Pediatric Obstructive Sleep-Disordered Breathing: Updated Polysomnography Practice Patterns

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Abstract

Objective. To assess the current practice patterns of pediatric otolaryngologists in managing obstructive sleep-disordered breathing 6 years following the 2011 publication of the clinical practice guideline “Polysomnography for Sleep-Disordered Breathing prior to Tonsillectomy in Children.”

Study Design. Cross-sectional survey.

Setting. American Society of Pediatric Otolaryngology (ASPO) members.

Subjects and Methods. An electronic survey to assess ASPO members’ adherence to polysomnography guidelines prior to tonsillectomy.

Results. Forty percent (170 of 427) of ASPO members completed the survey, with 73% in academic practice and 27% in private practice. Snoring represented, on average, 48% of the respondents’ practices. The percentage of respondents who requested a polysomnogram prior to tonsillectomy ≥90% of the time was 55% (n = 94) for Down syndrome, 41% (n = 69) for a child <2 years old, and 29% (n = 49) for obese children. A total of 109 (73%) and 112 (75%) respondents admit at least 90% of the time for a child with Down syndrome and for a child <3 years of age, respectively, but only 52 (35%) have a similar practice for an obese child. Only 37% adhere to the inpatient admission recommendation for children with documented obstructive sleep apnea on polysomnogram.

Conclusion. The current polysomnogram practice patterns for responding pediatric otolaryngologists are not aligned with the clinical practice guideline of the American Academy of Otolaryngology—Head and Neck Surgery Foundation. The threshold for overnight observation when a preoperative polysomnogram has not been performed may be too low. A campaign is necessary to educate clinicians who take care of children with obstructive sleep-disordered breathing and to obtain more evidence to further define best practice.

Keywords

practice guidelines as topic, otolaryngology, sleep apnea syndromes, polysomnography, child, tonsillectomy, surveys and questionnaires, ASPO

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In 2011, the American Academy of Otolaryngology—Head and Neck Surgery Foundation (AAO-HNSF) published the clinical practice guideline (CPG) “Polysomnography for Sleep-Disordered Breathing prior to Tonsillectomy in Children” on the use of polysomnography (PSG) in children considered for tonsillectomy with or without adenoidectomy for obstructive sleep-disordered breathing (oSDB). It included 5 key action statements on indications, admission criteria, communication with anesthesiologists, and the role of portable monitoring. It specifically stated that children who have Down syndrome (DS) or who are obese should undergo PSG before tonsillectomy and adenoidectomy (T&A).1 The American Academy of Pediatrics (AAP) and the American Academy of Sleep Medicine also published CPGs on the subject.2,3 The AAP CPG recommends obtaining PSG prior to T&A or referring to an otolaryngologist or sleep medicine specialist.2 The American Academy of Sleep Medicine recommends routine PSG before T&A.3 Prior to publication of the 2011 AAO-HNSF CPG, an electronic survey was sent to members of the American Society of Pediatric Otolaryngology (ASPO). Among respondents, 20% and 8% “always” requested preoperative PSG for children with DS or obesity, respectively.4 The primary reason for requesting

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PSG in an otherwise healthy child was reported as being inconsistent clinical evaluation (58%). Overnight observation was performed at least “most of the time” for the following groups: DS (83%), age <3 years (83%), and obesity (70%). The emphasis of the AAO-HNSF guideline was to educate otolaryngologists on the indications for PSG based on the best published evidence. The 2011 CPG recommends obtaining preoperative PSG for children who have DS or who are obese to assist in their perioperative care. Since these children are at an increased risk for surgical or anesthetic complications, one would assume that those clinicians who infrequently obtain preoperative PSG would observe these higher-risk children overnight. The primary objective of this study was to assess the current practice patterns of pediatric otolaryngologists in managing OSA 6 years following the 2011 CPG publication. As the AAO-HNSF is in the process of updating the 2011 CPG, this study highlights educational and research opportunities.

