated with adenotonsillectomy (14 with an MOS of 2; 2 with an MOS of 3). Among these 16 children, 96% (15 of 16) had appointments booked with the MCH otolaryngology service following their oximetry, with clinic visits attended by 80% (12 of 15) of children. Medical chart reviews on these 16 children with an abnormal MOS who did not have an adenotonsillectomy revealed that the 4 children who were not reevaluated by the otolaryngology service were lost to follow-up.

Clinical Course of Children With an Inconclusive MOS
Among the 266 children who had an inconclusive MOS, 30% (81 of 266) proceeded to an adenotonsillectomy, 12% (33 of 266) underwent further evaluation with PSG, and 57% (152 of 266) underwent clinical follow-up (ie, had neither adenotonsillectomy nor PSG). In this latter group of 152 children, 89% (135 of 152) had follow-up appointments booked with the MCH otolaryngology service, with visits attended by 89% of children (120 of 135).
In the case of an inconclusive oximetry result, our institution's otolaryngologists typically decide if the patient will be treated with adenotonsillectomy or will require further evaluation with PSG based on clinical evaluation. Among the 33 children who underwent evaluation with PSG following an inconclusive oximetry study, 14 were diagnosed as having OSA, all of whom did not have clinically significant hemoglobin desaturation during PSG testing. Diagnostic values in this group were consistent with mild to moderate OSA (median [IQR]: obstructive apnea–hypopnea index, 6.6 [1.9–14.3]; desaturation index, 3.2 [1.1–4.9]; and oxygen saturation nadir, 89% [87%–91%]).

Eighty-six percent of these children (12 of 14) underwent subsequent adenotonsillectomy. None of the 12 children who had adenotonsillectomy required more than 1 night of hospitalization. Moreover, none of the children were readmitted postoperatively, and 1 child presented to the emergency department with pain within the month following surgery. Two children who were diagnosed as having OSA on PSG but did not proceed to surgery were reevaluated by the MCH otolaryngology service. Two of 19 children with normal PSG test results underwent adenotonsillectomy based on a decision by the otolaryngologist and the child's caregivers.

Inconclusive oximetry testing results underwent adenotonsillectomy based on a decision by the otolaryngologist and the child's caregivers.

Table 2. Characteristics of 161 Children With an Inconclusive or Abnormal McGill Oximetry Score (MOS) Who Proceeded Directly to Adenotonsillectomy Without Preoperative Polysomnography

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Inconclusive (n = 81)</th>
<th>Abnormal (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolonged LOS</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Hospital readmission</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Bleeding</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Fever, pneumonia, Kawasaki disease</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Emergency department visit</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Bleeding</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Cough</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pharyngitis</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Fever</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pain</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Epistaxis</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Constipation</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
| Major perioperative complications
  a                           | 1                     | 2                 |
| Reintubation                      | 0                     | 1                 |
| (prolonged LOS)                   |                       |                   |
| Bleeding due to surgical trauma   | 0                     | 1                 |
| (prolonged LOS)                   |                       |                   |
| Bleeding requiring cauterization  | 1                     | 0                 |
| (hospital readmission)            |                       |                   |

Abbreviation: LOS, length of stay.

a Variables are expressed as number of cases.

b The 3 patients who experienced major perioperative complications overlap with the other categories listed.

In the case of an inconclusive oximetry result, our institution's otolaryngologists typically decide if the patient will be treated with adenotonsillectomy or will require further evaluation with PSG based on clinical evaluation. Among the 33 children who underwent evaluation with PSG following an inconclusive oximetry study, 14 were diagnosed as having OSA, all of whom did not have clinically significant hemoglobin desaturation during PSG testing. Diagnostic values in this group were consistent with mild to moderate OSA (median [IQR]: obstructive apnea–hypopnea index, 6.6 [1.9–14.3]; desaturation index, 3.2 [1.1–4.9]; and oxygen saturation nadir, 89% [87%–91%]).

