Using the Electronic Medical Record to Improve Preoperative Identification of Patients at Risk for Obstructive Sleep Apnea

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Purpose: *Obstructive sleep apnea (OSA) is a breathing disorder found in surgical patients and associated with complications in the postoperative period. The implementation of a preoperative universal screening process using the STOP-BANG questionnaire to identify patients at high risk for OSA provides opportunities for improved management.*
Design: *A pre-post design was used to evaluate screening compliance rates.*
Methods: *This initiative included staff education, which included the process for evaluating and documenting STOP-BANG scores. The data were collected via a chart review of the electronic medical record (EMR).*
Findings: *The rate of screening for OSA doubled after implementation of this initiative, and compliance with STOP-BANG questionnaire screening was 66.1%. High-risk designation in the EMR was 73.0%. Nearly half of the patients screened were found to be at high risk for OSA.*
Conclusions: *Implementation of a universal screening initiative for patients and design for the EMR improves compliance with screening and identification of patients at high risk for OSA.*

Keywords: *obstructive sleep apnea, STOP-BANG questionnaire, quality improvement, preanesthesia testing, electronic medical record.*

PATIENTS SCHEDULED FOR surgery who present for in-person preanesthesia evaluation at the main preanesthesia testing (PAT) clinic for a large academic medical center frequently have clinical characteristics that confer an elevated risk for obstructive sleep apnea (OSA). Before the introduction of this quality improvement initiative, there was no formal evidence-based screening for OSA performed in the PAT clinic. The assessment and documentation of OSA risk was nonstandardized among providers.

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Background

OSA is a disorder caused by the obstruction of the upper airway structures during sleep. It is characterized by periods of complete or partial airway obstruction from relaxed pharyngeal tissue that result in intrathoracic pressure changes, disruptions to oxygenation, and fragmented sleep.[1] OSA is associated with a multitude of negative physiological effects, including intermittent

hypoxemia during sleep, endothelial dysfunction, reduced availability of nitric oxide, resistance to insulin, systemic inflammation, increased oxidative stress, and hypercoagulability.[2] OSA severity is categorized using the apnea-hypopnea index, which quantifies the number of apnea and hypopnea events per hour of sleep.[3] Current estimates of the prevalence of clinically significant OSA, defined as apnea-hypopnea index greater than or equal to 15 events per hour, range from 6% to 17% in the general adult population.[4] However, according to an examination of an adult surgical population by Singh et al,[5] more than 70% of patients in the study population met criteria for OSA, and more than 80% of these patients were previously undiagnosed.

In order for patients with OSA to receive appropriate care and management in the perioperative period, high-risk patients should be identified preoperatively. According to guidelines from the American College of Physicians,[6] diagnosis of OSA in adults optimally requires a polysomnography test, an in-laboratory sleep study that is both resource intensive and subject to scheduling availability. Characteristics of definitive testing for OSA via polysomnography such as scheduling availability and resources and patient discomfort limit its usefulness for preoperative diagnosis of OSA in the often short period between PAT and the scheduled elective surgery. The STOP-BANG questionnaire was validated as an alternative to polysomnography testing to provide an easier, more rapid, and less resource-intensive method of identifying patients at high risk for OSA. It consists of eight yes/no items and was created as an easy-to-use tool to screen for OSA in surgical patients.[7] A patient's OSA risk is categorized based on this score. A score of three or greater is associated with a sensitivity of 93% and negative predictive value of 90% for the detection of moderate to severe OSA.[8] STOP-BANG scores of three or greater have been shown to correlate directly with an increased risk of perioperative respiratory complications[9,10] and prolonged hospital length of stay.[10]

Anesthesia medications used in the perioperative setting and the residual effects of medications and general anesthetics may increase the risk for airway obstruction by decreasing upper airway tone, depressing respiratory chemosensitivity, and preventing normal arousal from sleep.[11] OSA patients exhibit alterations in sleep efficiency and rapid eye movement sleep for up to 1 week postoperatively.[12] These postoperative alterations in sleep patterns are closely associated with exacerbations in the clinical manifestations of OSA, specifically the number of episodes of apnea and hypopnea observed in these patients,[12] and with numerous postoperative complications. These complications include an increased risk for hypoxemia,[13] acute respiratory failure and postoperative cardiac events,[14] pulmonary embolism and in-hospital mortality,[15] delirium,[16] extended hospital length of stays,[13] and increased time in the postanesthesia care unit.[17]

