Association Between Obstructive Sleep Apnea and Postoperative Adverse Events

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Abstract

Purpose

Adults with obstructive sleep apnea (OSA) arouse from sleep repeatedly due to hypoxemia and hyerpcapnea. General anesthesia, analgesics, and sedatives may interfere with these arousals and, thus, increase adverse events. Therefore, the purpose of this study is to compare postoperative recovery scores in adult surgical patients with and without diagnosed OSA. Significant differences in postoperative recovery scores between these groups may suggest an opportunity to improve patient care in the postoperative environment.

Methods

We performed a retrospective electronic data review to compare postoperative recovery scores in two matched cohorts of patients admitted to a large urban medical center between November 2009 and July 2011 for procedures requiring anesthesia. OSA and non-OSA cohorts were matched based on gender, age, and type of surgical procedure. We collected data regarding patients' post-anesthesia recovery scores in four categories: oxygen saturation, respiration rate, blood pressure, and level of consciousness.

Results

Our cohorts included 61 people with an ICD-9 code for OSA and 55 people who did not have an OSA diagnosis. We noted no significant differences in mean post-anesthesia recovery scores between the two cohorts in each of the four categories. We did find a significant difference (p = .05) between the number of assessments the OSA cohort received (M= 5.80, SD = 2.52) and the number of assessments the non-OSA cohort received (M=4.87, SD= 2.62). We also found that the OSA cohort's mean initial scores upon arrival to the post-anesthesia care unit (PACU) were significantly better for respiration (p = .05) and level of consciousness (p = .03) than were the non-OSA cohort's scores.

Conclusions

While the OSA cohort received better initial recovery scores upon arrival to the post anesthesia care unit (PACU), they had a higher number of assessments overall, indicating that they spent more time on the PACU before discharge. Numerous explanations exist to explain these results, indicating a need for further research.

Introduction

Obstructive sleep apnea (OSA) is a sleep disorder in which partial or complete cessation of breathing occurs five times or more per hour of sleep, lasts ten seconds or more, and causes a reduction in oxyhemoglobin saturation of four percent or more from baseline (Kryger, Roth, & Dement, 2005). It is the most common breathing disorder during sleep, and it is estimated that OSA is prevalent in two to four percent of the general population (Hiestand, Britz, Goldman, & Phillips, 2006) and is as high as 24% in surgical patients (Chung, Ward, Ho, Yuan, Kayumov, & Shapiro, 2007). However, 93% of women and 82% of men with moderate-to-severe OSA have never been diagnosed (Young, Evans, Finn, & Palta, 1997).

Adults with OSA arouse from deep sleep repeatedly due to hypoxemia (i.e., deficiency of oxygen in arterial blood) and hypercapnia (i.e., increased concentration of carbon dioxide in blood). These arousals serve as a protective mechanism in that they restore muscle tone to the airway so that the apneic event ends and breathing resumes. In adult surgical patients, general anesthesia, opioid analgesics, and sedative agents may interfere with these arousals and increase the risk of respiratory (Lakdawala, 2011), cardiac (Namtvedt et al, 2011), and neurologic complications (Liao, Yegneswaran, Vairavanathan, Zilberman, & Chung, 2009).

Gupta, Parvizi, Hanssen, & Gay (2001) found that OSA patients undergoing hip or knee replacement had a higher rate of adverse postoperative outcomes. Almost one-third of the OSA patients in Gupta and colleagues' study experienced a serious respiratory or cardiac complication. Moreover, the OSA patients in this study had significantly higher unplanned intensive care unit (ICU) admissions and longer lengths of stay (LOS). In another study, Liao, Yegneswaran, Vairavanathan, Zilberman, & Chung (2009) agreed that OSA patients have an increased incidence of postoperative complications, with the most common being oxygen desaturation due to respiratory complications. Liao and colleagues found that the majority of complications occurred after patients were transferred out of the post-anesthasia care unit (PACU) and that a significantly greater number of OSA patients required additional monitoring. Their study also showed a signifncatly higher rate of ICU admissions for the OSA group.

From these studies one can glean that general anesthesia, analgesics, and sedatives may interfere when one has been diagnosed with OSA, and, thus, there may be an increase in adverse events. Therefore, the purpose of this study is to compare postoperative recovery scores in adult surgical patients with and without diagnosed OSA. Significant differences in postoperative recovery scores between the OSA and non-OSA groups may suggest an opportunity to improve patient care in the postoperative environment.

