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SCIENTIFIC INVESTIGATIONS

Prevalence of risk for sleep apnea among hospitalized patients who survived a medical emergency team activation

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Study Objectives: Sleep-disordered breathing (SDB) is a common disorder that causes people to stop breathing in their sleep, and obstructive sleep apnea (OSA) is the most common form of SDB in the general population. Because OSA is often undiagnosed and undermanaged, it has been associated with adverse events and morbidity in hospitalized patients. The purpose of the study was to evaluate prevalence of OSA risk in a population of patients who survived a medical emergency team (MET) activation during hospitalization.
Methods: This prospective study was conducted at a hospital in the Midwest in 2014. Patients who survived a MET activation and consented to participate were administered the STOP-Bang questionnaire and asked other health and lifestyle questions. Review of the medical record was conducted to ascertain patient characteristics, comorbidities, and medications. Differences were assessed using Kruskal-Wallis one-way analysis of variance and the chi-square test.
Results: Of 148 study patients, median age was 68 years (interquartile range: 55–78) and 15% were morbidly obese (body mass index ≥ 40 kg/m^2). Fifty percent of patients (n = 74) were found to be at high risk for OSA, yet only 38% (n = 28) of those patients received a previous diagnosis of OSA. Variables available in the medical record were highly correlated with the overall STOP-Bang score (r =. 75, P < .001).
Conclusions: Half of patients who survived a MET activation during hospitalization screened at high risk for OSA. Standardized screening for risk of sleep apnea, as well as a truncated risk score generated by variables in the medical record, could guide clinical decision making in this at-risk population.
Keywords: hospitalized patients, medical emergency team (MET) activation, obstructive sleep apnea, sleep-disordered breathing, STOP-Bang
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BRIEF SUMMARY
Current Knowledge/Study Rationale: Obstructive sleep apnea (OSA) is common in the general population. It has been associated with an array of complications and is greatly underdiagnosed, especially in hospitalized populations.
Study Impact: Study findings indicate that most hospitalized patients who survived a medical emergency team (MET) activation are at high risk for OSA. Patients should be screened for OSA at hospital admission to better optimize care and decrease the likelihood of adverse events. In the absence of patient interview, data from the medical record can assist in determining or prescreening patients at higher risk.

INTRODUCTION

Sleep-disordered breathing (SDB) refers to a group of conditions characterized by respiration abnormalities during sleep.[1] Obstructive sleep apnea (OSA) is the most common form of SDB, affecting 10% to 20% of adults.[1–4] OSA is characterized as the repetitive episode of a collapsed upper airway, resulting in the reduction of airflow that can lead to hypoxia.[5,6] It presents through a variety of symptoms, including daytime sleepiness, a witnessed pause of breathing while sleeping, and snoring.

OSA is frequently underdiagnosed and undertreated in the general population, but even more so among hospitalized patients. Previous research has found that up to 40% of hospitalized patients are at moderate to high risk of OSA.[7–9] Patients with OSA are known to have difficulties with intubation, more frequent admissions to the intensive care unit (ICU), more postoperative complications, longer duration of hospital stay, and increased hospital readmission.[2,3,10–14]

Undiagnosed and/or untreated sleep apnea can lead to adverse events and morbidity in hospitalized patients receiving care for other illnesses or injuries. Hospitals often deploy a rapid response or medical emergency team (MET) when patients show signs of deterioration in order to rapidly identify and intervene to prevent fatal decline in patient status.[15–18] In a systematic review and meta-analysis, such teams have been associated with reduced in-hospital cardiopulmonary arrest and mortality.[16,18,19] Very few studies, however, have examined the role of diagnosed or undiagnosed OSA in MET activations. In a multiyear prospective evaluation of obese patients (body mass index [BMI] ≥ 30 kg/m^2), Sharma et al[20] determined that 76% of all patients were at high risk of OSA and 8% of high-risk patients experienced a MET activation during hospitalization. In a sample of hospitalized adults, Lyons et al[21] determined that 11% of patients had a diagnosis of OSA in their medical record and those patients had significantly more MET activations than patients without a diagnosis of OSA.

