

Management Plan to Reduce Risks in Perioperative Care of Patients with Obstructive Sleep Apnoea Averts the Need for Presurgical Polysomnography

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Abstract

Introduction: Obstructive sleep apnoea (OSA) is associated with increased perioperative morbidity and mortality. Patients at risk of OSA as determined by pre-anaesthesia screening based on the American Society of Anesthesiologists checklist were divided into 2 groups for comparison: (i) those who proceeded to elective surgery under a risk management protocol without undergoing formal polysomnography preoperatively and; (ii) those who underwent polysomnography and any subsequent OSA treatment as required before elective surgery. We hypothesised that it is clinically safe and acceptable for patients identified on screening as OSA at-risk to proceed for elective surgery without delay for polysomnography, with no increase in postoperative complications if managed on a perioperative risk reduction protocol. **Materials and Methods:** A retrospective review of patients presenting to the pre-anaesthesia clinic over an 18-month period and identified to be OSA at-risk on screening checklist was conducted (n = 463). The incidence of postoperative complications for each category of OSA severity (mild-moderate and severe) in the 2 study groups was compared. **Results:** There was no statistically significant difference in the incidence of cardiac (3.3% vs 2.3%), respiratory (14.3% vs 12.5%), and neurologic complications (0.6% vs 0%) between the screening-only and polysomnography-confirmed OSA groups respectively ($P > 0.05$). There was good agreement of the OSA risk that is identified by screening checklist with OSA severity as determined on formal polysomnography (kappa coefficient = 0.953). **Conclusion:** Previously undiagnosed OSA is common in the presurgical population. In our study, there was no significant increase in postoperative complications in patients managed on the OSA risk management protocol. With this protocol, it is clinically safe to proceed with elective surgery without delay for formal polysomnography confirmation.

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Key words: Postoperative complications, Preoperative screening, Risk management, Undiagnosed OSA

Introduction

A significant proportion of patients with underlying obstructive sleep apnoea (OSA) remain undiagnosed when they present for surgery.^{1,2} Epidemiologic data have placed the prevalence in the general adult Western populations with a diagnosis of OSA at up to 5%,³ with a higher incidence in certain subpopulations such as males and obese persons. As high as 75% of a cohort of ambulatory surgical patients identified as having a high propensity for OSA on pre-anaesthesia questionnaire screening had not yet been formally diagnosed.⁴

Anaesthetic, sedative and analgesic agents utilised during the perioperative period obtunds protective laryngeal

reflexes, predispose to episodic upper airway obstruction during sleep by reducing pharyngeal tone, and depress ventilatory responses to both hypoxia and hypercarbia,⁵ resulting in an increase in perioperative respiratory complications in the vulnerable OSA patient. Rapid eye movement (REM) sleep rebound and the link to increased sympathetic tone may be particularly dangerous, leading to myocardial ischaemia, infarction, and even unexplained postoperative death.^{6,7}

There is a substantial body of literature demonstrating that patients with OSA undergoing uvulopalatopharyngoplasty,^{8,9} major joint replacement,¹⁰ cardiac surgery,¹¹ have an

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increased risk of postoperative complications. This study will examine if instituting a perioperative risk management protocol will avert the need for standard criterion presurgical polysomnography confirmation in patients with presumed OSA on screening and undergoing a wide range of surgical procedures but without resulting in increased complications.

Despite the fact that a significant number of patients with underlying OSA present for surgery without receiving a prior formal diagnosis, costs and resource limitations make the routine use of polysomnography as a standard OSA screening tool for the general presurgical population prohibitive. Instead most tertiary hospital, including ours, have instituted screening to detect possible sleep apnoea in all preoperative patients, using the American Society of Anesthesiologists (ASA) checklist, or a variety of other questionnaires such as the STOP, STOP-BANG or Berlin questionnaires.^{12,13} The ASA, directed by expert consensus, has published practice guidelines pertaining to the perioperative considerations of OSA patients, enabling clinicians to form strategies addressing preoperative assessment and risk stratification, as well as postoperative management of patients with OSA.¹² These guidelines pertain to the presumptive diagnosis of OSA based on elevated body mass index (BMI), increased neck circumference, snoring, daytime somnolence and abnormalities on airway exam. ASA guidelines recommend that the OSA patient's postoperative care and disposition be based on assessment of risk factors in a weighted scoring system. The patient's overall risk is determined broadly by the following categories: (i) the severity of OSA (propensity to OSA based on preoperative clinical signs and symptoms, or formally diagnosed on polysomnography); (ii) the invasiveness of surgery and anaesthetic technique; and (iii) the requirement for perioperative opioids.

