Public Insurance and Timing of Polysomnography and Surgical Care for Children With Sleep-Disordered Breathing

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**Importance** Although children with low socioeconomic status (SES) have increased risk for sleep-disordered breathing (SDB), their access to subspecialty care is often limited. Polysomnography (PSG) is the gold standard diagnostic test used to characterize SDB and diagnose obstructive sleep apnea; however, it is unknown whether SES impacts timeliness of obtaining PSG and surgical treatment with adenotonsillectomy (AT).

**Objective** To evaluate the impact of SES on the timing of PSG, surgery with AT, and loss to follow-up for children with SDB.

**Design, Setting, and Participants** Retrospective cohort analysis conducted in tertiary outpatient pediatric otolaryngology clinics among patients newly evaluated for SDB over a 3-month period who did not have prior PSG ordered and had a minimum of 1-year follow-up.

**Main Outcomes and Measures** Public insurance (Medical Assistance [MA]) was used as a proxy for low SES. Demographics and disposition between groups were compared using t tests and χ² analysis. Logistic regression adjusting for disposition and insurance was used to predict loss to follow-up. Days to PSG and days to AT were evaluated using the Kaplan-Meier estimator, and the log-rank test was used to compare distribution of time to events between insurance groups.

**Results** A total of 136 children (without PSG) were evaluated for SDB over the course of 3 months; 62 (45.6%) had MA. Polysomnography was recommended for 55 children (27 of 55 [49%] with MA vs 28 of 55 [50%] with private insurance; P > .99). After the initial visit, 24 of 55 children with PSG requested (44%) were completely lost to follow-up (9 of 27 [33%] with MA vs 15 of 28 [54%] private insurance; P = .34). Children with MA who obtained PSG experienced longer intervals between initial encounter and PSG (mean interval, 141.1 days) than privately insured children (mean interval, 49.9 days) (P = .001). For those children who ultimately underwent AT surgery after obtaining PSG (n = 14), mean (SD) time to AT was longer for children with MA (222.3 [48.2] days vs 95.2 [66.1] days; P = .001).

**Conclusions and Relevance** Children with public insurance experienced longer intervals from initial evaluation to PSG or surgery. Almost half of patients with PSG requested were lost to follow-up, regardless of SES. These findings suggest that PSG may be a deterrent for definitive care for all children, and particularly for children with public insurance or low SES. This study emphasizes the need to understand factors contributing to disparities surrounding delay in care with PSG and surgery for children with SDB.
Despite an overarching agenda to make health care accessible to all children regardless of individual patient factors, low socioeconomic status (SES) remains a significant barrier to achieving quality care and improved health outcomes. There is overwhelming evidence showing that children from low-income families, who often live close to the poverty line or receive Medical Assistance (MA), experience worse access to care and health outcomes than privately insured children. In light of these findings, the identification and mitigation of child health disparities remains a national priority.

Sleep-disordered breathing (SDB) represents a spectrum of sleep disruption ranging from snoring to obstructive sleep apnea (OSA), and it has known physical and neurocognitive effects on child health. Low SES is a known risk factor for SDB. Although the causes of the association are not entirely clear, factors including household crowding, secondhand smoke, and increased rates of obesity in children from low-income families contribute to this predisposition. Prompt diagnosis and treatment of SDB in economically disadvantaged children is extremely important, particularly because these children are at increased risk of comorbid conditions such as obesity, poor school performance, and behavioral problems such as attention deficit hyperactivity disorder.

The gold standard test for diagnosis of OSA in children is polysomnography (PSG), an overnight test performed in a sleep laboratory. The American Academy of Otolaryngology–Head & Neck Surgery Foundation has published guidelines for the use of PSG in children undergoing evaluation for SDB. However, recommendations differ from other nonsurgical society statements and there is still wide variation in family and physician preference for PSG before or after otolaryngologic consultation and perceived necessity of PSG prior to surgical therapy with adenotonsillectomy (AT). Although low SES has previously been identified as a barrier to receiving surgical care, little is known regarding access or timing of PSG for these children. The purpose of this study was (1) to evaluate receipt and timing of PSG in relation to ultimate surgical therapy with AT for children undergoing evaluation for SDB, and (2) to evaluate differences based on SES.

