IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Research Article
December 2018 Vol.:11, Issue:2

Validation of ASA Scoring Algorithm for Perioperative Risk of Complications from OSA

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Lilia Dimitrov[1], Sarah Stewart1, Jelka Mitic[2], Otto Mohr[2], Terry O'Shaughnessy[1], Vladimir Macavei[*1]

1 - Respiratory Department, 2- Anaesthetic Department Newham University Hospital, Glen Road, London E13 8SL.

Submission: 20 November 2018
Accepted: 26 November 2018
Published: 30 December 2018

Keywords: American Society of Anesthesiologists Scoring, Perioperative Risk, Obstructive sleep apnea

ABSTRACT

Background: In 2014, the American Society of Anesthesiologists (ASA) Task force published a scoring system for perioperative risk from OSA. This study evaluated the ability of the ASA algorithm in assessing the risk of perioperative complications in patients undergoing surgery. **Methods:** A retrospective study was performed at Newham University Hospital between 1st June 2013 - 1st Jan 2016 of 211 consecutive surgical patients referred for sleep studies. 89 patients went on to have surgery and were included in this study. Participants were assessed for baseline characteristics and the variables specified in the ASA tool; severity of OSA, type of surgery and anaesthesia and use of post-operative opioids and CPAP. Statistical analysis was performed with STATAv12 software. **Results:** Prevalence of OSA was 35.9% with predominantly mild OSA 32.5%. Bivariate analysis using Mann-Whitney U test has identified obesity and opioid use in recovery to be significantly related with perioperative complications ($p<0.05$). Following logistic regression analysis, the overall perioperative risks core was found to have sensitivity (SN) of 65.9%, specificity (SP) of 48.8% with a positive predictive value of 56.8% and a negative predictive value of 58.3% in detecting perioperative complications. **Conclusions:** This is the first published study to validate the ASA scoring system for perioperative risk from OSA. We have demonstrated this tool to have moderate sensitivity and low specificity for the prediction of perioperative complications. Obesity and opiate use in recovery was associated with postoperative complications. There are a number of identified limitations that restrict the usefulness of this tool including the requirement for postoperative opiods to be assessed prior to surgery and lack of clarity regarding assignment of invasiveness of surgery.

INTRODUCTION

Obstructive sleep apnea (OSA), the most common form of sleep-disordered breathing (SDB), is characterized by repeated and intermittent closure (complete or partial) of the upper airway during sleep resulting in impaired ventilation and subsequent arousal to restore the airway.[1]

Prevalence among elective surgical patients is higher than in the general population at 45%,[2] reaching nearly 80% in high-risk surgical groups such as those undergoing bariatric surgery.[3] There is significant perioperative morbidity and mortality associated with OSA.[4] Two recent meta-analyses have shown that patients with OSA undergoing surgery have a higher incidence of postoperative desaturation, respiratory failure, postoperative cardiac events, and need for ICU admission.[5,6] The American Society of Anesthesiologists (ASA) recommends routine preoperative screening for OSA, in recognition of the potential complications.[7] Despite this, the majority of surgical patients with OSA remain undiagnosed at the time of surgery.[2,8] A large matched cohort study found patients undiagnosed with OSA prior to surgery had significantly higher rate of cardiovascular events (cardiac arrests and shock) than those with diagnosed OSA (2.20 versus 0.75, p0.009).[9]

Several screening tools have been validated in the surgical population for preoperative detection of OSA. There is indeed evidence to suggest that the utility of some of these tools may extend to risk stratifying patients for a number of perioperative and postoperative complications.[10] In 2006, the ASA Task Force on Perioperative Management of Patients with Obstructive Sleep Apnoea published practice guidelines[11] which were subsequently updated in 2014.[7] The updated document included an example scoring system for perioperative risk from OSA intended for use to estimate whether a patient is at increased risk of perioperative complications from OSA. This scoring system uses severity of sleep apnoea, invasiveness of surgery and anaesthesia and postoperative opiate requirement to calculate an overall point score, with those scoring 4 deemed at increased perioperative risk from OSA and those scoring greater than 4 at significantly increased perioperative risk. This scoring system has yet to be applied to patients in the published literature.