The perioperative risk score is a summation of Category 1, and the greater of the scores in either Category 2 or 3. This total perioperative risk score will be a guide for the anticipated requirement for postoperative monitoring and disposition (Table 1). The sensitivities of the Berlin questionnaire, ASA checklist, and STOP questionnaire were 68.9% to 87.2%, 72.1% to 87.2%, and 65.6% to 79.5% at different apnoea-hypopnea index cut-offs, with no significant difference between the 3 screening tools in the predictive parameters.¹⁴ Since 2007, we conduct screening for OSA for all presurgical patients based on the ASA checklist.

In the event that the checklist screening reveals a propensity for OSA, some patients may then be sent for standard polysomnography for formal diagnosis, and subsequently proceed to treatment for OSA as required, for example, nocturnal continuous positive airway pressure (CPAP) therapy. Frequently, this means a delay in elective surgery. Polysomnography, the gold standard for the

diagnosis of OSA, is impractical as a routine preoperative assessment tool for OSA as the test is expensive and labour intensive, which therefore restricts its utility in the preoperative setting. An alternative would be to proceed with surgery without a formal polysomnographic confirmatory diagnosis of OSA and tailor the perioperative management according to the likely level of perioperative OSA risk and severity elicited from the screening checklist and in accordance with risk reduction recommendations such as the anaesthetic strategies enumerated by Seet (Table 2),¹⁵ increased monitoring vigilance in the postanesthetic care unit (PACU) and careful deliberation on postoperative disposition (outpatient versus inpatient and high dependency/intensive care unit) as advocated by ASA (Table 1). Because OSA is not uncommon, it is vitally important to develop risk stratification methods so that resources may be used judiciously without compromising on safety of patients undergoing surgical procedures.

In this study, patients at risk for OSA as identified by pre-anaesthesia screening via the ASA checklist were classified into 2 groups for comparison: (i) those who proceeded to elective surgery under the OSA risk management protocol based on the ASA guidelines without further undergoing preoperative formal polysomnography (screening-only group); and (ii) those who had preoperative formal polysomnography confirmation diagnosis of OSA and any subsequent OSA treatment as required before elective surgery (polysomnography-confirmed group).

The aim of this retrospective study is to characterise the frequency of postoperative complications in these 2 groups. We hypothesised that it is clinically safe and acceptable for patients to proceed for elective surgery without the need to delay surgery for formal polysomnography, with no significant differences in postoperative outcomes between these 2 patient groups. Further, we also sought to determine the correlation of OSA severity as detected by screening checklist with the OSA severity as determined on polysomnography (in polysomnography-confirmed patients).

Materials and Methods

Since 2007, the Pre-Anaesthesia Counselling and Evaluation (PACE) clinic in our institution has adopted guidelines based on the ASA checklist for OSA screening. After institutional review board approval, a retrospective case-record review of all patients who had undergone elective surgery under general or regional anaesthesia from an 18-month period seen at the PACE clinic was conducted. The institutional review board waived the requirement for individual informed consent. All patients were screened for clinical symptoms and signs of OSA, and a total of 547 patients were identified to have heightened risk for OSA.

Table 1. OSA Screening and Institutional Perioperative Risk Management

Clinical S/S of OSA	
1.	Daytime somnolence (easily falls asleep during quiet time or Epworth score ≥ 14)
2.	Snoring with arousal
3.	BMI: ≥ 30
4.	Neck circumference: ≥ 42 cm
5.	Small receding mandible
6.	Hypertension: $\geq$ BP 140/90 mmHg

Category 1**Scoring of OSA Severity Based on Clinical S/S**

No. of S/S	Severity	Score
2	Mild	1
4	Moderate	2
6	Severe	3

Or

Scoring of OSA Severity Based on Standard Preoperative Polysomnography

AHI	Severity	Score
6 to 20	Mild	1
21 to 40	Moderate	2
>40	Severe	3

- Results of polysomnography supercedes clinical symptoms/signs
- Patient referred for polysomnography only if patient is agreeable for OSA investigation and surgeon is agreeable to postponing surgery
- Medical treatment involves the use of CPAP mask and a series of lifestyle modification
- Surgical treatment involves one of the many variations of OSA-related surgery