Methods

This research was reviewed and approved by The Johns Hopkins School of Medicine institutional review board, which waived written informed consent owing to the retrospective nature of the study.

A retrospective cohort analysis was performed of all children newly evaluated for SDB in an urban and suburban pediatric otolaryngology department during a 3-month period (June 1, 2011, to August 31, 2011). New and consult encounters were first identified through evaluation and management codes. Patients were then included for analysis based on International Classification of Diseases, Ninth Revision (ICD-9) codes broadly related to adenotonsillar hypertrophy, SDB, or obstructive sleep apnea (327.23, 474.1, 474.11, 474.12, 519.8, 780.57, 799.01, and 769.09).

Data were extracted from each child’s medical record. Recorded demographic data included age, sex, race or ethnicity (including Hispanic), and insurance type. Child age was further grouped by 0 to younger than 3 years, 3 to younger than 12 years, and 12 to 18 years. The assessment and plan for each new patient encounter were reviewed, and each patient was classified according to 1 of 4 recommendations: (1) PSG, (2) surgery with AT, (3) watchful waiting with supportive care, or (4) follow-up as needed. Children were excluded from analysis if they had undergone PSG prior to the initial otolaryngology encounter.

Records were also analyzed to assess timeline of care: date of the initial otolaryngology encounter, date of PSG, and date of AT were each recorded. Days from initial encounter to PSG and AT were calculated. Patients were considered lost to follow-up if they were recommended to have PSG or AT, did not pursue these options, and did not have any encounters thereafter. Timing of events was followed for 1 year.

Insurance provider information was obtained from the billing department. Insurance with state MA was used as the proxy for low SES in accordance with prior research. In the state of Maryland, children are eligible for MA if the household income is between $17,064 and $39,221 and eligible for the Children’s Health Insurance Program if the household income is between $21,780 and $89,970, depending on the number of children (1-7 children) in the household.

Statistical analyses comparing the MA group to the private insurance group were performed using Stata IC 10 (StataCorp LP). Descriptive statistics were used to classify patients into MA and non-MA groups and then by disposition. Mean age was compared using a t test, and the remainder of demographic characteristics were compared with χ² analysis. Logistic regression, adjusting for disposition and insurance, was used to predict loss to follow-up, and variables were tested for interaction prior to applying this model. The mean number of days to PSG and surgery were compared with t tests. To estimate time to PSG and AT, a survival analysis was conducted using the Kaplan-Meier estimator. The log-rank test was used to compare time-to-event distributions between patients with MA and private insurance. P < .05 was considered significant for all analyses.

Results

In the 3-month period studied, 171 children were newly evaluated for SDB; 35 of these children had undergone PSG prior to presentation, and therefore only 136 children were included in the analysis. Patient demographics are listed in Table 1. There were 62 children insured by MA (45.6%). No significant differences were noted between groups in mean age or sex. Compared with privately insured children, there were fewer white (21 vs 50) and more black children (30 vs 11) in the MA group (P < .001). Disposition for care recommendations at the conclusion of the consultation is summarized in Table 2. For the largest proportion of children (40.4%) PSG was recommended, followed by AT surgery (30.2%). There was no significant difference noted between insurance groups (P = .53).

Findings of loss to follow-up analysis are summarized in Table 3. Following the initial visit, 31 of 96 patients who had...
either AT or PSG recommended (32%) were lost to follow-up. For all children who had PSG requested, 24 of 55 were lost to follow-up (44%) (9 of 24 in the MA group [33%] vs 15 of 24 [54%] with private insurance; \( P = .13 \)). There was no significant interaction between disposition (AT or PSG) and insurance type. Children who had PSG recommended were more likely to be lost to follow-up than children who had AT recommended, regardless of insurance (odds ratio [OR], 4.84; 95% CI, 1.69-13.90; \( P = .003 \)). Insurance type did not significantly impact loss to follow-up (OR, 0.68; 95% CI, 0.27-1.67; \( P = .40 \)).

