BACKGROUND & AIMS: Among patients undergoing advanced endoscopy, unrecognized obstructive sleep apnea (OSA) could predict sedation-related complications (SRCs) and the need for airway maneuvers (AMs). By using an OSA screening tool, we sought to define the prevalence of patients at high risk for OSA and to correlate OSA with the frequency of AMs leading to sedation-related complications (SRCs) and the need for airway maneuvers (AMs). By using an OSA screening tool, we sought to define the prevalence of patients at high risk for OSA and to correlate OSA with the frequency of AMs leading to sedation-related complications (SRCs) and the need for airway maneuvers (AMs).

METHODS: We enrolled 231 consecutive patients undergoing endoscopic retrograde cholangiopancreatography (ERCP) (n = 176) and endoscopic ultrasound (n = 55). Propofol-based sedation and patient monitoring were performed by a nurse anesthetist and an anesthesiologist. A previously validated screening tool for OSA (STOP-BANG) was used to identify patients at high risk for OSA (score, ≥3 of 8; SB+ or 2.5% of the middle-aged population. Because the obesity epidemic has increased the prevalence of OSA, in which patients are monitored extensively overnight while they sleep. Unfortunately, polysomnography is time consuming, costly, and impractical to apply to a broad patient population. Although there are several screening instruments for OSA, the STOP-BANG questionnaire represents a highly sensitive bedside tool that is particularly useful to screen for patients with severe OSA (Supplementary Table 1). The Berlin questionnaire is an alternative screening tool for OSA that recently has been studied in patients undergoing standard endoscopy; however, STOP-BANG appears to be superior to the Berlin questionnaire in predicting postoperative complications when applied to a population of preoperative patients.

CONCLUSIONS: A significant number of patients undergoing advanced endoscopic procedures are at risk for OSA. AMs and hypoxemia occur at an increased frequency in these patients.

Keywords: ERCP; EUS; Monitored Anesthesia Care; Interventional Endoscopy.
SRCs of a propofol-based regimen compared with the standard combination approach in patients with OSA undergoing standard or advanced endoscopic procedures is unclear.

Among patients undergoing advanced endoscopic procedures such as endoscopic ultrasound (EUS) and endoscopic retrograde cholangiopancreatography (ERCP), the risk for airway complications is thought to be higher compared with standard endoscopy owing to longer procedure times and the need for relatively deeper levels of sedation. There is limited information on specific clinical predictors of developing SRGs during advanced endoscopy.\textsuperscript{18–20} We previously showed a correlation between patients with a higher body mass index (BMI) and an increased frequency of needing airway manipulation during advanced endoscopic procedures.\textsuperscript{18} We hypothesized that a bedside screening instrument for OSA would help to identify high-risk patients for SRGs and those who require airway maneuvers (AMs) during advanced endoscopy.

**Methods**

We performed a prospective cohort study of patients undergoing ERCP or EUS in the endoscopy unit at Washington University in St. Louis. The protocol was approved by our local Human Research Protection Office. Consecutive patients undergoing ERCP and EUS were enrolled between December 2008 and October 2009. Propofol-based sedation and patient monitoring were performed by a certified registered nurse anesthetist (CRNA) under the medical direction of an anesthesiologist. Our routine practice is to sedate patients undergoing advanced procedures using propofol alone or in combination with low-dose opiate and/or benzodiazepine. We previously published our experience using this approach in 799 patients undergoing advanced endoscopic procedures.\textsuperscript{18}

Before the procedure, patients are examined by an anesthesiologist with extensive experience in sedating patients in a tertiary care endoscopy unit. For induction, the use of propofol alone or in combination with low-dose benzodiazepine and/or opiate is left to the discretion of the CRNA. Sedative dosing is adjusted to maintain at least deep sedation throughout the procedure. A team of 1 anesthesiologist and 3 CRNAs, all with extensive experience sedating patients for advanced endoscopic procedures, participated in this study. The anesthesiologist obtained informed consent and enrolled patients in the endoscopy unit at the time of preprocedure evaluation. Other than prior documentation of OSA and the inability to give informed consent, there were no exclusion criteria. We intentionally did not exclude patients based on clinical characteristics that could predict SRGs such as morbid obesity and American Society of Anesthesiologists (ASA) class of 3 or higher.\textsuperscript{21}