A large multisite study by Corso et al[18] showed the wide-scale implementation of the STOP-BANG questionnaire for the screening of all elective surgery patients to be both feasible and organizationally sustainable. Corso et al[18] concluded that to appropriately plan a patient's perioperative care, it is vital to ensure that every patient scheduled for surgery be screened for OSA. Recently published guidelines from the Society of Anesthesia and Sleep Medicine[19] concur and recommend practice groups considered for screening OSA as part of the standard preanesthetic evaluation. Routine screening provides opportunities for increased awareness and possible risk reduction through the implementation of appropriate interventions in the perioperative period.[19]

Purpose

The purpose of this initiative was to improve the preoperative identification of PAT clinic patients at risk for OSA by implementing an evidence-based, universal systematic screening process using the STOP-BANG questionnaire. This initiative also sought to improve anesthesia providers' awareness of these patients on the day of surgery by introducing a *Risk factors for sleep apnea* designation in the electronic medical record (EMR). As part of this initiative, providers in the preanesthetic clinic were instructed to manually select this designation for patients with STOP-BANG scores of four or greater to clearly communicate these patients' risk status (Table 1).

Table 1. Procedures for Protocol Preparation and Implementation

Components of Innovation	Steps
Preparation	
Staff education	• PowerPoint (Microsoft Corporation, Redmond, WA) presentation to clinic staff in May 2016 - Topics: pathophysiology and prevalence of OSA, association between OSA and postoperative complications, introduction to STOP-BANG questionnaire, and review of proposed screening protocol • One-on-one EMR education with clinic providers - Topics: review of location and documentation of STOP-BANG questionnaire in EMR, criteria for high risk for OSA status, and documentation of high risk for OSA designation
Clinic preparation	• Disposable paper tape measures located in patient assessment areas • Tutorial signs in patient intake area for neck circumference measurement • Reminder signs on monitors to promote STOP-BANG questionnaire completion
Implementation	
STOP-BANG questionnaire screening process	• Nursing assistants obtain and document neck circumference during patient intake • EMR autopopulates remaining demographic elements of STOP-BANG questionnaire • Providers complete clinical STOP-BANG questionnaire elements during patient interview • EMR automatically generates STOP-BANG score and transfers score to PAT note
High-risk designation process	• For patients with STOP-BANG score of <4: - Patients are not at high risk for OSA - No additional documentation by providers in EMR • For patients with STOP-BANG score of ≥ 4: - Patients are at high risk for OSA - Providers select *Risk factors for sleep apnea* designation - EMR automatically creates *Risk factors for sleep apnea* alert on PAT note
Day of surgery	• Patient presents for scheduled elective surgery • PAT note in EMR reviewed by anesthesia team preoperatively • Anesthesia team members alerted to patient's high risk for OSA status, when applicable

OSA, obstructive sleep apnea; EMR, electronic medical record; PAT, preanesthesia testing.

Methods

Design

A two-group design was used to determine compliance with the systematic screening intervention and assess the effectiveness of identification of patients at high risk for OSA using the *Risk factors for sleep apnea* designation.

Aims

The aims for this quality improvement initiative were as follows:

1. To increase the proportion of patients screened for OSA using the STOP-BANG questionnaire.
2. To evaluate compliance with the STOP-BANG screening tool.
3. To increase the number of patients identified by the PAT providers as high risk for OSA using the *Risk factors for sleep apnea* designation in the EMR.

Sample

Patients scheduled for elective surgery at one of the medical center facilities who meet the criteria (Table 2) will undergo a phone interview with a registered nurse associated with the PAT clinic. Patients who do not meet these criteria for a phone interview are required to present for an in-person clinic PAT visit. The participants selected for this project study included those who presented for in-person screening at the PAT clinic only. Patients were identified for this study via a review of PAT clinic schedule records for dates selected in the preimplementation and postimplementation periods. Beginning with