Methods

We performed a retrospective matched cohort study of patients admitted to a large urban medical center between November 2009 and July 2011 for a procedure requiring anesthesia. While previous studies have examined the incidence of adverse postoperative events in OSA patients, they have spanned the entire postoperative period. In contrast, we focused on the immediate postoperative period while patients were still in the PACU. Following Human Subjects approval, we obtained de-identified data from a proprietary database of patient records.

Sample

From the de-identified data, we created two cohorts. The first consisted of patients who had ICD-9 code 327.23 for OSA (n=61); the second cohort were matched on criteria that included age, sex, and type of surgical procedure. In order to control for differences in post-anesthesia recovery due to length of sedation, we selected surgical procedures based on the typical time required to complete the surgery. These procedures included: (a) arthroscopy, knee or shoulder; (b) ligamentous reconstruction, knee; (c) endoscopy, wrist; (d) percutaneous skeletal fixation of femoral fracture; (e) treatment of fractures, femoral, fibular, tibular, ulnar; (f) arthroplasty, knee or acetabulum; (g) laparascopy, hernia repair; (h) neuroplasty; (i) laminotomy; and (j) cholecystectomy. Exclusion criteria included all surgical procedures involving the upper airway (e.g. tonsillectomy and uvulopalatoplasty) as these procedures may have been used to cure OSA. As well, it is estimated that 77% of people with a BMI greater than 35 have OSA (O'Keefe & Patterson, 2004). Therefore, we excluded these subjects from our non-OSA cohort.

Measures

We collected data based on the postoperative recovery scores that patients received upon arrival to the post-anesthesia care unit (PACU). These data included respiration, blood pressure level of consciousness, and oxygen saturation, and each was scored on a scale from zero (absent), one (abnormal), and two (normal). The categories for each assessment had varying definitions and are shown in Table 1.

Table 1 Category Score Definitions for Respiration, Blood Pressure, Level of Consciousness, and Oxygen Saturation Assessments

Assessment	2 (Normal)	1 (Abnormal)	0 (Absent)
Respiration	coughs and deep breaths	dyspneic	apneic
Blood Pressure	±20 mmHg	±20-50 mmHg	±50 mmHg
Level of Consciousness	awake	arousable on calling	nonresponsive
Oxygen Saturation (SpO_2)	> 94%	92-94%	< 92%

Note: Blood pressure indicates difference from pre-anesthesia baseline

Other data that were collected regarding the recovery scores included: (a) comprehensive first recovery scores (range=0 to 10); (b) comprehensive last recovery scores (range=0 to 10); and (c) first and last recovery scores for each of the four assessments (respiration, blood pressure, level of consciousness, and oxygen saturation). To derive the first and last scores for each of the four assessments, we recoded the absent (0) or abnormal (1) scores to one (abnormal) and recoded the normal (2) scores to zero (normal). While in the PACU, patients were assessed at 15-minute intervals or more frequently if nurses deemed it necessary. Consequently, the total number of assessments each patient received was used as a proxy variable for length of time patients remained in the PACU since the data set did not include length of stay in the PACU.

Data analysis

We used *Student's paired t-test* and *Pearson's chi-square* to test differences in means and frequencies between the OSA and non-OSA groups. Alpha was set at 0.05. A *priori* power analysis (Cohen, 1988), with an alpha set at .05 and power at .80, indicated we needed a sample size of 64 paired observations for a moderate effect size.

Results

The OSA cohort (*n*=61) had 54% men and 46% women. The non-OSA cohort (*n*=55) had 55% men and 46% women The non-OSA cohort sample could be matched on age category and gender but in six cases there was missing data for the subject with a corresponding surgical procedure code. The average age was 62 years (*range* = 25 to 89) for the OSA cohort and 62 years (*range*= 23 to 89) for non-OSA cohort. We found no significant differences between the two groups in sex, age, language, marital status, or race. See Table 2 for all demographic data.