Category 2**Scoring of Invasiveness of Surgery or Anaesthetic Technique**

Surgery	Anaesthesia	Score
Superficial or peripheral	No sedation	0
Superficial or peripheral	Sedation or RA	1
Superficial or peripheral	GA	2
Major	GA	3

Category 3**Scoring of Perioperative Opioid Requirement**

Opioid Requirement	Score
None	0
Low dose oral	1
High dose oral	2
Parenteral or neuraxial	3

Total Perioperative Risk Score of OSA

OSA severity + [(invasiveness of anaesthesia/surgery) or (opioid requirement)]
(1-3) (0-3) (0-3)

≤ 4 : increased perioperative risk = outpatient surgery acceptable but inpatient facility should be available.

- Monitoring in PACU for a median 3 hours longer than non-OSA patients in unstimulated environment if SpO₂ = baseline and airway is unobstructed.
- Monitoring in PACU for a median 7 hours longer than non-OSA patients if there is an episode of airway obstruction or hypoxaemia on room air.

≥ 5 : significant increased perioperative risk = outpatient surgery not acceptable, need ICU/HD postoperative monitoring.

- Continuous postoperative SpO₂ monitoring in ICU/HD

AHI: apnoea-hypnoea index; BMI: body mass index; BP: blood pressure; HD: high-dependency; ICU: intensive care unit; OSA: obstructive sleep apnoea; PACU: postanesthetic care unit; GA: general anaesthesia; RA: regional anaesthesia; S/S: symptoms/signs

Table 2. Perioperative Anaesthetic Management of the Patient with OSA

Phase	Anaesthetic Concern	Principles of Management
Preoperative period	Cardiac arrhythmias and unstable haemodynamic profile	Indirect evidence advocating the usefulness of PAP to reduce cardiac arrhythmias, stabilise variable blood pressure, and decrease myocardial oxygen consumption.
	Multisystemic comorbidities	Preoperative risk stratification and patient optimisation Individualised intraoperative anaesthetic management tailored to comorbidities.
	Sedative premedication	α 2-adrenergic agonist (clonidine, dexmedetomidine) premedication may reduce intraoperative anaesthetic requirements and have an opioid-sparing effect.
	OSA risk stratification, evaluation and optimisation	Preoperative anaesthesia consults for symptom evaluation, airway assessment, polysomnography if indicated, and formulation of anaesthesia management.
Intraoperative period	Difficult intubation (8 times more prevalent)	Sniffing position. Ramp from scapula to head. Adequate preoxygenation. ASA difficult airway algorithm.
	Opioid-related respiratory depression	Opioid avoidance or minimisation. Use of short-acting agents. Regional and multimodal analgesia. (non-steroidal anti-inflammatory drugs, acetaminophen, tramadol, ketamine, gabapentin, pregabalin, dexamethasone)
	Carry-over sedation effects from longer-acting intravenous sedatives and inhaled anaesthetic agents	Use of propofol for maintenance of anaesthesia. Use of insoluble potent anaesthetic agents (desflurane).
	Excessive sedation in monitored anaesthetic care	Use of capnography for intraoperative monitoring.
Reversal of anaesthesia	Postextubation airway obstruction and desaturations	Verification of full reversal of neuromuscular blockade. Ensure patient fully conscious and cooperative before extubation. Semi-upright posture for recovery.
Immediate postoperative period	Suitability for day-case surgery	Lithotripsy, superficial, or minor orthopedic surgeries using local or regional techniques may be considered for day surgery. No requirement for high-dose postoperative opioids. Transfer arrangement to inpatient facility should be available.
	Postoperative respiratory event in known and suspected high-risk patients with OSA	Longer monitoring in the PACU. Continuous oximetry monitoring and PAP therapy may be necessary if recurrent PACU respiratory events occur (desaturation, apnea, bradypnea, pain-sedation mismatch).

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Two separate groups of these thus-identified OSA at-risk patients were compared: (i) screening-only group: those who proceeded without delay to elective surgery under the OSA risk management protocol; and (ii) polysomnography-confirmed group: those who deferred surgery until formal polysomnography diagnosis and subsequent OSA treatment (if any) in advance of surgery, if required. The patients were further subdivided into 3 different levels of OSA severity (mild, moderate and severe) in the screening-only group, corresponding to similar stratifications of OSA severity (mild, moderate, severe) in the polysomnography-confirmed group (Fig. 1). Procedures included a wide range of otolaryngological (non-OSA related), ophthalmologic, orthopaedic, plastic, general surgical, neurologic, and urologic surgeries.