Methods
A 17-question 5-minute electronic survey (see appendix, available in the online version of the article) was designed to evaluate the current practice patterns of pediatric otolaryngologists since the publication of the 2011 AAO-HNSF CPG. The survey was pilot tested and peer reviewed by the ASPO research committee and was in compliance with the ASPO survey guidelines. The institutional review board at the University of Colorado School of Medicine approved the study. The survey was sent to all ASPO members who practice in the United States. The initial survey was sent on March 21, 2017. Second and third reminders were sent on May 4 and June 2, 2017. A REDCap platform (research electronic data capture) was utilized to enter all survey results. It is hosted at the University of Colorado School of Public Health, and it is a secure web-based application that is compliant with the Health Insurance Portability and Accountability Act and designed to support data capture for research studies.

A 5-point interval scale was used to examine physician agreement with AAO-HNSF CPG guidelines for the following action statements: indications for preoperative PSG and use of home sleep apnea testing. The interval scale was as follows: rarely, <10%; sometimes, 10% to 49%; most of the time, 50% to 89%; almost always, ≥90%; always, 100%. A 4-point interval scale was used to examine physician agreement with AAO-HNSF CPG guideline inpatient admission for children with obstructive sleep apnea (OSA) documented in results of PSG. The interval scales were tailored to each guideline to best understand respondents’ management philosophies. Cumulative logistic regression was used to account for the interval nature of the variables.

Descriptive statistics were used to summarize interval data and demographics of survey respondents. Ordinal logistic regressions were fit to test for the association of preoperative PSG request and postoperative overnight observation for each risk category (ie, DS, <2 years of age, and obesity). Covariates of practice setting, years of practice as a pediatric otolaryngologist, and the estimated number of tonsillectomies performed on an annual basis were included as potential confounders. Odds ratio point estimates, 95% CIs, and associated P-values were calculated for each model. Additionally, predicted probabilities were calculated for each combination of covariates found to be significant in the model while averaging over the nonsignificant covariates. Data were analyzed with R version 3.5.1 with the MASS package utilized for the ordinal logistic regressions. A P value ≤.05 was considered statistically significant.

Before regression models were fit to the data, for the preoperative PSG request and postoperative overnight observation variables, the original 5 levels were collapsed into 3 to deal with convergence issues due to low numbers of observations. For preoperative PSG requests, the rarely (<10%) and sometimes (10%-49%) levels were combined, as were the almost always (≥90%) and always (100%) levels. For the postoperative overnight observation variables, the rarely (<10%) and sometimes (10%-49%) levels were combined. This collapsing of levels does not fundamentally change the interpretation of these survey responses, nor does it compromise the statistical validity of the inference. Due to low responses in the ≤5 years’ practice level, it was combined with the 5 to 10 years’ practice level.

Results
The initial survey was sent to 427 ASPO members, with 338 sent a single reminder and 293 sent an additional survey request. Physicians who indicated that they did not treat children with OSA were given the opportunity to opt out of the survey. A total of 170 ASPO physicians (40%) completed the survey.

Demographics
A total of 124 (73%) ASPO respondents were in an academic practice, and 46 (27%) were in private practice. Sixty-six (39%) respondents were in practice as a pediatric otolaryngologist for ≥21 years; 53 (31%), between 11 and 20 years; 45 (26%), between 5 and 10 years; and 6 (4%), for <5 years. In sum, 161 (95%) respondents had a clinical practice that mainly (≥90%) cared for children. A primary complaint of snoring represented, on average, 48% of the respondents’ practice (range, 8%-99%; SD, 25%). Overall, 151 respondents (89%) referred children to a dedicated pediatric sleep laboratory, where the mean estimated wait was 6.8 weeks (range, 2-24; SD, 4.4).

CPG: Polysomnogram prior to Tonsillectomy for Children with Sleep-Disordered Breathing
The primary reasons for requesting PSG for a healthy 5-year-old child was an inconsistent history and physical examination (n = 98, 58%) or caregiver uncertainty about the need for surgery (n = 43, 25%). Twelve respondents (7%) indicated that they requested PSG to facilitate perioperative management. Fifty-five respondents (32%) indicated that home sleep apnea testing was not available in
AAA observed the child overnight if PSG had not been requested preoperative PSG for a child with DS, 73 (90%) (33%) for obese children. Of the 81 respondents who AAA for the age criteria, 112 respondents (75%) observed a child and 21 (12%) observed any child with oSDB overnight. As an anesthesia administration.