Eighty-six percent of these children (12 of 14) underwent subsequent adenotonsillectomy. None of the 12 children who had adenotonsillectomy required more than 1 night of hospitalization. Moreover, none of the children were readmitted postoperatively, and 1 child presented to the emergency department with pain within the month following surgery. Two children who were diagnosed as having OSA on PSG but did not proceed to surgery were reevaluated by the MCH otolaryngology service. Two of 19 children with normal PSG test results underwent adenotonsillectomy based on a decision by the otolaryngologist and the child's caregivers.

Time to Surgery

Children with an abnormal MOS were operated on soonest after testing and were triaged for adenotonsillectomy on the basis of OSA severity. The median (IQR) number of days from oximetry testing to surgical intervention with adenotonsillectomy by decreasing MOS severity was 3.4 days (2.3–6.3 days) for MOS 4, 5.5 days (21.3–71.3 days) for MOS 3, 18.1 days (84.5–285.1 days) for MOS 2, and 24.6 days (154.3–448.3 days) for MOS 1. Among children with an inconclusive MOS, those who underwent adenotonsillectomy directly had shorter median surgical wait times than those children who underwent additional testing with PSG prior to adenotonsillectomy (202 vs 336 days, respectively).

Prolonged Length of Stay, Readmissions, Emergency Department Visits, and Major Complications

Prolonged Length of Stay

Most children in our study (150 of 161 [93%]) were discharged on the day of surgery or stayed a single night in hospital postoperatively. The maximum duration that any child was admitted to hospital following adenotonsillectomy was 3 nights. Table 2 shows that among the 161 children who underwent adenotonsillectomy directly following oximetry testing without preoperative PSG, no child with an inconclusive MOS required prolonged postoperative hospitalization, whereas 14% of children with abnormal MOS (11 of 80) were hospitalized for 2 or 3 nights ($\chi^2 = 12.0; P = .001$). Six of these 11 children (55%) with a prolonged length of stay were younger than 3 years. Our hospital’s policy for children undergoing adenotonsillectomy is that children younger than 3 years and those with MOS 4 must stay overnight in the pediatric intensive care unit or postanesthesia care unit for observation following adenotonsillectomy. Those children with MOS 3 often stay in hospital for close observation overnight following adenotonsillectomy. Thus, we used a prolonged length of stay as one surrogate for major perioperative complications. Medical chart reviews of the 11 children with length of stay longer than 1 night showed that 2 children with prolonged length of stay had major perioperative complications: 1 respiratory (reintubation) and the other nonrespiratory (bleeding due to surgical trauma; see Major Perioperative Complications subsection). The other 9 children had less severe complications: poor oral intake (7 children), continuing oxygen requirement (2 children), or both (2 children).

Readmissions and Emergency Department Visits Related to Adenotonsillectomy

Table 2 describes the postoperative readmissions and emergency department visits related to complications of adenotonsillectomy in the month following surgery for those children who underwent adenotonsillectomy directly following oximetry testing. Rates of postoperative hospital readmissions and emergency department visits were similar and low in children with and without an abnormal MOS. The overall rate of postoperative readmissions was 3% (5 of 161 children). Three of 81 children with an inconclusive MOS were readmitted for bleeding: in 2 children, bleeding was minimal and resolved spontaneously during a 1-night admission; in the third child, bleeding required surgical cauterization (for details, see the following subsection). Among 80 children with an abnormal MOS, 1 child was admitted for minor postsurgical bleeding; an-
other child was admitted for fever and pneumonia, prescribed antibiotics, and discharged after 24 hours. Two days later, he was readmitted for persistent fever and diagnosed as having Kawasaki disease. The overall rate of postoperative emergency department visits was 6% (9 of 161 children). Reasons for return emergency department visits were varied: 6 children with preoperative MOS 1 visited the emergency department: 1 each for bleeding, cough, pharyngitis, pneumonia, pain, and constipation. Three children with preoperative abnormal MOS visited the emergency department: 1 each for fever, pain, and epistaxis.