Table 2. Criteria for Phone Screening at the PAT Clinic*

Acceptable Comorbidities
- Patients scheduled for second procedure within 3 mo of previous assessment by PAT, and no patient reported decline in baseline activity or increase in symptoms frequency, which impact activities of daily living, occurring since the last medical evaluation
- Controlled diabetes as evidenced by:
  - Documented Hgb A1C < 9% within the last 6 mo
  - No symptomatic hypoglycemia in the last month

Exclusion criteria
- Age 75 y or older
- BMI >45 kg/m^2
- Non-English and non-Spanish speaking or deaf patients
- Scheduled for moderate-risk or high-risk surgery (brain, heart, lung, major abdominal, or surgery with potential for blood loss >1,000 mL)
- Coronary heart disease or valvular disease resulting in dyspnea, fatigue, or chest pain at rest, with minimal exercise
- Shortness of breath/chest pain at rest or with a single flight of stairs, or with recent deterioration
- Hypertension with either systolic blood pressure >180 or diastolic blood pressure >95
- Cardiac-implanted electronic device (pacemaker, AICD, and LVAD)
- Coronary artery stent placement within 1 y
- Blood clot, stroke, or transient ischemic attach within past 3 mo
- Chronic obstructive pulmonary disease or asthma with a persisting worsening in cough, wheeze, or pattern of inhaler use occurring since the last medical evaluation
- Use of home oxygen therapy
- Any anticoagulant or antiplatelet agent with exception of aspirin at a dose of ≤650 mg/d
- Known bleeding disorder
- Insulin-dependent diabetes with multiorgan involvement
- Dialysis dependent
- Anemia with Hgb < 11 g/dL unless associated with known menorrhagia or related to planned surgery
- Refusal of blood transfusion unless seen by Duke Center for Blood Conservation within 90 d
- Systemic disease that increasingly restricts activities of daily living
- Metastatic cancer currently being treated with chemotherapy and/or radiation
- History of malignant hyperthermia involving patient or family
- Patient reports problems with anesthesia (airway, difficult intubation, and cardiac arrest)
- Pregnancy unless surgery is a pregnancy-related surgery (eg, dilation and evacuation procedure)
- Seizures in last 3 mo
- Carcinoid tumor

PAT, preanesthesia testing; Hgb, hemoglobin; BMI, body mass index; AICD, automatic internal cardiac defibrillator; LVAD, left ventricular assist device.

*Adapted from Ronald Olson, MD, electronic mail communication, May 2017.

the first patient scheduled for each day, patients were included consecutively until suggested statistical power of 100 preimplementation and 150 postimplementation patients was met. Patients were excluded from the study if they were younger than 18 years or were scheduled for endoscopy procedures or electroconvulsive therapy.

Setting

The setting for this initiative was the main PAT clinic at a large, southern, academic medical center. The PAT clinic coordinates preanesthesia screening services for the ambulatory surgery center and the associated academic tertiary care hospital. A multidisciplinary team of health care providers, including nurse practitioners, physician assistants, and medical residents perform in-person preanesthesia evaluations for patients scheduled for procedures requiring anesthesia. A total of 43,140 patients were screened through the medical center's PAT department in 2016, including 20,672 in-person evaluations and 22,468 phone screening events (Anthony Basil,

RN, electronic mail communication, March 2017). This study was granted exemption from the institutional review board.

Procedures

The PAT note is a single-page document within the EMR that contains documentation of all portions of the preanesthesia evaluation, including the patient's vital signs, allergies, past medical and surgical history, medications, and physical assessment. Alerts related to anesthesia, such as a history of postoperative nausea and vomiting, diagnosed OSA, or difficult airway are listed at the top of this form, which is reviewed by the patient's anesthesia team on the day of surgery.

A redesign of the location of the requirements of the STOP-BANG questionnaire completion was implemented during the project development phase to address identified concerns from the PAT clinic providers. The project lead worked closely with both the clinic's EMR liaison and the technical lead of the EMR company to revise the STOP-BANG questionnaire documentation in the EMR. Adaptations were necessary to support completion of the project. These included relocating the STOP-BANG questionnaire within the EMR to allow the clinic nursing assistants to document essential elements of the SB questionnaire (such as body mass index [BMI] and neck circumference) and programming the EMR to autopopulate these elements into the final SB score in the PAT note. The final score created an alert for patients at high risk for OSA as defined by their STOP-BANG score. This alert was reserved for patients with a STOP-BANG score of four or greater to optimally balance sensitivity and specificity considering the demographic characteristics of the PAT clinic patients and the proven increases in predicted probability, odds ratio, and specificity for having OSA associated with higher STOP-BANG scores.[20]

The newly designed process for universal screening and standardized documentation of patients at high risk for OSA was implemented in the PAT clinic in July 2016. The steps used for the launch of this protocol included staff education, clinic preparation, and introduction of a novel process for evaluating and documenting both STOP-BANG questionnaire results and OSA risk (Table 1).