Screening for OSA risk is critical, and there are several screening scales that isolate the symptoms of OSA to determine risk level.[3,22,23] One of those scales, the STOP-Bang,[2,24] has very good sensitivity and has been validated as a screening tool to estimate the probability and severity of OSA.[6,11,25] Several elements of the STOP-Bang scale can only be obtained through patient interview, which is not always practical for inpatient settings. Only one study of which we are aware has tested a tool derived solely from information in the electronic medical record; the authors found that age, sex, BMI, and medical history are superior to symptom variables in predicting OSA risk.[26]

The purpose of this study is to determine the prevalence of OSA risk for patients who survived a MET activation during hospitalization. A secondary purpose was to determine whether components of the risk assessment could be extracted from the medical record to compute risk of OSA without patient interview.

METHODS

The study was a prospective evaluation of adult patients at a tertiary hospital in the Midwest. During the study period (May-November 2014), the research team was notified when the MET had been activated for a hospitalized patient. Within 48 hours of the MET activation, a research team member consulted with the patient's nurse to determine whether the patient was able to be interviewed and had capacity to provide informed consent. If the answer was affirmative, the patient was approached by the research team member and asked to participate in the study. Consent was obtained from the patient, and participants were administered the STOP-Bang questionnaire and additional health and lifestyle questions. Patients were considered missed recruits if they discharged from the hospital before the research team could obtain consent, were non-English speaking, or lacked competence to provide consent. This also included patients who did not survive the MET activation or were unable to provide consent after the MET activation due to intubation or altered mental status. Study procedures were approved by the institutional review board at the study hospital.

Study variables

The STOP-Bang is composed of eight questions to assess risk for OSA.[2,22] The first three components (snoring, tiredness, and observed apnea) were obtained through patient interview. Pressure (hypertension) was asked about during the interview and confirmed in the medical record if the patient had a diagnosis of hypertension or prescription medication to treat hypertension. Body mass index (BMI $\geq$ 35), age, and gender were obtained from the medical record. It was not feasible to measure neck circumference for inpatients receiving oxygen or connected to other machines, so shirt size was used as a proxy for neck circumference; any patient who indicated a size extra-large (XL) or greater was considered to meet the criteria for neck size > 40 cm. Affirmative responses were summed to compute an overall STOP-Bang score: low risk (STOP-Bang score 0–2), intermediate risk (STOP-Bang score 3–4), and high risk (STOP-Bang score 5–8).[2,11] Intermediate risk was further differentiated using previously published criteria.[2]

During the interview patients were also asked about prior diagnosis of OSA, family history of OSA, and alcohol and smoking history. Patients with a previous diagnosis of OSA indicated whether they owned a continuous positive airway pressure (CPAP) or bilevel positive airway pressure machine and whether they used the machine at home. Information about the MET activation was obtained from paperwork completed at the time of the activation, which specified all indications for and outcomes of the activation. If a patient had more than one MET activation during hospitalization, only the first activation was included in the analyses. One patient was excluded from the study sample because hospital length of stay exceeded 90 days and three patients were excluded because the first MET activation was more than 30 days after hospital admission.

Patient demographics, hospital procedures, and home and hospital medications were abstracted from the medical record. Comorbidities were also abstracted, including history of asthma, chronic obstructive pulmonary disease, congestive heart failure, coronary artery disease, diabetes, gastroesophageal reflux disease, and stroke. Morbid obesity was defined as BMI $\geq$ 40 kg/m^2. Medication abstraction included opioids and psychotropics (benzodiazepines and antipsychotic drugs). For data abstracted from the medical record, 20% of charts were blindly selected for interrater reliability review. Initial interrater reliability review percent agreement did not meet the acceptable threshold of 90%, so all comorbidity and medication variables were reabstracted by a second reviewer. The initial review included only the history and physical component of the medical record that was specific to the patient encounter, whereas the subsequent review included a history component that compiled comorbidities across patient encounters.