For those children who underwent surgery (n = 51), time to AT was longer for children with MA (mean interval, 109.9 vs 79.3 days), but the difference did not reach statistical significance (\( P = .23 \)). For the children who underwent PSG (n = 27), patients with MA had significantly longer time to PSG than privately insured patients (mean interval, 141.1 vs 49.9 days; \( P = .001 \)). For those children who ultimately underwent surgery after obtaining PSG (n = 14), time to AT was longer for children with MA (mean interval, 222.3 vs 95.2 days; \( P = .001 \)). Kaplan-Meier curves between insurance groups showed significant differences (\( P < .001 \)) in time to PSG for all patients, and time to AT for patients who were referred for PSG prior to surgery (Figure).

Table 1. Patient Demographics for Children Undergoing Primary Consultation for SDB From June Through August 2011

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Children, No. (%)</th>
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<tbody>
<tr>
<td></td>
<td>Total (N = 136)</td>
<td>MA (n = 62)</td>
<td>Private Insurance (n = 74)</td>
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<tr>
<td>Mean age, y</td>
<td>6.01</td>
<td>6.62</td>
<td>5.57</td>
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<td>Age group, y</td>
<td></td>
<td></td>
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<tr>
<td>0 to &lt;3</td>
<td>31 (22.8)</td>
<td>12 (19)</td>
<td>19 (26)</td>
</tr>
<tr>
<td>3 to &lt;12</td>
<td>91 (66.9)</td>
<td>40 (65)</td>
<td>51 (69)</td>
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<tr>
<td>12-18</td>
<td>14 (10.3)</td>
<td>10 (16)</td>
<td>4 (5)</td>
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<tr>
<td>Sex</td>
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<tr>
<td>Male</td>
<td>70 (51.5)</td>
<td>29 (47)</td>
<td>41 (55)</td>
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<td>Race or ethnicity</td>
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<tr>
<td>White</td>
<td>71 (52.2)</td>
<td>21 (34)</td>
<td>50 (65)</td>
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<tr>
<td>Black</td>
<td>41 (30.1)</td>
<td>30 (48)</td>
<td>11 (15)</td>
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<tr>
<td>Othera</td>
<td>24 (17.6)</td>
<td>11 (18)</td>
<td>13 (18)</td>
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Table 2. Disposition at Conclusion of Primary Consultation by Insurance Type

<table>
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<tr>
<th>Care Recommendation</th>
<th>Children, No. (%)</th>
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<tr>
<td></td>
<td>Total (N = 136)</td>
<td>MA (n = 62)</td>
<td>Private Insurance (n = 74)</td>
</tr>
<tr>
<td>Surgery with AT</td>
<td>41 (30.2)</td>
<td>18 (29.0)</td>
<td>23 (31.1)</td>
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<tr>
<td>Obtain PSG</td>
<td>55 (40.4)</td>
<td>27 (43.6)</td>
<td>28 (37.8)</td>
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<tr>
<td>Follow-up for reevaluation</td>
<td>12 (8.8)</td>
<td>7 (11.3)</td>
<td>5 (6.8)</td>
</tr>
<tr>
<td>Follow-up as needed</td>
<td>28 (20.6)</td>
<td>10 (16.1)</td>
<td>18 (24.3)</td>
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</table>

Table 3. Logistic Regression Analysis of Loss to Follow-up for Children Recommended to Undergo AT or PSG (n = 96)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Lost to Follow-up</th>
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<tbody>
<tr>
<td></td>
<td>Patients, No. (%)</td>
<td>Unadjusted OR</td>
<td>Adjusted OR (95% CI)</td>
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<tr>
<td>Disposition</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Undergo AT surgery</td>
<td>7 (23)</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>Obtain PSG</td>
<td>24 (77)</td>
<td>3.76*</td>
<td>4.84 (1.69-13.90)</td>
</tr>
<tr>
<td>Insurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>18 (58)</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>Medical assistance</td>
<td>13 (42)</td>
<td>0.74</td>
<td>0.46 (0.15-1.40)</td>
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**Discussion**

In this study, referral for PSG resulted in significant loss to follow-up for all children and delayed definitive surgical treatment for children with public insurance. One-third of all children studied, including more than half of children who had PSG requested, were lost to follow-up, regardless of insurance status. Timing to PSG was delayed for children with MA compared to those with private insurance. For children who underwent surgery, the delay in time to AT for children with MA was statistically significant (mean interval, 222.3 vs 95.2 days; \( P = .001 \)).