Information was gathered via a data collection sheet with regard to demographic data (age, gender, ASA physical

classification, associated medical comorbidities, body mass index (BMI)), screening symptoms/signs, OSA severity (as determined by screening questions for symptoms/signs versus confirmatory polysomnography, if done), surgical procedure, anaesthetic management, and postoperative complications including cardiac complications (arrhythmia, myocardial ischemia/infarction, congestive heart failure), neurologic or psychiatric complications (postoperative delirium/mental confusion, stroke), respiratory complications (hypoxemia, bronchospasm, aspiration, need for reintubation) and increased resource utilisations (prolonged PACU length-of-stay, OSA-related intensive care unit (ICU) admissions, both planned and unplanned, and hospital length-of-stay). For patients who had undergone more than one surgery, records from all eligible procedures were examined.

We hypothesised that there was no difference in

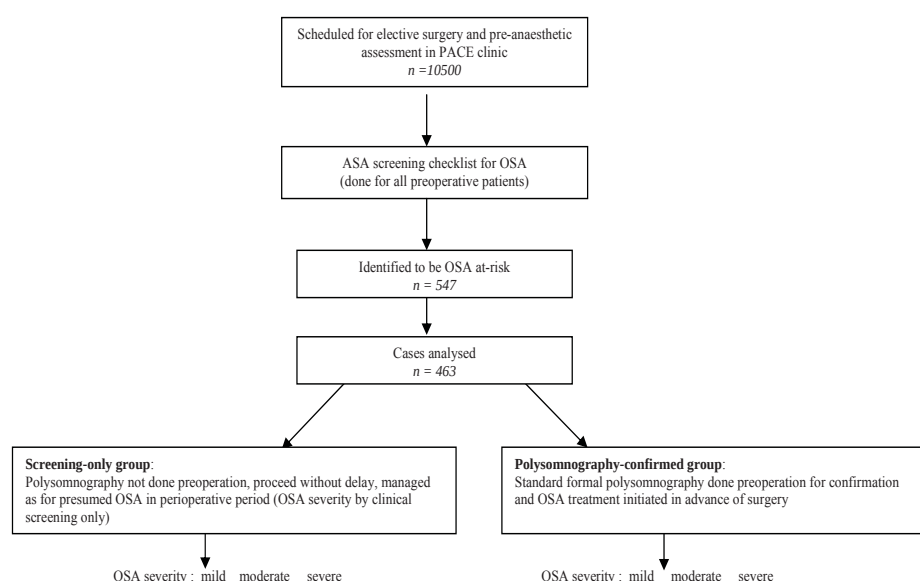


Fig 1. Chart showing OSA severity subgroups.

postoperative outcomes between the screening-only versus polysomnography-confirmed groups, i.e. patients in the screening-only group managed on the OSA risk management protocol, which did not delay elective surgery, also did not experience an adverse increase in morbidity when compared to patients who underwent formal polysomnographic evaluation before surgery.

We aimed to confirm that the ASA checklist as a clinical screening tool for sleep apnoea signs and symptoms is effective in identifying and stratifying perioperative OSA risk in our population. We proposed that by using the OSA risk management protocol based on the ASA recommendations, it is equally safe and clinically acceptable that the “standard of practice” in the suspected/presumed OSA patient presenting for elective surgery is to proceed with the surgery and manage in commensuration with the level of OSA severity and risk identified on screening (without need for preoperative formal polysomnography which delays surgery). We further reviewed the subset group of patients who had undergone preoperative polysomnography-confirmation, to define how well the OSA severity as identified on screening checklist is correlated with the formal polysomnography diagnosis.

Statistical Analysis

The independent student t-test and Mann-Whitney U test were used to analyse parametric and non-parametric continuous data respectively. Chi-squared test and Fisher’s exact tests were used to analyse categorical data. Level of significance was set at $P < 0.05$ using 2-tailed tests. Data are displayed as mean $\pm$ SD unless otherwise specified. All analysis was analysed using STATA version 10.0 (Stata

Corp, College Station, Texas, USA).