Table 1

<table>
<thead>
<tr>
<th>Respondents</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child with Down syndrome</td>
<td></td>
</tr>
<tr>
<td>Rarely (&lt;10%)</td>
<td>5 (3)</td>
</tr>
<tr>
<td>Sometimes (10%-49%)</td>
<td>16 (11)</td>
</tr>
<tr>
<td>Most of the time (50%-89%)</td>
<td>19 (13)</td>
</tr>
<tr>
<td>Almost always (≥90%)</td>
<td>109 (73)</td>
</tr>
<tr>
<td>Child &lt;3 y of age for sleep-disordered breathing</td>
<td></td>
</tr>
<tr>
<td>Rarely (&lt;10%)</td>
<td>7 (5)</td>
</tr>
<tr>
<td>Sometimes (10%-49%)</td>
<td>15 (10)</td>
</tr>
<tr>
<td>Most of the time (50%-89%)</td>
<td>15 (10)</td>
</tr>
<tr>
<td>Almost always (≥90%)</td>
<td>112 (75)</td>
</tr>
<tr>
<td>Obese child</td>
<td></td>
</tr>
<tr>
<td>Rarely (&lt;10%)</td>
<td>15 (10)</td>
</tr>
<tr>
<td>Sometimes (10%-49%)</td>
<td>46 (31)</td>
</tr>
<tr>
<td>Most of the time (50%-89%)</td>
<td>36 (24)</td>
</tr>
<tr>
<td>Almost always (≥90%)</td>
<td>51 (34)</td>
</tr>
</tbody>
</table>

Abbreviations: PSG, polysomnography; T&A, tonsillectomy and adenoidectomy.

aIndividuals who admit all children with obstructive sleep-disordered breathing did not see the overnight observation branching, resulting in a total of 149 for the overnight admissions variable.

bOne response missing.

requested. In contrast, only 19 of the 42 (45%) physicians who requested preoperative PSG <50% of the time AAA observed the child overnight following T&A when they did not obtain preoperative PSG. For obese children, the AAA overnight observation rate was 62% for the 42 respondents who AAA requested preoperative PSG when they did not obtain preoperative PSG. For those respondents who requested PSG <50% of the time, 14 of 67 respondents (21%) AAA observed the child overnight.

For children with DS, only the preoperative PSG ordering habits variable was statistically significant with type III tests (likelihood ratio [LR] χ² = 26.879, P < .0001; Table 2). For all levels of the preoperative PSG ordering habits variable, the predicted probabilities show that providers tend to order postoperative overnight observation, with a mean predicted probability of 0.5911. However, the spread of the predicted probabilities across all postoperative overnight observation categories is related to preoperative PSG ordering habits: those who are less likely to request preoperative PSG are also less likely to request overnight observation, given that PSG was not requested. Those who requested preoperative PSG <50% of the time had a predicted probability of 0.4027 for responding “almost always” for postoperative overnight observation, while a provider who requested preoperative PSG >90% of the time had a predicted probability of 0.7672 for responding “almost always” for overnight observation when preoperative PSG was not requested.

C�P: Inpatient Admission for Children with OSA Documented in Results of PSG

Sixty-two respondents (37%) reported that they utilized the AAO-HNSF criteria for overnight observation (apnea-hypopnea index [AHI] ≥10 and/or nadir <80%). Twenty-five physicians (15%) did not use the saturation nadir, just an AHI ≥10. Fifteen respondents (9%) used the AAP overnight observation criteria (AHI ≥24 and/or nadir <80%), and 21 (12%) observed any child with oSDB overnight. As for the age criteria, 112 respondents (75%) observed a child <3 years of age >90% of the time if preoperative PSG was not performed. Table 1 summarizes the frequency distribution of overnight observation following T&A for respondents who did not plan to admit all children without preoperative PSG.