**STOP-BANG**

A previously validated screening tool, STOP-BANG, was administered by the anesthesiologist to assess OSA risk before the procedure. The instrument is composed of 4 questions and 4 clinical characteristics (age $>50$ y; male sex; BMI $>35$ kg/m$^2$; and neck circumference $>40$ cm). Scores of 3 or higher out of 8 have high sensitivity and negative predictive value for moderate to severe OSA.\textsuperscript{8} Specifically, a score of 3 or greater has a sensitivity of 83.6% for patients who have an apnea-hypopnea index greater than 5 on subsequent full polysomnography; the sensitivity increases to 92.9% for those with an apnea-hypopnea index greater than 15, which correlates with moderate to severe OSA. The results of STOP-BANG were not disclosed to the sedating CRNA or treating endoscopist, so the results would not be expected to impact on the approach to sedation.

**Patient Monitoring**

All patients underwent continuous electrocardiography and heart rate, pulse oximetry, nasal capnography, and intermittent blood pressure monitoring during the procedure. If nasal capnography suggested hypopnea/apnea (defined as $<6$ breaths/min), the CRNA evaluated for airway patency and chest expansion before intervening. In addition, the CRNA moved the nasal cannula in front of the oropharynx to assess end tidal CO$_2$. The CRNA used all of these variables in assessing for the presence of hypopnea/apnea. Supplemental oxygen by nasal cannula (3 L/min) was provided to all patients at the onset of sedation. Administration of propofol and other sedatives was determined solely by the CRNA, who had no other involvement in the procedure except to monitor the patient. Patients undergoing ERCP were typically in the prone position whereas those undergoing EUS were in the left lateral decubitus position. Depth of sedation was assessed by the sedating CRNA using the Modified Observer’s Assessment of Alertness/Sedation (MOAA/S) score at the time of endoscopic intubation, a previously validated quantitative measure of sedation depth.\textsuperscript{22}

**Airway Maneuvers and Sedation-Related Complications**

We deliberately separate SRGs and AMs for analysis. AMs reflect active airway problems during the sedation period that require one or more interventions whereas SRGs typically reflect the end point of unsuccessful AMs and adjustments to the sedation regimen to maintain patient stability. AMs were defined a priori as a chin lift maneuver, nasopharyngeal airway, modified mask airway, positive pressure ventilation (also called bag-mask ventilation), or endotracheal intubation. We classified a chin lift as any manipulation of the chin or a jaw thrust maneuver to improve upper airway patency for optimal airflow. A modified mask airway was defined as the use of a customized oxygen delivery system that permitted a higher fraction of inspired oxygen compared with a nasal cannula without interfering with the endoscope. A nasopharyngeal airway involved the insertion of a tube through a nostril and into the nasopharynx to prevent the tongue from blocking airflow. Positive pressure ventilation and endotracheal intubation were reserved for patients who did not respond to less-invasive AMs along with alterations in the sedation regimen. AMs were performed solely at the discretion of the CRNA for laryngospasm, upper airway obstruction, hypoxemia, and hypopnea/apnea (defined as $<6$ breaths/min), which may have occurred with or without hypoxemia. Of note, all patients with hypoxemia required one or more AMs, but not all patients who required an AM necessarily developed hypoxemia or other SRC. The anesthesiologist does not routinely assist in the decision to implement or implementation of AMs, with the exception of endotracheal intubation.

SRGs include hypoxemia (defined as a pulse oximetry $<90\%$ for any duration); hypotension, defined as a systolic blood pressure of less than 90 mm Hg or a decrease of more than 25% from baseline; or hypopnea/apnea, defined as fewer
than 6 breaths/min based on capnography. Early procedure termination for an alternative SRC (eg, refractory laryngospasm) also was recorded.