The aim of this study was to assess the utility of this proposed scoring system in predicting perioperative risk from OSA. A retrospective study design was chosen using a pre-existing

complications databases that the scoring system could be evaluated against known post-operative complications. The primary outcome of this study was to calculate the sensitivity and specificity of this tool for perioperative complications. Secondary outcomes included to establish the prevalence of OSA in our surgical cohort and to assess other baseline characteristics for perioperative risk including age, gender, obesity and comorbidities.

METHODS

Materials and Participants

Study cohort included 211 consecutive surgical patients referred to the sleep clinic following pre-assessment at Newham University Hospital, Barts Health NHS Trust between 1st June 2013 and 1st Jan 2016. They were evaluated according to a specifically designed respiratory protocol which included presenting symptoms, past medical history (respiratory, metabolic, cardiovascular comorbidities and smoking status) and demographic details (age, gender, and ethnicity). Subsequently, anthropometric measurements such as height, weight, neck size, waist/hip ratio, Mallampati score, Epworth Sleepiness Score, STOP-BANG score and spirometry lung function were obtained. All 211 patients underwent overnight oximetry sleep studies. The analysis and interpretation of the sleep study data was performed according to the manufactures instructions (Konica Minolta® pulseoximetry).

The oxygen desaturation index (ODI) was calculated by dividing the total number of episodes of oxygen desaturation of 4% below the baseline, by the total sleep time. Patients with an ODI of > 10 events/ hour were diagnosed with OSA. Severity of OSA was scaled according to ODI: mild (10-20events/hour), moderate (20-30events/hour) and severe (>30events/hour).[12] Other sleep parameters included lowest oxygen level (SpO2), mean SpO2, total number of events, longest oxygen desaturation, TRT 90 (total recorded time with SpO2 < 90%).

From 211 patients investigated for OSA, 89 patients underwent surgical interventions and have been included in the study group. Specific perioperative information was obtained from the operative notes retrospectively according to the study protocol and included: type of surgery, type of anaesthesia, requirement of opioids during surgery and recovery, difficult airway management (difficult intubation, failed extubation, difficult mask ventilation and re-intubation), perioperative complications (cardio-vascular, infective, ARDS), ITU admission, length of stay and peri-operative mortality.

The ASA proposed algorithm for assessing the risk of perioperative complications was used and included the severity of OSA(A), invasiveness of the surgery (B), requirement of opioids (C) and CPAP treatment (Table1). An overall perioperative risk of complications from OSA was calculated by adding the score of A plus the greater of the score for either B or C (0-6) according to ASA recommendations. One point was subtracted for patients on CPAP or NIPPV prior to surgery. The score also includes the addition of one point if resting PaCO2 is above 50 mmHg. Arterial blood gases were limited to patients with nocturnal hypoventilation syndrome and therefore not included in the current study.

Ethical Approval for the study was obtained from the Clinical Effectiveness Committee (Reference No7052 Barts Health NHS Trust, London, UK).

Table 1 –ASA scoring system for perioperative risk from OSA

Category	**Score**
Severity of OSA	
None	0
Mild	1
Moderate	2
Severe	3
Invasiveness of procedure	
Superficial surgery under local or peripheral nerve block without sedation	0
Superficial surgery with moderate sedation or GA	1
Peripheral surgery with spinal /epidural anaesthesia	1
Peripheralsurgery with general anesthesia	2
Airway surgery withmoderate sedation	3
Major surgery, general anesthesia	3
Airway surgery, general anesthesia	3
Postoperative analgesic requirements	
None	0
Low-dose oral opioids	1
High-dose oralopioids, parenteral or neuraxial opiods	3
Other	
CPAP/NIPPV prior to surgery or post-operative Setting	-1
Resting PaCO2 > 50mmHg /6.66kPa	+1
A+ highest of B or C. Total0-6. 0-2 = low risk 3-4= med risk 5-6 = high risk	

Data Analysis

Patient's clinical details, physiological measurements and sleep study findings were transferred from the Sleep Clinic Database (Excel) to the Stata v12 Database. Demographic, anthropometric, perioperative data and sleep study data of all 89 cases was analysed. Prevalence of OSA was determined by establishing proportion of patients meeting known criteria for the diagnosis of OSA. Firstly, group comparison analysis was performed between OSA versus non-OSA surgical patients using t-test, χ^2or Mann-Whitney U test when applicable. Group comparison between perioperative complications versus comorbidities, sleep data and perioperative outcomes was completed using Mann-Whitney U test.

