



Society of Anesthesia and Sleep Medicine Educational Document: Recommendations for Management of Obstructive Sleep Apnea in the Perioperative Period

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Abbreviation list:

AHI = apnea-hypopnea index

APAP = auto-adjusting positive airway pressure

BPAP = bilevel pressure support

CPAP = continuous positive airway pressure

HSAT = home sleep apnea testing

ICU = intensive care unit

O₂ = oxygen

OSA = obstructive sleep apnea

PACU = post-anesthesia care unit

PAP = positive airway pressure

PCA = patient-controlled analgesia

PSG = polysomnography

UP3 = uvulopalatopharyngoplasty

1. INTRODUCTION

Patients with obstructive sleep apnea (OSA) are at risk for adverse perioperative events. Unrecognized, undiagnosed or untreated OSA in the perioperative period is even more concerning. Studies associating OSA with increased perioperative morbidity are accumulating,^{1-4, 29} though the overall impact of OSA on postoperative mortality is less clear.^{4-6, 29} Screening tools in the preoperative period can identify at-risk patients.^{7,30} For patients with diagnosed OSA who are non-compliant with continuous positive airway pressure or do not use it perioperatively, the risk for complications increases.^{8, 31-33}

National guidelines or protocols have not been established to risk-stratify or to guide practitioners in managing patients with OSA postoperatively. Despite the number of patients diagnosed with OSA, the large number of patients undiagnosed or at-risk for OSA, and the growing literature demonstrating its association with increased perioperative morbidity, many practitioners underestimate the risk for serious adverse events in these patients when they undergo anesthesia. No consensus has been reached on the best monitoring and management strategies. Few health care systems have protocols in place to allow for enhanced monitoring on a scale that is likely to be needed.

The Society of Anesthesia and Sleep Medicine (SASM) has produced this paper as an educational tool for health care providers who wish to develop institutional protocols for patients with known or suspected OSA. It is structured to proceed from the preoperative arena, through perioperative care and postoperative management to follow-up after discharge. Case descriptions of actual patients dying or suffering serious adverse events are included with each section. The cases are presented to highlight the circumstances that lead to morbid incidents. References to preoperative screening and testing tools, and example protocols from a few institutions that have implemented protocols are included.

This paper is intended as a resource; it cannot be considered definitive nor will it apply to all patients and all situations. SASM is not responsible for outcomes based on care suggested in this document. The SASM intends to regularly revise these recommendations as further knowledge accumulates in this rapidly developing field.

2. PREOPERATIVE EVALUATION

Recent guidelines advocate for routine screening for OSA as part of standard risk assessment prior to elective surgery.³⁰ Ideally, this should be performed prior to referral for elective surgery, however the timing and methods for performing this are not standardized and there is clearly a need for more research in this area. There is increasing data suggesting that screening can be effectively implemented to identify patients at risk for OSA-related adverse outcomes in the perioperative setting. A screening program identifies patients at risk for OSA, and uses that information for informed clinical decision making. In some instances, confirmatory testing may be appropriate (see Preoperative Testing Options), however, there is insufficient evidence at this time to support cancelling or delaying surgery for a formal diagnosis in patients with suspected OSA, unless there is evidence of an associated significant or uncontrolled systemic disease or additional problems with ventilation or gas exchange.³⁰

A. CASE

A 49-year-old female with osteoarthritis and morbid obesity (BMI 50 kg/m²) had a positive result on the STOP-Bang screening tool (see details below in questionnaire section) in the presurgical evaluation clinic, placing her at high risk for OSA. She then underwent bilateral total knee replacements under general anesthesia. Her risk for OSA was not addressed in the medical record by the anesthesiologists or the surgeon. There was no arrangement for the patient to go to a monitored bed postoperatively.

The patient was sent to the surgical floor with an IV hydromorphone PCA pump. Later the patient became lethargic with oxygen saturations found to be in the 60% range. Naloxone was administered and the patient was transferred to the ICU. The remaining postoperative course was uneventful. Polysomnography performed 2 weeks after surgery revealed an AHI of 94 events per hour associated with severe hypoxia (lowest saturation of 55%).

Issue: The patient was identified as being at risk for OSA preoperatively. However, there was a failure to act on this information and a failure to monitor this high-risk patient while she was receiving opioids.

Outcome: Urgent intervention and ICU transfer. Discharged without further sequelae.

B. PREOPERATIVE OSA SCREENING QUESTIONNAIRES

Screening for OSA prior to surgery is recommended during pre-operative evaluation. There are several questionnaires available for preoperative screening, though many institutions favor the STOP-Bang questionnaire⁹ due to its ease of use and growing data on its utility in the preoperative arena. However, a number of validated questionnaires are available, and are referenced below. All of the questionnaires have been validated in surgical patients.

1) **STOP-Bang Questionnaire** (www.stop-bang.ca)⁷

STOP-Bang Questionnaire	
1. Snoring: Do you snore loudly (loud enough to be heard through closed doors)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2. Tired: Do you often feel tired, fatigued, or sleepy during daytime?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3. Observed: Has anyone observed you stop breathing during your sleep?	<input type="checkbox"/> Yes <input type="checkbox"/> No
4. Blood Pressure: Do you have or are you being treated for high blood pressure?	<input type="checkbox"/> Yes <input type="checkbox"/> No
5. BMI: BMI more than 35 kg m ⁻² ?	<input type="checkbox"/> Yes <input type="checkbox"/> No
6. Age: Age over 50 yr old?	<input type="checkbox"/> Yes <input type="checkbox"/> No
7. Neck circumference: Neck circumference >40 cm?	<input type="checkbox"/> Yes <input type="checkbox"/> No
8. Gender: Male?	<input type="checkbox"/> Yes <input type="checkbox"/> No
High risk of OSA: Yes to 5-8 questions. Intermediate risk of OSA: Yes to 3-4 questions Low risk of OSA: Yes to 0-2 questions.	
Questionnaire reproduced with permission from Dr. Chung. ⁷	

2) **American Society of Anesthesiologists' Checklist**⁹

3) **Berlin Questionnaire**^{10,11}

4) **Sleep Apnea Clinical Score**¹²

5) **Perioperative Sleep Apnea Prediction Score (P-SAP)**¹³

C. PREOPERATIVE TESTING OPTIONS

1) Overnight Oximetry

Overnight oximetry with recording, which can report an oxygen desaturation index (ODI), remains somewhat controversial as a screening tool for OSA. The sensitivity and specificity of the ODI can be highly variable depending upon the definitions used for respiratory events. If scoring apneas and hypopneas during sleep only requires an accompanying desaturation (as opposed to an arousal), then the ODI correlates well with the apnea-hypopnea index (AHI). This has been demonstrated in surgical populations, where screening overnight oximetry is a sensitive and specific tool for detecting sleep-disordered breathing that is characterized by respiratory events associated with desaturations.^{14,15} However, when the criteria for scoring apneas and hypopneas as respiratory events allows for the events to be associated with EEG arousals (in addition to desaturations), as is now recommended in the latest AASM guideline,¹⁶ then the precision of the ODI in predicting the AHI will decline. In addition, variability in how physicians interpret oximetry tracings may further limit their utility in

practice.¹⁷ Oximetry does not establish a diagnosis of OSA for purposes of prescribing CPAP. Nevertheless oximetry does directly measure the degree of OSA-associated hypoxemia which is an important metric in determining severity of OSA independent of AHI.