Of the 21 respondents who admitted all children for overnight observation following T&A with a diagnosis of oSDB, 13 (62%) obtained preoperative PSG at least almost always (AAA; ie, ≥90% of the time) for children with DS and 7 (33%) for obese children. Of the 81 respondents who AAA requested preoperative PSG for a child with DS, 73 (90%) AAA observed the child overnight if PSG had not been

Figure 1. Distribution of 2017 responses to frequency of polysomnogram request prior to tonsillectomy and adenoidectomy among children with Down syndrome, aged <2 years, with obesity and sleep-disordered breathing. Numbers above bars indicate raw values.

their areas. Fifteen respondents (9%) “rarely” requested home sleep apnea testing; 1, “sometimes”; and the remaining respondents, never. Ninety-nine respondents (58%) determined if a child was obese by calculating the body mass index (BMI) percentile for age. The frequency that respondents always (100% of the time) requested attended overnight PSG for children with suspected oSDB was as follows: DS, 46 (27%); child <2 years of age, 27(16%); and obese, 14 (8%). Only 6 (3.5%) respondents requested attended overnight PSG ≥90% of the time for children with suspected oSDB prior to T&A (Figure 1). A total of 156 (92%) respondents indicated that they routinely communicated abnormal PSG results to the anesthesiologist before anesthesia administration.

Table 1. Distribution of Responses to Frequency of Overnight Admissions following T&A If Preoperative PSG Was Not Performed.
For children <3 years of age, practice setting (LR $\chi^2 = 9.079$, $P = .0026$) and years in practice (LR $\chi^2 = 12.886$, $P = .0016$) were statistically significant in the type III tests (Table 3). Providers in an academic setting had higher predicted probabilities of commonly ordering postoperative overnight observation for children <3 years of age than providers in private practice (mean predicted probabilities, 0.8046 vs 0.5546) regardless of the number of years in practice when preoperative PSG was not requested. However, among those providers with the highest level of experience ($\geq 21$ years), the predicted probability for commonly ordering postoperative overnight observation was the lowest across both practice settings (mean predicted probabilities, 0.7306 and 0.4357, respectively). The survey did not query the practice patterns for ordering preoperative PSG for children <3 years of age, so predicted probabilities were not calculated for preoperative PSG ordering habits and postoperative overnight observation for children <3 years old.

Finally, with type III tests, only 2 covariates were statistically significant for pediatric patients who were obese: practice setting (LR $\chi^2 = 25.746$, $P < .0001$) and preoperative PSG request habits (LR $\chi^2 = 9.371$, $P = .0022$; Table 4). Providers within an academic setting had a higher predicted probability (point estimate, 0.3904) of almost always ordering postoperative overnight observation for obese children following T&A as compared with their private practice counterparts (point estimate, 0.1885), but this was modulated by their preoperative PSG requests. Providers (whether academic or private) who did not commonly order preoperative PSG had the lowest predicted probability of routinely ordering postoperative overnight observation, with a predicted probability of 0.1167 for answering “almost always” ($\geq 90\%$) versus 0.6999 for answering <50% when preoperative PSG was not requested.

**Discussion**

oSDB is commonly treated by pediatric otolaryngologists. This most recent oSDB survey of ASPO members reported the current practice patterns 6 years after the publication of the CPG to guide clinicians on the use PSG among children...
with oSDB. A statistical comparison with the 2011 survey was not possible, as the surveys were not identical and validity could not be guaranteed between them. According to the current survey, most respondents are not obtaining PSG 100% of the time prior to T&A, but the compliance improves to 55% for children with DS, 41% for a child 2 years old, and 29% for obesity if the outcome measure is 90% of the time. Since the 2011 CPG, pediatric otolaryngologists who responded to the survey are increasingly using the appropriate metric (BMI percentile for age) to identify obesity. However, nearly half are still not using a BMI percentile for age to determine if a child is obese, as recommended by the Centers for Disease Control and Prevention. As for the other CPG action statements, respondents are compliant with routinely communicating PSG results to anesthesiologists and not utilizing home sleep apnea testing.