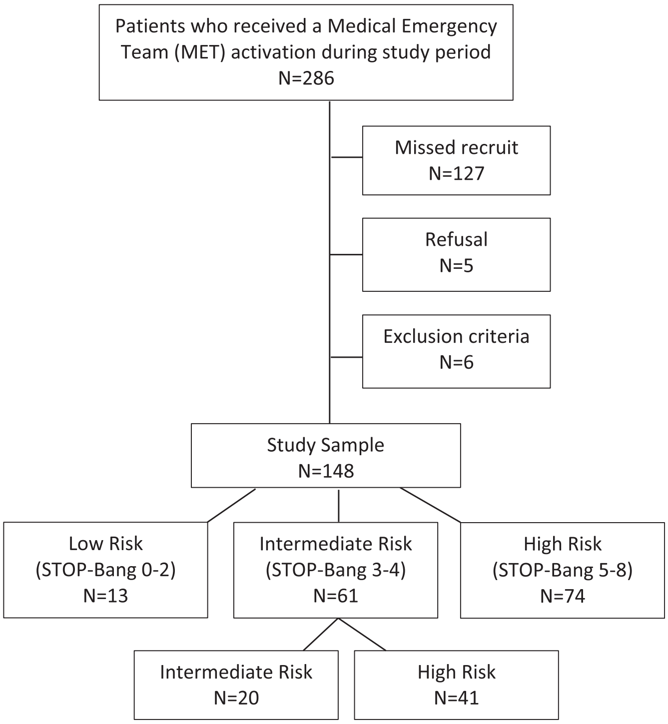
Statistical method

Analyses were performed with IBM SPSS Basic Statistics for Windows, version 20.0 (IBM Corp, Armonk, New York, United States). Descriptive statistics were examined and reported for continuous data as medians and interquartile ranges; categorical data were reported as counts and percentages. Statistical tests were two-tailed and based on a 0.05 significance level. Because data were not normally distributed and sample sizes were unequal, differences between medians were assessed using the Kruskal-Wallis one-way analysis of variance. Differences between nominal variables were assessed using the chi-square (χ^2) test and associations between variables were assessed using Pearson correlation coefficients (r).

RESULTS

During the study period, there were 286 MET activations. As shown in **Figure 1**, 44% of the patients (n = 127) were missed recruitments, including patients who did not survive the MET activation, were unable to provide consent after the MET activation, or discharged from the hospital before the research team could recruit for the study. In addition, 2% of patients (n = 5) refused to participate in the study and 2% of the patients met study exclusion criteria due to multiple MET activations, prolonged length of stay, or delayed MET activation. The final

Figure 1—Flow chart of study sample.



sample included 148 patients (52% of MET activations in the study period), and 74 patients (50%) scored at high risk of OSA on the STOP-Bang questionnaire. The intermediate risk category was further differentiated to identify a subgroup considered at high risk; using this classification, 78% (n = 115) of the total sample was considered to be at high risk of OSA.

Table 1 shows the demographic and health characteristics of the study sample. Overall, the median age was 68 years (interquartile range 55–78), 39% of patients received a surgical procedure during hospitalization, and 47% of patients were admitted to the hospital by the internal medicine service. The most common comorbidities were diabetes (34%), coronary artery disease (31%), and gastroesophageal reflux disease (31%). When comparing patients by their STOP-Bang risk levels, there were no statistically significant differences by group in age, race, or surgical procedure. Patients who were at high risk for OSA had higher rates of diabetes and morbid obesity than patients in the low and intermediate risk categories. Home psychotropic medications were common in the sample, with 69% of patients indicating that they took that type of medication at home. Hospital days, ICU days, and mortality did not differ by risk level.