Secondly, univariate analysis between perioperative complications and anthropometric variables, comorbidities, sleep data and perioperative data was calculated using Pearson's correlationor Kendall's tau test when applicable.

Logistic regression analysis was used to determine sensitivity and specificity of the perioperative risks core in detecting perioperative complications. ROC curve analysis was completed using various cut-off points of total perioperative risk score.

Data analysis was performed using Stata version 12 statistical software. Statistical significance was set at $p<0.05$ (two-tailed).

RESULTS

From 211 patients investigated for OSA, 89 patients underwent surgical interventions and were included in the study. The mean age was 52.7±12 years and 31.4% (28/89) were females. The surgical interventions included: trauma and orthopaedic surgery (40.5%), general surgery (31.4%), urological interventions (11.2%), obstetrics and gynaecology (11.2%) and ENT (5.6%).

Prevalence of OSA was 35.9% with mild OSA accounting for 78% of the OSA cases. Differences between the OSA and non-OSA groups are detailed in table 2. Predominance of the male gender was noted in OSA patients (75%) versus non-OSA (64%). Certain comorbidities such as essential hypertension (HTN), hyperlipidaemia, diabetes mellitus (DM) and obesity were more frequently associated with OSA as presented in Table 2. Congestive heart failure and obstructive pulmonary disease (asthma/COPD) were more frequently met in

the non-OSA group. Length of hospital stay was lower in OSA group when compared to non-OSA (1.8vs2 days).

Table 2– Patient demographics and comorbidities in OSA versus non OSA group

Demographics/Comorbidities	OSA(N=32)	Non OSA(N =57)
Age	54.8 ±13.3	51.5 ±12.8
Gender	25%F (8) 75%M(24)	35.1%F(20) 64.9%M (37)
HTN	59.3%(19)	45.6%(26)
Hyperlipidaemia	40.6%(13)	33.3%(19)
DM	31.2%(10)	18.1%(10)
CCF	3.2%(1)	8.9%(5)
Obesity(BMI>30kg/m2)	62.5%(20)	50.8%(29)
Asthma/COPD	12.5%(4)	24.5%(14)
Length of hospital stay (days)	1.8 ± 2.2	2±2.4
Postoperative desaturations	34%(11)	34.5%(19)
Prolonged recovery stay	37.5%(12)	38.1%(21)
Overall complications	53.1%(17)	49%(27)

50.5%of patients experienced perioperative complications. Prolonged recovery was seen in 37.5% of patients. The second most frequently seen complication was post-operative oxygen desaturations 34.4%, followed by intraoperative oxygen desaturations in 13.7%. Airway management complications included difficult mask ventilation 2.2% (2/89), laryngospasm 1.1% (1/89), laryngeal mask insertion (LMA) 3.3% (3/89) and post-operative NIV 1.1% (1/89). Other complications included respiratory failure 2.2% (2/89) and post-operative infections 2.2% (2/89). There were no cardiovascular complications, pulmonary oedema or ARDS recorded in the study group. There was no fatality recorded. Post-operative admission to ITU was present in 2.2% (2/89).

We evaluated the ability of the ASA tool for predicting postoperative complications by calculating the area under the receiver operating characteristic curve (Figures 1 and 2).

