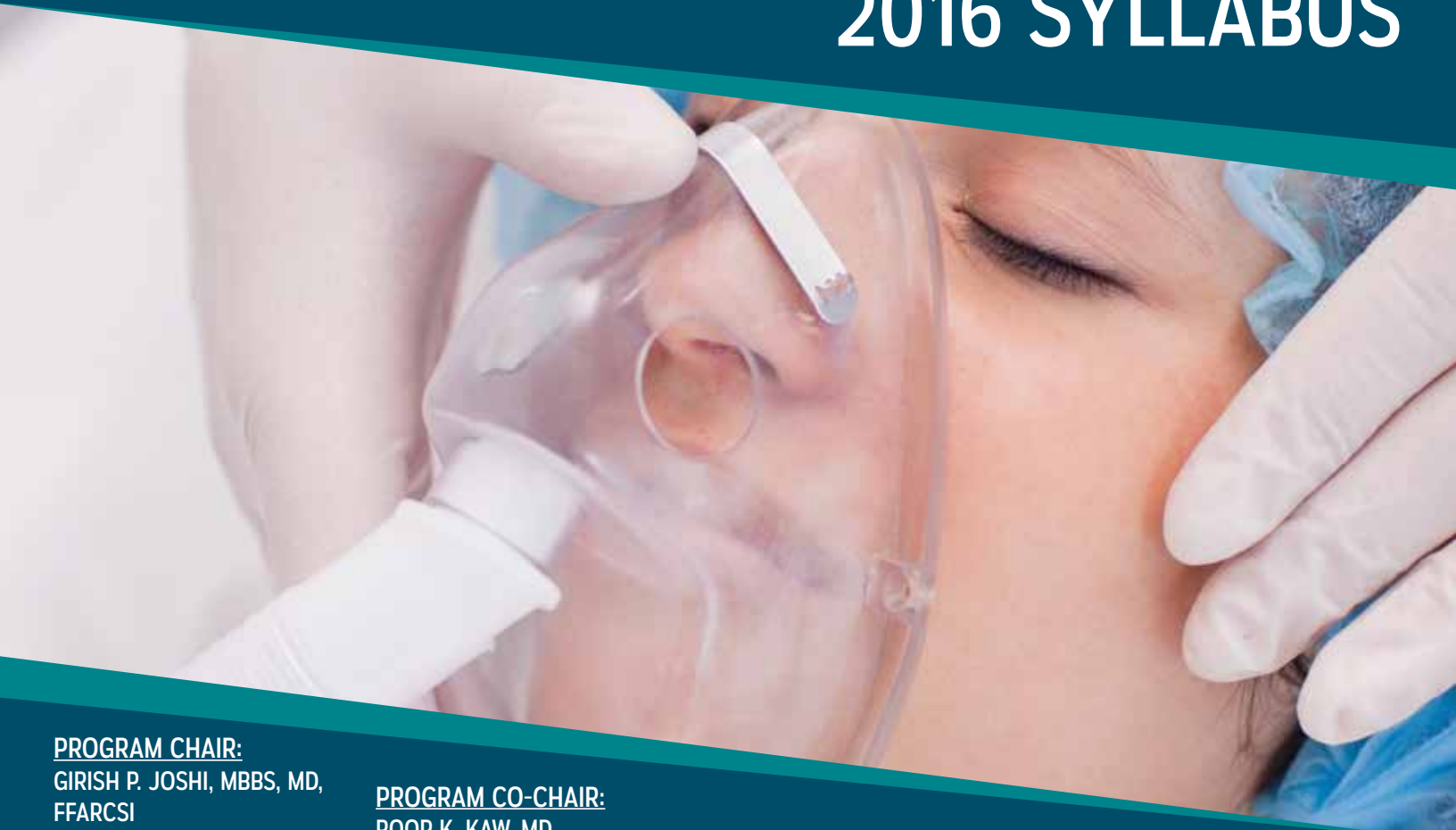


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## SASM 6<sup>TH</sup> ANNUAL MEETING

OCTOBER 20-21, 2016

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**BREATHING: IT'S NOT JUST SLEEP APNEA**

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## PROGRAM OBJECTIVE

The objective of this meeting is to provide a forum for discussions pertaining to the common grounds between sleep and anesthesia. The goal is to promote excellence in medical care, research and education in anesthesia, sleep medicine and perioperative medicine.

## TARGET AUDIENCE

This conference is designed for anesthesiologists, critical care physicians, residents, fellows-in-training, general medicine physicians, pulmonary physicians, sleep medicine physicians, surgeons, scientists and allied health care professionals.

## PRACTICE GAPS

The overall goal of SASM is to advance standards of care for clinical problems shared by anesthesiology and sleep medicine, including perioperative management of sleep disordered breathing (SDB), and to promote interdisciplinary communication, education and research in matters common to anesthesia and sleep.

**To identify and address present clinical practice gaps, we propose to explore the following gaps existing today in care of patients with sleep-disordered breathing:**

- Special challenges in perioperative management of restless leg syndrome, narcolepsy and insomnia
- Difficulty in recognition of sleep-disordered breathing in pregnant females; concerns regarding neuraxial opioids in pregnant patients undergoing labor or delivery; and PAP therapy in pregnant patients
- What's new on monitoring and devices

## LEARNING OBJECTIVES

1. Discuss preoperative considerations and management in special situations like restless leg syndrome, narcolepsy and insomnia.
2. Explore alternative therapies to positive airway pressure and the changing landscape of non-invasive ventilation.
3. Discuss anesthetic risks for neuraxial opioids in parturients with sleep-disordered breathing undergoing labor epidural and/or cesarean section, as well as for parenteral opioids in non-obstetric surgery in the obstetric patient.
4. Examine European perspectives in management of sleep-disordered breathing.

## ACCREDITATION STATEMENT

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of Amedco and the Society of Anesthesia and Sleep Medicine (SASM). Amedco is accredited by the ACCME to provide continuing medical education for physicians.

## CREDIT DESIGNATION STATEMENT

Amedco designates this live activity for a maximum of **12.75 AMA PRA Category 1 Credits™**. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