Data Collection

Data for the pre- and postimplementation patients were collected via a manual EMR chart review. Demographic information was collected for each patient (Table 3). The presence or the absence of a previous diagnosis of OSA as well as five additional comorbidities that included hypertension, coronary artery disease, peripheral vascular disease, chronic kidney disease, and diabetes mellitus were collected. This detail provided a comprehensive impression of the patient's overall health. Additional data collected included the surgical service, type of anesthesia, procedure duration (minutes), and postanesthesia care unit length of stay (minutes). The presence or the absence of a STOP-BANG score, was recorded for all patients. Providers' use of the *Risk factors for sleep apnea* designation was recorded for the postimplementation group patients. The presence of evidence for nonstandardized evaluation for OSA, defined as free-text documentation of the provider's assessment of OSA symptoms using the terms "snore(s)," "snoring," and "apnea," was recorded for the preimplementation group patients only.

Results

Preimplementation Group

Within the preimplementation group, 19.0% of patients had a previous OSA diagnosis according to documentation in the PAT note. Patients without a previous OSA diagnosis were screened using a nonstandardized evaluation at a rate of 33.3%. The use of nonstandardized questions identified 18.5% of patients screened as being at risk for OSA.

Postimplementation Group

Within the postimplementation group, 19.3% of patients had a previous OSA diagnosis. Patients without a previous OSA diagnosis were screened using the STOP-BANG questionnaire at a rate of 66.1%, of which 46.3% were found to have a STOP-BANG score of four or greater, which represented 30.6% of patients who met the criteria for STOP-BANG screening in the

Table 3. Descriptive Statistics of PAT Patient Population

	Total N = 250 (100%)	Preimplementation Group N = 100 (40%)	Postimplementation Group N = 150 (60%)
Variables		**Mean (SD)**	
Age (y)	60.64 (14.03)	61.04 (14.03)	60.37 (14.08)
BMI (kg/m^2)	29.05 (6.15)	29.18 (6.46)	28.97 (5.96)
Number of comorbidities	1.36 (1.25)	1.25 (0.44)	1.43 (1.32)
Variables		***N* (%)**	
Gender			
Male	134 (53.6)	52 (52.0)	82 (54.7)
Female	116 (46.4)	48 (48.0)	68 (45.3)
Race			
White	177 (70.8)	73 (73.0)	104 (69.3)
Black	57 (22.8)	21 (21.0)	36 (24.0)
Other	16 (6.4)	6 (6.0)	10 (6.7)
ASA			
ASA 1	3 (1.2)	0 (0.0)	3 (2.0)
ASA 2	47 (18.8)	16 (16.0)	31 (20.7)
ASA 3	186 (74.4)	79 (79.0)	107 (71.3)
ASA 4	14 (5.6)	5 (5.0)	9 (3.6)
Prior OSA diagnosis			
Yes	48 (19.2)	19 (19.0)	29 (19.3)
No	202 (80.8)	81 (81.0)	121 (80.7)

PAT, preanesthesia testing; SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists; OSA, obstructive sleep apnea.

postimplementation group. Nearly 90% of patients in the high STOP-BANG score group were American Society of Anesthesiologists physical status three or greater, had an average of 1.84 comorbidities, and the mean BMI for this group was 30.18 km/m^2, which met the classification of obesity (Table 4). PAT clinic providers flagged these patients as instructed using the *Risk factors for sleep apnea* designation at a compliance rate of 73.0%.

Discussion

The focus of this initiative was to implement STOP-BANG screening, develop and implement a novel high-risk designation within the EMR, and evaluate compliance with this innovation. Provider education, integration of the STOP-BANG questionnaire into provider workflow, and alterations to the EMR were strategies used to maximize compliance with this initiative.