**Table 1. Patient Demographics for Children Undergoing Primary Consultation for SDB From June Through August 2011**

**Table 2. Disposition at Conclusion of Primary Consultation by Insurance Type**

**Table 3. Logistic Regression Analysis of Loss to Follow-up for Children Recommended to Undergo AT or PSG (n = 96)**

* Other includes Hispanic (n = 10), Asian (n = 3), multiracial (n = 3), and unidentified (n = 8).
pared with children with private insurance. Moreover, in the 14 children who had both PSG and surgery, children with MA experienced a longer interval to AT from the initial encounter. To our knowledge, this study is the first to evaluate timing of PSG and delay of care for children with lower SES.

Children with low SES or public insurance are known to experience more chronic illness, morbidity, and disability than affluent children. This disparity may stem from a myriad of factors including lower parental education or health literacy, low household income, or problems obtaining reliable transportation to medical tests and visits. Despite significant public health efforts to mitigate these differences, health disparities among children and adolescents in the United States have stagnated or worsened over the past decade.

The Children's Health Insurance Program Reauthorization Act provides expansion of health insurance funding in individual states for children from lower income families. Broadening insurance coverage has not resulted in equal access to care for children with low SES, and disparities in access to subspecialty care may be even greater. A recent report audited 273 specialty clinics and found that more than 60% of children with public insurance were denied appointments outright, and when offered an appointment, they had to wait an average of 22 days longer than children with private insurance.

Moreover, minority children may have greater risk for SDB, which has been shown to be more common in black children and Hispanic children than in white children. Likewise, children in families of low SES appear to be at increased risk for SDB. Although the causes of this increased risk are not completely clear, household crowding in lower-income homes, increased obesity among minority racial or ethnic subgroups, and exposure to secondhand smoke may contribute. One study of a New York adult cohort showed that only 38% of black patients adhered to their primary care physician's recommendation to undergo subspecialty evaluation for SDB, suggesting cultural preferences and referral or scheduling issues as barriers to care.

In our study, perhaps the most important finding was the loss to follow-up rate for all children for whom PSG was ordered, regardless of SES. Barriers to PSG have not been explored in detail but may include convenience, cost, and perceived necessity. Despite its merits in characterizing SDB and OSA, PSG entails an overnight visit for both the child and a parent. A single-institution study found that although 87% of parents report a positive experience with pediatric PSG, 8% of children reported pain, and children younger than 3 years were less likely to have a typical night's sleep during the PSG. Another survey of practice patterns in otolaryngology showed that less than 12% of children undergo PSG prior to AT, potentially owing to local factors and surgeon background. Polysomnography may result in additional office visits along with surgical consultation and surgery, and charges for PSG range from $1250 to $6700 in the United States, although direct costs to the family will vary by insurance plan. Furthermore, some parents and children may miss some portion of a work or school day, which could result in both direct and indirect costs. Although specific patient- or family-level reasons for the large proportion of loss to follow-up cannot be concluded from the data in the present study, it is possible that the children who were lost to follow-up may have had less severe disease than children who underwent testing or surgery. Future research is necessary to fully understand the impact of these potential barriers to children obtaining PSG for SDB.

For the children who underwent both PSG and surgery, there were significant insurance-related differences in time to obtain PSG. Studies across other disciplines have shown delays in care based on race or insurance. For example, adult patients who were black and insured by Medicaid have demonstrated delays in initiation of chemotherapy for breast cancer up to 3 months greater than that for white patients who were commercially insured. Adult patients with Medicaid, regardless of race, are known to experience higher rates of perforation during episodes of acute appendicitis. Children with public insurance have been noted to have significant delays in emergency orthopedic care compared with children covered by private insurance. Interestingly, a recent study per-
formed in Canada, where socialized health care delivery is the primary model, showed no significant differences by SES for access to surgical specialty care.34