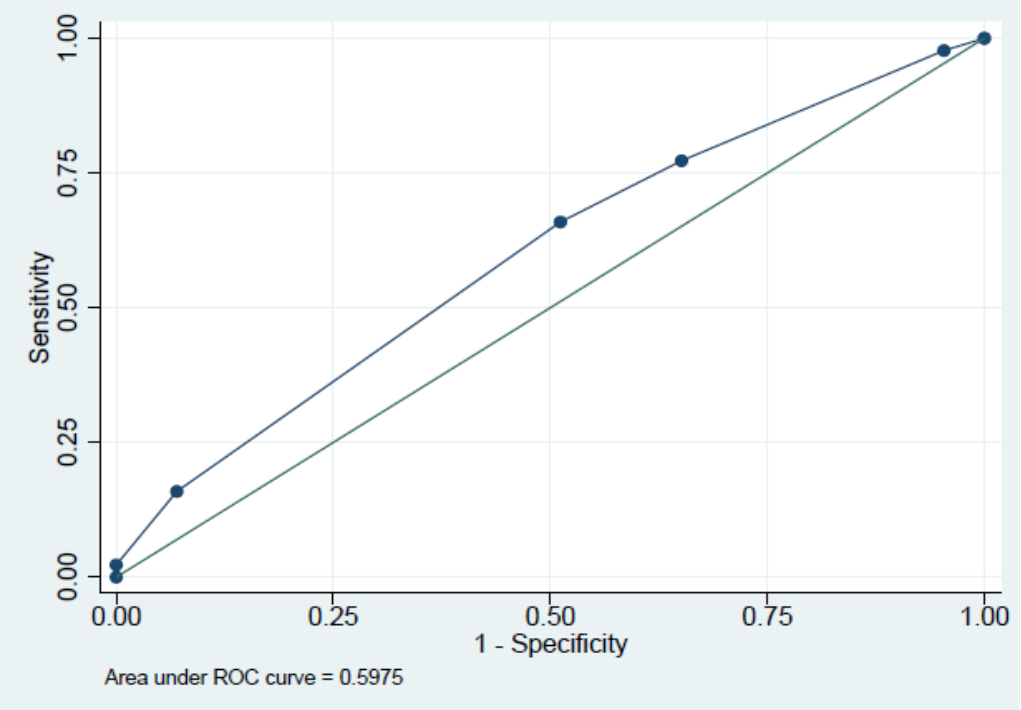

Figure 1–Receiver operating characteristics (ROC) curve analysis for the ASA scoring system for perioperative risk from OSA

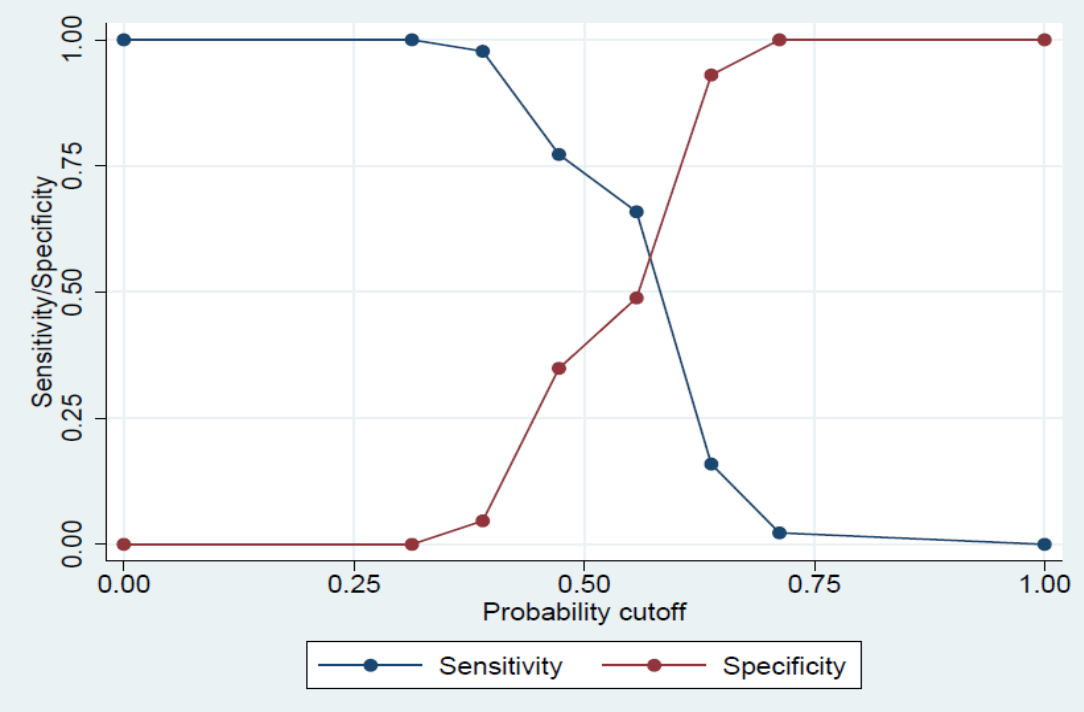

Figure2 Receiver operating characteristic curves showing probability cut offs for the ASA scoring system for perioperative risk from OS

The area under the curve was 0.5975. The overall perioperative risk score was found to have a sensitivity (SN) of65.9%, specificity (SP) of 48.8% with a positive predictive value of 56.8% and a negative predictive value of 58.3% in detecting perioperative complications. We were unable to conduct an analysis by category of ASA score due to the very small number of patients with a score of 4 or more. Bivariate analysis using Mann-Whitney U test has identified obesity and opioid use in recovery to be significantly related with perioperative complications ($p<0.05$) (Table 3).