Components of the STOP-Bang questionnaire

Half of all patients (n = 74) were considered to be at high risk of OSA; they were significantly more likely to meet criteria for every component of the STOP-Bang questionnaire (**Table 2**). They were also more likely to have any prior diagnosis of OSA (38%), to have previously completed a sleep study (37%), and to own a CPAP machine (28%). In this high-risk group, patient-reported compliance with their home CPAP machine was 71%.

Positive responses on the four components found in the medical record (pressure, BMI, age, and gender) were highly correlated with overall STOP-Bang score ($r = .75$, $P < .001$). The most highly correlated components with overall risk score, however, were ascertained through patient interview: neck/shirt size ($r = .59$, $P < .001$) and observed stop to breathing ($r = .54$, $P < .001$).

Reasons for MET activation

As shown in **Table 3**, patients in each risk category had multiple MET activations during hospitalization. More than one-third of all initial MET activations were during the evening shift, but this did not differ across risk group. There were no statistically significant differences across groups for reasons for MET activation, but in all groups the most common reasons for MET activation were family or staff concern or low oxygen saturation. Nearly three-fourths of the sample received an opioid during hospitalization (n = 106, 72%) and nearly half of those patients received multiple different opioids during their stay (n = 68, 46%); neither of these variables were significantly different across the risk categories.

DISCUSSION

Adverse events and morbidity in hospitalized patients are not uncommon, but they can occur at increased rates for patients with undiagnosed and/or untreated sleep apnea. In situations where patients show signs of clinical deterioration, hospitals often activate medical emergency teams to intervene. Our study found that half of all hospitalized patients who survived a MET call activation were considered to be at high risk of OSA, with 62% of these patients having no prior diagnosis of OSA.

The STOP-Bang questionnaire has been previously validated as a screening tool with high sensitivity in estimating the probability and severity of OSA. Four components of this scale can be readily found in the medical record (pressure, BMI, age and gender), and these components were highly correlated with the overall STOP-Bang score. In a study done by Ustun and colleagues, [26] variables extracted from electronic health records were found to be superior to the symptom variables reported by patients in predicting OSA. Thus, it is feasible that preliminary screening for sleep apnea can derived from patients' medical records, especially in instances where interviewing patients is not feasible due to altered mental status or intubation. Notification of OSA risk could be flagged in the electronic medical records to increase physician and nurse awareness.

The most common comorbidities in the population of patients with a MET activation were diabetes, coronary artery disease, and gastrointestinal reflux disease; however, there were statistically significant differences in rates of diabetes and morbid obesity across the risk categories. Forty-three percent of patients at high risk for OSA had diabetes and 27% of patients had morbid obesity. When universal screening of all hospitalized patients is not possible, it would be beneficial for health care providers to exercise additional monitoring or screening in

Table 1—Demographic characteristics of the study sample (n = 148).