Results

The records of a total of 547 patients who were identified by checklist screening to be at risk for OSA were examined (547 patients out of a total of 10,500 patients screened over a period of 18 months gives an OSA at-risk incidence of 5.2% in the general presurgical population), of which 69 patients did not proceed with the planned surgery, 14 patients underwent surgery under local anaesthesia and/or sedation only, and 1 patient whose medical records pertaining to surgery was missing. Hence a total of 463 cases were analysed. The operations in all groups were elective procedures.

Adhering to the ASA risk stratification system, we assigned patients to the OSA severity of mild, moderate and severe classifications. For the purposes of this study, we subdivided these patients into 2 groups for analysis: those with mild-moderate OSA and those with severe OSA (Table 3).

Of a total of 463 cases identified to be OSA at-risk on screening and subsequently analysed, 406 (87.7%) of the at-risk patients had mild-moderate OSA severity, and 57 (12.3%) had severe OSA on clinical screening (based on signs/symptoms on ASA checklist).

Baseline demographic and perioperative information for the groups is provided in Table 3. Patients with severe OSA (both screening-only and polysomnography-confirmed subgroups) were similar in terms of gender, age, ASA physical status, BMI, neck circumference, and anaesthetic technique (general versus spinal/regional anaesthesia). However, there were differences in the gender proportion and age of patients of mild-moderate OSA.

Table 3. Characteristics of OSA Patients

Characteristics*	Groups					
	Mild-moderate OSA		P	Severe OSA		P
	Screening-only†	PSG-confirmed‡		Screening-only†	PSG-confirmed‡	
Sex, n (%)						
Male	177 (54.1)	54 (68.4)	0.02	8 (100)	43 (87.8)	0.30
Female	150 (45.9)	25 (31.7)		0 (0)	6 (12.2)	
Total	327	79		8	49	
Age, mean ± SD, year	48.2 ± 0.84	44.1 ± 1.7	0.03	49.3 ± 15.1	46.7 ± 13.5	0.63
ASA score, n (%)						
1	5 (1.5)	1 (1.3)	0.91	0	1 (2.0)	0.84
2	236 (72.2)	55 (69.6)		1 (12.5)	9 (18.4)	
3	85 (26.0)	23 (29.1)		19 (57.6)	29 (79.6)	
4	1 (0.3)	0 (0)		0	0	
BMI, kg/m ²						
20.0 to 24.9, no. (%)	30 (9.2)	12 (15.2)	0.31	0 (0)	11 (22.5)	0.11
25.0 to 29.9, no. (%)	96 (29.4)	21 (26.6)		1 (12.5)	17 (34.7)	
30.0 to 34.9, no. (%)	123 (37.6)	32 (40.5)		5 (62.5)	13 (26.5)	
≥35.0, no. (%)	78 (23.9)	14 (17.7)		2 (25.0)	8 (16.3)	
Neck circumference, ≥42 cm.						
Yes/No, n (%)						
Y	74 (22.6)	17 (21.5)	0.83	5 (62.5)	14 (28.6)	0.06
N	253 (77.4)	33 (78.5)		3 (37.5)	35 (71.4)	
Anaesthesia, n (%)						
General	272 (83.2)	68 (86.1)	0.53	6 (75.0)	43 (87.8)	0.34
Spinal/regional	55 (16.8)	11 (13.9)		2 (25.0)	6 (12.2)	
OSA-related ICU Admission, n (%)	19 (20.9)	12 (26.7)	0.72	4 (9.1)	38 (77.6)	0.10

*Characteristics are compared between OSA subgroups on screening-only vs polysomnography-confirmed diagnosis of OSA

†OSA at-risk and severity as identified on screening questions only

‡Checklist screening followed by polysomnographic confirmation of OSA severity

ASA: American Society of Anesthesiologists; BMI: body mass index; ICU: intensive care unit; OSA: obstructive sleep apnoea; PSG: polysomnography

Postoperative Complications

Table 4 summarises the occurrence of postoperative complications in OSA patients belonging to the screening-only groups versus patients in the polysomnography-confirmed groups.

Mild-moderate OSA (Screening-only Group vs Polysomnography-confirmed Group)

This group consisted of 406 patients with mild-moderate OSA risk detected on clinical screening via checklist, of which 327 patients proceeded straightaway for surgery while the remainder 79 patients had subsequent preoperative formal polysomnographic confirmation of mild-moderate OSA. Table 4 compares the number of episodes of different types of complications encountered in the screening-only versus polysomnography-confirmed mild-moderate OSA.