# PROGRAM COMMITTEE & SPEAKER DISCLOSURES

## PROGRAM COMMITTEE

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Program Chair

**Roop K. Kaw, MD**  
2016 Annual Meeting  
Program Co-Chair

## SPEAKERS

*For a full list of speaker disclosures, please see insert.*

# SCHEDULE OF EVENTS

## THURSDAY, OCTOBER 20, 2016

1:00 – 1:05 pm	<b>Welcome – 6th Annual Meeting Anniversary Highlights</b>	<i>Girish P. Joshi, MBBS, MD, FFARCSI</i>
1:05 - 2:45 pm	<b>Devices in Management of Sleep-Disordered Breathing Patients: Interfaces; Moderator: Roop Kaw, MD</b>	<b>Room: Regency Ballroom A</b>
1:05 – 1:35 pm	<b>CNEP Device</b>	<i>Nicholas Hill, MD</i>
1:35 – 2:05 pm	<b>Alternative Treatments to Positive Airway Pressure Therapy for OSA</b>	<i>Peter Gay, MD</i>
2:05 – 2:35 pm	<b>The Changing Landscape of NIV: Introducing Helmet Ventilation</b>	<i>Bhakti Patel, MD</i>
2:35 – 2:45 pm	<b>Panel Discussion</b>	
2:45 – 3:15 pm	<b>Coffee Break</b>	<b>Room: Regency Ballroom Foyer</b>
3:15 - 5:00 pm	<b>Monitoring for Patients with Sleep-Disordered Breathing Moderator: Frances Chung, MB BS</b>	<b>Room: Regency Ballroom A</b>
3:15 - 3:45 pm	<b>Monitoring Other? Delirium, Mood and Pain Scales</b>	<i>Pratik Pandharipande, MD</i>
3:45 - 4:15 pm	<b>Update on Continuous Respiratory Monitoring Options for Low Acuity Settings</b>	<i>Frank Overdyk, MSEE, MD</i>
4:15 - 4:45 pm	<b>Monitoring and Troubleshooting Adherence to PAP Devices and Understanding Device Downloads</b>	<i>Christine Won, MD</i>
4:45 - 5:00 pm	<b>Panel Discussion</b>	
5:30 - 6:30 pm	<b>Welcome Reception</b>	<b>Room: Regency Ballroom C/D/E</b>
6:00 - 8:00 pm	<b>Dinner *Additional Fee Applies for Non-Gold Patron Members</b>	<b>Room: Regency Ballroom B</b>
6:00 - 6:05 pm	<b>Welcome and Introductions</b>	<i>Peter Gay, MD</i>
6:05 - 7:00 pm	<b>The Patient Safety Movement Foundation</b>	<i>Joe Kiani</i>
7:00 - 8:00 pm	<b>Sleep and Patient Safety: Not So Strange Bedfellows</b>	<i>Tim Morgenthaler, MD</i>

## FRIDAY, OCTOBER 21, 2016

7:00 - 7:30 am	<b>Registration and Continental Breakfast</b>	<b>Room: Regency Ballroom C/D/E</b>
7:30 - 7:55 am	<b>Annual General Meeting; Peter Gay, MD, SASM President</b>	<b>Room: Regency Ballroom A</b>
8:00 - 10:00 am	<b>Keynote Speakers and Special Topics Moderator: Dennis Auckley, MD</b>	<b>Room: Regency Ballroom A</b>
8:00 – 8:05 am	<b>Welcome - Overview</b>	<i>Dennis Auckley, MD</i>
8:05 - 8:55 am	<b>KEYNOTE SESSION: Sleep-Disordered Breathing and Safety in Hospitalized Patients</b>	<i>Phyllis C. Zee, MD, PhD</i>
8:55 - 9:45 am	<b>KEYNOTE SESSION: Obesity Hypoventilation Syndrome: The Big and the Breathless</b>	<i>Babak Mokhlesi, MD</i>
9:45 - 10:00 am	<b>Panel Discussion</b>	
10:00 – 10:30 am	<b>Refreshment Break and Poster Viewing</b>	<b>Room: Regency Ballroom C/D/E</b>
10:30 - 12:15 pm	<b>Sleep-Disordered Breathing in Pregnancy Moderator: Alexandra S. Bullough, MBChB, FRCA, MD</b>	<b>Room: Regency Ballroom A</b>
10:30 - 11:00 am	<b>Sleep-Disordered Breathing in Pregnancy: What's All the Fuss About?</b>	<i>Judette Louis, MD, MPH</i>
11:00 - 11:30 am	<b>Screening and Drugs: Like the TSA...</b>	<i>Ellen Lockhart, MD</i>
11:30 - 12:00 pm	<b>PAP Therapy in Pregnancy</b>	<i>Louise O'Brien, PhD, MS</i>

# SCHEDULE OF EVENTS

FRIDAY, OCTOBER 21, 2016 <i>CONTINUED</i>		
12:00 - 12:15 pm	Panel Discussion	
12:15 - 1:15 pm	Awards & Presentations Luncheon	<i>Room: Regency Ballroom C/D/E</i>
	<i>Moderators: Malin Jonsson Fagerlund, MD, PhD and Toby Weingarten, MD</i>	
12:30 - 1:00 pm	1st, 2nd and 3rd Place Best Scientific Abstract Award Presentations	
	<i>Moderators: Anthony Doufas, PhD and Roop Kaw, MD</i>	
1:00 - 1:05 pm	2016 Research Grant Recipient Award	
1:05 - 1:15 pm	2015 Research Grant Recipient Presentation	<i>Mandeep Singh, MD</i>
1:15 - 3:00 pm	Perioperative Potpourri <i>Moderator: Peter Gay, MD</i>	<i>Room: Regency Ballroom A</i>
1:15 - 1:45 pm	Patient with Restless Leg Syndrome: Perioperative Considerations	<i>Lynn Marie Trotti, MD</i>
1:45 - 2:15 pm	Patient with Narcolepsy: Perioperative Considerations	<i>Mandeep Singh, MD</i>
2:15 - 2:45 pm	Patient with Insomnia: Perioperative Considerations	<i>Dennis Auckley, MD</i>
2:45 - 3:00 pm	Panel Discussion	
3:00 - 3:15 pm	Refreshment Break and Poster Viewing	<i>Room: Regency Ballroom C/D/E</i>
3:15 - 5:00 pm	Perioperative Care of Patients with Sleep-Disordered Breathing: European Perspective; <i>Moderator: Stavros Memtsoudis, MD</i>	<i>Room: Regency Ballroom A</i>
3:15 - 3:45 pm	Sleep-Disordered Breathing and Surgery of Colorectal Cancer	<i>Karl Franklin, MD</i>
3:45 - 4:15 pm	Managing Sleep-Disordered Breathing in the Perioperative Period: A Research Update	<i>Malin Jonsson Fagerlund, MD, PhD</i>
4:15 - 4:45 pm	Anxiety Free Operating Room: Implications for a Patient with Sleep-Disordered Breathing	<i>Holger Sauer, MD</i>
4:45 - 5:00 pm	Panel Discussion	
5:00 pm	Closing Remarks and i-Pad Giveaway	<i>Girish P. Joshi, MBBS, MD, FFARCSI</i>

## CONTINUING MEDICAL EDUCATION (CME) CERTIFICATE

### IMPORTANT!

To obtain your Continuing Medical Education (CME) certificate, go to [SASM.CmeCertificateOnline.com](http://SASM.CmeCertificateOnline.com). Click on the "SASM 6th Annual Meeting" link, complete the survey and print your certificate. Questions? Email [Certificate@AmedcoEmail.com](mailto:Certificate@AmedcoEmail.com)

# RESEARCH GRANT AWARD

Congratulations to Principal Investigator Vidya T. Raman, MD, with the Nationwide Children's Department of Anesthesiology & Pain Medicine, for winning the SASM 2016 Research Grant! Dr. Raman will be awarded at the 6th Annual Meeting luncheon on Friday, October 21, 2016.