**Analysis Plan**

By using a STOP-BANG score of 3 or higher for high risk as recommended by Chung et al,8 patients were dichotomized into high risk (SB+) and low risk (SB−) for OSA groups. Our primary outcomes were 2-fold: (1) to define the frequency of SB+ patients at an advanced endoscopy referral center and, (2) to compare the rate of AMs and SRCs between SB+ and SB− groups. Rates are reported as simple proportions (percentages) and standard comparative analyses performed using chi-square testing. The incremental risks of AMs and SRCs in SB+ patients are reported as relative risks (RRs) and corresponding 95% confidence intervals (CIs). In addition to any SRC, we calculated the RR for developing hypoxemia specifically because we consider this SRC most closely linked to underlying OSA risk. Demographic, procedural, and pharmacologic characteristics were compared between groups using the chi-square test for dichotomous variables and unpaired t testing or the Mann-Whitney test for continuous variables. We then calculated an adjusted RR to correct for ASA class of 3 or higher using the Mantel-Haenszel stratification method. Finally, we present simple proportions to report the frequency of a positive response to each element of the STOP-BANG.

Sample size estimates were based on the anticipated rate of AMs in SB+ and SB− patients. We assumed the rate of AMs would be 15% based on prior experience,18 and estimated this rate would increase to 25% for patients with an SB+ and decrease to 10% for SB− patients. Enrolling 226 patients would give us 80% statistical power to detect a significant difference in the frequency of AMs with a 2-sided α error of .05. Statistical analyses were completed using Stata version 10.0 (StataCorp LP, College Station, TX).

**Results**

During the study period, 231 patients who met our inclusion/exclusion criteria were enrolled, including 176 (76%) patients undergoing ERCP and 55 (24%) patients undergoing EUS. No patients refused to participate. The prevalence of a STOP-BANG score of 3 or higher (ie, SB+) was 43.3% (100 of 231). Patient, procedure, and pharmacologic characteristics are summarized in Table 1, stratified by OSA risk. As expected (because age, BMI, and male sex are components of the STOP-BANG assessment tool), SB+ patients were significantly older, predominantly male, and had higher BMIs compared with the SB− group. Prone positioning was used less frequently and patients had a significantly higher MOAA/S score (ie, they were not sedated as deeply in the SB+ compared with the SB− group) at the time of endoscopic intubation, although the clinical relevance of this numeric difference is unclear. MOAA/S scores of less than 1 are typically associated with a depth of sedation equivalent to general anesthesia. The use of combination regimens and propofol infusion time were similar in both groups. However, weight-based induction and total propofol doses were significantly less in the SB+ group.

The frequency of AMs and SRCs is reported in Table 2. Twenty-eight of 231 (12.1%) patients required one or more AMs; of these, there were 3 cases of positive pressure ventilation for apnea (2 cases) and upper airway obstruction (1 case). There were no cases of endotracheal intubation in the entire cohort. The RR of a patient needing at least one AM was significantly higher among SB+ patients (20%) compared with the SB− group (6.1%) (RR, 1.81; 95% CI, 1.36–2.42). The adjusted risk remained statistically significant after modifying for ASA class of 3 or higher (RR, 1.70; 95% CI, 1.28–2.24).

SRCs occurred in 52 (22.5%) patients, primarily hypotension (15.6%) and hypoxemia (6.9%). Other SRCs included premature termination of the procedure in 2 patients (0.9%) for refractory laryngospasm and apnea in 2 (0.9%) others. The only cases of apnea (2) occurred in SB+ patients. Among SB+ patients, the