No significant differences in the incidence of postoperative cardiac, respiratory and neurologic complications were evident between the screening-only and polysomnography-confirmed patients. However the polysomnography-confirmed mild-moderate OSA patients stayed a median duration of 33 minutes longer in PACU as compared to the screening-only group. Hence, we observed that if OSA is confirmed on formal polysomnography prior to surgery, there is a tendency for anaesthesiologists to extend PACU monitoring in patients with OSA for a longer period, although the patients do not experience an increased postoperative complication rate.

Severe OSA (Screening-only Group vs Polysomnography-confirmed Group)

This group consisted of 57 patients with high OSA risk detected on clinical screening via checklist, of which a

Table 4. Postoperative Complications in OSA Patients

Complications	Groups								
	Mild-moderate OSA (n = 406)			Severe OSA (n = 57)			All Cases OSA (n = 463)		
	Screening- only (n = 327)	PSG- confirmed (n = 79)	P	Screening- only (n = 8)	PSG- confirmed (n = 49)	P	Screening- only (n = 335)	PSG- confirmed (n = 128)	P
Cardiac,* n (%)	11 (3.4)	0 (0)		0 (0)	3 (6.1)		11 (3.3)	3 (2.3)	
None	316	79		8	46		324	125	
Arrhythmia	10	0	0.26	0	1	0.47	10	1	0.34
MI	0	0		0	0		0	0	
CCF	1	0		0	2		1	2	
Respiratory,† n (%)	46 (14.1)	8 (10.1)		2 (25.0)	8 (16.3)		48 (14.3)	16 (12.5)	
None	281	71		6	41		287	112	
Hypoxemia	39	7		2	7		41	14	
Bronchospasm	5	1	0.76	0	1	0.70	5	2	0.96
Aspiration	0	0		0	0		0	0	
Re-intubation	0	0		0	0		0	0	
Others	2	0		0	0		2	0	
Neurologic,‡ n (%)	2 (0.6)	0 (0)		0 (0)	0 (0)		2 (0.6)	0 (0)	
None	325	79	0.49	8	49	N.A	333	128	1.0
Stroke	0	0		0	0		0	0	
Others	2	0		0	0		2	0	
PACU LOS, mean ± SD, minutes	101 ± 99	134 ± 99	<0.01	163 ± 166	153 ± 85	0.46	102 ± 101	141 ± 93	0.02
Hospital LOS, mean ± SD, days	3.29 ± 3.77	2.68 ± 2.14	0.75	3.88 ± 2.47	2.88 ± 2.723	0.07	3.31 ± 3.74	2.76 ± 2.37	0.12

*Arrhythmia, myocardial infarction/ischaemia (MI), congestive cardiac failure (CCF)/acute pulmonary oedema

†Hypoxemia (cause not otherwise specified) in PACU, bronchospasm, aspiration, airway obstruction requiring re-intubation, others e.g. pulmonary embolism

‡Cerebrovascular accident/stroke, others e.g. delirium/confusion, nerve injuries

LOS: length of stay; PACU: postanaesthetic care unit

Footnote: We used the following definitions for the various postoperative outcomes 1. Arrhythmia: any rhythm other than sinus, as picked up on ECG. 2. Myocardial ischaemia/infarction: A typical rise of troponin or a rapid rise and fall of CK-MB, plus one of the following: (i) ischaemic symptoms, (ii) pathological Q waves, (iii) ECG changes indicative of ischaemia, (iv) coronary artery intervention, and/or (v) new or presumed new wall motion abnormality on echocardiography or MIBI. 3. Cerebrovascular accident: cerebral infarction or haemorrhage on CT or MRI scan, or new neurological signs (paralysis, weakness or speech difficulties) lasting more than 24 hours. 4. Hypoxemia: pulse oximetry persistently <90% on room air in PACU or requiring oxygen supplementation at PACU discharge 5. PACU length-of-stay (LOS): from the start (date, time) of arrival at PACU to fit for PACU discharge.

minority of only 8 patients proceeded straightaway for surgery while the majority of them (49 patients) had subsequent formal polysomnographic confirmation of severe OSA preoperatively. Again, there was no significant difference in the incidence of postoperative cardiac, respiratory and neurologic complications between the screening-only and polysomnography-confirmed patients. There are no significant differences in the PACU length-of-stay, OSA-related ICU admission rates and hospital length-of-stay.