2) Limited Channel Home Sleep Apnea Testing (HSAT)

With the Center for Medicare and Medicaid Services' (CMS) approval of HSAT for the diagnosis of OSA, limited channel home studies have gained widespread use. Parameters such as airflow, oximetry and chest wall motion are typically monitored, though some devices may make assessments of sleep disordered breathing utilizing other or additional parameters. Advantages include accessibility, ease of use, ability to study patients in their home and potential cost-savings. It adds diagnostic accuracy to questionnaire findings which tend to be sensitive but relatively non-specific. Apart from providing information regarding numbers of respiratory events (AHI, ODI) it allows assessment of their duration and associated hypoxemia. However, the use of HSAT should be limited to patients without significant cardiac, pulmonary or neurologic disease (i.e. those at risk for central sleep apnea and/or significant hypoventilation) as these require more rigorous evaluation, often including polysomnography. Rigorous quality oversight, including review of the raw data by a knowledgeable practitioner, is necessary to ensure good patient care. Data suggests that HSAT can identify OSA preoperatively in a substantial portion of the adult surgical population at risk for OSA.¹⁸ HSAT provides sufficient data for a valid diagnosis of OSA for most insurance carriers, which is necessary for patients to obtain their own personal CPAP equipment. However, a negative home sleep test in a patient highly suspected of having OSA should warrant further testing; usually in-lab polysomnography.

3) Laboratory Polysomnography (PSG)

PSG is considered the gold standard for identifying OSA.¹⁹ It may be the preferred diagnostic modality if the patient has co-morbid medical conditions (such as cardio-pulmonary disease), if a HSAT is negative in a patient with a high pretest clinical suspicion for OSA, or if the timing of surgery is not an important factor. In addition to providing a diagnosis, in some cases therapy may be implemented during the same testing period (i.e. a "split night" study with Continuous Positive Airway Pressure (CPAP) titration in the second portion of the study). CPAP titration performed in the sleep laboratory also allows for precise determination of CPAP settings for an individual. However, PSG is expensive and access to testing may be limited in some areas due to backlogs in scheduling in some sleep laboratories. In addition, routine surgical patients may be reluctant to undergo such labor intensive testing preoperatively.

D. ADDITIONAL SASM BEST PREOPERATIVE PRACTICE RECOMMENDATIONS³⁰

- 1)** Members of the healthcare team and the patient should be made that both diagnosed OSA (whether treated, partially treated, or untreated) and suspected OSA may be associated with increased perioperative morbidity.
- 2)** Consideration should be given to obtaining the results of the sleep study and the recommended Positive Airway Pressure (PAP) setting before surgery.

- 3) If resources allow, facilities should consider having PAP equipment for perioperative use, or have patients bring their own PAP equipment with them to the surgical facility.
- 4) Additional evaluation for preoperative cardiopulmonary optimization should be considered in patients with known, partially treated/untreated and suspected OSA who have uncontrolled systemic conditions e.g. i) hypoventilation syndromes, ii) severe pulmonary hypertension, and iii) resting hypoxemia in the absence of other cardiopulmonary disease.
- 5) Patients with known OSA, partially treated/untreated and suspected OSA with optimized co-morbid conditions may proceed to surgery provided strategies for mitigation of postoperative complications are implemented.
- 6) The risks and benefits of the decision should include consultation and discussion with the surgeon and the patient.
- 7) The use of PAP therapy in previously undiagnosed but suspected OSA patients should be considered case by case. Due to the lack of evidence from randomized controlled trials, we cannot recommend its routine use.

3. PERIOPERATIVE MANAGEMENT

Data suggests that patients with OSA or suspected OSA are at increased risk for intraoperative and immediate postoperative adverse events. From difficulty with tracheal intubation, to increased hypoxia and vasopressor use intraoperatively to cardiopulmonary complications in the post-anesthesia care unit, these patients may require extra precautions and interventions.

A. CASE

A 55-year-old male with osteoarthritis, benign prostate hypertrophy, a history of gastric bypass surgery with residual obesity (BMI 31.4 kg/m²) and OSA (PSG showed an AHI of 38.0 events per hour, compliant with PAP therapy) underwent a transurethral resection of the prostate (TURP) under general anesthesia. He was extubated in the OR but 30 minutes after arrival in the PACU, obstructive apneic episodes were noted with desaturations into the 60%-70% range. The patient was reintubated and transferred to the ICU. His sodium level at the time was 143 mmol/L, making TURP syndrome an unlikely reason for his clinical decompensation. Upon regaining alertness, he was extubated, and the remainder of his hospital course was uncomplicated.

Issues: Premature extubation after surgery under general anesthesia. Faulty assumption that patients with a history of OSA who have significant weight loss may no longer have OSA.

Outcome: Re-intubation and ICU transfer. The patient was discharged without further sequelae.

B. INTRAOPERATIVE AND IMMEDIATE POSTOPERATIVE MANAGEMENT (CONSENSUS RECOMMENDATIONS)

1) Airway management and Anesthesia

- a) Local or regional anesthesia should be considered when possible.²⁰
- b) If moderate sedation is required, continuous capnography is warranted during the procedure.
- c) If general anesthesia is planned, pre-oxygenation should be considered and providers should preferably use a technique that allows early emergence (i.e. short acting agents with adequate of reversal of muscle relaxants).
- d) Difficult airway equipment should be readily available.
- e) Extubation in a position other than supine is desirable. The lateral or semi upright positions can decrease upper airway collapsibility.²¹
- f) Ready availability of CPAP is important either during sedation or post-extubation.
- g) Whenever possible, the use of sedatives and opioids should be minimized.
- h) Extra caution should be used for patients with known or suspected OSA who are opioid naïve.

- i) Consideration should be given to a non-opioid multimodal analgesia approach (e.g., local/regional analgesia, non-steroidal anti-inflammatory drugs, acetaminophen, and steroids).
- j) If opioids are required, use short-acting ones, where possible.

2) Recovery (operating room and post-anesthesia care unit - PACU)

- a) Consider extubation only once awake.
- b) Place patients in a semi-upright position prior to extubation.²¹
- c) Patients who are considered high risk for OSA (based upon pre-operative screening or observations intraoperatively or postoperatively) should be identified to all members of the care team, including bedside staff and pharmacy personnel, in order to monitor for requests for long acting opioids and soporific medications. Identification will allow appropriate OSA management algorithms to be enacted.
- d) Consider the use of a sedation scale (e.g., Richmond Agitation Sedation Scale²²) to help guide management.
- e) Avoid systemic opioids, if possible. If necessary, titrate long acting opioids (e.g., morphine and hydromorphone) to the lowest dose that works.
- f) Observe patients for apneic episodes, increased FiO₂ requirements, pain-sedation mismatch, or episodes of desaturation.²³ These patients should receive extra vigilance. This may include enhanced monitoring (i.e. continuous pulse oximetry and/or placement in a step-down unit) or interventions (i.e. head of the bed elevation, use of nasal trumpets or the implementation of positive airway pressure).
- g) Consider placing patients in a lateral decubitus position post-extubation and during PACU recovery, if the surgery allows, to minimize anatomical obstructive events secondary to supine positioning.
- h) Patients with known OSA on therapy should be placed on PAP therapy (either their home machine, a hospital machine adjusted to home settings, or auto-CPAP) in the PACU. One may need to consider adjusting the settings if obstructive events are observed on therapy.
- i) If oxygen desaturation occurs while on oxygen therapy, use of PAP therapy should be considered before discharge from the PACU (i.e. CPAP, auto-CPAP or bilevel pressure support (= BPAP)).
- j) Outpatient facilities should be prepared for respiratory care interventions as noted above and have transfer agreements with inpatient facilities.

4. POSTOPERATIVE MANAGEMENT

Optimal strategies for postoperative management of known or suspected OSA patients have yet to be developed. However, it is likely that judicious use of opioids (monitored by pharmacy alerts), avoidance of sedatives, increased levels of monitoring and perhaps use of positive airway pressure therapy (CPAP or bilevel pressure support) are all important in minimizing risk for postoperative complications.

