Certified Registered Nurse Anesthetists (CRNAs) provide care for patients with undiagnosed obstructive sleep apnea (OSA). This evidence-based practice project demonstrated that the STOP-BANG Questionnaire (SB) identified patients with OSA preoperatively and reduced hypoxemia in the postanesthesia care unit (PACU). Evidence from the literature is described; based on this evidence, a change in clinical anesthesia practice was made. Four literature databases were searched using keywords from the following PICOT (patient, intervention, comparison, outcome, time) question: Do patients (P) who have high SB scores (I) compared with patients who do not have high SB scores (C) have a higher incidence of pulmonary complications (O) postoperatively (T)? Five observational cohort studies were critically appraised. The results consistently found that patients with an SB score of 3 or greater had significantly greater postoperative pulmonary complications, including lower oxyhemoglobin saturation (SpO2) in the PACU. At the Brooke Army Medical Center in San Antonio, Texas, the SB was implemented during the preanesthesia assessment. A query of the electronic medical record identified patients with undiagnosed OSA and patients with hypoxemia (SpO2 < 94%) in the PACU. Implementation of the SB increased identification of undiagnosed OSA by 78% preoperatively and reduced the incidence of hypoxemia in the PACU.

Keywords: Obstructive sleep apnea, postoperative pulmonary complications, STOP-BANG Questionnaire.
predictive value of the questionnaire to more than 90% for these patients.8

It is unclear if the SB is effective in identifying patients with moderate to severe OSA who are at greater risk of postoperative pulmonary complications. The purpose of this evidence-based practice project was to describe the evidence from the literature on the effectiveness of the SB in identifying patients with moderate to severe OSA who are at greater risk of postoperative pulmonary complications.

Literature Review

• Search Methods. Four literature databases were searched to locate effective evidence that would answer the following PICOT (patient, intervention, comparison, outcome, time) question. Do patients (P) who have high SB scores (I) compared with patients who do not have high SB scores (C) have a higher incidence of postoperative pulmonary complications (O) postoperatively (T)? The terms STOP Bang questionnaire and postoperative pulmonary complications were entered into each database. These search terms were connected with the term AND. The databases searched included the Cumulative Index to Nursing & Allied Health Literature (CINAHL), PubMed, Cochrane, and Ovid MEDLINE. Selection criteria included both retrospective and prospective studies based on their relevancy to the search terms. Three areas of focus were identified in the literature review: (1) the use of the SB in the preoperative assessment, (2) postoperative desaturation, and (3) length of stay (LOS). Patient populations included in the literature search had the following commonalities: adults who presented for noncardiac elective surgery; most demonstrated greater than 2 risk factors per the SB; if an AHI was referenced, the minimum score for inclusion was 5; and patients in prospective cohort studies were followed up for at least 30 days after their surgery. Studies excluded were those not in English. Five observational cohort studies were included.

• Studies. Chudeau et al9 conducted a prospective, observational study of 189 patients who were administered the SB within a 6-month period to evaluate whether this questionnaire could identify patients at high risk of respiratory complications in an urgent surgical population. The estimated incidence of respiratory complications was 20% in those patients with an SB score of 3 or greater, 5% in patients with an SB score less than 3, and an overall prevalence of 50%. With a power of 90% and an α risk of 5%, the necessary estimated sample size to show a statistical difference in proportion was 186 patients (93 per group). Patients 18 years old or greater who were undergoing an urgent surgery were included. The 189 selected participants were divided into 2 groups related to their respective SB score. One hundred four (55%) patients were determined to be at high risk of OSA (SB of ≥ 3), and 85 (45%) patients were at low risk of OSA (SB of ≤ 2). Results showed a statistically significantly greater incidence of perioperative respiratory complications between the 2 groups: difficult intubation (6 vs 0, respectively), desaturation on induction (9 vs 1, respectively), PACU desaturation (47 vs 25, respectively), and difficult oxygen weaning (51 vs 21, respectively). The LOS was also significantly different between the 2 groups (6 days for group 1 vs 4 days for group 2, P = .0002).9