While the present study shows loss to follow-up for nearly half of patients, and a significant increase in time to PSG for children with MA compared with privately insured children, the precise reasons for these findings cannot be determined using the current methodology, a limitation inherent in health services research studies that analyze claims or administrative or electronic medical record data. Multiple issues may influence delay in care or loss to follow-up, including access to PSG (obtaining prior authorization), disease severity, family values, or the direct and indirect costs of obtaining an additional test. It is possible that findings from this study demonstrate limitations of access to care specific to the local health care market surrounding Baltimore; therefore, findings may not be generalizable to other practice regions, where access to PSG for patients with MA may be improved. Likewise, access to PSG may be dictated by the number of sleep specialists or centers in a particular region, thereby limiting availability of this test for all patients regardless of insurance. To our knowledge, there are no comprehensive data available showing wait time for pediatric PSG in the United States. Practitioners who evaluate children for SDB should become familiar with local market influences and availability of PSG.

Although statistical significance was not noted for time to surgery between groups, a trend toward longer interval was seen in children with MA. Furthermore, for children who underwent both PSG and AT, time to surgery was significantly longer in the MA group. The increased length of time to both diagnostic testing with PSG and also surgery with AT for children with public insurance suggests considerable delay in care for this group. Decisions for testing and treatment in children with SDB should potentially include a frank discussion of family environment and values, including social factors and cost of care.33,35,36 Shared decision making based on a full understanding of risks and benefits of both PSG and surgery and assessment of family preferences for diagnosis and treatment are paramount to address this disparity in the future. It should be noted however, that while shared decision making is a valuable communication model for all families of children facing decisions about surgery, utilization of PSG should be strongly considered and encouraged for children who exhibit symptoms and signs of severe SDB or OSA, as well as children in high-risk subgroups such as trisomy 21, obesity, or age less than 3 years.32

To our knowledge, this is the first study to evaluate differences in timing by insurance status of PSG and surgery for children with SDB. Findings from this study, while profound, should be further validated with patient-level prospective research prior to formal changes in practice or policy. In this study, neither clinical factors nor physician decision logic were reviewed, and therefore the indications for obtaining PSG or for proceeding with AT in the absence of PSG are unknown.

Indeed, there may be both medicolegal and financial implications of avoiding PSG, as there may be a tradeoff between delaying surgical care vs incurring unnecessary surgical intervention or proceeding with AT without appropriate risk stratification. Furthermore, validated screening tools that evaluate symptom severity and quality of life for children with SDB have been proposed for use as a surrogate for PSG. However even the most extensively used questionnaire, the Pediatric Sleep Questionnaire (PSQ), had only 78% sensitivity and 72% specificity compared with PSG and is therefore not currently recommended for definitive diagnosis of OSA.37

There were several limitations that should be addressed. First, the time of data collection for the initial encounters spanned only 3 months, and therefore sample size and power of the study may have been affected. There also may be heterogeneity of practice patterns and recommendations by individual physicians or heterogeneity of referral patterns within the institution or region. The severity of SDB for the children who were lost to follow-up is unknown. The small sample size and large number of patients lost to follow-up may have affected the internal validity and power of the study, as seen by the large 95% CIs surrounding the OR of 4.84 for children referred for PSG who were lost to follow-up. Finally, this study did not evaluate clinical parameters or family preferences for care, both of which may impact adherence and timing of diagnostic testing or surgery.

Conclusions

Children with SDB who have public insurance experienced longer intervals between initial SDB evaluation and PSG. Almost half of children who were recommended to undergo PSG were lost to follow-up, regardless of insurance type. Children with public insurance who had both PSG and surgery experienced longer wait times to surgery. These findings emphasize the need to explore reasons for delay in care with PSG and surgery for all children, and particularly in children with public insurance.

Polysomnography has the advantages of definitively diagnosing and assessing the severity of OSA, thus defining perioperative risk and helping to predict likelihood of surgical cure of OSA. Despite these distinct advantages, still only a minority of children undergo this testing in real-world circumstances. It is possible that recommendation for PSG may prevent or delay treatment of a subset of children who might benefit from AT. Future research may qualitatively evaluate barriers and facilitators to PSG and AT for families of children with SDB. Additionally, a process of shared decision making that includes an active assessment of patient and family social factors and preferences during the physician-family discussion may help address these disparities for families of children with SDB as they make decisions regarding both PSG and surgery.