A. CASE

A 45-year-old male with a recent diagnosis of OSA (PSG results were not available) presented to the emergency room (ER) after a motor vehicle accident with resultant leg trauma. Oxygen desaturation was noted in the ER after IV morphine was given for pain, and the patient required mask ventilation. The patient then underwent general anesthesia for an open reduction and internal fixation (ORIF) of a tibial fracture. The patient was extubated in the OR, but apneic episodes were noted with desaturations in the 80% range documented in the PACU. The patient was sent to the floor with a request for continuous pulse oximetry. Continuous pulse oximetry was not applied, and further apneic episodes were documented by the nurses. After 30 minutes, the patient was found in cardiopulmonary arrest. The patient was intubated and CPR was performed until spontaneous respirations returned. Severe anoxic neurologic injury resulted and the patient subsequently died.

Issue: Premature release from the PACU after general anesthesia in a patient with known OSA. Failure to monitor a patient with known OSA given IV opioids postoperatively despite documented apneas and desaturation while receiving opioids.

Outcome: Severe anoxic neurologic injury and death.

B. POSTOPERATIVE CONSIDERATIONS (CONSENSUS RECOMMENDATIONS)

1) After release from PACU

- a) Patients with known OSA who are already on therapy should be placed on PAP therapy (either home machine, hospital machine adjusted to home settings, or auto-adjusting CPAP) during periods of sleep while hospitalized. One may need to consider adjusting the settings if obstructive events are observed on therapy. This can be initiated in PACU, though care should be given to ensure patients requiring supplemental oxygen in the immediate postoperative period to offset hypoxemia secondary to atelectasis or other pulmonary problems not be denied oxygen in place of PAP therapy alone.
- b) Exercise caution in OSA patients who develop prolonged and/or frequent severe respiratory events (e.g., sedation analgesic mismatch with opioids, desaturation, and apneic episodes) in the postoperative period.²³ These patients may require additional respiratory monitoring (i.e. continuous pulse oximetry and/or placement in a step-down unit).
- c) Oxygen therapy may be needed to prevent hypoxemia in some patients, especially when opioids are used. However, oxygen therapy should be used with caution and a search for potential underlying causes is recommended: one

should not assume that hypoxia is due only to untreated OSA. Additional caveats include:

- i. Oxygen may prolong apneas in some individuals.²⁴
 - ii. Use of supplemental oxygen therapy may also mask the development of hypercapnia. Patients with obesity hypoventilation syndrome or overlap syndrome such as OSA and chronic obstructive lung disease are at higher risk of hypercapnia with oxygen therapy. Significant hypercapnia may be seen in patients with known OSA who require supplemental oxygen added to home PAP therapy, as well as in patients with suspected OSA who require upward titration of oxygen supplementation.
- d) The ideal locations for monitoring, and the parameters to be monitored, have not been clearly established.
- i. Monitoring locations may include intensive care units, stepdown units and general ward beds with additional monitoring capability. In some patients, no additional monitoring may be warranted. Numerous factors (i.e. type of surgery, type of anesthesia, postoperative analgesic requirements, co-morbidities, OSA severity and treatment) should play a role in decision making.
 - ii. Continuous pulse oximetry is often recommended for monitoring known or suspected OSA patients postoperatively (see protocol examples later in the document). Guidelines for how best to utilize pulse oximetry have not been established, though data is beginning to emerge in this area.²⁵ Practitioners should be aware that monitoring oximetry alone can fail to detect significant hypercapnia in some patients. Continuous capnography (carbon dioxide monitoring) may be appropriate in some cases, though many facilities do not have capnography resources outside of the operating room / PACU setting. Continuous respiratory rate monitoring may be considered as a surrogate in these cases.
- e) Naloxone should be readily available for any patients receiving opioids.

2) Significant Respiratory Depression

- a) Appropriate resuscitation should be initiated—this may include noninvasive positive-pressure ventilation or tracheal intubation as well as appropriate use of naloxone and/or other drug reversal agents.
- b) Consider transfer of ambulatory patients to an inpatient facility for additional monitoring.
- c) Hospitalized patients should be placed on a floor or care unit with experience in treating OSA patients, complete with a system capable of providing appropriate monitoring. Continuous capnography (carbon dioxide) monitoring technology is evolving, and may be a useful tool in the future, as may other measures to continuously monitor oro-nasal airflow.

5. FOLLOW-UP CARE AFTER DISCHARGE

The timing of discharge from the PACU has been addressed in the previous section, but many of the same principles are relevant regarding one's final disposition to home. Due to factors such as post-operative sleep disruption resulting in subsequent nights of REM rebound, the lingering effects of anesthesia, and the concomitant use of opioids, OSA can be greatest on postoperative night 3 and may not normalize for several more nights. It is therefore imperative that patients with known and suspected sleep apnea are provided with appropriate follow-up care.

Patients with suspected but not yet diagnosed OSA should be treated cautiously with regards to the use of opioids and sedatives in the home setting. They should be informed of their high risk for OSA status and recommended to see their primary care provider or a sleep specialist for further evaluation upon discharge from the hospital. OSA is a chronic medical condition associated with significant long-term health consequences when left untreated. Identifying patients at risk for OSA in the preoperative setting should serve as an impetus to request that patients undergo additional evaluation. The key points that should be emphasized are education of patients and their families, and specific follow-up plans.

A. CASE

A 52-year-old male with hypertension, osteoarthritis, obesity (BMI 34.6 kg/m²) and mild OSA (PSG with an AHI of 6.5 events per hour, not on therapy) underwent general anesthesia for a lumbar laminectomy. The patient was extubated and monitored overnight in a surgical ward with continuous oximetry monitoring. The patient was discharged home the following day with acetaminophen/oxycodone and cyclobenzaprine. While in his family room, the patient took his prescriptions and fell asleep. He became apneic and cyanotic and his wife could not awaken him. She administered a precordial thump and called 911. The patient regained consciousness and was not postictal. The patient was transported to the ER where intermittent polymorphic ventricular tachycardia (VT) was documented. He required defibrillation/cardioversion X 3 and an amiodarone infusion. He had no history of cardiac disease, arrhythmias or seizures. A cardiac workup was negative (normal echo, negative cardiac catheterization and electrophysiology study). No electrolyte abnormalities were noted. No clear cause for the VT was found except for possible hypoxemia related to OSA, likely worsened by the combination of his prescription drugs with resulting arrhythmia. An implantable cardioverter-defibrillator (ICD) was placed. No subsequent episodes of arrhythmia were documented.

Issue: Excessive narcotic and sedative medications prescribed postoperatively in a patient with known OSA.

Outcome: Admission to the ICU, extensive cardiac workup, and ICD placement.

B. HOME TREATMENT AND FOLLOW-UP (CONSENSUS RECOMMENDATIONS)

1) Known OSA

- a) Patients on PAP therapy, and their families, should be educated at the time of discharge by the discharge or transition team to have patients use their PAP therapy whenever sleeping, and to avoid opiates as much as possible due to adverse effects on breathing.

- b) If possible, inspection of the patient's home CPAP equipment should be performed by a respiratory therapist to verify proper working condition, adequate mask fit, etc.
- c) If a patient with known OSA is non-compliant with therapy, efforts should be made to provide appropriate education regarding risks of untreated sleep apnea, identify barriers that have resulted in non-compliance, and to ensure that follow up with an appropriate provider is arranged. Depending on local resources and clinical circumstances, such patients may be appropriate candidates to be seen in consultation before discharge by a sleep specialist, a respiratory therapist, or CPAP educator.