**Project Title:** Post-Operative Outcomes from Obstructive Sleep Apnea (OSA) Screening Questions with BMI and Neck Circumference

**Principal Investigator:** Vidya T. Raman, MD

## ABSTRACT AWARDS

### FIRST PLACE AWARD

**Abstract:** Counterintuitively, Higher Continuous Infusion Rate of Dexmedetomidine Shows the Tendency to Retain Both Hypoglossal and Phrenic Nerve Activities Compared to Lower Rate in Anesthetized Rabbits

**Co-Authors:** Shinichi Nakamura, MD, Takato Uchida, MD, Natsuo Kimura, MD, Shingo Hijikata, MD and Yuichi Fukushima, MD, General Hospital, Saitama, Japan

### SECOND PLACE AWARD

**Abstract:** Role of an Ancestral Protein in the Mechanism of Restorative Sleep

**Co-Authors:** Matthew A. Strobe, DO Candidate, College of Osteopathic Medicine, Kansas City University of Medicine and Biosciences, Kansas City, Missouri, Julie L. Mustard and Norbert W. Seidler, PhD, Division of Basic Sciences, Kansas City University of Medicine and Biosciences, Kansas City, Missouri

### THIRD PLACE AWARD

**Abstract:** Mobile Phone App-Based Novel Oximetry System

**Co-Authors:** Edwin Seet, MBBS, MMed (Anesthesiology), Head and Senior Consultant, Department of Anesthesia, Alexandra Health System, Daniel Chia, PhD, Director Transformation Office, Alexandra Health System

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\* = First Place Award Winner, \*\* = Second Place Award Winner, \*\*\* = Third Place Award Winner

## **A Novel Nasal PAP Mask Assembly as a Rescue Device for Emergency Intubation in an Obese Patient with Difficult Airway and Bi-PAP Dependence**

**Co-Authors:** Rose Alloteh, MD, Amanda Zarchin, MD, Antonio Chiricolo, MD, Arpit Patel, MD, Amanda Doucette, MD and James Tse, PhD, MD

Department of Anesthesiology, Rutgers-Robert Wood Johnson Medical School, New Brunswick, NJ

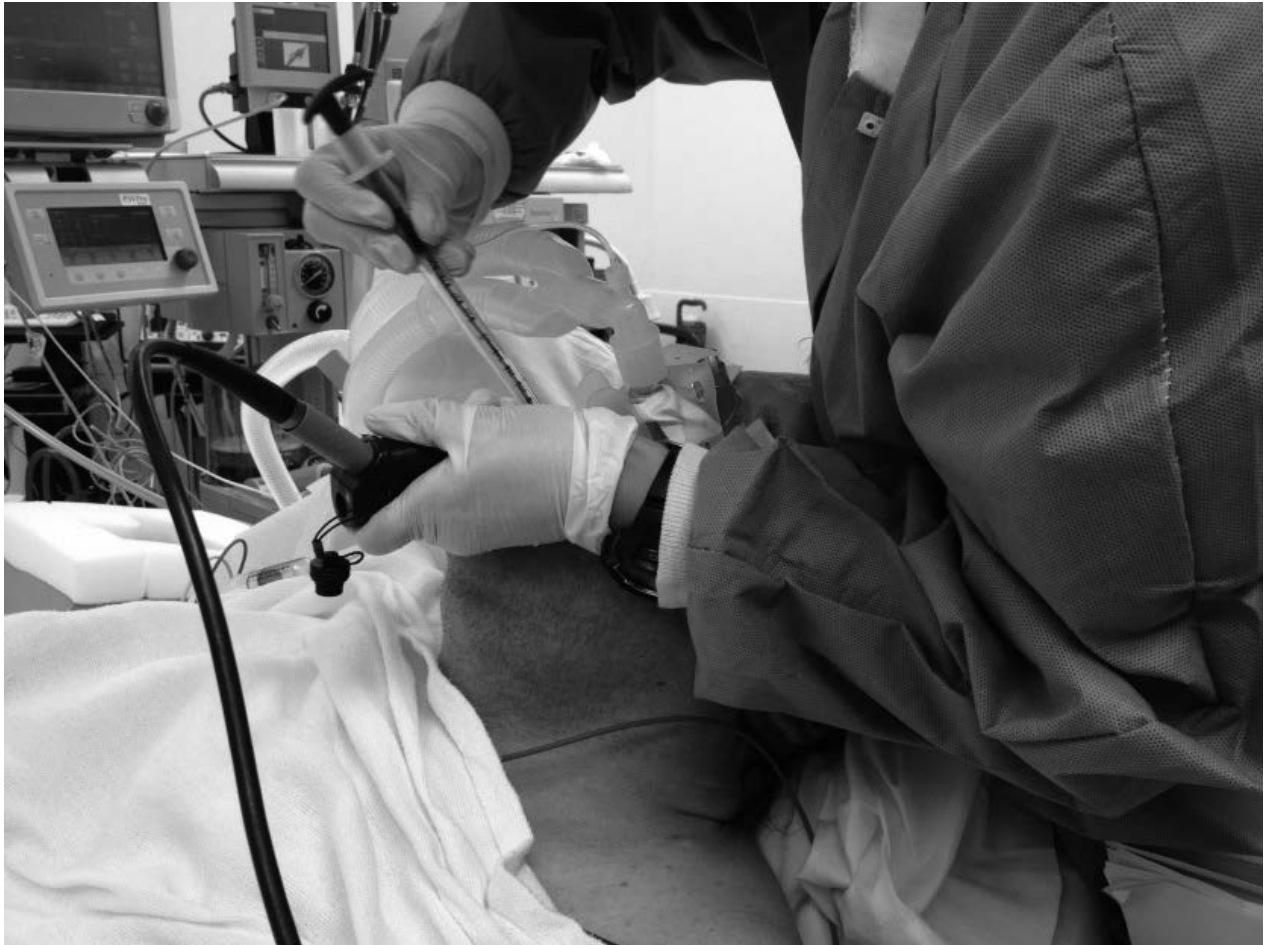
**Introduction:** Emergency endotracheal intubations can present great challenge in obese patients, but even more so in those reliant on noninvasive ventilation methods to maintain their oxygen saturation. A simple nasal PAP mask assembly has been shown to provide nasal CPAP to maintain spontaneous ventilation and to improve oxygenation in sedated obese patients with OSA.<sup>1-4</sup> We used this nasal mask assembly to maintain an obese patient with respiratory failure on BiPAP during endotracheal intubation.

**Case Description:** A 58-year-old obese male (BMI 35 kg/m<sup>2</sup>) with history of ESRD on HD, DM, HTN, CHF, was determined to need emergent intubation because of respiratory failure despite BiPAP after acute CVA. Upon arrival to patient room, the patient was noted to be agitated, tachypneic and tachycardic with SpO<sub>2</sub> at 99% on BiPAP with 1.0 FiO<sub>2</sub>. With face mask/bag-valve device in place for pre-oxygenation, propofol 50mg was administered. Direct laryngoscopy was attempted with a Macintosh 3 blade. Patient immediately desaturated to 93%. Bag mask ventilation was resumed to bring his SpO<sub>2</sub> to 100%. Additional 50 mg of propofol was administered. An infant mask with a fully inflated air-cushion was secured over his nose and attached to the BiPAP machine. Endotracheal intubation was accomplished with a video-laryngoscopy while the nasal BiPAP providing continuous oxygenation. The patient maintained 99-100% SpO<sub>2</sub> throughout the second intubation attempt. Two days later patient was able to be extubated successfully and was stable on O<sub>2</sub> via nasal cannula.

**Discussion:** This simple nasal mask assembly was used to provide BiPAP to improve oxygenation during emergent intubation of an obese, BiPAP dependent patient. It prevented severe desaturation and allowed calm endotracheal intubation attempts in a patient with a difficult airway. Using existing equipment, this technique may improve patient safety during emergent intubations at a very low cost.