The most common indication for requesting preoperative PSG for a healthy child is inconsistent history and physical examination; however, the survey did not query why PSG was requested preoperatively for children with comorbidities. A major rationale for preoperative testing is to facilitate perioperative management and risk stratification. Jiang et al evaluated the prevalence of severe OSA among 160 children who underwent T&A. They divided the cohort into 3 groups according to the AAO-HNSF CPG action statements: perform PSG prior to surgery, advocate for PSG, or no CPG indication for PSG. For children who qualified to have a sleep study by meeting the PSG criteria of action statement 1—"Before performing tonsillectomy, the clinician should refer children with [sleep-disordered breathing] for PSG if they exhibit any of the following: obesity, DS, craniofacial abnormalities, neuromuscular disorders, sickle cell disease, or mucopolysaccharidoses"—the prevalence of severe OSA was 45%. Interestingly, 34% of children with no indications for preoperative PSG had severe OSA. For children with DS, it has been reported that caregivers are unable to predict OSA severity by clinical criteria. The Jiang et al study suggests that the parents of otherwise healthy children are also unable to predict OSA severity. These parents either are not observing their children closely, especially in the early morning hours during REM sleep, or are unaware of what to look for.

Since there is no objective measure of oSDB severity without PSG, many providers who do not request preoperative PSG for children with comorbidities are erroneously assuming that these children do not have severe OSA. If these children are not being monitored overnight, they may be having undetected complications at home. Kieran et al evaluated 4000 children undergoing T&A and reported that 7% had sustained saturations <90% in the first 24 hours postoperatively. Their multivariable analysis identified DS and obesity as 2 of the 7 independent clinical risk factors for desaturations in the initial 24-hour postoperative period. Due to the increased chance that a child with comorbidities has severe OSA, if clinicians forego preoperative PSG, they should have a low threshold to observe the child overnight following surgery. Unfortunately, for children with DS and/or obesity, those respondents who infrequently requested PSG were also less likely to observe a child overnight. Interestingly, the subgroup (12%) that observes all children with oSDB overnight was more likely to obtain preoperative PSG than those who infrequently obtain preoperative PSG. Rather than utilizing the PSG to assist in perioperative management, it could be assumed that the PSG is requested to confirm the diagnosis of OSA.

Potential explanations for the lack of compliance with the CPG for requesting preoperative PSG prior to T&A for children with DS or obesity may be costs, access to PSG, family preference, physician bias, and shared decision making with the family to forgo PSG. Although the 2011 CPG did not specifically state an age criterion for when

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**Table 4. Ordinal Logistic Regression Results for Association between Preoperative PSG Ordering Habits and Postoperative Overnight Observation for Pediatric Patients with Obesity.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Odds Ratio</th>
<th>Point Estimate</th>
<th>95% Confidence Limits</th>
<th>P Value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative PSG</td>
<td>Most of the time (50%-89%)</td>
<td>2.045</td>
<td>0.936-4.503</td>
<td>.0734</td>
</tr>
<tr>
<td></td>
<td>Almost always (≥90%)</td>
<td>8.851</td>
<td>3.725-22.157</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Private practice</td>
<td>0.304</td>
<td>0.136-0.655</td>
<td>.0028</td>
<td></td>
</tr>
<tr>
<td>Years in practice</td>
<td>11-20</td>
<td>1.496</td>
<td>0.654-3.471</td>
<td>.3433</td>
</tr>
<tr>
<td></td>
<td>≥21</td>
<td>0.953</td>
<td>0.421-2.167</td>
<td>.9084</td>
</tr>
<tr>
<td>No. of tonsillectomies per week</td>
<td>1-2</td>
<td>0.873</td>
<td>0.059-23.332</td>
<td>.9226</td>
</tr>
<tr>
<td></td>
<td>3-4</td>
<td>1.565</td>
<td>0.123-38.197</td>
<td>.7363</td>
</tr>
<tr>
<td></td>
<td>5-6</td>
<td>2.630</td>
<td>0.215-62.863</td>
<td>.4610</td>
</tr>
<tr>
<td></td>
<td>&gt;6</td>
<td>2.244</td>
<td>0.179-54.408</td>
<td>.5414</td>
</tr>
</tbody>
</table>

Abbreviation: PSG, polysomnography.