Table 2 Demographic Data Comparing the OSA and non-OSA Cohorts

Demographic	**OSA** *n (%)*	**Non-OSA** *n (%)*	X^2	*p*
Patients	61	55		
Sex				
Male	33 (54)	30 (55)	.002	.96
Female	28 (46)	25 (46)		
Age categories				
<45	7 (12)	7 (13)	.923	.92
45-54	9 (15)	5 (9)		
55-64	13 (21)	13 (24)		
65-74	24 (39)	23 (42)		
75 or greater	8 (13)	7 (13)		
Race				
White	54 (89)	41 (75)	5.372	.07
Black	7 (12)	11 (20)		
Other	0	3 (6)		
Language				
English	50 (82)	43 (78)	.261	.61
Other	11 (18)	12 (22)		
Marital Status				
Married	37 (61)	39 (71)	1.507	.68
Divorced	7 (12)	4 (7)		
Widowed	8 (13)	5 (9)		
Single	9 (15)	7 (13)		
	M (SD)	*M (SD)*	*t-test*	*p*
Age in years	61.92 (12.85)	62.27 (14.58)	-.14	.89

Note: Some categories may not add up to 100% due to rounding.

We examined the mean score of all assessments for each patient in each category, as shown in Table 3. There were no significant differences between the OSA and non-OSA cohorts on the mean scores for the four assessments: respiration, blood pressure, level of consciousness, or oxygen saturation.

Table 3 Mean Scores and Ranges by Assessment Category for the OSA and non-OSA cohorts

Category	OSA	Non-OSA	*t*	*p*
Respiration				
Mean (SD)	1.83 (.38)	1.85 (.24)	.381	.70
Range	.00-2.00	1.00-2.00		
Blood Pressure				
Mean (SD)	1.92 (.19)	1.92 (.21)	-.081	.94
Range	1.25-2.00	1.00-2.00		
Level of Consciousness				
Mean (SD)	1.49 (.39)	1.46 (.36)	-.549	.58
Range	.33-2.00	.67-2.00		
Oxygen Saturation				
Mean (SD)	1.89 (.26)	1.96 (.11)	1.766	.08
Range	1.00-2.00	1.50-2.00		

We also examined the patients' comprehensive scores on arrival to the PACU (their first recovery score) and on discharge from the PACU (their last recovery score), as depicted in Table 4. These scores included five categories that are typically assessed in the PACU, not just the four assessments for which we had separate data. These five categories were summed to create the recovery score; therefore, the maximum total score possible is 10. There were no significant differences between cohorts for these scores.

Table 4 First and Last Comprehensive Recovery Scores Differences between OSA and Non-OSA Cohorts

	OSA	Non-OSA
First Recovery Score*		
Mean (SD)	8.21 (1.51)	8.14 (1.31)
Range	3-10	3-10
Last Recovery Score*		
Mean (SD)	9.67 (.61)	9.64 (.52)
Range	7-10	8-10

Note: Includes five parameters measured in PACU *Non-significant differences between cohorts.

In comparing patients' first and last scores upon arrival to the PACU, we looked at whether they had a normal (0) or an abnormal score (1) in each of the four assessment categories as detailed in Table 5. We found that the OSA cohort had a higher percentage of normal first scores than did the non-OSA cohort in each category except for oxygen saturation where they had an equal

percentage of normal scores. The OSA cohort had significantly higher or better scores on arrival to the PACU than the non-OSA group in respiration and level of consciousness. As expected, we found no significant differences between the two cohorts on the last scores before discharge from the PACU since all patients must achieve a minimum score before discharge.

Table 5 First and Last Scores (Normal vs. Abnormal) on Four Assessment Scores between OSA and Non-OSA cohorts

	OSA *n (%)*		**Non-OSA** *n(%)*		X^2		*p*	
	First	Last	First	Last	First	Last	First	Last
Respiration								
Normal	49 (80)	57 (93)	35 (64)	54 (98)	4.034	1.575	.05*	.21
Abnormal	12 (20)	4 (7)	20 (36)	1 (2)				
Blood Pressure								
Normal	57 (93)	60 (98)	47 (85)	52 (95)	1.990	1.264	.16	.26
Abnormal	4 (7)	1 (2)	8 (15)	3 (5)				
Level of Consciousness								
Normal	25 (41)	41 (67)	12 (22)	41 (75)	4.891	.750	.03*	.39
Abnormal	36 (59)	20 (33)	43 (78)	14 (25)				
Oxygen Saturation								
Normal	54 (89)	56 (92)	49 (89)	54 (98)	.151	2.399	.70	.12
Abnormal	7 (12)	5 (8)	5 (11)	1 (2)				

Note: "Normal (2)" recoded to 0; "Abnormal (1)" or "Absent (0)" recoded to 1. Some categories may not add up to 100% due to rounding. * Denotes significance at the $p \leq .05$ level

Since we did not have information about the length time patients spent in the PACU, we used the number of times patients were assessed (*range*=1 to 12) as a proxy measure for time. Three of the non-OSA and none of the OSA patients were assessed only once before discharge from the PACU. Six of the non-OSA patients and six OSA patients received two assessments. One of the non-OSA patients and two of the OSA patients received the maximum number of 12 assessments. We then examined the total count of assessments by category, which can be seen in Table 6. On average, there were significant differences (p = .05) between the cohorts, with the OSA group receiving significantly more assessments in the categories of respiration, blood pressure, and level of consciousness than the non-OSA subjects. For an unknown reason, the patients in both cohorts received fewer assessments of oxygen saturation. Even though the number of assessments for the non-OSA cohort was lower, it was not significant (p=.06).