**References:** References: 1.[www.TSEMmask.com](http://www.TSEMmask.com); 2. A Simple and Effective Technique to Improve Oxygenation of Obese Patients with Obstructive Sleep Apnea under Deep Propofol Sedation during Upper GI Endoscopy. Poster Presentation at the SAMBA 28<sup>th</sup> AM, Scottsdale, AZ, April 11-14, 2013; 3 & 4. A New and Low-Cost TSE-Alloteh Nasal CPAP/CF Mask/Circuit Improved Oxygenation of a High-Risk Obese Patient with OSA under MAC for TEE; A New and Low-Cost

TSE-Alloteh Nasal CPAP/CF Mask/Circuit Improved Oxygenation of a High-Risk Obese Patient with OSA under MAC for Bronchoscopy. Poster Presentations at the SASM 2013 AM, San Francisco, CA, Oct 10-11, 2013



## No Neck, Tongue Laceration - Maintaining Oxygenation and Ventilation in a Sedated Patient with Mandibular Neck Fractures During Repair of Tongue Lacerations

Rose Alloteh, MB, ChB, Department of Anesthesiology, Rutgers-Robert Wood Johnson Medical School, New Brunswick, NJ

**Introduction:** Case description: A 75-year-old male sustained bilateral mandibular neck fractures and multiple tongue and lip lacerations from a fall secondary to syncope. He had NIDDM and denied cardiac diseases. His ECG revealed sinus rhythm with PACs and nonspecific T wave changes. Transthoracic Echo-cardiography revealed normal ventricular function, mild diastolic function and no valvular diseases. He had a very limited mouth opening because of the rigid cervical collar and pain. His oral surgeon planned to repair the lacerations under local anesthesia and requested N<sub>2</sub>O via a nasal mask assembly and IV sedation. He was pre-treated with 10 mg metoclopramide despite he was NPO>18 hours. An infant mask was secured over his nose with head straps and connected to a breathing circuit and the anesthesia machine via a flexible connector. The APL valve was adjusted to deliver 4-5 cm H<sub>2</sub>O CPAP with 2 L/min O<sub>2</sub> and 2 L/min N<sub>2</sub>O. Deep sedation was induced with 40 lidocaine and 60 mg propofol and maintained on 50% N<sub>2</sub>O and propofol infusion (50-100 mcg/kg/min). He maintained spontaneous ventilation and 100% PsO<sub>2</sub> throughout the procedure. He recovered quickly from sedation.

**Discussion:** A Nasal CPAP mask/circuit was used to maintain general anesthesia with spontaneous respiration and oxygenation without interruption to the surgical field due to any airway obstruction. Using existing anesthesia equipment, this technique allows for improved patient safety as well as decreased need for airway manipulation due to obstruction, resulting in less interruption of the procedure.



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## The Perioperative Experience of Narcolepsy Patients Undergoing Anesthesia or Moderate Sedation: A Patient Survey. SASM-Narcolepsy Network Task Force

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**Introduction:** Narcolepsy is a central hypersomnia usually associated with REM epiphenomena (e.g. cataplexy, hypnagogic and hypnopompic hallucinations, sleep paralysis). Stimulants and gamma-hydroxy butyrate (GHB) and/or antidepressants are used for symptom control. Narcolepsy Type I is associated with low CSF hypocretin levels, thought to be important in emergence from general anesthesia. Concerns have been raised regarding narcolepsy in the perioperative setting, including medication interactions, enhanced sensitivity to anesthetics, postoperative respiratory complications and worsening of cataplexy. This survey study sought to better understand the perioperative experience of narcolepsy patients undergoing anesthesia or moderate sedation.

**Methods:** A 22 item questionnaire was developed and administered to the members of the Narcolepsy Network (NN), a patient support group for people with narcolepsy and their families. The questionnaire was distributed 3 times by email to the NN listserve, as well posted on the NN Facebook page for access between September and November of 2015. Descriptive and comparative statistics were used to analyze the responses.

**Results:** A total of 1162 responses were received, of which 1020 responses were from patients with narcolepsy who had undergone at least one procedure under anesthesia or moderate sedation. Respondents were generally female (79.5%) and Caucasian (84.9%) with a mean age of 45 years old. Respondents were infrequently counseled about the potential for increased sleepiness (20.9%), increased cataplexy (4.0%) or driving restrictions following surgery (34.1%). About fifty-four percent of respondents were concerned about their ability to take stimulants postoperatively, and 52.3% were concerned about difficulty awakening after surgery. Perioperative complication related to their narcolepsy were perceived by 18.2% of respondents, including difficulty awakening (35.6%), and increased antidepressants use (8.1%). In addition, 12.5% reported inadequate pain relief with 7.3% stating their pain medications were limited due to the use of gamma hydroxy butyrate. A multivariable logistic regression found that having 5 or more surgeries or procedures had a 2-fold increase in self-reported surgical complications (OR 2.36, p=.00), difficulty waking up (OR 2.12, p=.000) and inadequate pain relief (OR 1.67, 95% CI..., p=.05). The presence of cataplexy before surgery was associated with increased risk of surgical complications (OR 1.49, p=.02).

**Conclusions:** Patients with narcolepsy undergoing anesthesia or moderate sedation are infrequently counseled regarding the potential for worsening of narcolepsy symptoms after surgery. A majority have concerns about perioperative risks, and 18% perceived postoperative complications that were related to narcolepsy. Further work is needed to assess the knowledge of perioperative providers regarding narcolepsy and whether patients with narcolepsy are at increased risk of postoperative complications.

## Ability of Clinical Scores to Predict Severe Obstructive Sleep Apnea Among Bariatric Patients

Noemie Banaïas, MD, CHRU Lille

**Introduction:** This study aimed at comparing STOP-Bang, DES-OSA and DIS (Difficult Intubation Scale) within the same population of bariatric patients, and regarding their ability to detect severe OSA (sOSA). sOSA was defined as an Apnea Hypopnea Index (AHI) > 30.

**Materials and Methods:** Following informed consent and IRB approval, 210 consecutive adult bariatric patients were recruited (ClinicalTrial.gov: NCT02324946). For each patient, the above three scores were collected. Each patient had a polysomnography (PSG). The ability of the 3 scores to predict sOSA (AHI>30) were compared using sensibility (Se), specificity (Sp) and area under ROC curve (AUROC). Three different analyses were performed: 1) whole study sample, 2) patients with a BMI<40 kg/m<sup>2</sup>, 3) patients with a BMI>40 kg/m<sup>2</sup>. A two-tailed P value lower than 0.05 was considered significant.

### Results:

1) Whole study sample (figure 1A): Se and Sp (%) were 81.3 and 70.5 for STOP-Bang, 75.0 and 70.5 for DES-OSA, and 35.9 and 82.2 for DIS. STOP-Bang and DES-OSA were significantly more sensible and specific than DIS. AUROC (95% CI) were 0.813 (0.744-0.882) for STOP-Bang, 0.763 (0.688-0.838) for DES-OSA, and 0.622 (0.538-0.707) for DIS. AUROC of STOP-Bang and DES-OSA were significantly greater than DIS.

2) BMI<40 kg/m<sup>2</sup> (figure 1B): Se and Sp (%) were 62.5 and 74.5 for STOP-Bang, 62.5 and 94.5 for DES-OSA, and 31.3 and 87.3 for DIS. DES-OSA was significantly more specific than STOP-Bang. AUROC (95% CI) were 0.802 (0.664-0.940) for STOP-Bang, 0.829 (0.698-0.960) for DES-OSA, and 0.628 (0.465-0.790) for DIS. AUROC of DES-OSA was significantly greater than DIS.