<sup>a</sup>P values are associated with odds ratio estimates for each parameter or level of parameter (for categorical variables). Italics indicate P < .05.
PSG should be obtained before surgery, one may assume that providers are not routinely obtaining preoperative PSG for a child <2 years of age for similar reasons. Neurobehavioral deficits have been reported for children with even mild oSDB who had a normal obstructive AHI. There was no clear correlation between oSDB severity and degree of neurocognitive impairment.10 ASPO respondents and caregivers may believe that, as snoring may affect quality of life irrespective of oSDB severity, proceeding with T&A without PSG is appropriate for the child.10-12

The current evidence supports overnight observation for children with comorbidities with oSDB after T&A, especially if preoperative PSG has not been performed to assess OSA severity. For children with DS, our models found that those providers who are less likely to request preoperative PSG are also less likely to request overnight observation, given that PSG was not requested. For children <2 years of age, providers in an academic setting were more likely to request overnight observation, but those respondents with the highest level of experience (≥21 years) were the least likely to request postoperative overnight observation regardless of practice settings. As for obesity, respondents within an academic setting have a higher predicted probability of ordering postoperative overnight observation for following T&A than do their private practice counterparts, but this was modulated by their preoperative PSG requests. Although these ordinal logistic regression analyses did demonstrate that some significant differences were present for requesting overnight observation when a preoperative sleep study was not performed, the exceedingly wide 95% confidence limits suggest that results may be spurious. These findings are potentially secondary to large covariate variability and the outcome-of-interest combinations. Even for those respondents who obtain routine preoperative PSG for children >2 years of age, the majority are not following the recommended AAO-HNSF PSG admission criteria. Interestingly, the AAP has a higher AHI threshold for admission (AHI ≥24) than that of the AAO-HNSF, but both use an oxygen saturation nadir <80%. Nine percent of respondents are using the AAP criteria. Although some may argue that current admission criteria are too conservative, the AAO-HNSF CPG bases this on the best current available evidence. To facilitate implementation of a CPG, the action statements need to be action ready (ie, use unambiguous language telling providers what to do in specific circumstances), which is why the current CPG uses specific numbers for the AHI and saturation nadir.13 Future outcome studies are likely to clarify the optimal admission criteria, but for now the best available evidence supports an AHI ≥10 and/or saturation nadir <80%.

The strengths of this study are that it provides updated compliance data for the 2011 CPG on PSG use for children with oSDB and surveys only ASPO members who practice in the United States. However, there are a number of limitations. The response rate was acceptable for a survey but was <50% nevertheless. The respondents’ demographics and response options were not identical to the 2013 survey on the subject; therefore, a direct comparison of how the 2011 CPG affected clinical practice is not possible. The wide confidence intervals do not allow one to determine if practice setting, tonsillectomy volume, or years in practice fully account for the variability in CPG compliance. ASPO respondents were predominantly in an academic practice, and their approach may be different than that of private practitioners. General otolaryngologists as compared with fellowship-trained pediatric otolaryngologists may also manage pediatric oSDB differently, and they were not surveyed.

Conclusion

PSG is underutilized by current ASPO members, and their current practice is still not aligned with the CPGs from the AAP, American Academy of Sleep Medicine, or AAO-HNSF. The threshold for overnight observation when preoperative PSG has not been performed is probably too low. A campaign is necessary to educate clinicians who take care of children with oSDB, as well as more investigations on factors associated with adherence to CPGs by otolaryngologists. In an era of shared decision making, universal compliance with CPGs may never be achieved. However, documentation is key to tracking outcomes and improving future practice pathways.

Author Contributions

Norman R. Friedman, designed study, designed analysis plan, helped with participant recruitment and data collection; drafted the article and critically reviewed edits by other authors; approved final version and agrees to be accountable for the work; Amanda G. Ruiz, built survey, data management, collected data, designed analysis plan, and worked with statistician to analyze and interpret data; critically reviewed and revised manuscript; approved final version and agrees to be accountable for the work; Dexiang Gao, data analysis, data interpretation; critically reviewed and revised manuscript; approved final version of manuscript and agrees to be accountable for the work; Alexandria Jensen, data analysis, data interpretation; critically reviewed and revised manuscript; approved final version of manuscript and agrees to be accountable for the work; Ron B. Mitchell, designed study and helped with analysis interpretation; critically reviewed and revised the article; reviewed edits by other authors; and approved final manuscript and agrees to be accountable for the work.

Disclosures

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Supplemental Material

Additional supporting information is available in the online version of the article.

References