Fernandez-Bustamante et al10 conducted a retrospective database review of 28,912 patients and compared the rates of adverse respiratory events among 3 groups. The first group consisted of 1,546 patients (5.3%) with an SB score of 3 or more identified as moderate/high risk of OSA (S-OSA). The second group consisted of 3,432 patients (11.9%) patients with diagnosed OSA (D-OSA).
The third group consisted of 23,934 patients (82.8%) with an SB score of 2 or less identified as no OSA risk (No-OSA). Hypoxic events were defined as an oxyhemoglobin saturation (SpO2) of 90% or less in the PACU. The rate of hypoxic events between the S-OSA group (n = 118, 7.7%) and D-OSA group (n = 305, 8.9%) was statistically significantly greater compared with the No-OSA group (n = 1,306; 5.5%). Adverse respiratory events also included postoperative reintubation, assisted ventilation, and direct intensive care unit admission. The incidence of these 3 adverse respiratory events was significantly greater in the S-OSA group (131, 8.5%; 179, 11.6%; 199, 12.9%, respectively) compared with the D-OSA group (204, 5.9%; 285, 8.3%; 333, 9.7%) and the No-OSA group (1,363, 5.7%; 1,834, 7.7%; 1,865, 7.8%; Table 1). There was no significant difference in the mean hospital LOS among the 3 groups at 3 days. The 30-day mortality rate was significantly greater in the S-OSA group, (23, 1.5%) compared with the D-OSA group, (23, 0.7%) and the No-OSA group (234, 1.0%).10

Proczko et al,6 in 2014, conducted a retrospective cohort study of 693 morbidly obese patients who underwent bariatric surgery between January 2009 and November 2013 in Gdansk, Poland. These patients were divided into 3 groups. Group A consisted of 99 patients in whom OSA was preoperatively diagnosed with PSG and who used continuous positive airway pressure (CPAP) preoperatively and postoperatively. Group B consisted of 182 patients who had no diagnosis of OSA by PSG but who scored at least 3 on the SB. Group C consisted of 412 patients who scored < 3 on STOP-BANG Questionnaire (Table 2). There was no significant difference in the mean hospital LOS among the 3 groups at 3 days. The 30-day mortality rate was significantly greater in the S-OSA group, (23, 1.5%) compared with the D-OSA group, (23, 0.7%) and the No-OSA group (234, 1.0%).10

Seet et al11 conducted a retrospective cohort study of 9,178 patients who underwent elective surgery during a 1-year period in Singapore in 2011; their goal was to examine if preoperative use of the SB predicts the occurrence of unexpected intraoperative and early postoperative adverse events. Information was obtained from the preoperative assessment via the hospital’s electronic medical record (EMR). Of the 5,432 patients included in the study, 485 (8.9%) had SB scores of 3 to 8, and 76 (1.4%) had SB scores of 5 to 8; 7.4% had unexpected intraoperative and early postoperative adverse events. When stratified according to SB scores, including odds ratios (ORs) and 95% confidence intervals (CIs), the risk of having an unexpected intraoperative and early postoperative adverse event was found to rise with increasing SB scores. The results of this study found that patients with SB scores less than 3 had a 5.5% chance of having

### Table 1. Incidence of Adverse Respiratory Events From Study by Fernandez-Bustamante et al10

<table>
<thead>
<tr>
<th>Group</th>
<th>Postoperative reintubation</th>
<th>Assisted ventilation</th>
<th>Direct ICU admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate/high risk of OSA (S-OSA)</td>
<td>131 (8.5)</td>
<td>179 (11.6)</td>
<td>199 (12.9)</td>
</tr>
<tr>
<td>Diagnosed OSA (D-OSA)</td>
<td>204 (5.9)</td>
<td>285 (8.3)</td>
<td>333 (9.7)</td>
</tr>
<tr>
<td>No OSA risk (No-OSA)</td>
<td>1,363 (5.7)</td>
<td>1,834 (7.7)</td>
<td>1,865 (7.8)</td>
</tr>
</tbody>
</table>

Abbreviations: ICU, intensive care unit; OSA, obstructive sleep apnea.

### Table 2. Group Comparisons of Study by Proczko et al6

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>99</td>
<td>OSA by polysomnography</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use CPAP machine</td>
</tr>
<tr>
<td>B</td>
<td>182</td>
<td>Scored ≥ 3 on STOP-BANG Questionnaire</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No OSA</td>
</tr>
<tr>
<td>C</td>
<td>412</td>
<td>Scored &lt; 3 on STOP-BANG Questionnaire</td>
</tr>
</tbody>
</table>

Abbreviations: CPAP, continuous positive airway pressure; OSA, obstructive sleep apnea.
an adverse event, and those with scores of 7 to 8 had a 44.4% chance (Table 3). Other independent predictors of perioperative adverse events found were older age, ASA class of 2 or higher, and uncontrolled hypertension. No correlation was found between patients known to have OSA and perioperative adverse events.11