3) BMI>40 kg/m<sup>2</sup> (figure 1C): Se and Sp (%) were 87.5 and 68.1 for STOP-Bang, 79.2 and 58.2 for DES-OSA, and 37.5 and 79.1 for DIS. STOP-Bang and DES-OSA were significantly more sensible than DIS, DES-OSA was significantly more specific than DIS. AUROC (95% CI) were 0.814 (0.733-0.895) for STOP-Bang, 0.728 (0.636-0.820) for DES-OSA, and 0.611 (0.511-0.712) for DIS. AUROC of STOP-Bang and DES-OSA were significantly greater than DIS.

**Conclusion:** In our population STOP-Bang and DES-OSA performed better than DIS in their ability to predict sOSA. For patients with a BMI<40 kg/m<sup>2</sup>, DES-OSA was more specific than STOP-Bang. For patients with a BMI>40 kg/m<sup>2</sup>, STOP-Bang tends to perform better than DES-OSA but without statistical significance.

## Depression and Sleep Disordered Breathing Symptoms in a Socioeconomically Disadvantaged Pregnant Population

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**Background and Goal of Study:** Untreated sleep disordered breathing (SDB) is a known risk factor for depression. The prevalence of depression in pregnancy is between 8-18% with higher rates in women of low socioeconomic status. Furthermore, SDB and poor quality of sleep during early pregnancy are possible risk factors for depressive symptoms later in pregnancy as well as post-partum depression. The goal of this study looking at SDB symptoms in a socioeconomically disadvantaged pregnant population before and after 20 weeks gestation was to ascertain when sleep symptoms occur in pregnancy, feasibility of sleep questionnaire screening in a pregnant population and to detect associated depression symptoms and other maternal co-morbidities in this underrepresented, vulnerable population.

**Methods and materials:** We recruited socioeconomically disadvantaged (Medicaid) pregnant women over 18 years of age to complete sleep questionnaires before and after 20 weeks gestation. The four sleep questionnaires administered included: STOP, Epworth sleepiness scale, General sleep disturbance scale (GSDS), a pregnancy specific questionnaire. Additionally, the Edinburgh postnatal depression scale (EPDS), restless leg syndrome and short demographic questionnaires were administered. After completion of the questionnaires patient medical data was also reviewed. Paired analyses were performed using Wilcoxon signed-rank and McNemar tests, while change in EPDS by comorbidities were analyzed using the Wilcoxon rank-sum test.

**Results and discussion:** Prospective, preliminary data (n=24) show women with daytime sleepiness at baseline had a significant negative change in depressive symptoms from pre-20 to post-20 weeks gestation as evidenced by a median change in EPDS score of -1 (IQR: -3 – 0) compared to 0 (IQR: 0 – 2), ( $p=0.04$ ). From the applied sleep questionnaires, only the GSDS showed a significant increase in SDB symptoms from pre-20 weeks to post-20 weeks gestation (median change (IQR): 2 (-1 – 7),  $p=0.048$ ). BMI also significantly increased after 20 weeks gestation ( $p=0.003$ ). Detection of depression in patients with SDB symptoms in a socioeconomically disadvantaged pregnant population is challenging as no ideal sleep-screening tool has been identified. Our preliminary data shows an unpredicted improvement in depressive symptoms from pre-20 to post-20 weeks gestation in women with baseline daytime sleepiness. This could potentially be confounded by the fact that women with daytime sleepiness started out with a higher baseline EPDS score ( $p=0.053$ ). Further data collection is necessary to better evaluate this finding.

**Conclusion:** Women with baseline daytime sleepiness are more likely to start out with worse depressive symptoms in pregnancy but mildly improve as evidenced by significant negative changes in EPDS scores. The GSDS may be a sleep-screening tool that can be used effectively in pregnancy to identify patients with SDB.



## Passive EPAP May Be Sufficient for Postoperative OSA Management

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**Introduction:** During spontaneous respiration, upper airways are narrowest near end-expiration; a small decrease in airway pressure at the beginning of inspiration may lead to upper airway collapse and complete obstruction. Continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP) prevents obstructive sleep apnea (OSA) most likely because of the positive pressure during expiration: both maneuvers are often necessary post-operatively to prevent OSA. Our goal was to show that this can be accomplished more conveniently while breathing spontaneously using an expiratory resistance device.

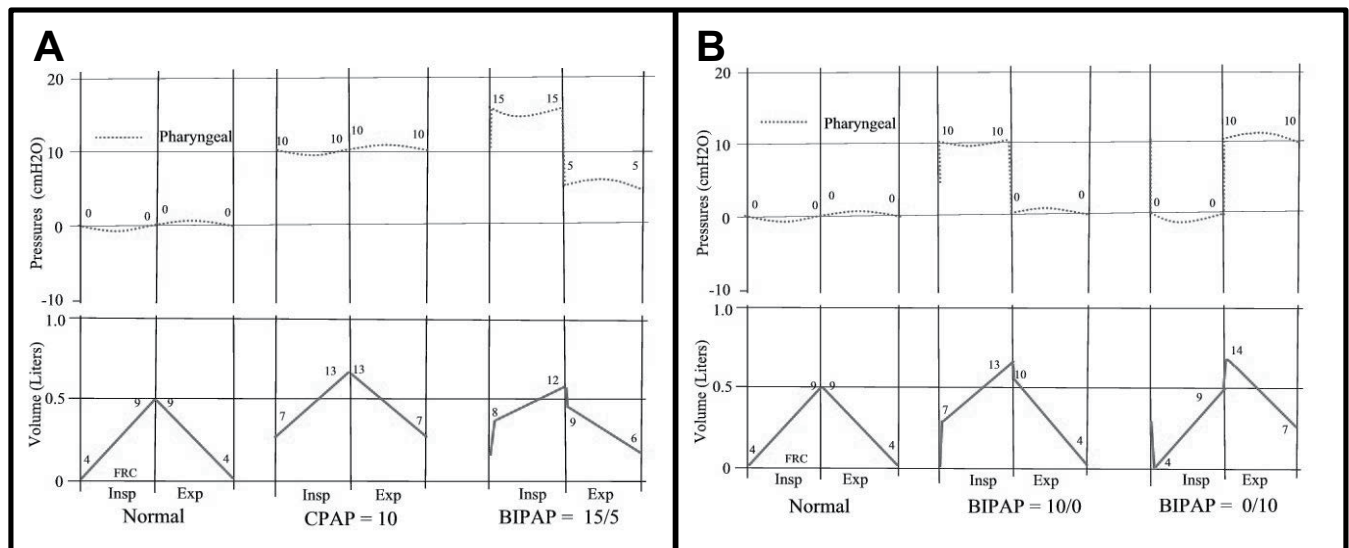
**Methods:** Figure 1A schematically illustrates the changes in pharyngeal pressure and lung volume during the application of CPAP of 10cmH<sub>2</sub>O (middle panel) or BiPAP of 15/5 cmH<sub>2</sub>O (right panel). The changes during normal breathing are also illustrated (left panel). Zero volume represents normal FRC. The numbers near the tracing represent the pressures at the beginning and end of each breath. Numbers near the volume tracing represent transmural pressure (alveolar-pleural) at the beginning and end of each breath. Figure 1B illustrates changes in pharyngeal pressure and lung volume during application of BiPAP of 10/0 cmH<sub>2</sub>O (middle panel) or 0/10 cmH<sub>2</sub>O (right panel) using a BiPAP machine (current BiPAP machines do not allow such pressure settings). The left panel demonstrates normal inspiration and expiration, as in Figure 1A. CPAP or BiPAP in Figure 1A are effective in treating OSA because the pressure during expiration remains positive, alleviating upper airway collapse. Likewise a BiPAP of 0/10 (Figure 1B) is also likely to be effective for treating OSA because the pressure during expiration is positive. The positive pressure during inspiration may be helpful but not necessary to reverse OSA.