Table3–Results from Mann-Whitney analysis for association of variables with postoperative complications

Variable	P-value
Total ASA perioperative risk from OSA score	0.0942
Severity of OSA	0.5334
Invasiveness of surgery	0.1420
Opiod use in recovery	0.0046
Age	0.4808
Gender	0.1843

DISCUSSION

Our study has found that the scoring system for assessing the baseline perioperative risk from suspected OSA has a sensitivity of 65.9% and specificity of 48.8%. These values are in keeping with the sensitivity and specificity of screening tools for OSA in the literature.[10] Our secondary outcome identified that obesity and use of opiates in recovery were also associated with post-operative complications. This complements several recently reported findings in the literature.[13-15] It has been proposed that this effect may be mediated by alterations in pain processing in patients with OSA leading to enhanced pain,[14] as well as predisposition to opiod-induced ventilator impairment.[15]

The ASA scoring system uses severity of OSA, invasiveness of surgery and anaesthesia, and requirement for post-operative analgesia. A benefit of this tool is that all of the aforementioned parameters can be retrieved from hospital records. Previous scores that have been used to predict postoperative complications include the STOP-BANG questionnaire, the Berlin Questionnaire, and the ASA Checklist, have relied on information obtained from direct

medical encounters which can be subject to physician-dependent factors.[16] The Score for Preoperative Prediction of Obstructive Sleep Apnoea (SPOSA) is a new prediction score that uses only data available from hospital records, thereby removing this issue.[17]This is useful in the clinical setting and for purposes of audit of practice whereby documentation of clinical assessment findings is not always easily accessible.

Concerns with the scoring system.

This scoring system has been specified for use in assessing the baseline perioperative risk from suspected OSA, but counter-intuitively one of the three major components of the scoring system (requirement for post-operative opiates) can only be known at the post-operative period. The scoring system does not specify whether an anticipated need for post-operative opiates is meant. Should this be the case, this still causes challenges as post-operative pain levels vary with a number of pre-operative variables such as age, sex, and psychosocial status as well as the occurrence of post operative complications[18] and therefore cannot always be accurately predicted.[19] A second issues with this particular category is that no clear definition of what is meant by low dose or high oral opiates is provided. This made scoring for this particular feature uncertain and could introduce site-dependent variability in scoring.

The second scoring category in the ASA perioperative risk scoring system is a joint category combining both the invasiveness of surgery and type of anaesthesia. The evidence base for the particular sub-heading scoring categories is not clear and lacks a robust justification for the difference in scoring between sub-categories of surgery. Again an issue of definition of terms is apparent for this case. No criteria for “major surgery” or “superficial surgery” or “peripheral surgery” are provided. This classification is not in keeping with validated surgical classification systems used in clinical practice such as the P-POSSUM score which uses the categories of “minor, moderate, major, complex major”.[20] Furthermore, definitions of anaesthetic terms are not clearly specified thus leaving the user in doubt as to what “moderate sedation” and “no more than moderate sedation” refers to. For this tool to be used these issues need to be considered and clarified as lack of precise definitions is likely to lead to confusion and error when using the tool.

Current Study Limitations

There were a number of limitations to this study, which need to be considered when drawing

conclusions from the results presented here. The most significant limitation is the low rate of post-operative complications detected. From 50.5% of patients who had identified complications, nearly all were attributed to intra-and post-operative desaturations. This may represent opiate-induced ventilation impairment which is recognized as a significant issue in perioperative OSA patients.[21] Only 1 patient required admission to ITU. These low rates of complications may be related to the retrospective nature of our study and relying on documentation of complications. Furthermore, only documented complications that occurred during the admission were included thereby missing complications in the later post-operative period. Most of the operations included in this study did not require overnight admission and the overall average length of stay was 1.9 days. Therefore, there is a significant risk that we were not aware of the post-operative side effects in the early post-operative period when the patients were no longer at the hospital. An important direction for future evaluation of this scoring tool would be to conduct a study with a prospective design and active monitoring of pre-specified complication data.

In addition to the low complication rates recorded the ASA scores were predominately below 4 therefore falling into the "low risk"category with only 9 participants deemed at risk and only1 at significant risk. This meant that we could not analyse the results based on the categories specified by the ASA perioperative risk from OSA scoring system.