Provider Education and Workflow Integration

This initiative was designed to maximize provider participation by optimizing integration within the existing provider workflow and providing education regarding the utility of STOP-BANG screening. Observations were conducted of multiple preanesthesia evaluations to establish the process for a standard patient interview and physical assessment. Interviews were conducted to determine existing OSA screening practices and identify barriers to universal STOP-BANG questionnaire adoption.

Providers expressed uncertainty during these interviews regarding the need for universal STOP-BANG screening, and the perception that patients at risk for OSA could be reliably identified based on physical inspection was widespread. This belief remains common among health care providers despite evidence that physicians' ability to predict OSA by visual assessment is only marginally

Table 4. Descriptive Statistics of Patients at High Risk for OSA (STOP-BANG Score of ≥4)

	Total (N = 37)
Variables	**Mean (SD)**
Age (y)	64.65 (9.82)
BMI (kg/m^2)	30.18 (6.88)
Number of comorbidities	1.84 (1.28)
Variables	***N* (%)**
Gender	
Male	30 (81.1)
Female	7 (18.9)
Race	
White	27 (73.0)
Black	7 (18.9)
Other	3 (8.1)
ASA	
ASA 1	1 (2.7)
ASA 2	3 (8.1)
ASA 3	31 (83.8)
ASA 4	2 (5.4)

OSA, obstructive sleep apnea; SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists.

superior to chance.[21] Systems with high levels of implementation tend to describe a specific need for the program.[22] The developers of this project concluded that it was critical to emphasize the need for this initiative among the clinic providers and primary stakeholders. To improve provider buy-in, an educational presentation was designed to emphasize the utility of and the need for universal STOP-BANG screening. Presentation topics included the demonstrated superiority of the STOP-BANG tool over provider assessment for the identification of patients with OSA, the high prevalence of undiagnosed OSA, and the perioperative risks associated with OSA. Providers expressed a greater understanding of the need for universal systematic screening after the educational intervention, which was reflected in the high compliance rates with this initiative.

Providers also expressed concerns that obtaining a neck circumference measurement would be disruptive to the flow of their patient interview and that excessive time would be required to complete and document the STOP-BANG questionnaire. These concerns were addressed with revisions to the original innovation design. Responsibility for obtaining the neck circumference measurement was shifted to the clinic nursing assistants, who could obtain this measurement while collecting patient vital signs, height, and weight. In addition, the STOP-BANG questionnaire documentation burden was reduced through the use of EMR adaptations.

EMR Integration

Using a configurable EMR system to integrate customized screening tool documentation elements into the existing documentation process can significantly increase screening rates.[23] In addition, automated EMR calculation of risk scores can be used to decrease the time required to complete risk assessments at the point of care,[24] thereby increasing productivity. Optimizing the integration of the STOP-BANG questionnaire into the providers' workflow required extensive EMR modification. The adaptability of the EMR system and its potential for customization were significant factors in the project developers' ability to achieve the goal of reducing workflow disruption and time burden associated with the screening process. A new field was created within the EMR for the nursing assistants to document neck circumference. The STOP-BANG questionnaire was also reconfigured to autopopulate patients' BMI, age, gender, and neck circumference. The questionnaire was further redesigned to automatically calculate a final STOP-BANG score and transfer this score to the PAT note. A new designation was created for the identification of a patient as high risk for OSA. The EMR automatically created an alert on the PAT note when the designation was selected. This process demonstrated the relative advantage of this initiative by replacing a nonstandardized and time-consuming process relying on free-text comments with a single-click action that has the potential to significantly improve the day of surgery providers' awareness of high-risk patients.

Compliance

Designing process improvements based on stakeholder input, providing adequate staff education, and modifying protocols to promote efficiency and ease of use can greatly increase compliance with standardized screening initiatives.[25] However, initiatives designed to promote screening tool use

may not achieve target compliance rates, especially if an absence of screening for patient risk is not understood.[26] The combination of provider education, provider workflow integration, and EMR customization resulted in a compliance rate of more than 66% using the STOP-BANG questionnaire and 73% assigning the high risk for OSA designation. Future linkage of outcomes to the STOP-BANG score within the local surgical population might impel providers to further improve compliance with STOP-BANG screening.