**Results:** It is commonly believed that treatment of OSA requires pressure during inspiration to remain positive, equal to, or greater than the pressure during expiration. Apparently, OSA can be treated with only positive pressure during expiration while keeping the pressure during inspiration near zero. The tracings illustrate that BiPAP of 0/10 generates positive pressure during expiration, preventing potential upper airway collapse, while continuing to allow the patient to breathe spontaneously. Indeed expiratory resistance devices (EPAP devices) generate positive pressure during expiration and have been shown to be effective in treating OSA in patients. Therefore, there is reason to suggest that positive pressure during inspiration is not

necessary in treating OSA patients who otherwise have healthy respiratory muscles and are able to inhale spontaneously. Positive pressure can be generated spontaneously with EPAP devices, which may be sufficient to treat OSA in many patients. This is convenient because a CPAP machine may not be required.

**Conclusion:** Novel ventilatory EPAP devices (OptiPillows EPAP mask or Provent) support the hypothesis that EPAP is sufficient to treat OSA because they help maintain positive expiratory pressure spontaneously. Such EPAP devices may potentially be useful in post-operative management without the need for a CPAP or BiPAP machine. EPAP devices allow the patient to increase EPAP spontaneously just like pursed-lips breathing, and cause the pressure during expiration to become elevated while the pressure during inspiration remains zero.

**Figure 1.** A) Schematic illustration of changes in pharyngeal pressure and lung volume during normal control or application of CPAP of 10 cmH<sub>2</sub>O (middle panel) or BiPAP of 15/5 cm H<sub>2</sub>O. Zero volume represents FRC during spontaneous breathing. B) Changes in pharyngeal pressure and lung volume during application of BIPAP of 10/0 (middle panel) or 0/10 (right panel) cm H<sub>2</sub>O using a theoretical BIPAP machine allowing such settings.



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## Reduction in Post-Operative Opiates After Opiate-Free Anesthesia

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**Introduction:** Opiates produce undesirable side effects including respiratory depression, sedation, nausea/vomiting, constipation, and ileus, which can lead to significant morbidity and mortality. Additionally, short-acting opiates used during anesthesia may lead to acute opioid-induced tolerance and hyperalgesia [1]. Furthermore, opiate addiction and overdose has become an increasing national problem. Most of the overdose deaths are related to prescription opiates [2]. Multimodal opiate-sparing analgesia has become an alternative to managing post-surgical pain in the last 2 decades [3]. We evaluated the feasibility of using non-opiate, multi-modal analgesics perioperatively to obtain adequate analgesia.

**Methods:** We conducted an IRB-approved retrospective study of the surgical cases performed by four surgeons, each of whom utilized a single anesthesiologist. Recent evidence convinced this anesthesiologist to change his anesthesia regimen from opiate-sparing anesthesia (OSA) to opiate-free anesthesia (OFA) [4]. This created a unique study paradigm: we compared groups of patients from the last 2 months of 2013 and the last 2 months of 2015. Patients received extensive breast reconstruction or middle ear surgeries when the anesthesiologist utilized OSA (2013) and OFA (2015). Our control group consisted of patients operated on by the same surgeons when the anesthesiologist was being covered for by another anesthesiologist using a standard opiate anesthesia (OA) regimen.

All patients received general anesthesia utilizing varying concentrations of inhalational agent, Sevoflurane. The OA cases were done with a typical dosing of intraoperative opioids (average 17mg morphine equivalent). The OSA cases were performed with sparing use of Fentanyl (average of 1.8mg morphine equivalent). The OFA cases were performed with no opiates at all. Three preoperative oral medications (1000mg acetaminophen, 400mg gabapentin, and 400mg celecoxib) and 3 intraoperative intravenous medications (magnesium, ketamine, dexetomidine) were used instead of opiates. We utilized t-tests with Bonferroni corrections to compare post-op opiates and Zofran use.

**Results:** Table 1 summarizes the opiate needs of the 3 groups of patients: both the OA and OSA

groups needed double the opiates in the PACU as the OFA group ( $p < 0.007$ ). This difference maintained significance in the surgical post-operative unit (SPU). The 3 groups of patients had similar age, BMI, and length of surgery. The OFA group also required less Zofran, albeit this difference was not significant. 73% of the OFA patients required no postoperative opiates, compared to 37% of the OSA patients and 52% of OA patients. We noted longer PACU times in the OA group, but this result could be attributed to factors other than the anesthesia regimen.

**Discussion:** The study shows that a general anesthetic can be provided safely without opiates, perhaps indicating multimodal analgesics are acting preemptively. Future prospective studies can elucidate which medications utilized during the OFA regimen are essential. Patients can also be monitored post-operatively to help us better understand opiate needs for at-home pain. Decreased postoperative opiate requirements may lead to decreased prescriptive opiates and decreased opiate prescription abuse.

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**Table 1.** Opiate use in opiate anesthesia, opiate-sparing anesthesia, and opiate-free anesthesia patients. Opiate dosage in milligram of morphine equivalent  $\pm$  1 standard deviation. Patients receiving OFA had the least requirement of opiate in PACU and in SPU. (Note: \* denotes statistical significant)

Anesthesia Regimen	# Patients	Avg. Age	Duration of Surgery	Avg. BMI	Avg. PACU	Opiate Usage Intraoperatively * between all 3 groups	Opiate Usage in PACU * for OFA vs OS and OA	Opiate Usage in SPU * for OFA vs OS and OA	Zofran in PACU	Zofran in SPU
Opiate Anesthesia (OA) - Control	36	54.03	1:21	29.7	3:24	17.4 $\pm$ 14.6	4.5 $\pm$ 6.1	0.19 $\pm$ 0.4	0.78 $\pm$ 1.7	0
Opiate-Sparing Anesthesia (OSA)	143	54.4	1:39	28.5	1:52	1.8 $\pm$ 2.6	5.03 $\pm$ 6.5	0.25 $\pm$ 0.4	0.73 $\pm$ 1.6	0.11 $\pm$ 0.7
Opiate-Free Anesthesia (OFA)	177	54.6	1:38	29.2	1:51	0	2.05 $\pm$ 4.2	0.062 $\pm$ 0.2	0.59 $\pm$ 1.5	0.11 $\pm$ 0.7

## Post-Operative Pain in Sleep Surgery: A New Era

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**Background:** Obstructive sleep apnea (OSA) is a common condition affecting approximately 5% of the population.<sup>1</sup> First-line management of OSA in adults is typically medical therapy such as continuous positive airway pressure (CPAP). However, up to 50% of patients cannot tolerate or adhere to CPAP therapy.<sup>2</sup> Patients may then consult a surgeon to explore surgical therapy despite the potential morbidity including significant pain with associated procedures such as uvulopalatalpharyngoplasty, maxillomandibular advancement, and midline glossectomy. Oral narcotics have traditionally been a mainstay in the management of post-operative pain following sleep surgery but carry the increased risk of respiratory suppression in patients already known to have sleep disordered breathing. A newer type of sleep surgery, hypoglossal nerve stimulator implantation, has been shown to provide impressive results in the management of OSA without surgical modification of the pharyngeal airway.<sup>3</sup> As a result, the significant pharyngeal pain and narcotic burden following surgery may be significantly reduced or eliminated.