A second limitation was that the majority of the cohort did not have a diagnosis of OSA as found on overnight sleep studies. Furthermore, 35.9% of patients with a diagnosis of OSA, 32.5% had only mild OSA. These particular characteristics of our study cohort mean that general conclusions that can be applied to OSA based on severity of disease are limited. There may also be concerns raised regarding the assessment of OSA using overnight oxygen desaturation indices. Nocturnal intermittent hypoxaemia is a cardinal feature of OSA and certainly in the UK, overnight oximetry is the most commonly used screening test for OSA.[22] Furthermore, it has been shown as both a sensitive and specific tool in the detection of undiagnosed SDB in surgical patients.[23] We acknowledge however that oximetry cannot be used to differentiate between central and obstructive causes of OSA and can be affected by other factors apart from OSA. Full polysomnography is the gold standard for diagnosis but due to the considerable impracticalities is rarely required and more frequently limited sleep studies is carried out, often at home.[24]

Thirdly, the scoring system specifies 2 additional modulating factors whereby a point can be deducted if CPAP is used in the perioperative period and a point can be added in the presence of a resting PaCO2 of> 50mmHg in t those with mild to moderate OSA. Our protocol for sleep studies does not include the measurement of PaCO2 unless patients present with nocturnal hypoventilation syndrome.

Therefore we did not have these data available and this was omitted in the overall score for estimation of the perioperative risk. The authors argue that our practice is in line with general trends in the sleep study community and therefore the practical utility of this additional point is questionable.

SUMMARY

In summary, this is the first published study to validate the ASA scoring system for perioperative risk from OSA. We have demonstrated this tool to have moderate sensitivity and low specificity for the prediction of perioperative complications. Limitations of small sample size, low prevalence of OSA amongst our surgical cohort, and low rates of complications, however mean the results presented here should be taken with caution and further research is required to confirm these results.

Several limitations have been identified that question the practical use of this tool. In particular, there are concerns that the postoperative analgesia requirement cannot be accurately predicted. Secondly, a greater clarity categorizing the type of anaesthesia and surgery is needed for this tool to be used consistently across different centers and practitioners. Thirdly, we also question the necessity of encorporating a measure of resting CO2 levels into the tool.

List of Abbreviations

ASA –American Society of Anesthesiologists

CCF – Congestive cardiac failure

CPAP – Continuous positive airway pressure

DM-Diabetes Mellitis

EDS –Excessive daytime sleepiness

HTN - hypertension

LMA–Laryngeal mask airway

NIPPV - non-invasive positive pressure ventilation

ODI –oxygen desaturation index

OSA –Obstructive sleep apnoea

OSAS –Obstructive sleep apnoea syndrome

SDB–Sleep disordered breathing

SN –Sensitivity

SP–Specificity

SpO2–Oxygen saturation

SPOSA – Score for Preoperative Prediction of Obstructive Sleep Apnea TRT90- Total recoded time with SpO2<90%).

DECLARATIONS

Ethics Approval and Consent to Participate

Ethical Approval for the study was obtained from the Clinical Effectiveness Committee (Reference No7052,Barts Health NHS Trust, London, UK).

Consent for Publication Not applicable.

Availability of Data and Materials

The data sets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Funding

No funding was used for this research.

Authors Contributions

LD and VM were the major contributors of data analysis and in the writing of the manuscript. JM and OM contributed to the data collection of perioperative data from anaesthetic records. VM and TOS were the major contributors to the data collection of sleep study results. SS and LD contributed to the data collection of baseline characteristics, perioperative data from anaesthetic records and calculation of the ASAs cores. All authors read an approved the final draft of the manuscript.