**Table 1. Patient and Procedural Characteristics, Stratified by Risk for OSA (n = 231)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>SB+ (n = 100)</th>
<th>SB− (n = 131)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age ± SD, y</td>
<td>60.3 ± 12.7</td>
<td>50.1 ± 17.2</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>% Male sex (95% CI)</td>
<td>73.0 (64.3–81.7)</td>
<td>26.7 (19.1–34.3)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Mean BMI ± SD</td>
<td>31.4 ± 7.8</td>
<td>26.1 ± 6.3</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>% ASA ≥ 3 (95% CI)</td>
<td>74.0 (65.4–82.6)</td>
<td>50.4 (41.8–58.9)</td>
<td>&lt;.003</td>
</tr>
<tr>
<td>Mallampati score, median (IQR)</td>
<td>2 (1–3)</td>
<td>2 (1–2)</td>
<td>&lt;.003</td>
</tr>
<tr>
<td>STOP-BANG score, median (IQR)</td>
<td>4 (3–4)</td>
<td>1 (1–2)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Procedural data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean endoscopy time ± SE, min</td>
<td>28.5 ± 24.7</td>
<td>31.1 ± 22.7</td>
<td>.39</td>
</tr>
<tr>
<td>Prone position, % (95% CI)</td>
<td>57.0 (47.2–66.7)</td>
<td>70.2 (62.4–78.1)</td>
<td>.04</td>
</tr>
<tr>
<td>MOAA/S score at endoscopic intubation, median (IQR)</td>
<td>0 (0–0)</td>
<td>0 (0–0)</td>
<td>.02</td>
</tr>
<tr>
<td>MOAA/S during the procedure, median (IQR)</td>
<td>0 (0–0)</td>
<td>0 (0–0)</td>
<td>.10</td>
</tr>
<tr>
<td>Pharmacologic data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concomitant use of benzodiazepine and/or opiate, %</td>
<td>50.0 (40.2–59.8)</td>
<td>56.5 (48.0–65.0)</td>
<td>.33</td>
</tr>
<tr>
<td>Mean induction propofol dose ± SE, mg/kg</td>
<td>2.1 ± 1.1</td>
<td>3.0 ± 1.4</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Mean total propofol dose ± SE, mg/kg</td>
<td>6.5 ± 4.7</td>
<td>9.1 ± 6.3</td>
<td>.0006</td>
</tr>
<tr>
<td>Mean propofol infusion time ± SE, min</td>
<td>35.2 ± 25.8</td>
<td>37.9 ± 23.1</td>
<td>.40</td>
</tr>
</tbody>
</table>

IQR, interquartile range; SD, standard deviation; SE, standard error of the mean.

*Age > 50, male sex, and BMI > 35 kg/m² are components of the STOP-BANG assessment.
*Two-sample, Wilcoxon rank-sum (Mann–Whitney) test.
The frequency of having at least one SRC was not significantly higher (RR, 1.18; 95% CI, 0.85–1.63). However, if SRCs were limited to cases of hypoxemia (an SRC that more likely is associated with OSA), the RR was significantly higher among SB/H11001 patients (1.83; 95% CI, 1.32–2.54). This remained statistically significant after adjusting for ASA class of 3 or higher (RR, 1.63; 95% CI, 1.19–2.25).

Responses to each element of the STOP-BANG assessment are summarized in Figure 1. As expected, each component of the STOP-BANG was present more frequently among SB/H11001 patients (P < .0001 for each comparison).

**Table 2. Use of Airway Maneuvers and Prevalence of SRCs**

<table>
<thead>
<tr>
<th>Complication/intervention</th>
<th>SB+, % (n = 100)</th>
<th>SB−, % (n = 131)</th>
<th>Total, % (n = 231)</th>
<th>Unadjusted RR (95% CI)</th>
<th>Adjusted RR(^a) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any AM(^b)</td>
<td>20 (20.0)</td>
<td>8 (6.1)</td>
<td>28 (12.1)</td>
<td>1.81 (1.36–2.42)</td>
<td>1.70 (1.28–2.24)</td>
</tr>
<tr>
<td>Chin lift maneuver</td>
<td>12 (12.0)</td>
<td>6 (4.6)</td>
<td>18 (7.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified mask airway</td>
<td>12 (12.0)</td>
<td>6 (4.6)</td>
<td>18 (7.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal airway</td>
<td>10 (10.0)</td>
<td>2 (1.5)</td>
<td>12 (5.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bag-mask ventilation</td>
<td>3 (3.0)</td>
<td>0 (0.0)</td>
<td>3 (1.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endotracheal intubation</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRCs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any SRC(^b)</td>
<td>26 (26.0)</td>
<td>27 (21.4)</td>
<td>53 (22.9)</td>
<td>1.18 (0.85–1.63)</td>
<td>1.14 (0.83–1.56)</td>
</tr>
<tr>
<td>Hypoxemia (pulse oximetry &lt;90%)</td>
<td>12 (12.0)</td>
<td>4 (5.2)</td>
<td>16 (6.9)</td>
<td>1.83 (1.32–2.54)</td>
<td>1.63 (1.19–2.25)</td>
</tr>
<tr>
<td>Apnea (determined by CRNA)</td>
<td>2 (2.0)</td>
<td>0 (0.0)</td>
<td>2 (0.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypotension (SBP &lt;90 or &gt;25% decline from baseline)</td>
<td>14 (14.0)</td>
<td>22 (16.8)</td>
<td>36 (15.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedure termination</td>
<td>0 (0.0)</td>
<td>2 (1.5)</td>
<td>2 (0.9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SBP, systolic blood pressure.
\(^a\)Adjusted for ASA class ≥3.
\(^b\)Any AM and SRC are described on a per-patient basis. That is, 28 patients required at least one AM and 52 had at least one SRC. However, because more than one AM or SRC could occur in each patient, the total number of AMs does not add up to 28. AMs and SRCs were not counted more than once if the same maneuver was repeated on a patient.