2) Suspected OSA

- a) Patients who are suspected of having OSA based on clinical criteria should be urged to follow up with their primary care or a sleep medicine provider to consider further sleep evaluation.
Triage tools that might trigger a more urgent follow-up include:
 - i. STOP-Bang score ≥ 5
 - ii. Abnormal screening oximetry, or prolonged need for O₂ during recovery or hospitalization
 - iii. Requirement for opioids
- b) In general, most insurances will not permit patients suspected of having OSA who have been placed on PAP therapy in the postoperative period to be permanently discharged home with CPAP or BPAP equipment until a formal diagnosis of OSA has been established (with HSAT or PSG). For this reason, formal testing needs to be strongly considered in most patients.
 - i. In some regions, relationships may be made with local vendors to provide PAP therapy on a short term basis until sleep study results become available.
 - ii. There is limited data to suggest that limited channel testing (such as HSAT) in hospitalized patients may be feasible.^{26,27} However, careful patient selection and, in some cases, outpatient confirmation of inpatient testing may be indicated.
 - iii. Patients with significant hypoventilation syndromes requiring BPAP therapy may need to meet separate criteria for therapy and the reader is referred to regulatory agency (i.e. CMS) guidelines for these requirements.
- c) Home O₂ therapy as a bridge for treatment of sleep apnea (before definitive treatment with CPAP or BPAP can be arranged) can be considered, but is not universally recommended.
 - i. There are concerns that supplemental O₂ may blunt hypoxic respiratory drive or cause V/Q mismatching that may result in significant hypercapnia in certain individuals (e.g. those with COPD).

- ii. Conversely, O₂ may be beneficial in preventing adverse consequences related to hypoxemia in certain individuals. Clinical judgment should be used.
- iii. Patients who are on home O₂ may be more motivated to follow up with a specialist, in order to determine when O₂ may be appropriately discontinued. This results in an opportunity to provide education and optimize care.

6. PROTOCOLS

Many institutions have initiated screening and monitoring protocols for patients with known or suspected OSA. Below are four examples, each developed and utilized at different institutions. Note that these are examples of what are considered best clinical practices, though the impact these protocols might have on patient outcomes has not yet been established.

Protocol 1

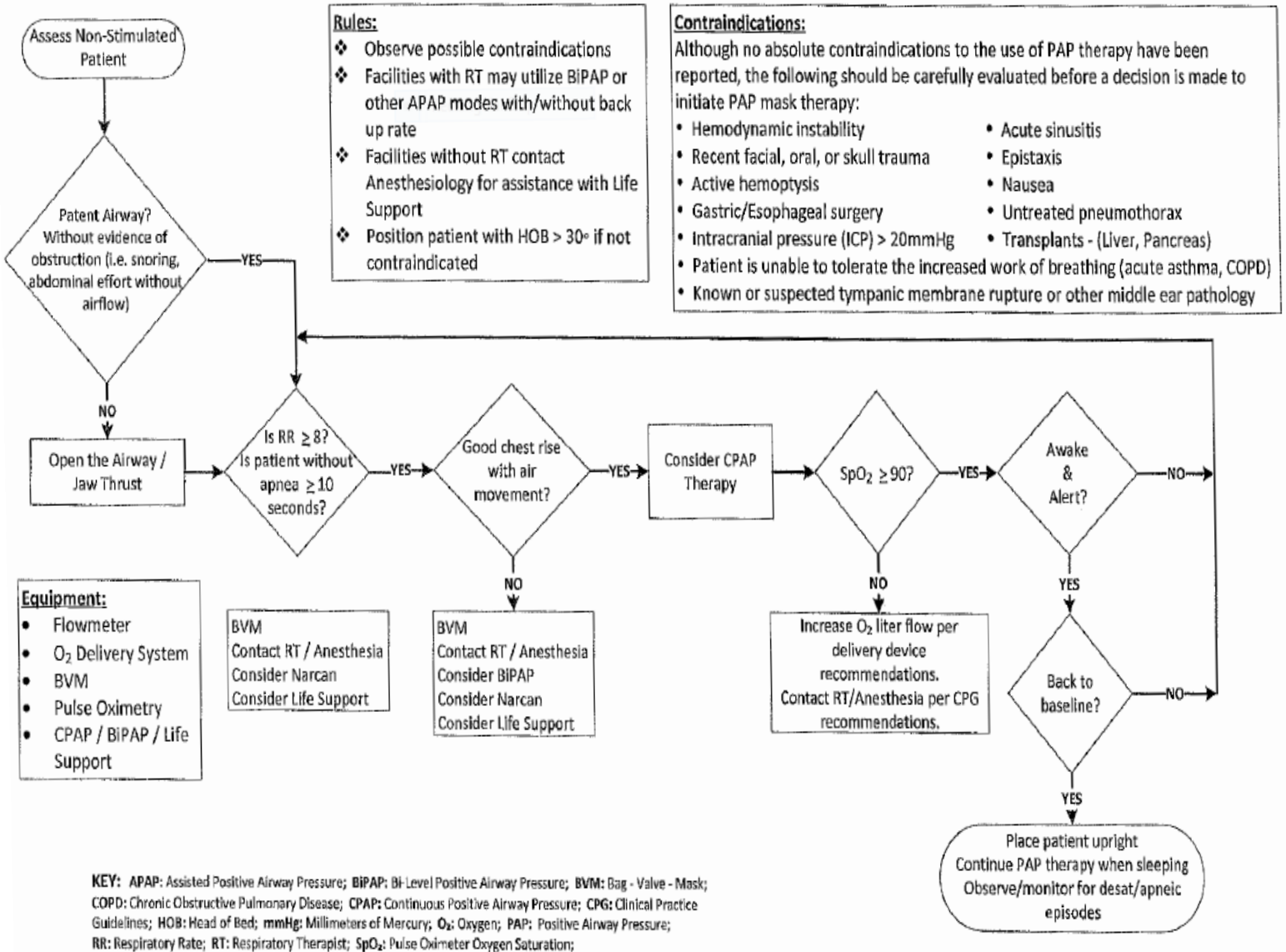
This protocol comes from Intermountain Health Care (IHC), a large non-profit HMO based in Salt Lake City and affiliated with the University of Utah. The program has a joint Sleep Medicine Fellowship Program shared by IHC and the University of Utah.

The goals of managing sleep apnea on a large scale in the perioperative setting at Intermountain Healthcare are as follows:

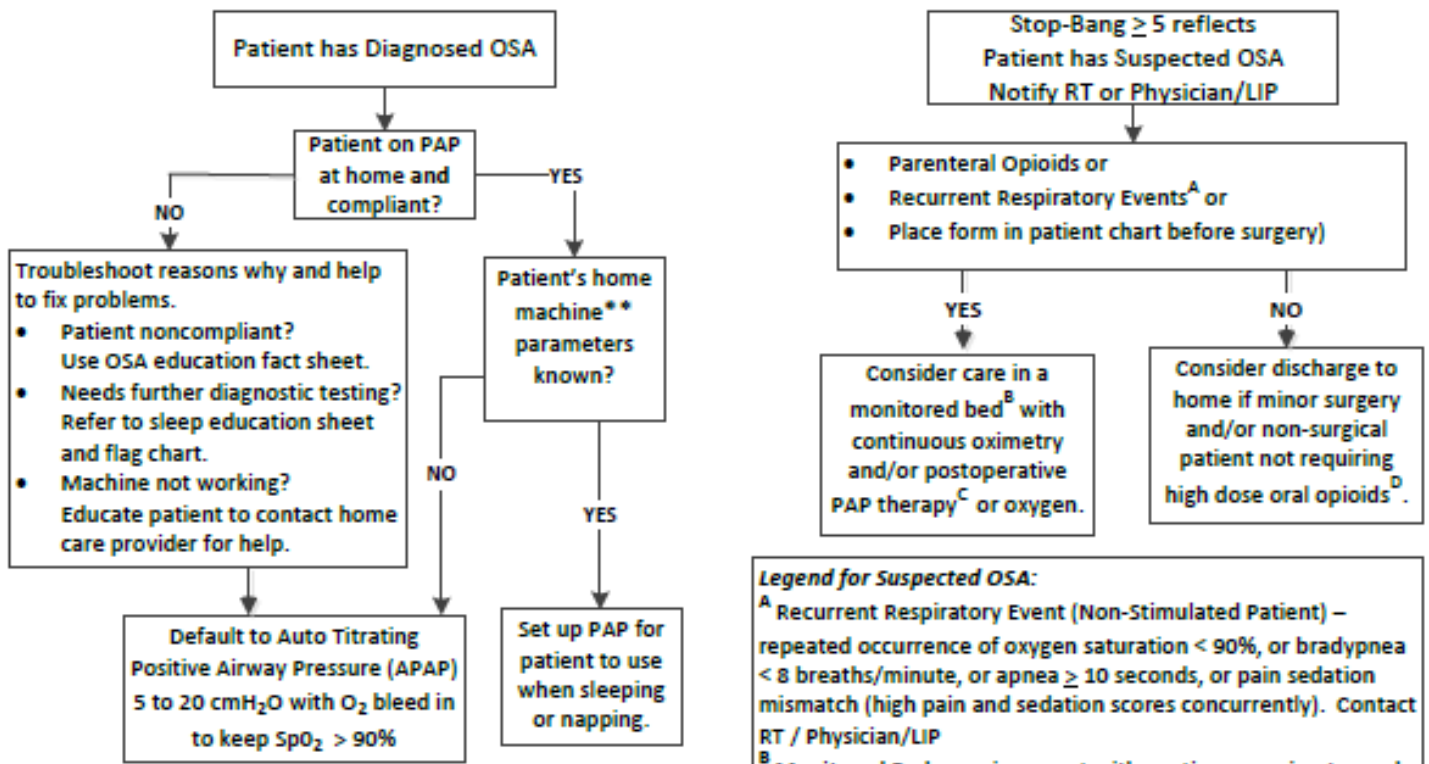
- a) Every patient undergoing inpatient or outpatient surgery is screened for sleep apnea, using the STOP-BANG Questionnaire.
- b) Patients with sleep apnea or suspected sleep apnea have a pre-defined respiratory assessment protocol in the post-surgical environment (PACU) or if they are on opioids (see protocol)
- c) Patients with known OSA and using CPAP at home are prescribed CPAP (either using their own machine, using a hospital-owned PAP machine at their settings if known, or autoadjusting CPAP (APAP) set to limits of 5-20 cm H₂O if settings are unknown) with an O₂ bleed in to keep oxygen saturations >90%.
- d) Patients with known OSA and not using CPAP are seen by a respiratory therapist (RT) and it is determined why they are not using PAP therapy (machine or mask malfunction, insurance issues, psychosocial issues, etc.). Patients are educated, charts are flagged, and appropriate referrals or follow-up arranged. These patients are placed on APAP 5-20 cm H₂O with an O₂ bleed in to keep oxygen saturations >90%.
- e) Patients with suspected sleep apnea, defined as a STOP-BANG ≥ 5 are flagged, which alerts a call to notify RT or their physician. See protocol for details of their management.
- f) Appropriate monitoring, judicious use of opioids and respiratory depressants, and patient/family education regarding sleep apnea in the perioperative period.
- g) Capability to provide inpatient sleep medicine consultation for urgent cases.
- h) Capability to perform inpatient diagnostic testing (and titration studies, if necessary), in order to expedite PAP/O₂ therapy at discharge.
- i) Coordinating care with surgeons, anesthesiologists, PACU and hospital staff, discharge planners and DME providers.
- j) Provision of outpatient Sleep Medicine consultation or follow-up for appropriate patients.

Protocol 1

OSA / Suspected OSA Respiratory Assessment for Post Surgical & Patients on Opioids



Positive Pressure for Diagnosed Obstructive Sleep Apnea Patients & Suspected Obstructive Sleep Apnea Patients



**** For Patients with Central Sleep Apnea and Heart Failure:**
On ASV – Contact Sleep Physician or Telehealth and place patient in monitored bed.

RULES:

- High risk surgical patients must be monitored in post anesthesia care unit (PACU) for longer duration.
- Patient education provided to patient and caregiver responsible for post-op care/discharge care; including Home O₂, CPAP, and Sleep Study education by the RT (RN if RT unavailable), and Opioid information given by the RN or Pharmacy.
- At any time if patient requires more than 5 L/min bleed in or if there has been an increase in O₂ need greater than 3 L/min from the starting baseline, contact the Physician/LIP.

Legend for Suspected OSA:

^A Recurrent Respiratory Event (Non-Stimulated Patient) – repeated occurrence of oxygen saturation < 90%, or bradypnea < 8 breaths/minute, or apnea ≥ 10 seconds, or pain sedation mismatch (high pain and sedation scores concurrently). Contact RT / Physician/LIP

^B Monitored Bed - environment with continuous oximetry and the possibility of early medical intervention (e.g. intensive care unit, step-down unit, or remote pulse oximetry with telemetry in surgical ward).

^C Positive Airway Pressure (PAP) Therapy – automatically adjusting PAP for surgical patients 5-20 cmH₂O with O₂ bleed in to keep SpO₂ > 90%, or per physician order. Contact Physician/LIP for non-surgical patients.

^D Consult with RN or Pharmacist caring for patient to determine if opioid use is high dose. See Common Definitions for Opioid Dosing in table below and also an approved Intermountain opioid conversion chart from the Pharmacy in the provided hyperlink as well.

Term	Morphine Equivalents
Low Dose	< 40 mg
Medium Dose	41-90 mg
High Dose	> 91 mg

[opioid conversion chart](#)

KEY: ASV: Adaptive Support Ventilation; cmH₂O: Centimeters of Water Pressure; CPAP: Continuous Positive Airway Pressure; LIP: Licensed Independent Practitioner; L/min: Liters per minute; O₂: Oxygen; OSA: Obstructive Sleep Apnea; PAP: Positive Airway Pressure; RN: Registered Nurse; RT: Respiratory Therapist; SpO₂: Pulse Oximeter Oxygen Saturation

RESPIRATORY CARE PATIENT CARE PLAN / ORDER

(DOCUMENT ID #)



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Protocol 2

This protocol was developed at the Mayo Clinic in Rochester, MN via a clinical practice initiative to identify and manage patients at risk for undiagnosed OSA. We developed a protocol whereby we use the sleep apnea clinical score (SACS) preoperatively (Figure 1) combined with a PACU assessment (Figure 2) for specific respiratory events (at 3 time periods) to risk stratify patients. We then performed a prospective cohort study to identify patients at high risk for postoperative respiratory complications. This two- phase screening process is currently utilized for all patients undergoing inpatient surgical procedures at our institution.

Patients who are identified as high risk by either the SACS or PACU events that otherwise meet criteria for floor level care are monitored on the floor remotely with pulse oximetry for 24-48 hours after discharge from the PACU. PACU staff can order monitoring independently (Figure 3). Floor nurses are made aware of high-risk status at time of transfer to the floor by PACU nursing. Events that are noted by remote oximetry (monitored by respiratory therapy) are reported to the nurse caring for the patient.