	All Patients (n = 148)	Risk			P
		Low (n = 13)	Intermediate (n = 61)	High (n = 74)	
Age, median (IQR)	68 (55, 78)	69 (36, 88)	73 (58, 82)	66 (55, 75)	.22
White race, n (%)	136 (92)	13 (100)	56 (92)	67 (91)	.52
Surgical procedure during hospitalization, n (%)	57 (39)	6 (46)	19 (31)	32 (43)	.30
Do not resuscitate at time of MET activation, n (%)	22 (15)	3 (23)	12 (20)	7 (10)	.18
Admitting service, n (%)					.97
Internal medicine	70 (47)	5 (39)	30 (49)	35 (47)	
Other surgical service	37 (25)	3 (23)	17 (28)	17 (23)	
Pulmonology	15 (10)	1 (8)	5 (8)	9 (12)	
Oncology	12 (8)	2 (15)	7 (12)	3 (4)	
Cardiology	8 (5)	0 (0)	2 (3)	6 (8)	
Orthopedic surgery	6 (4)	2 (15)	0 (0)	4 (5)	
Comorbidities, n (%)					
Diabetes	50 (34)	2 (15)	16 (26)	32 (43)	.04
Coronary artery disease	46 (31)	3 (23)	17 (28)	26 (35)	.54
Gastroesophageal reflux disease	46 (31)	3 (23)	15 (25)	28 (38)	.21
Chronic obstructive pulmonary disease	34 (23)	2 (15)	14 (23)	18 (24)	.78
Congestive heart failure	29 (20)	2 (15)	8 (13)	19 (26)	.18
Drinks alcohol	27 (18)	4 (31)	11 (18)	12 (16)	.46
Morbid obesity	22 (15)	0 (0)	2 (3)	20 (27)	<.001
Stroke	21 (14)	0 (0)	10 (16)	11 (15)	.30
Current smoker	18 (12)	1 (8)	9 (15)	8 (11)	.69
Asthma	18 (12)	2 (15)	8 (13)	8 (11)	.86
Home psychotropic medication, n (%)	102 (69)	7 (54)	40 (66)	55 (74)	.826
Home sleep aid, n (%)	24 (16)	2 (15)	10 (16)	12 (16)	.99
Hospital days, median (IQR)	10 (7, 16)	14 (8, 19)	9 (6, 16)	11 (7, 17)	.30
Spent any days in ICU, n (%)	76 (51)	5 (39)	28 (46)	43 (58)	.23
Length of first ICU stay (days), median (IQR)	2 (1, 4)	2 (1, 3)	1 (1, 2)	2 (1, 4)	.32
Mortality, n (%)	9 (6)	1 (8)	4 (7)	4 (5)	.93

ICU = intensive care unit, IQR = interquartile range, MET = medical emergency team.

patients who are morbidly obese and/or have diabetes. The International Diabetes Federation Taskforce on Epidemiology and Prevention strongly recommends that patients with type 2 diabetes should be screened for OSA, given the high association between the two conditions.[27]

Screening patients for OSA is essential for optimal management of their care. Among patients at high risk of OSA, only 38% had a diagnosis of OSA prior to hospitalization. Identification and treatment of OSA is noninvasive, and the gold-standard test is polysomnography (PSG).[6,22] In the absence of PSG or patient willingness/ability to undergo assessment, abstraction of STOP-Bang questionnaire components from medical records and patient interview can play a vital role in identifying patients with risk for OSA.

Universal screening for risk of OSA in all hospitalized patients could allow for proactive and effective management of complications associated with OSA. Half of all patients were considered to be at high risk for OSA, and patients in each risk category had multiple MET activations during their hospitalization. Continuous and/or remote monitoring is imperative, as is more frequent nurse rounding to assess breathing, sedation level, arousal level, full vital signs including pulse oximetry, end-tidal carbon dioxide, and pain. In a study of patients undergoing bariatric surgery, it was found that when patients were evaluated for OSA before the procedure and treated with perioperative CPAP therapy and close monitoring, there was no association between the severity of their sleep apnea and the rate of perioperative complication.[28] In addition, it was found that patient compliance with CPAP therapy was associated with a reduced reoccurrence of MET activations.[20]

There are several limitations to this study. First, this is a relatively small sample that only includes patients who survived a MET activation. This may not represent a general hospitalized population, especially among those patients who

Table 2—STOP-Bang scores (n = 148).