**General Aim:** Our review investigates the post-operative management of 14 consecutive patients following implantation of a hypoglossal nerve stimulator system for OSA. The peri-operative course including pre-operative, operative, and post-operative management were reviewed along with their discharge timing, pain scales, and any morbidities.

**Materials and Methods:** A retrospective review of consecutive surgical patients implanted with a hypoglossal nerve stimulator system was conducted. Subjects were all patients who were previously intolerant of CPAP therapy or refractory to other treatment methods. Subjects' pre-operative anesthesia records, operative log, and post-operative records were reviewed to identify methods used to reduce post-operative pain and the need for narcotics.

**Results:** Sleep apnea surgery was performed by implanting the hypoglossal nerve stimulator system in combination with a narcotic-sparing, multimodal anesthetic technique. This method allowed for a substantial reduction in pain with eight patients receiving no narcotics after the PACU, with six reporting 0/10 pain score through their entire postoperative course. No patients

required IV pain meds after leaving the PACU. No patients took narcotics after post-operative day three. No significant post-operative complications or morbidity was identified.

**Discussion:** The anesthetic plan for each patient had the goal of minimizing postoperative sedation and narcotic use. Narcotics, the most common type of medication used for postoperative pain control, have been associated with exacerbation of sleep-disordered breathing, worsened hypoxemia, and sleep fragmentation.<sup>4</sup> These have been linked to hyperalgesia. Our narcotic-sparing anesthetic with the use of liposomal bupivacaine infiltration of the incision sites resulted in an almost uniformly alert wake up with very little pain. This alert/comfortable post-operative course is particularly beneficial in these high-risk OSA patients who are intolerant of CPAP.

**Conclusion:** Surgery for obstructive sleep apnea that involved implantation of a hypoglossal nerve stimulator system along with enhanced pain management techniques both before and after surgery substantially reduced the need for post-operative narcotic use. Same day discharge also became feasible. We found a very different post-operative course versus traditional sleep surgery with pharyngeal reconstructive techniques and feel this represents a new era in sleep surgery anesthesia care.

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## Comparison of Clinical Scores in Their Ability to Detect Hypoxemic Severe OSA Patients.

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**Background:** Severe obstructive sleep apnea (sOSA) and preoperative hypoxemia represent risk factors of postoperative complications. Some patients exhibit the combination of both factors. Obesity and benzodiazepine intake are risk factors of hypoxemia in sOSA patients.

**General Aim:** Four scores (STOP-Bang, P-SAP, OSA50, and DES-OSA) are currently used in the preoperative setting to predict OSA patients. This study compared their ability to detect specifically hypoxemic sOSA patients.

**Materials and Methods:** 159 patients scheduled for an overnight polysomnography (PSG) were prospectively enrolled. The ability of the four scores to predict hypoxemic sOSA patients were compared using sensitivity (Se), specificity (Sp), Cohen kappa coefficient, and the area under ROC curve (AUROC) analyses. A second set of analyses was performed after the adjunction of the item “benzodiazepine intake” to each of the four scores compared.

**Results:** The highest Se [95% CI] was obtained for OSA50 (1 [0.89-1]) and was significantly greater than those of STOP-Bang. DES-OSA was significantly more specific (0.58 [0.49-0.66]) than the three other scores. The AUROC of DES-OSA (0.8 [0.71-89]) was significantly the greatest. The highest Kappa value was obtained for DES-OSA (0.33 [0.21-45]) and was significantly greater than those of STOP-Bang, and OSA50. The four scores were significantly less sensitive but more specific with the adjunction of benzodiazepine intake.

**Discussion:** In our population, only 48.8% of the sOSA patients experienced nocturnal hypoxemia. Hypoxemic sOSA who cumulate risks to develop postoperative complications might represent an important subgroup of patients to identify preoperatively. However so far, no score was tested to detect especially hypoxemic sOSA patients. Our findings demonstrate that, in our population, the DES-OSA score is more efficient to detect hypoxemic severe OSA patients than the STOP Bang, OSA50 and P-SAP scores. The addition of the criterion daily benzodiazepine intake, an independent risk factor of hypoxemia in sOSA patients, to the DES-OSA score significantly improves its specificity (0.72 vs. 0.58) but at the expense of a decreased sensibility (0.65 vs. 0.87), and with minimal changes regarding AUROC, and Kappa coefficient. This latter modification does not seem to be clinically relevant.



**Conclusion:** In our population, the DES-OSA appears to be at least as effective than the three other scores to detect specifically hypoxemic sOSA patients. Despite an increased in specificity, the adjunction of parameter “benzodiazepine intake” to the four scores does not seem to be clinically relevant.

**Table:** Ability of the four scores to predict at hypoxemic sOSA patients in terms of sensitivity (Se), specificity (Sp), Youden Index (YI), positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (+LR), and negative likelihood ratio (-LR). Results are given in fraction with 95% Confidence Interval (95% CI). The *Mc Nemar* test was applied to compare sensitivities and specificities. To correct for multiple comparisons and to avoid type I errors, the level of statistical significance was set at  $P = 0.0083$  ( $0.05/6$ ). Significant results of between 4 scores comparisons ( $P < 0.0083$ ) were indicated as follow: “1” between STOP-Bang and DES-OSA, “2” between STOP-Bang and P-SAP, “3” between STOP-Bang and OSA50, “4” between DES-OSA and P-SAP, “5” between DES-OSA and OSA50, “6” between OSA50 and P-SAP. The highest values for each analysis (Se, Sp, PPV, NPV, YI and +LR) and the lowest values for -LR are in indicated in hatched cells. The *Mc Nemar* test was also applied to compare sensitivity and specificity of each score between their initial form and the modified score taking account of benzodiazepine intake. “\*” indicates significant results ( $P < 0.05$ , Appendix 1).

		Ability to detect hypoxaemic sOSA patients with initial scores			Ability to detect hypoxaemic sOSA patients with scores modified with benzodiazepine intake		
		Value	95% CI		Value	95% CI	
STOP-Bang	Se	<b>0.800</b> <sup>2,3</sup>	0.649	0.897	<b>0.625</b> <sup>3*</sup>	0.470	0.758
	Sp	<b>0.370</b> <sup>1,3</sup>	0.288	0.459	<b>0.571</b> <sup>1,2,3*</sup>	0.482	0.657
	YI	<b>1.179</b>	1.101	1.239	<b>1.196</b>	1.121	1.271
	PPV	<b>0.299</b>	0.212	0.386	<b>0.329</b>	0.223	0.435
	NPV	<b>0.846</b>	0.748	0.944	<b>0.819</b>	0.736	0.902
	+LR	<b>1.269</b>	1.032	1.562	<b>1.458</b>	1.062	2.003
	-LR	<b>0.541</b>	0.279	1.049	<b>0.656</b>	0.427	1.008
P-SAP	Se	<b>0.975</b> <sup>2</sup>	0.857	1.000	<b>0.800</b> <sup>*</sup>	0.649	0.897
	Sp	<b>0.303</b> <sup>4,6</sup>	0.227	0.391	<b>0.429</b> <sup>2,4,6*</sup>	0.343	0.518
	YI	<b>1.278</b>	1.185	1.371	<b>1.229</b>	1.147	1.311
	PPV	<b>0.320</b>	0.237	0.402	<b>0.320</b>	0.229	0.411
	NPV	<b>0.973</b>	0.921	1.000	<b>0.864</b>	0.777	0.952
	+LR	<b>1.398</b>	1.230	1.589	<b>1.400</b>	1.124	1.744
	-LR	<b>0.083</b>	0.012	0.583	<b>0.467</b>	0.243	0.897