Protocol 2

Figure 1

OSA Questionnaire



Patient Name: _____
 Clinic #: _____ - _____ - _____
 Date: _____

Known OSA? No, complete remainder of this form
 Yes, refer to algorithm (unnecessary to complete form below)

Ask the patient the following questions, and use the subsequent table to estimate risk of OSA.

- Do you have high blood pressure or have you been told to take medication for high blood pressure?
 Yes
 No
- People who have shared (or are sharing) my bedroom tell me that I snore. Please pick the best response for the frequency of your snoring:
 I don't know
 Never
 Rarely (1-2 times per year)
 Occasionally (4-8 times per year)
 Sometimes (1-2 times per month)
 Often (1-2 times per week)
 Usually (3-5 times per week) [equals 1 "Historical Feature"]
 Always (every night) [equals 1 "Historical Feature"]
- I have been told by other people that I gasp, choke, or snort while I am sleeping. Please pick the best response for the frequency of any of these symptoms:
 I don't know
 Never
 Rarely (1-2 times per year)
 Occasionally (4-8 times per year)
 Sometimes (1-2 times per month)
 Often (1-2 times per week)
 Usually (3-5 times per week) [equals 1 "Historical Feature"]
 Always (every night) [equals 1 "Historical Feature"]
- Neck measurement. (We will measure you.) _____ cm

Total number of Historical Features: _____

Prediction of OSA

(Circle the patient's score.)

Sleep Apnea Clinical Score

Neck Circ (cm)	Not Hypertensive Historical Features*			Hypertensive Historical Features*		
	None	One	Both	None	One	Both
<30	0	0	1	0	1	2
30/31	0	0	1	1	2	4
32/33	0	1	2	1	3	5
34/35	1	2	3	2	4	8
36/37	1	3	5	4	6	11
38/39	2	4	7	5	9	16
40/41	3	6	10	8	13	22
42/43	5	8	14	11	18	30
44/45	7	12	20	15	25	42
46/47	10	16	28	21	35	58
48/49	14	23	38	29	48	80
>49	19	32	53	40	66	110

*Historical Features: 1. Habitual snoring
 2. Partner reports of gasping, choking, or snorting

Probability of Sleep Apnea

Low – Sleep Apnea Clinical Score <15
 High – Sleep Apnea Clinical Score ≥15

TOTAL SLEEP APNEA CLINICAL SCORE: _____

Flemons et al, Am J Respir Crit Care Med 1994; 150 :1279-85
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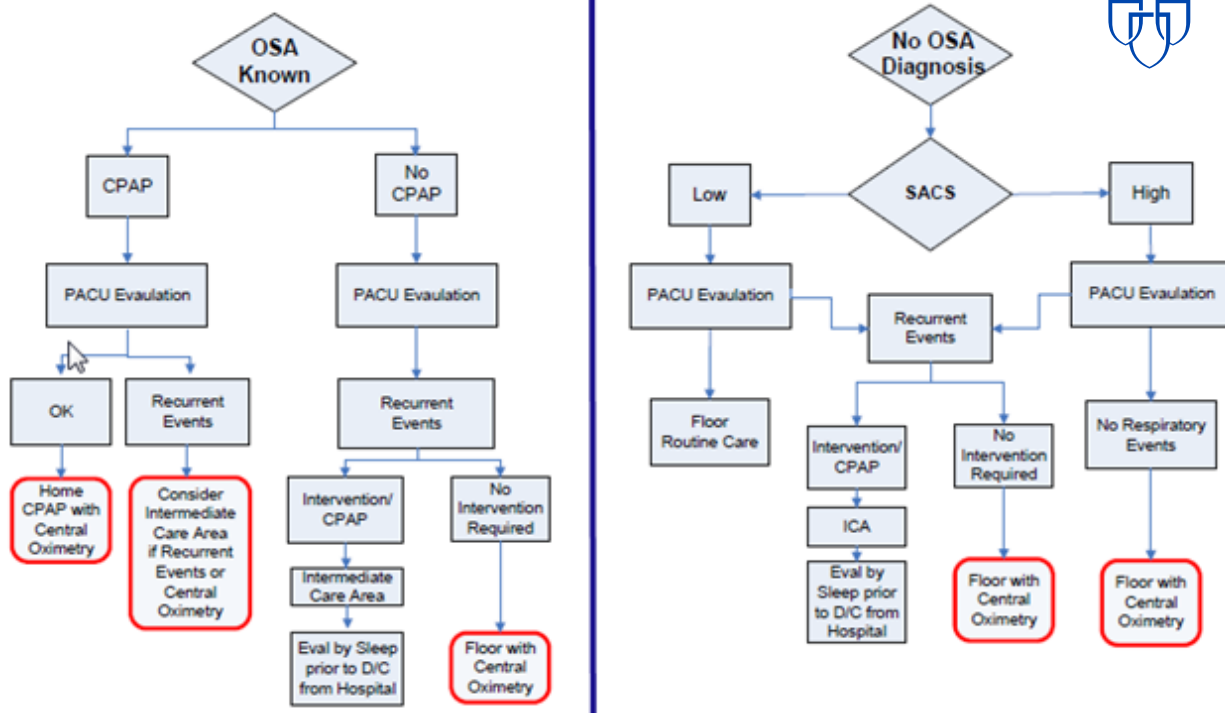
Protocol 2



Figure 2

PACU Evaluation			
	Evaluation Period		
Bradypnea: < 8 respirations/minute (3 episodes needed for yes)	Initial 30 min. after extubation or PACU admit (whichever occurs later)	2nd 30 min. after Initial eval. (60 min after extubation or PACU admit)	3rd 30 min. after 2nd eval. (90 min after extubation or PACU admit)
Apnea: ≥ 10 seconds (only 1 episode needed for yes)			
Desaturations: Pulse Ox <90% with nasal cannula (3 episodes needed for yes)			
Pain/Sedation mismatch: RASS score -3 thru -5 and Pain scale score > 5 (only 1 episode needed for yes)			
RASS = Richmond Agitation-Sedation Scale Pain Score = Visual Analog Score Recurrent events: if any event occurs at more than one eval period (not necessary to be same event)			