Acknowledgements: nil

REFERENCES

1. Kapur VK, Auckley DH, Chowdhuri S, et al. Clinical Practice Guideline for Diagnostic Testing for Adult Obstructive Sleep Apnea: An American Academy of Sleep Medicine Clinical Practice Guideline. *J Clin Sleep Med*. 2017;13(3):479-504. P
2. Singh M, Liao P, Kobah S,Wijeysundera DN, Shapiro C, Chung F. Proportion of surgical patients with undiagnosed obstructive sleep apnoea. BrJ Anaesth.2013;110(4):629-636.
3. Ravesloot MJ, van Maanen JP, Hilgevoord AA, van Wagensveld BA, de Vries N. Obstructive sleep apnea is under recognized and underdiagnosed in patients undergoing bariatric surgery. Eur Arch Otorhinolaryngol.2012;269(7):1865-1871.
4. Macavei V. Perioperative Management of Obstructive Sleep Apnoea .Berlin: Lambert Academic Publishing; 2017.
5. 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(6):897-906.
6. Hai F, Porhomayon J, Vermont L, Frydrych L, Jaoude P, El-Solh A A. Postoperative complications in patients with obstructive sleep apnea: a meta-analysis. J Clin Anesth.2014;26(8):591-600.
7. Practice guidelines for the perioperative management of patients with obstructive sleep apnea: an updated report by the American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea. Anesthesiology.2014;120(2):268-286.
8. Finkel KJ, Searleman AC, Tymkew H, et al. Prevalence of undiagnosed obstructive sleep apnea among adult surgical patients in an academic medical center.Sleep Med.2009;10(7):753-758.
9. Mutter TC, Chateau D, Moffatt M, Ramsey C, Roos LL, Kryger M.A matched cohort study of postoperative outcomes in obstructive sleep apnea: could preoperative diagnosis.
10. Dimitrov L, Macavei V. Can Screening Tools for Obstructive Sleep Apnea Predict Postoperative Complications? A Systematic Review of the Literature.J Clin Sleep Med.2016;12(9):1293-1300.
11. Gross JB, Bachenberg KL, Benumof JL, et al. Practice guidelines for the perioperative management of patients with obstructive sleep apnea: a report by the American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea. Anesthesiology.2006;104(5):1081-1093;quiz 1117-1088.
12. Jun JC, Chopra S,Schwartz AR. Sleep apnoea. Eur Respir Rev.2016;25(139):12-18.
13. Doufas A.Obstructive sleep apnea, pain, and opioid analgesia in the postoperative Patient. Curr Anesthesiol Rep. 2014;4:1–9.

14. Ramachandran SK, Haider N, Saran KA, etal. Life-threatening critical respiratory events: a retrospective study of postoperative patients found unresponsive during analgesic therapy. J Clin Anesth 2011; 23:207–213
15. Doufas AG, Tian L, Davies MF, Warby SC. Nocturnal intermittent hypoxia is independently associated with pain in subjects suffering from sleep-disordered breathing. Anesthesiology 2013;119:1149–1162.
16. Skomro RP, Kryger MH. Clinical presentations of obstructive sleep apnea syndrome. Prog Cardiovasc Dis. 1999;41(5):331-340.
17. Shin CH, Grabitz SD, Timm FP,et al. Development and validation of a Score for Preoperative Prediction of Obstructive Sleep Apnea (SPOSA) and its perioperative outcomes. BMC Anesthesiol. 2017;17(1):71.
18. Garimella V, Cellini C. Postoperative Pain Control. Clin Colon Rectal Surg.2013;26:191-196.
19. Caumo W, Schmidt AP, Schneider CN, et al. Preoperative predictors of moderate to intense acute postoperative pain in patients undergoing abdominal surgery. Acta Anaesthesiol Scand.2002;46(10):1265-1271.
20. CopelandGP,JonesD,WaltersM.POSSUM:ascoringsystemforsurgicalaudit.BrJSurg.1991;78(3):355-360.
21. Nightingale CE, Margarson MP, Shearer E, et al. Peri-operative management of the obese surgical patient 2015: Association of Anaesthetists of Great Britain and Ireland Society for Obesity and Bariatric Anaesthesia. Anaesthesia.2015;70(7):859-876.
22. Sleep section of the Royal Society of Medicine. Management of obstructive sleepapnoea. 2018.https://www.nice.org.uk/guidance/ta139/documents/cpap-acd-nonmanufacturer-submissions-royal-society-of-medicine-sleep-section2.Accessed on20Aug 2018.
23. Chung F, Liao P, Elsaid H, et al.Oxygen desaturation index from nocturnal oximetry: a sensitive and specific tool to detect sleep-disordered breathing in surgical patients. Anesth Analg.2012;114(5):993-1000.
24. NICE.Obstructive sleep apnoea syndrome.2018.https://cks.nice.org.uk/obstructive-sleep-apnoea-syndrome#!scenario. Accessed on 20 Aug 2018.