Vasu et al12 conducted a historical cohort study of 135 patients who were administered the SB within a 3-day period to examine if high risk scores on the questionnaire correlated with a higher rate of pulmonary and cardiac complications related to OSA syndrome. The authors estimated that one-third of the population was at high risk of OSA and the incidence of complications was 30%. Selecting a power of 90% and an α of 0.05, the sample size necessary to show a significant difference was 134 patients. Patients with renal failure and low albumin levels were excluded; 135 patients presenting for elective surgery met the study criteria and were administered the SB. Fifty-six (41.5%) of these patients had a score of 3 or greater. Pulmonary complications evaluated included hypoxemia, atelectasis, pulmonary emboli, and pneumonia. Cardiac complications included new-onset atrial fibrillation, systemic hypotension, and myocardial infarction. Patients with an SB score of 3 or greater had a significantly higher occurrence of postoperative complications (19.6% vs 1.3%; P = .003) and a significantly higher percentage of postoperative pulmonary complications and longer LOS (3.6 vs 2.1; P = .003) compared with surgical patients with an SB score of 2 or less.12

• Synthesis of Evidence From the Literature. The results of these 5 studies consistently demonstrated that patients with an SB score of 3 or greater had a significantly higher percentage of postoperative pulmonary complications and longer LOS. These 5 studies were consistent in using an SB score of 3 or greater as placing the patient at moderate and/or high risk of OSA preoperatively. Evidence from these studies demonstrates that the SB is an effective preoperative tool to identify patients who may be at greater risk of postoperative pulmonary complications. A change in practice was designed from this evidence.

Methods: Evidence-Based Practice Project

The SB was implemented during the preanesthesia assessment at the Brooke Army Medical Center (BAMC) in San Antonio, Texas. Implementation consisted of 3 phases: before implementation, implementation, and after implementation. During the preimplementation phase, a waiver was granted by the institutional review board at the University of North Florida in Jacksonville, Florida. At BAMC several meetings were held with key stakeholders, including anesthesia and nursing staff, to discuss the evidence on the effectiveness of the assessment tool screening for OSA and the addition of the OSA assessment tool preoperatively to reduce the risk of hypoxemia in the PACU. Questions and concerns were addressed, and support for the project was obtained. Anesthesia providers and nurses in the preoperative anesthesia unit were informed about the content of the SB and patient benefits. The anesthesia preoperative assessment in the EMR was revised to include the SB, and the results were made available to anesthesia providers on the day of surgery. Information from the EMR for a 30-day period before implementation was collected, which included patients with a diagnosis of OSA, and PACU SpO2 values less than or equal to 94% in these patients with a diagnosis of OSA.

Phase 2 consisted of a 30-day period during which the SB was included in the preanesthesia assessment. Patients were presented educational material on the SB and why it is an important assessment tool.

Phase 3 consisted of a 30-day period following implementation in which the following information was obtained: the number of patients screened with the SB, the number of patients identified at risk of OSA by the SB, the number of patients with OSA diagnosed by PSG, and the number of patients with an SpO2 less than or equal to 94% in the PACU.

Results

Outcomes data were collected via the EMR for a 30-day period after implementation. Use and documentation of the SB in the preanesthetic evaluation increased from 0% to 78.2% (420 of 537 patients) within the first 30 days of implementation. Before implementation, 93 (21.5%) of 432 patients had the formal diagnosis of OSA by PSG. Following implementation, 99 (18.4%) of 537 patients had the formal diagnosis of OSA by PSG, and an additional 80 patients (for a total of 33.3%) were identified as having OSA through the SB. The total number of patients with either a formal diagnosis of OSA or those identified by the SB increased from 21.5% to 33.3% after implementation. The incidence of hypoxemia in the PACU was reduced following implementation of the SB: from 133/432 (30.7%) to 147/537 (27.3%).

Discussion

This evidence-based practice project demonstrated that by using an assessment tool in the preoperative period, patients likely to have OSA were identified, and hypox-

<table>
<thead>
<tr>
<th>STOP-BANG score</th>
<th>Chance of event, %</th>
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<tbody>
<tr>
<td>&lt; 3</td>
<td>5.5</td>
</tr>
<tr>
<td>3-4</td>
<td>25.4</td>
</tr>
<tr>
<td>5-6</td>
<td>34.3</td>
</tr>
<tr>
<td>7-8</td>
<td>44.4</td>
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Table 3. Risk of Having an Unexpected Adverse Intraoperative Event and Early Postoperative Event Increases With Increasing STOP-BANG Questionnaire Score
emia in the PACU was reduced. The SB is a reliable perioperative risk indicator for hypoxemia among same-day surgical patients with intermediate to severe undiagnosed OSA. Other studies have demonstrated that through use of a preanesthesia assessment tool, reintubation after planned extubation can also be reduced. The development and use of preanesthesia assessment tools can be beneficial to the patients, providers, and facility.

When implemented in the preoperative anesthesia assessment, the SB demonstrates a minimal impact on existing workflows, a reduction in subjective error through a standardized questionnaire, and a cost-effective method to alert perioperative personnel of the increased risk of postoperative pulmonary complications.

REFERENCES

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DISCLOSURES
The authors have declared no financial relationships with any commercial entity related to the content of this article. The authors did not discuss off-label use within the article.