Figure 3



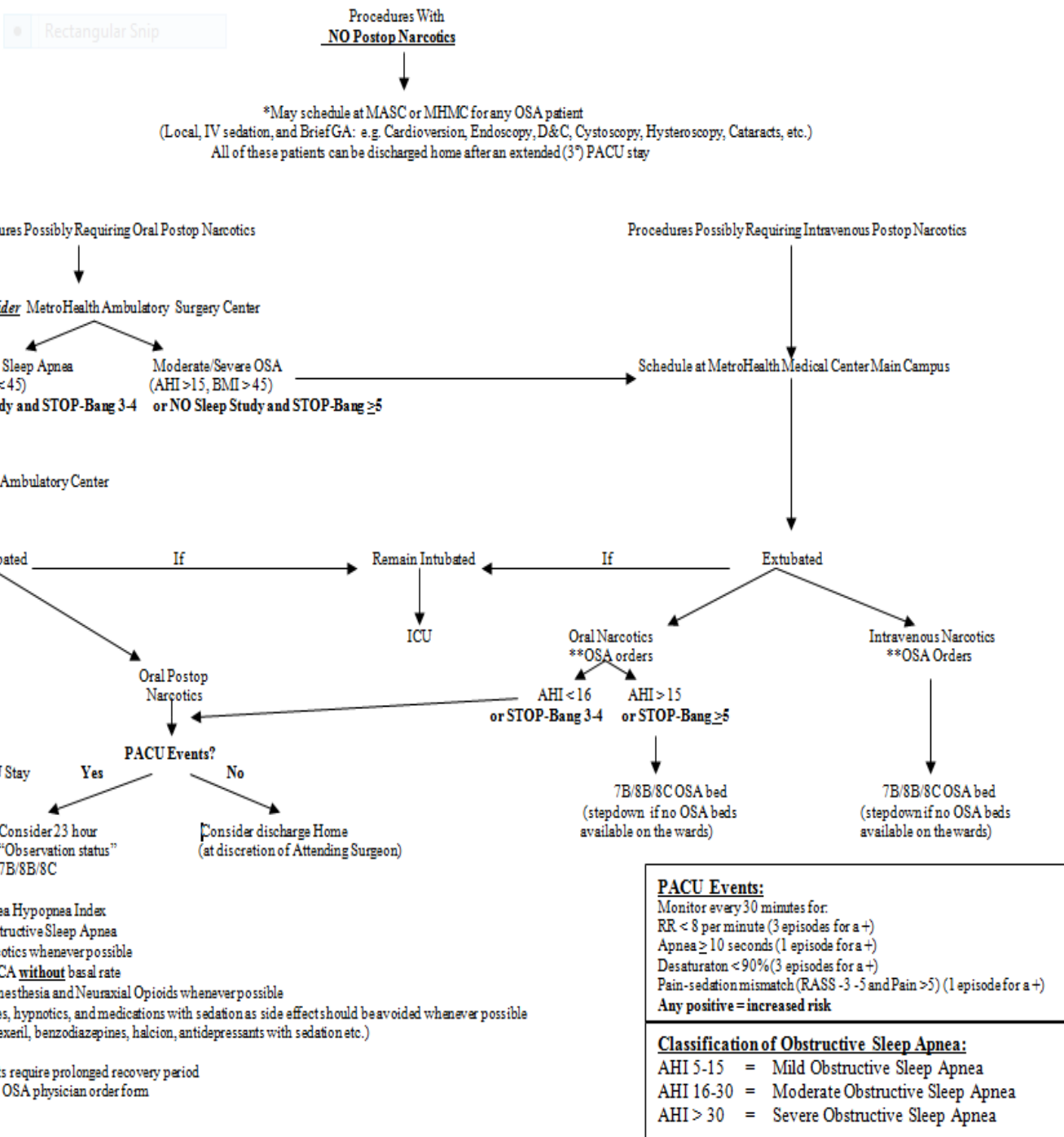
Protocol 3

This protocol was developed at MetroHealth Medical Center, affiliated with Case Western Reserve University and located in Cleveland, OH. Following the case of an OSA patient undergoing surgery who experienced an adverse outcome directly attributable to OSA, our institution convened a quality committee to determine how best to identify and manage patients with known or suspected OSA preoperatively. The committee included representation from pulmonary / sleep medicine, anesthesiology, surgery, ambulatory surgery, nursing (PACU and floor nursing), hospital administration and the legal department. The goal of the committee was to optimize safety without causing significant disruption to the OR schedule or patient throughout. An algorithm was developed, implemented, and monitored. Quality data was collected and reviewed and the protocol was revised with the current algorithm shown below.

The important decision points of the algorithm take into consideration the presence of known versus suspected OSA (suspected are considered to have at least moderate to severe OSA) and the anticipated or actual use of narcotics postoperatively. In the algorithm, patients are screened in the preoperative screening clinic with the STOP-Bang questionnaire to determine risk for OSA. Recommendations (i.e. minimizing sedatives, avoid supine positioning if possible) are included in the protocol.

Protocol 3

MetroHealth Medical Center Obstructive Sleep Apnea Algorithm



OSA beds = floor beds with continuous pulse oximetry monitoring capability (alarms at nursing station)

MASC = ambulatory surgery site
MHMC = main campus surgery site

Protocol 4

This protocol comes from Toronto Western Hospital, part of the University Health Network at the University of Toronto (Canada) as well as Khoo Teck Puat Hospital, part of Alexandra Health System (Singapore). The perioperative functional algorithms were formulated with input from various academic medical centers including San Diego Health Care System, Kingston General Hospital, Beth Israel Deaconess Medical Center, MetroHealth Medical Center, University of California, and the Ottawa Hospital.

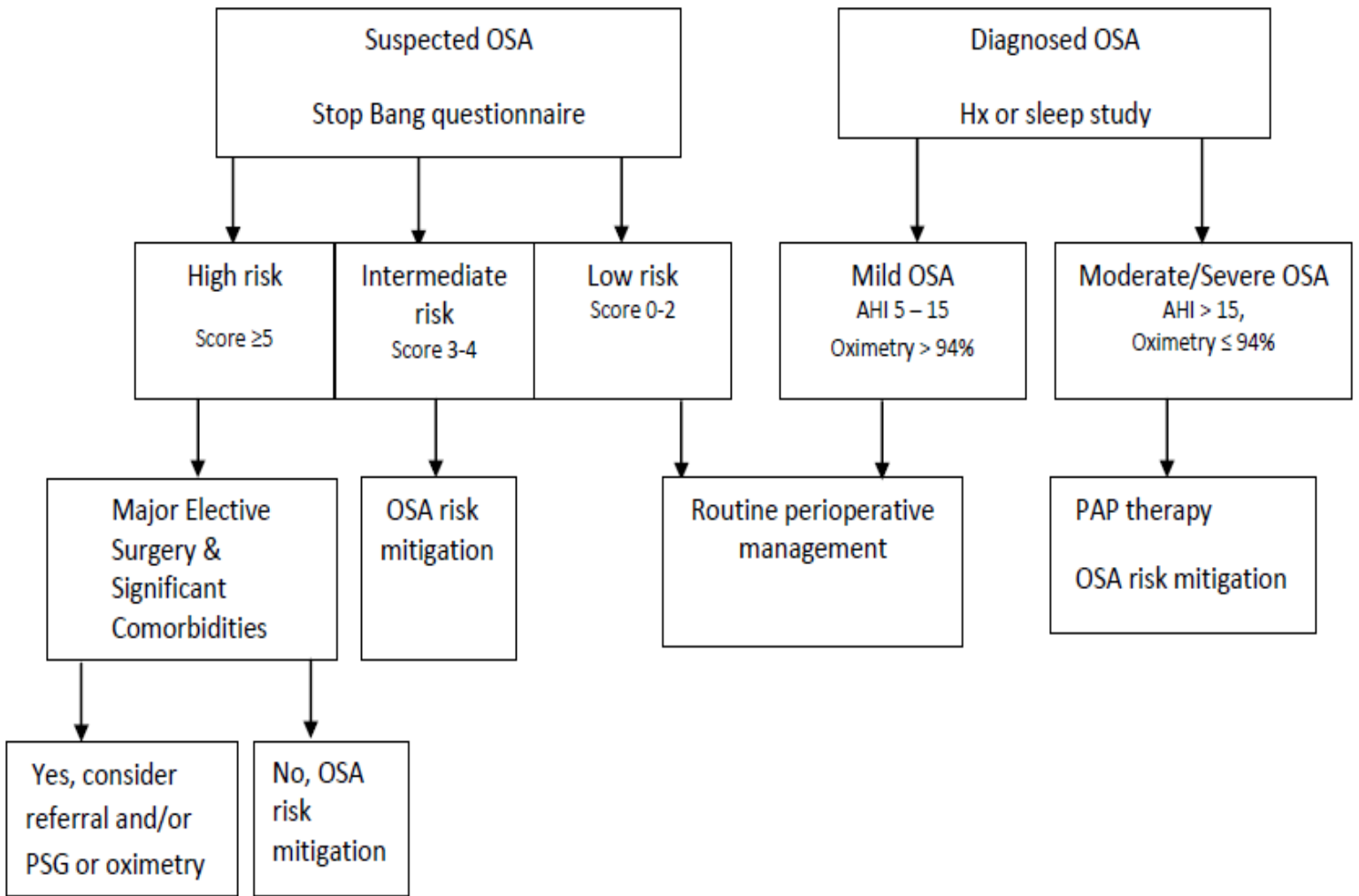
The algorithms have been published,²⁸ and address the following issues:

1. Evaluation of a known / diagnosed OSA patient preoperatively (Figure 1).
2. Evaluation of a suspected OSA preoperatively (Figure 1).
3. Minimize/mitigate the risk posed by OSA intraoperatively (Table 1).
4. Determination of postoperative disposition of a known diagnosed OSA patient after general anesthesia (Figure 2).
5. Determination of the postoperative disposition of a suspected OSA patient after general anesthesia (Figure 2).