All-severity OSA (Screening-only Group vs Polysomnography-confirmed Group)

When all stratifications of OSA severity (mild, moderate and severe) were combined and analysed, there is also no statistically significant difference in the incidence of cardiac (3.3% vs 2.3%), respiratory (14.3% vs 12.5%), and neurologic complications (0.6% vs 0%) between the screening-only and polysomnography-confirmed groups respectively ($P > 0.05$).

Correlation

At each level (mild, moderate and severe) of OSA severity identified on the screening checklist, there is good agreement with the eventual corresponding polysomnography-confirmed OSA severity. The kappa correlations based on

each level of severity are as follows: (a) mild: 0.961, (b) moderate: 0.967, (c) severe: 0.933, and (d) overall: 0.953.

Discussion

The physiologic perturbations resulting from anaesthesia and postoperative analgesics are believed to place OSA patients undergoing surgery at risk for perioperative morbidity and mortality. Anaesthetic, sedative and analgesic agents obtund arousal, a very important defense mechanism in OSA patients.

OSA is therefore of particular concern to anaesthesiologists, particularly since obesity and associated comorbidities, as well as potential perianaesthetic issues such as difficult intubation and delayed emergence often coexist with OSA. OSA diagnosis as a risk factor for perioperative complications has been borne out by several studies. Gupta et al¹⁰ found a twofold increase in the frequency of adverse perioperative outcomes (respiratory, cardiac unplanned ICU transfers and prolonged length of hospital stay) in OSA patients undergoing knee or hip replacement compared to a group of matched control patients. The presurgical undiagnosed OSA patient may therefore be of greater concern as a lack of perioperative awareness on the part of the healthcare providers of sleep apnoea propensity may lead to greater morbidity in undiagnosed patients.

Additionally, some authors have cautioned that we need to afford greater attention to patients with the severe form of OSA. For example, Fleisher argues that while less severe forms (i.e. mild-moderate) of this disease may not incur the same detrimental consequences, it has been well established that patients with severe sleep apnoea suffer major health consequences as a result of their condition.¹⁶ Insofar as few absolute conclusions can be drawn at this time about the long-term consequences of mild-to-moderate OSA, mild-to-moderate OSA patients with optimised comorbid conditions may be able to safely undergo ambulatory surgery. However, current expert opinion has affirmed that severe OSA patients are not ideal candidates for ambulatory surgery.¹⁷ Hence, for the purposes of this study, we subdivided our patients into 2 groups for analysis: those with mild-moderate OSA and those with severe OSA.

In our study, we found that there were no significant increased composite risks for cardiac, respiratory and neurologic complications when OSA at-risk patients identified in the screening-only group were compared to those who eventually had formal preoperative polysomnography confirmation, for their respective subgroups of OSA severity (i.e. mild-moderate and severe).

In our review, hypoxemia was defined as a fall in oxygen saturation on the pulse oximeter to less than 90% on room air in PACU, or requiring oxygen supplementation at PACU

discharge. We did not pick up a significant difference in the incidence of hypoxaemia when both groups were compared. Hypoxemia was the most frequent respiratory and overall complication in our study. Oxygen desaturation, which was most likely due to atelectasis and hypopnea in this patient population, is easily overcome by the administration of supplemental oxygen. No OSA patient required reintubation during the study period.

We included ischaemic or arrhythmic cardiac events and neurologic complications in the present study because REM sleep deprivation, sleep fragmentation, blood pressure perturbations and postoperative hypoxemia in OSA can contribute to the pathogenesis of these events.^{18,19} However, in our study, the incidences of cardiac and neurologic postoperative complications were low in both the screening-only and polysomnography-confirmed groups of OSA patients.

Similar to other prior cohort studies that suggest 3% to 7% of an unselected presurgical population had previously undiagnosed sleep apnoea,¹ our study has shown that the local prevalence of OSA based on preanaesthesia screening alone is 5.2%. These patients with underlying OSA have not undergone previous polysomnography and therefore, carry no formal diagnosis.² Taking into current Singapore national surgical volume, it is possible that a few thousands of patients with undiagnosed OSA undergo surgery each year, with widespread implications for what constitutes appropriate perioperative intervention for this group of at-risk surgical patients.