**Major Perioperative Complications**

As noted in Table 2, we identified 3 children with major perioperative complications. Two children who required prolonged length of stay postoperatively had major complications. The first child, a 2-year-old boy who had a preoperative MOS 4 oximetry, had stridor requiring reintubation. He remained in the pediatric intensive care unit on the first postoperative night, was extubated and sent to the in-patient wards for 1 night, and was discharged home the following day. A 6-year old boy who had a preoperative MOS 2 oximetry lost 100 cm³ of blood when a lingual artery was lacerated during drainage of a tongue hematoma that developed intraoperatively. One of 5 children readmitted postoperatively had a major perioperative complication: a 7-year-old boy with a preoperative MOS 1 presented to the emergency department with active tonsillar bleeding and subsequently underwent surgical cauterization of the tonsillar bed. No child who had perioperative bleeding required blood transfusion.

**Comparative Cost Estimations: MOS Approach vs PSG-for-All Approach**

Figure 3 shows the costs to evaluate children for OSA using several diagnostic algorithms assuming estimated costs for oximetry and PSG of $100 and $1000, respectively. The horizontal line shows the $1 000 000 cost to evaluate 1000 children with PSG. Oximetry alone, assuming no PSGs were performed, would cost $100 000 (point A). If all children had oximetry and 9.1% of children proceeded to PSG as in the current series, the estimated cost would be $191 000 (point B). Costs would be less than that for the PSG-for-all approach if fewer than 90% of patients proceed to PSG (point C). If all children had oximetry and then PSG was performed for all children with inconclusive oximetry in a proportion similar to that of our study cohort (73%), the estimated cost would be $830 000 (point D).

**Discussion**

**Validation of the McGill Oximetry Score**

Nocturnal pulse oximetry is a demonstrated practical tool for the evaluation of children with adenotonsillar hypertrophy referred for suspected OSA. Abnormal oximetry has been shown to have a 97% positive predictive value to detect OSA diagnosed by in-laboratory PSG.11-13 In our study, 80 of 96 children who had an abnormal MOS (83%) proceeded directly to treatment of OSA with adenotonsillectomy, including all 13 children with MOS 4 severity. Our oximetry-based diagnostic approach not only streamlines the diagnosis and treatment of OSA but also allows for the most serious cases of OSA to be identified and special care to be taken at the time of adenotonsillectomy. Perioperative measures specific to children with moderate to severe OSA, including lower perioperative narcotic doses, close monitoring and overnight hospital admission, are followed to reduce surgical morbidity in this group at increased risk of perioperative respiratory complications of adenotonsillectomy.26

The proportion of children in our cohort undergoing PSG is similar to that reported by 2 large otolaryngology practice surveys27,28 conducted in the United States. In our study, 33 children (9.1%) who were referred for possible OSA and had an inconclusive MOS underwent further testing with PSG. Of the 33 children evaluated with PSG, 14 (42%) were diagnosed as having OSA. Notably, the clinical values for this latter group, such as the obstructive apnea-hypopnea index, desaturation index, and oxygen saturation nadir, designate these children as having OSA in the mild to moderate range and without clinically significant desaturations, thus supporting the utility of oximetry as a particularly effective tool for identifying cases of severe OSA.

Polysomnography, although often regarded as the diagnostic gold standard for OSA, is not without limitations. It is expensive and requires an overnight stay in a sleep laboratory for the child and the parent or caregiver, thus entailing a greater level of inconvenience for the child and his or her family than with home oximetry. Diagnostic and severity cutoffs for OSA on PSG are not absolute; some children with low apnea-hypopnea indices may benefit from adenotonsillectomy, just as some children with higher indices may not benefit from...
treatment with adenotonsillectomy or their OSA may resolve with watchful waiting or standard care. Current otolaryngology guidelines propose that evaluation in-laboratory PSG is not necessary for all children with suspected OSA. For children with adenotonsillar hypertrophy considered at risk for OSA, our diagnostic approach identifies the most severely affected children with repetitive hemoglobin desaturations during sleep. Otolaryngologists then use the oximetry results in conjunction with clinical information to decide on whom to operate, in which setting, and with what level of perioperative care and monitoring.

On a broader level, and in a rationed health care system such as ours and that of many other countries worldwide, the limitations of oximetry are offset by the cost savings and the diagnostic and treatment streamlining benefit of performing oximetry as an accessible and economical test for otherwise healthy children with suspected OSA due to adenotonsillar hypertrophy. Sleep laboratory technician time accounts for the greatest part of the cost associated with laboratory PSG. Home oximetry reduces sleep laboratory technician time and accounts for the major cost savings associated with the oximetry-based approach. Thus, oximetry is a time-saving tool that fosters optimum clinical management and the reallocation of resources, such as technician time, to more complex cases that truly require overnight laboratory PSG for diagnosis and management decisions.