Figure 1: Preoperative Evaluation of Suspected or Diagnosed OSA Patient

Figure 1: Preoperative Evaluation of Suspected or Diagnosed OSA Patient in the Anesthesia Clinic

• Rectangular Snip



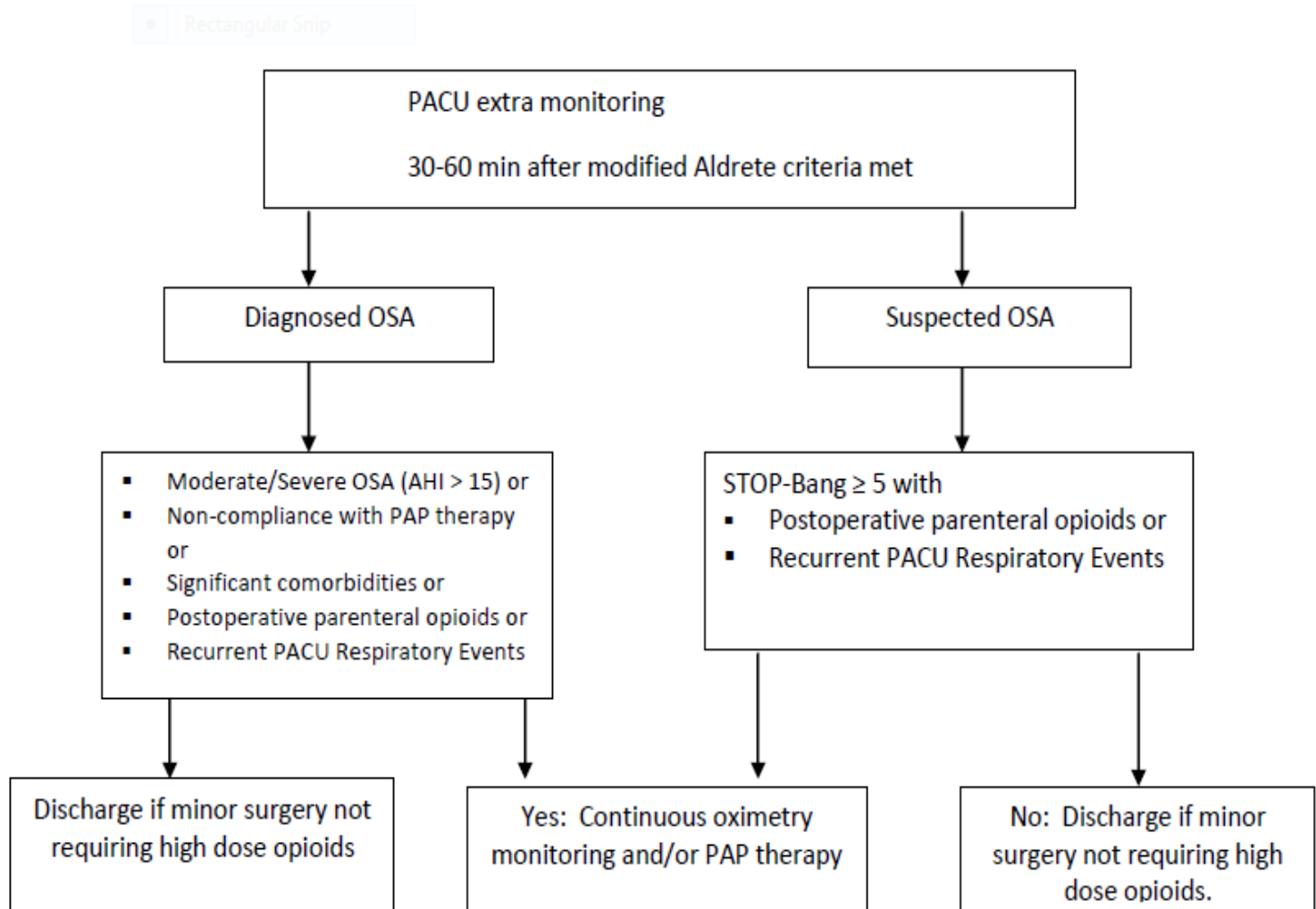
Adapted from Seet E, Chung F Can J Anesth 2010; 57: 849-64

Table 1: Intraoperative Precautions and Strategies

Anesthetic Concern	Principles of Management
Premedication	Avoid sedating premedication Consider Alpha-2 adrenergic agonists (clonidine, dexmedetomidine)
Potential difficult airway (difficult mask ventilation and tracheal intubation)	Optimal positioning (Head Elevated Laryngoscopy Position) if patient obese Adequate preoxygenation Consider CPAP preoxygenation Two-handed triple airway maneuvers Anticipate difficult airway. Personnel familiar with a specific difficult airway algorithm
Gastroesophageal reflux disease	Consider proton pump inhibitors, antacids, rapid sequence induction with cricoid pressure
Opioid-related respiratory depression	Minimize opioid use Use of short-acting agents (remifentanil) Multimodal approach to analgesia (NSAIDs, acetaminophen, tramadol, ketamine, gabapentin, pregabalin, dexmedetomidine, clonidine, Dexamethasone, melatonin) Consider local and regional anesthesia where appropriate
Carry-over sedation effects from longer-acting intravenous and volatile anesthetic agents	Use of propofol / remifentanil for maintenance of anesthesia Use of insoluble potent anesthetic agents (desflurane) Use of regional blocks as a sole anesthetic technique
Excessive sedation in monitored anesthetic care	Use of intraoperative capnography for monitoring of ventilation
Post-extubation airway obstruction	Verify full reversal of neuromuscular blockade Extubate only when fully conscious and cooperative Non-supine posture for extubation and recovery Resume use of positive airway pressure device after surgery

Figure 2: Postoperative Disposition of Known and Suspected OSA Patient

Figure 2 - Postoperative Management of the Diagnosed or Suspected OSA Patient after General Anesthesia



Adapted from Seet E, Chung F Can J Anesth 2010; 57: 849-64

Legend

^A Positive Airway Pressure (PAP) therapy - including continuous PAP, bilevel PAP, or automatically adjusting PAP.

^B Significant comorbidities – heart failure, arrhythmias, uncontrolled hypertension, cerebrovascular disease, metabolic syndrome, obesity BMI > 35 kg/m²

^C Recurrent Postanesthesia Care Unit (PACU) Respiratory Event – repeated occurrence of oxygen saturation < 90%, or bradypnea < 8 breaths / min, or apnea ≥ 10 s, or pain sedation mismatch (high pain and sedation scores concurrently).²¹

^D Monitored bed - environment with continuous oximetry and the possibility of early medical intervention (e.g. intensive care unit, step-down unit, or remote pulse oximetry with telemetry in surgical ward).

^E Equianalgesic doses of oral opioids – Codeine 60mg Q4H, Oxycodone 5mg Q4H, Hydromorphone 2mg Q4H

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