The incentive to diagnosing OSA preoperatively is in reducing the perioperative complication rate. These adverse outcomes may be more likely to happen when the care providers are unaware of the underlying diagnosis and cannot properly identify these patients to take preventative precautions. The main issue is centred on deciding what is the most cost-efficient and reliable tool available for assessing the presence and severity of OSA. Polysomnography remains the “gold standard” for diagnosing OSA. Yet, costs, restricted access and practical application (delay in patient’s scheduled surgery) may limit its utility in the preoperative setting. The alternative is to manage such patients using a tailored risk reduction protocol, such as the ASA practice guidelines for the screening and perioperative management of patients with OSA, which has been implemented in our institution since 2007. In adherence to the ASA recommendations, we manage the postoperative care of patients suspected with OSA with pulse oximetry in an appropriately monitored care setting, cautioned the use of opioids, and encouraged the use of regional anaesthesia whenever possible.

Anaesthesiologists have a responsibility to identify patients with underlying OSA and refer them for treatment

because they may be the first physician to note the sleep apnoea pattern. Our study supports the concept that patients identified to be OSA at-risk may be able to avoid preoperative polysomnography confirmation and yet undergo a wide range of elective surgical procedures without increased risk of major adverse outcome, provided a perioperative risk management strategy is employed. It is not the intention of this study to propose that polysomnography is completely or subsequently not necessary later on postsurgery, but only that the need for preoperative polysomnography confirmation may be averted if a perioperative risk management protocol is adhered to. Especially for those patients identified to be at risk of severe OSA, polysomnography will still be required at a later stage for long-term management.

The risk management protocol recommends a period of PACU monitoring appropriate to the OSA propensity and severity (Table 1). The PACU is an area specifically for cardiorespiratory monitoring of postoperative patients, as well as pain management. As explained above, sedatives or analgesics, as well as the residual effects of anaesthetic agents may worsen OSA symptomology. PACU events such as desaturation or oxygen dependence or sedation-analgesia mismatch could act as second phase indicators, that is, whether untoward events, such as apnoea or desaturation episodes, have already been observed in the patient's early postoperative period.²⁰ It has been shown that patients identified as OSA at-risk by preoperative screening and who subsequently develop respiratory events in the PACU would be more likely to have significant hypoxemia postoperatively than would be patients who did not have preoperative indicators or PACU events. This is the reason for an extended period of PACU observation for patients at risk of OSA, when identified on screening checklist. Additionally, our study has demonstrated that patients with severe OSA tended to be monitored postoperatively for a longer period in the PACU when compared to patients with mild-moderate OSA (Table 4). For example, patients screened as at risk for severe OSA are monitored in PACU for a mean 62 minutes longer than those screened positive for mild-moderate OSA.

We recognise that there are several important limitations to our study. First, although only in one patient was the records pertaining to surgery missing, this was a retrospective analysis with all outcomes collected post hoc and hence, complete data may not have been retrievable in every patient. This retrospective study was based on consecutive inclusion of all patients seen in our institution's PACE clinic in the 18-month period as stated, and therefore no power calculation was performed before the study. Achieving sufficient power in such studies similar to ours remains a challenge, but the sample described in our study is fairly large. We were able to analyse 463 at-risk patients planned

for elective surgery over an 18-month period, and this figure is comparable to studies^{2,4,21} similar to ours. However, our study did not specifically review patients undergoing therapeutic airway surgery for OSA or weight reduction surgery. The prevalence of OSA in bariatric surgical patients is very much higher and most centres recommend routine polysomnography for every bariatric patient as an essential part of the surgical workup.^{22,23} Furthermore, it would be difficult to determine with complete certainty whether all patients at risk of OSA underwent risk reduction strategies. This represents a real-life limitation. However, these anaesthesia management risk reduction strategies were formulated based on current literature evidence and expert consensus guidelines, and were agreed upon at the institutional level. It is therefore expected that there was a large degree of compliance with the recommended risk reduction strategies.

Finally, our study has also demonstrated the feasibility of universal screening for OSA in a preoperative assessment clinic, similar to the study by Finkel KJ et al.² The screening was able to correctly identify a large number of surgical patients with undiagnosed OSA undergoing a wide variety of surgical procedures, since the screening results correlated strongly (kappa correlation = 0.95) with the eventual OSA severity on confirmatory polysomnography.

Conclusion

Previously undiagnosed OSA in the presurgical population is not uncommon. With a stratified risk management protocol, it is clinically safe to proceed with elective surgery without delay for formal polysomnographic confirmation.

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