Although most adopted this practice change, additional compliance advances could be achieved by further customizing the EMR to mandate STOP-BANG questionnaire completion via a hard stop. Haut et al[27] increased compliance rates with evidence-based venous thromboembolism prophylaxis from 66% to 84% by implementing an EMR tool. They improved patient outcomes significantly by implementing an EMR-based decision support tool that mandated completion of a risk factor checklist and recommended appropriate prophylaxis based on a patient's risk stratification level.[27] A 2016 study by Merkl et al[28] noted a substantial impact of a mandatory embedded screening question within the EMR to identify more than 400 veterans presenting to emergency departments. Many of these veterans were connected to additional resources as a result of this initiative.[28] These examples demonstrate the potential compliance gains that can be made by mandating screening within the EMR, which would be a promising future direction for initiatives such as this.

Limitations

Limitations to the customization potential of the EMR system resulted in time delays and the need to work extensively with information technology professionals to find alternatives within the confines of the system. The location of the modified STOP-BANG questionnaire within the EMR was less than optimal because of these constraints, which may have adversely impacted compliance rates. In addition, issues with the creation of data queries for customized EMR elements such as the *Risk factors for sleep apnea* designation complicated the process of data extraction. Manual data extraction had to be completed to include these elements, which created a practical limitation on the sample size and scope of the data collected.

Conclusions and Implications

The new process provided an effective and efficient method for the identification and designation of patients at high risk for OSA. As evidenced by the compliance rates with both STOP-BANG screening and the use of the high-risk designation in the EMR, this screening process was feasible to implement on a wide-scale basis at the PAT clinic. Based on STOP-BANG score results, the STOP-BANG score cutoff of four was reasonable considering the high-risk clinic population. Implementation of the screening innovation replaced a previously nonstandardized screening and documentation process with an evidence-based systematic screening process, increasing the overall number and percentage of patients screened for OSA, identifying a high percentage of patients at risk for OSA, and demonstrating the importance of universal screening for OSA in this population. Further examination of the association between OSA risk and outcomes would provide a direction for future research. The success of this initiative validated the importance of designing practice change initiatives to be integrated into the stakeholders' existing workflow and demonstrated the value of EMR optimization to improve an innovation's ease of use and workflow integration.

References

1. Sutherland K, Cistulli PA. Recent advances in obstructive sleep apnea pathophysiology and treatment. *Sleep Biol Rhythms*. 2015;13:26-40.

2. Hopps E, Caimi G. Obstructive sleep apnea syndrome: Links between pathophysiology and cardiovascular complications. *Clin Invest Med*. 2015;38:E362-E370.

3. Ho V, Crainiceanu CM, Punjabi NM, Redline S, Gottlieb DJ. Calibration model for apnea-hypopnea indices: Impact of alternative criteria for hypopneas. *Sleep*. 2015;38:1887-1892.

4. Senaratna CV, Perret JL, Lodge CJ, et al. Prevalence of obstructive sleep apnea in the general population: A systematic review. *Sleep Med Rev*. 2017;34:70-81.

5. Singh M, Liao P, Kobah S, Wijeysundera DN, Shapiro C, Chung F. Proportion of surgical patients with undiagnosed obstructive sleep apnoea. *Br J Anaesth*. 2013;100:629-636.

6. Qassem A, Dallas P, Owens DK, Starkey M, Holty JE, Shekelle P, Clinical Guidelines Committee of the American College of Physicians. Diagnosis of obstructive sleep apnea in

adults: A clinical practice guideline from the American College of Physicians. *Ann Intern Med*. 2014;161:210-220.

7. Chung F, Yegneswaran B, Liao P, et al. STOP questionnaire: A tool to screen patients for obstructive sleep apnea. *Anesthesiology*. 2008;108:812-821.

8. Chung F, Abdullah HR, Liao P. STOP-BANG questionnaire: A practical approach to screen for obstructive sleep apnea. *Chest*. 2016;149:631-638.

9. Vasu TS, Doghramji K, Cavallazzi R, et al. Obstructive sleep apnea syndrome and postoperative complications: Clinical use of the STOP-BANG questionnaire. *Arch Otolaryngol Head Neck Surg*. 2010;136:1020-1024.