	Risk			*P*
	Low (n = 13)	**Intermediate (n = 61)**	**High (n = 74)**	
Responses, n (%)				
Snoring	4 (31)	35 (57)	62 (83)	< .001
Tired	5 (39)	35 (57)	61 (82)	< .001
Observed apnea	0 (0)	8 (13)	39 (53)	< .001
Hypertension medication	2 (15)	35 (57)	64 (87)	< .001
BMI > 35 kg/m^2	0 (0)	6 (10)	32 (43)	< .001
Age > 50 years	8 (62)	53 (87)	66 (89)	.03
Neck circumference (XL or larger)	0 (0)	12 (20)	56 (76)	< .001
Gender (male)	1 (8)	34 (56)	41 (55)	.004
Diagnosed with obstructive sleep apnea prior to hospitalization, n (%)	0 (0)	3 (5)	28 (38)	< .001
Previously completed a sleep study, n (%)	0 (0)	3 (5)	27 (37)	< .001
Owns CPAP machine, n (%)	0 (0)	2 (3)	21 (28)	< .001
Compliant with CPAP machine, n (%)	–	1 (50)	15 (71)	–

BMI = body mass index, CPAP = continuous positive airway pressure.

Table 3—Characteristics of the medical emergency team activation (n = 148).

	Risk			*P*
	Low (n = 13)	**Intermediate (n = 61)**	**High (n = 74)**	
Multiple MET activations during hospitalization, n (%)	2 (15)	15 (25)	16 (22)	.76
First MET activation during evening shift (10:00 PM to 7:00 AM), n (%)	6 (46)	18 (30)	27 (37)	.46
Days between admission and first MET activation, median (IQR)	2 (1, 4)	2 (1, 3)	2 (1, 5)	.48
Reason for MET activation (not mutually exclusive), n (%)				
Family or staff concern	7 (54)	19 (31)	26 (35)	.30
Acute change in HR	3 (23)	10 (16)	6 (8)	.19
Acute change in SBP	4 (31)	12 (20)	10 (13)	.28
Acute change in RR	1 (8)	8 (13)	8 (11)	.83
Low oxygen saturation (SpO_2 < 90%)	5 (39)	17 (28)	26 (35)	.59
Altered mental status	1 (8)	11 (18)	12 (16)	.66
Dyspnea	2 (15)	7 (12)	8 (11)	.89
Chest pain	0 (0)	6 (10)	15 (20)	.07
Received opioid in the hospital, n (%)	8 (62)	44 (72)	54 (73)	.70
Received 2 or more different opioids in hospital, n (%)	6 (46)	24 (39)	38 (51)	.37

HR = heart rate, IQR = interquartile range, MET = medical emergency team, RR = respiratory rate, SBP = systolic blood pressure.

did not have a MET activation. It also excludes patients who did not survive the MET activation or experienced altered mental status because of the activation and could therefore not be recruited into the study. Second, primary reason for the activation was unreliable and has been omitted from the manuscript. An ICU nurse reviewed all activations to determine the primary reason for the activation, and 20% of charts were reviewed by a physician to assess interrater reliability. This effort achieved only 62% agreement. Because MET activations are multifactorial, it was not feasible to determine one single cause of the activation. Third, the study team did not ask about or measure actual neck size and used reported shirt size as a proxy for the Neck component of the STOP-Bang. There is no precedent in the literature for this surrogate measure and results for this component should be viewed with caution. Finally, the study data did not include route (intravenous versus oral) of opioid medication. It is possible that patients who received intravenous medications were more likely to receive a MET activation and thereby meet study inclusion criteria.

CONCLUSIONS

Half of patients who survived a MET activation during hospitalization screened at high risk for OSA. Assessment of OSA risk is essential for optimal patient care and should guide clinical decision making for this high-risk population.

ABBREVIATIONS

SDB, sleep-disordered breathing
OSA, obstructive sleep apnea
ICU, intensive care unit
MET, medical emergency team
BMI, body mass index
CPAP, continuous positive airway pressure
PSG, polysomnography

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DISCLOSURE STATEMENT

All authors have read and approved the final manuscript. All data were collected at Iowa Methodist Medical Center, Des Moines, Iowa. Ms. Tang presented an earlier version of this manuscript as a poster presentation at the Des Moines University research symposium, December 2018. The authors report no conflicts of interest.