**Discussion**

The obesity problem in the United States is staggering. In 2008, only one state (Colorado) reported an obesity prevalence of less than 20% and 32 states reported a prevalence of 25% or greater.\(^{23}\) With these rates increasing each year, the frequency of undetected OSA is expected to increase. In our cohort of patients referred to an academic medical center for advanced endoscopic procedures, the prevalence of a positive score using STOP-BANG was 43.3%. Nevertheless, all patients were sedated using a propofol-based regimen with no
cases requiring endoscopic intubation. Although the overall rate of AMs and SRCs were 12% and 23%, respectively, most of these would be considered minor; there were only 2 cases of premature procedure termination and 3 patients who required bag-mask (also called positive pressure) ventilation transiently.

Each of the 8 components to STOP-BANG were represented more commonly in the SB+ group, and daytime fatigue as well as witnessed apnea were reported only among SB+ patients. Patients with a positive STOP-BANG required more AMs and had more frequent airway-related SRCs including hypoxemia and apnea. Although we did not detect a statistically significant difference in the relative rate of all SRCs after adjusting for ASA class, our sample size was underpowered for this outcome measure. Still, the rate of AMs and hypoxemia remained significantly higher after adjusting for ASA class of 3 or higher, a previously described risk factor for SRCs.24 Despite these less favorable results in SB+ patients, this higher-risk subgroup received relatively less sedation (in terms of induction and total doses of propofol) and was not as deeply sedated compared with SB− patients, based on the MOAA/S score at the time of endoscopic intubation. Both groups met criteria for deep sedation or greater, based on an MOAA/S score of less than 1. Finally, prone positioning was used less frequently in SB+ patients because of limitations related to their body habitus. Of the 176 ERCP cases, 9 of 101 SB− (8.9%) compared with 18 of 75 (24%) of SB+ were performed in the left lateral decubitus position. In our experience, prone positioning does not appear to be an independent predictor of SRCs or AMs; however, this has not been studied in a prospective fashion.18 Among SB+ patients, the frequency of hypoxemia, any AM, or any SRC was not significantly different in patients who underwent their procedure in the prone position (data not shown). Although the sedating CRNA was unaware of the patient’s STOP-BANG score, their preprocedure airway evaluation likely impacted on the decision to position a minority of ERCP cases in the left lateral decubitus position. Nevertheless, the lower induction and total propofol doses along with the lower frequency of prone positioning in SB+ patients likely impacted on the rate of AMs and SRCs in this higher-risk subgroup.