10. Pereira H, Xara D, Mendonca J, Santos A, Abelha FJ. Patients with a high risk for obstructive sleep apnea syndrome: Postoperative respiratory complications [in Portuguese]. *Rev Port Pneumol*. 2013;19:144-151.

11. Wolfe RM, Pomerantz J, Miller DE, Weiss-Coleman R, Solomonides T. Obstructive sleep apnea: Preoperative screening and postoperative care. *J Am Board Fam Med*. 2016;29:263-275.

12. Chung F, Liao P, Yegneswaran B, Shapiro CM, Kang W. Postoperative changes in sleep-disordered breathing and sleep architecture in patients with obstructive sleep apnea. *Anesthesiology*. 2014;120:287-298.

13. Kaw R, Pasupuleti V, Walker E, Ramaswamy A, Foldvary-Schafer N. Postoperative complications in patients with obstructive sleep apnea. *Chest*. 2012;141:436-441.

14. Kaw R, Chung F, Pasupuleti V, Mehta J, Gay PC, Hernandez AV. Meta-analysis of the association between obstructive sleep apnoea and postoperative outcome. *Br J Anaesth*. 2012;109:897-906.

15. D'Apuzzo MR, Browne JA. Obstructive sleep apnea as a risk factor for postoperative complications after revision joint arthroplasty. *J Arthroplasty*. 2012;27:95-98.

16. Flink BJ, Rivelli SK, Cox EA, et al. Obstructive sleep apnea and incidence of postoperative delirium after elective knee replacement in the nondemented elderly. *Anesthesiology*. 2012;116:788-796.

17. Brousseau CA, Dobson GR, Milne AD. A retrospective analysis of airway management in patients with obstructive sleep apnea and its effects on postanesthesia care unit length of stay. *Can J Respir Ther*. 2014;50:23-26.

18. Corso RM, Petrini F, Buccioli M, et al. Clinical utility of preoperative screening with STOP-BANG questionnaire in elective surgery. *Minerva Anestesiol*. 2014;80:877-884.

19. Chung F, Memtsoudis SG, Ramachandran SK, et al. Society of Anesthesia and Sleep Medicine guidelines on preoperative screening and assessment of adult patients with obstructive sleep apnea. *Anesth Analg*. 2016;123:452-473.

20. Chung F, Subramanyam R, Liao P, Sasaki E, Shapiro C, Sun Y. High STOP-BANG score indicates a high probability of obstructive sleep apnea. *Br J Anaesth*. 2012;108:768-775.

21. Cheung K, Ishman SL, Benke JR, et al. Prediction of obstructive sleep apnea using visual photographic analysis. *J Clin Anesth*. 2016;32:40-46.

22. Liang S, Kegler MC, Cotter M, et al. Integrating evidence-based practices for increasing cancer screenings in safety net health systems: A multiple case study using the Consolidated Framework for Implementation Research. *Implement Sci*. 2016;11:1-12.

23. McGuire R, Moore E. Using a configurable EMR and decision support tools to promote process integration for routine HIV screening in the emergency department. *J Am Med Inform Assoc*. 2016;23:396-401.

24. North F, Fox S, Chaudhry R. Clinician time used for decision making: A best case workflow study using cardiovascular risk assessments and Ask Mayo Expert algorithmic care process models. *BMC Med Inform Decis Mak*. 2016;16:1-12.

25. Titsworth WL, Abram J, Fullerton A, et al. Prospective quality initiative to maximize dysphagia screening reduces hospital-acquired pneumonia prevalence in patients with stroke. *Stroke*. 2013;44:3154-3160.

26. Asomaning N, Loftus C. Identification of Seniors at Risk (ISAR) screening tool in the emergency department: Implementation using the plan-do-study-act model and validation results. *J Emerg Nurs*. 2014;40:357-364.

27. Haut ER, Lau BD, Kraenzlin FS. Improved prophylaxis and decreased rates of preventable harm with the use of a mandatory computerized clinical decision support tool for prophylaxis for venous thromboembolism in trauma. *Arch Surg*. 2012;147:901-907.

28. Merkl MA, Tanabe P, Sverha JP, Turner B. A quality improvement initiative for designing and implementing a military service screening tool for a community emergency department. *J Emerg Nurs*. 2016;42:400-407.