Table 6 Mean Number of Assessment Scores by Category between OSA and Non-OSA Cohorts

Category	OSA	Non-OSA	*t*	*p*
Respiration				
Mean (SD)	5.80 (2.51)	4.87 (2.62)	-1.951	.05*
Range	2-12	1-12		
Blood Pressure				
Mean (SD)	5.80 (2.51)	4.87 (2.62)	-1.951	.05*
Range	2-12	1-12		
Level of Consciousness				
Mean (SD)	5.80 (2.51)	4.87 (2.62)	-1.951	.05*
Range	2-12	1-12		
Oxygen Saturation				
Mean (SD)	5.38 (2.58)	4.46 (2.47)	1.933	.06
Range	1-12	1-12		

* Denotes significance at the $p \leq .05$ level

Discussion

Patients in the OSA cohort had significantly better scores on arrival to the PACU than did non-OSA patients in two categories: respiration and level of consciousness. This finding is counterintuitive to what we expected and warrants further study to determine the factors that cause OSA patients to have better initial outcomes following anesthesia. Even though OSA patients arrive to the PACU with significantly better scores in respiration and level of consciousness, the patients in the OSA group received significantly more assessments of respiration, level of consciousness, and blood pressure. This finding may indicate that the OSA patients remained in the PACU longer than the non-OSA patients, which may indicate a longer recovery time. Alternatively, nurses may have conducted more frequent assessments of the OSA patients due to anticipated or actual adverse events.

Implications

This study suggests that OSA patients may have a higher risk for adverse events following anesthesia than do non-OSA patients, even though their initial scores on arrival to the PACU were not significantly different. Our findings highlight the importance of assessing OSA patients frequently and watching them closely following anesthesia. It is important for nurses to avoid assuming that OSA patients' high initial PACU scores mean that their recoveries will be uneventful, particularly in light of findings that OSA patients have a higher risk for adverse events than do non-

OSA patients for up to five days post-anesthesia (Gross et al, 2006). Moreover, many patients with OSA remain undiagnosed. Given our study findings, it is important for nurses to recognize the risk factors for OSA and closely monitor post-anesthesia patients who fit the criteria for OSA for adverse events.

Limitations

This study has several limitations, many of which are due to the limitations of conducting a secondary data analysis. First, while the patients in the non-OSA cohort did not have an ICD-9 code for OSA, they may have had undiagnosed OSA. We did not have the data to determine if these patients had risk factors for OSA. Thus, it is likely that some of the patients in our non-OSA cohort did have OSA. This information certainly illuminates another area for research: examining records of undiagnosed patients who have risk factors for OSA and comparing their outcomes with patients who do not have risk factors for OSA.

We also did not have information regarding interventions patients may have received in the PACU, such as oxygen, anti-hypertensives, pressors, or pain medications. These interventions would affect results from assessments and, if used, may help explain why the OSA group had significantly better scores in respiration and level of consciousness on arrival to the PACU than did the non-OSA group. Moreover, since the OSA patients had a known diagnosis, it is possible that their anesthetic procedure differed in some way from the non-OSA group. For instance, the anesthesiologist may have used a different type or concentration of sedative or may have kept the OSA patients in the operating room longer. We also do not know the post-anesthesia protocol for OSA patients. They may be required to remain in the PACU longer so nurses can continue to assess them. It is also possible that some of the OSA patients used CPAP following anesthesia as part of their recovery.

Finally, our *a priori* power analysis (Cohen, 1988), with an alpha set at .05 and power maintained at .80, indicated we needed a sample of 64 paired observations for a moderate effect size. With only 61 OSA and 55 non-OSA patients in the study with usable data, the study may be under-powered. Also, the process for retrieving data from the electronic health record that was used for this study is still under development and has some usability issues that may have affected the data we collected.

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