Study Limitations
Our retrospective study design was limited to the information contained in our sleep laboratory and hospital administrative databases and patient medical records. As such, we are not able to account for children who did not have otolaryngology clinic follow-up appointments booked, nor are we able to explain why some families chose to forgo clinical follow-up appointments. Our study’s data sources are also largely limited to treatment in our own institution, leaving open the possibility that some children were treated or evaluated in other clinics or hospitals. Our strategy for determining clinically significant perioperative complications was to perform detailed medical chart reviews of children with prolonged length of stay, or readmission or ER visits within a month of surgery. We acknowledge that minor complications may have occurred in children who were not included in these medical chart reviews.

In our study, for children who proceeded directly from oximetry testing to adenotonsillectomy without preoperative evaluation by PSG, rates of hospital readmissions and emergency department visits were low, irrespective of oximetry results (whether inconclusive or abnormal). Postoperative prolonged length of stay occurred exclusively in children with abnormal oximetry results; 6 of 11 (55%) were younger than 3 years. Medical chart reviews identified only 3 children with major perioperative complications (1 respiratory, 2 bleeding). Our modest sample size and the fact that very few children had to stay in hospital more than 1 night or return to the hospital within 1 month of adenotonsillectomy precluded an analysis to determine if age and severity of nocturnal desaturation were independent risk factors for perioperative respiratory complications.

In our study, we determined and described the clinical course of children within our diagnostic framework. However, we were not able to specify the complex clinical decision-making process underlying each child’s clinical course. What remains unclear is the reason for or the level of urgency of referrals to the sleep laboratory, the particularities of individual otolaryngologists’ decision-making processes with regard to the nature and timing of treatments, and the role of the family’s degree of concern and decisions about their child’s care. Future studies should prospectively collect information from otolaryngologists as well as the caregivers of children with suspected OSA to determine the factors that may predict severity of OSA and the factors that may influence the pursuit of surgical or other interventions.

Conclusions
Polysomnography remains the most comprehensive and accurate way to assess sleep-disordered breathing in children. However, for reasons of cost and limited health care resources, it seems that PSG will be unavailable for most children with adenotonsillar hypertrophy at risk of having clinically significant OSA. For such children, it has been previously shown that nocturnal oximetry scored using the MOS can identify children with the most severe OSA who have repetitive desaturations during sleep and are at the highest risk for perioperative respiratory complications of adenotonsillectomy.

In our moderate-sized cohort, higher-risk children with repetitive desaturations (preoperative MOS 2, 3, or 4) had expedited surgery and a very low major complication rate, likely owing to appropriate perioperative care. Those without repetitive desaturations (preoperative MOS 1) had no serious perioperative respiratory complications. In a setting where resources for OSA testing are rationed or severely limited, an oximetry-based diagnostic approach can help maximize cost savings and help minimize the occurrence of adverse perioperative events by ensuring the implementation of appropriate management strategies in those children at highest risk for perioperative respiratory complications.
Conflict of Interest Disclosures: Dr Brouillette is medical director of and has equity in PHD Medical Inc, the company that provided the Montreal Children's Hospital Sleep Laboratory database software for this project. No other disclosures are reported.

Funding/Support: Ms Horwood was awarded a doctoral studentship award from the Research Institute of the McGill University Health Centre—Foundation of Stars. Dr Constantin has been awarded a grant as a clinical research scholar from the Fonds de recherche du Québec-Santé and thanks them for their support. Drs Constantin and Brouillette are members of the Research Institute of the McGill University Health Centre, which is supported in part by the Fonds de recherche du Québec-Santé.

Role of the Sponsor: The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Additional Contributions: Maxim Kirstman, MD, was involved in the initial phases of the study when he was completing his medical studies at McGill University. He received a studentship award from McGill University.

REFERENCES


Copyright 2014 American Medical Association. All rights reserved.