Our results contradict Khiani et al,11 who did not detect a correlation between positive scores using the Berlin questionnaire and higher rates of hypoxemia in patients undergoing standard endoscopic procedures (upper endoscopy and colonoscopy). There are several explanations for this. First, the majority (67%) of patients in the Khiani et al11 trial underwent colonoscopy alone, for which the depth of sedation and impact on the upper airway are presumably less than ERCP and EUS. Their sedation approach (non-propofol-based) also was distinct. In addition, the Berlin questionnaire originally was designed for a primary care patient population whereas STOP-BANG originally was validated in a preprocedure (ie, surgical or endoscopic) patient population.8–10 Patients undergoing advanced endoscopic procedures are more likely to represent a surgical patient population whereas those undergoing standard endoscopy (eg, in the Khiani et al11 study) are akin to a primary care population. The increased sensitivity of STOP-BANG in a surgical cohort may account for our improved correlation with SRCs. Finally, hypoxemia (the primary outcome measure in the Khiani et al11 trial) represents the end point of suboptimal ventilation as a result of apnea, upper airway obstruction, or poor alveolar air exchange, among others. We prefer the outcome measure of AMs in favor of hypoxemia or other SRCs because the use of AMs quantifies the need for active airway monitoring and manipulation during the endoscopy as a result of suboptimal airflow. Although an AM may not be a true complication, it unequivocally highlights the importance of a having a provider who is solely responsible for airway management during the endoscopy.25 In our cohort, 20% of SB+ patients required at least one AM, compared with 6% in the SB− group.

There were limitations of this analysis. First, we did not confirm the presence of OSA using polysomnography in those patients with a STOP-BANG score of 3 or higher; therefore, we cannot define the actual rate of OSA but only the prevalence of those at high risk. However, Chung et al26 previously reported a positive predictive value of 81% for a positive STOP-BANG score, so a majority of SB+ patients in our cohort are considered likely to have a positive polysomnography study. Our patient population represents a unique subgroup undergoing advanced endoscopy at a tertiary referral center, with the majority having an ASA score of 3 or higher, older age, and a high rate of obesity. In addition, we have a dedicated anesthesiologist in the endoscopy unit along with 3 CRNAs, each of whom previously has sedated more than 2000 patients undergoing ERCP or EUS. Patients in both OSA risk groups were deeply sedated, with mean MOAA/S scores of less than 1 at the time of endoscopic intubation. These providers undoubtedly are skilled, and their complication and AM rates are unlikely to reflect those of a less-experienced provider. Along these lines, our use of capnography also may have reduced our rate of SRCs, particularly among obese patients, as reported in a recent randomized clinical trial using capnography in patients undergoing ERCP and EUS.26 BMI is an independent predictor of AMs and SRCs among patients undergoing standard and advanced endoscopic procedures.18,26,27 In addition, an increased BMI is a reliable predictor of OSA.28 However, data in the endoscopic literature are lacking on the clinical significance of undetected OSA as a risk factor for SRCs.29

The use of STOP-BANG is an easy bedside screening tool that supplements previously validated instruments such as ASA class in identifying which patients are at highest risk for AMs and SRCs. With the ongoing debate regarding the safe administration of propofol by nonanesthesiologists, risk stratification before endoscopy is critical.30 By incorporating several variables in a rapid bedside instrument, STOP-BANG complements the current approach to the preprocedure assessment and helps identify patients likely to encounter SRCs and require AMs during advanced endoscopic procedures.

Supplementary Material

Note: To access the supplementary material accompanying this article, visit the online version of Clinical Gastroenterology and Hepatology at www.cghjournal.org, and at doi:10.1016/j.cgh.2010.05.015.

References


Reprint requests
Address requests for reprints to: Gregory A. Coté, MD, Division of Gastroenterology, Indiana University, 550 North University Boulevard, IU 4100, Indianapolis, Indiana 46202. e-mail: gcote@iupui.edu; fax: (317) 278-0164.

Conflicts of interest
The authors disclose no conflicts.
**Supplementry Table 1. STOP-BANG Questionnaire**

1. Do you **Snore** loudly (louder than talking or loud enough to be heard through closed doors)?
   - Yes
   - No

2. Do you often feel **Tired**, fatigued, or sleepy during daytime?
   - Yes
   - No

3. Has anyone **Observed** you stop breathing during your sleep?
   - Yes
   - No

4. Do you have or are you being treated for high blood **Pressure**?
   - Yes
   - No

5. **BMI** > 35 kg/m²? (BMI = ________)
   - Yes
   - No

6. Age > 50 years
   - Yes
   - No

7. Neck circumference > 40 cm? (Neck circumference = ________cm)
   - Yes
   - No

8. Gender male?
   - Yes
   - No

**NOTE.** A score of 3 or greater denotes a high risk for obstructive sleep apnea.