<b>OSA50</b>	Se	<b>1.000<sup>3</sup></b>	0.893	1.000	<b>0.900<sup>3,5*</sup></b>	0.762	0.965
	Sp	<b>0.092<sup>3,5,6</sup></b>	0.051	0.160	<b>0.210<sup>3,5,6*</sup></b>	0.146	0.293
	YI	<b>1.092</b>	1.043	1.141	<b>1.110</b>	1.056	1.164
	PPV	<b>0.270</b>	0.199	0.342	<b>0.277</b>	0.200	0.354
	NPV	<b>1.000</b>	1.000	1.000	<b>0.862</b>	0.737	0.988
	+LR	<b>1.102</b>	1.040	1.167	<b>1.139</b>	0.992	1.309
	-LR	<b>0.000</b>			<b>0.476</b>	0.176	1.285
<b>DES-OSA</b>	Se	<b>0.875</b>	0.733	0.949	<b>0.650<sup>5*</sup></b>	0.494	0.779
	Sp	<b>0.580<sup>1,4,5</sup></b>	0.490	0.665	<b>0.723<sup>1,4,5*</sup></b>	0.636	0.795
	YI	<b>1.455</b>	1.329	1.581	<b>1.373</b>	1.262	1.484
	PPV	<b>0.412</b>	0.307	0.516	<b>0.441</b>	0.314	0.567
	NPV	<b>0.932</b>	0.875	0.990	<b>0.860</b>	0.792	0.928
	+LR	<b>2.083</b>	1.636	2.651	<b>2.344</b>	1.621	3.389
	-LR	<b>0.216</b>	0.094	0.496	<b>0.484</b>	0.313	0.750

## Risk Factors for Nocturnal Hypoxemia in Patients with Severe Obstructive Sleep Apnea

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**Background:** Severe obstructive sleep apnea (OSA) and hypoxemia are both risk factors for postoperative complications. In some but not all patients, severe obstructive sleep apnea is associated with frequent hypoxic episodes during sleep.

**General Aim:** The aim of this retrospective study was to identify the risk factors for exhibiting hypoxemia in patients with severe obstructive sleep apnea patients.

**Materials and Methods:** Records of 786 patients, mainly obese (Body Mass Index [mean + SD] = 30.2 + 6.0 kg/m<sup>2</sup>), were analyzed. Univariate and multivariate analyzes were applied to identify predictive risk factors for hypoxemia. Prediction probability was used to test the association between potential risk factors (obesity, age, gender, smoking, alcohol consumption, and benzodiazepines use) and the combination of severe obstructive sleep apnea and hypoxemia. A P value < 0.05 was considered as statistically significant.

**Results:** Univariate and multivariate analyzes identified five risk factors for hypoxemia in the whole population: age (P<0.001), obesity (P<0.001), benzodiazepine use (P<0.001), smoking (P=0.016), and male gender (P=0.029). The same analyzes applied to patients with severe obstructive sleep apnea identified two independent risk factors for hypoxemia: obesity (P<0.001), and benzodiazepine use (P=0.017). Obesity obtains the best prediction probability [95% CI] for the combination of severe obstructive sleep apnea and hypoxemia: 0.74 [0.69-0.79].

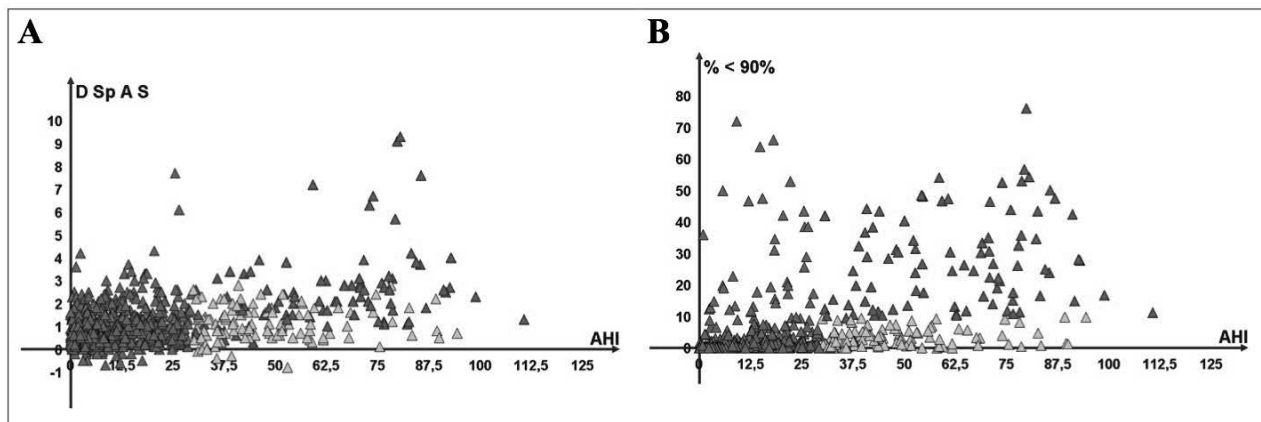
**Discussion:** Our findings illustrate marked variations in the frequency of hypoxic events and in the magnitude of hypoxemia in patients with severe OSA. Less than 50% of these patients experience nocturnal hypoxemia. Whether hypoxemic and non-hypoxemic severe OSA patients share the same risk or whether only patients with both severe OSA and hypoxemia are actually at risk is unknown before this present study.

**Conclusion:** Daily benzodiazepine intake and particularly obesity are independent risk factors for exhibiting nocturnal hypoxemia among severe OSA patients. Use of benzodiazepine in obese patients should, therefore, use cautiously. Future studies should concentrate on this subgroup of OSA patients, severe OSA with nocturnal hypoxemia, who appear to be particularly at risk for postoperative complications.

**Figure:** Distribution of the patients according to AHI and the difference between awake and sleep  $SpO_2$  (A), and the percentage of nighttime spent with a  $SpO_2 < 90\%$  (B).

Green triangles depict non-severe OSA patients; yellow triangles, non-hypoxemic severe OSA patients; and red triangles, hypoxemic severe OSA patients.

AHI = Apnea Hypopnea Index, D Sp A S = Difference between awake and sleep  $SpO_2$ , % < 90% = percentage of time spent during the night with a  $SpO_2 < 90\%$ .



## A Retrospective Assessment of Cardiomyopathy Risk in Women with OSA in Pregnancy

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**Background:** Obstructive sleep apnea (OSA) affects 15%-20% of obese pregnant women. A recent national inpatient database study showed that pregnant women with OSA have a significantly increased risk of co-morbid cardiomyopathy (aOR 9.0), congestive heart failure (aOR 8.94), and pulmonary edema (aOR 7.5) after controlling for obesity, as well as a 5-fold increased risk of in-hospital death<sup>1</sup>. Cardiomyopathy is a leading cause of maternal mortality in the United States. Our hospital is a major regional referral center for women with peripartum heart disease.

**Aim:** The purpose of this study was to examine the incidence of OSA in pregnancy among women treated at Duke University Medical Center (DUMC) with cardiomyopathy during or following pregnancy.

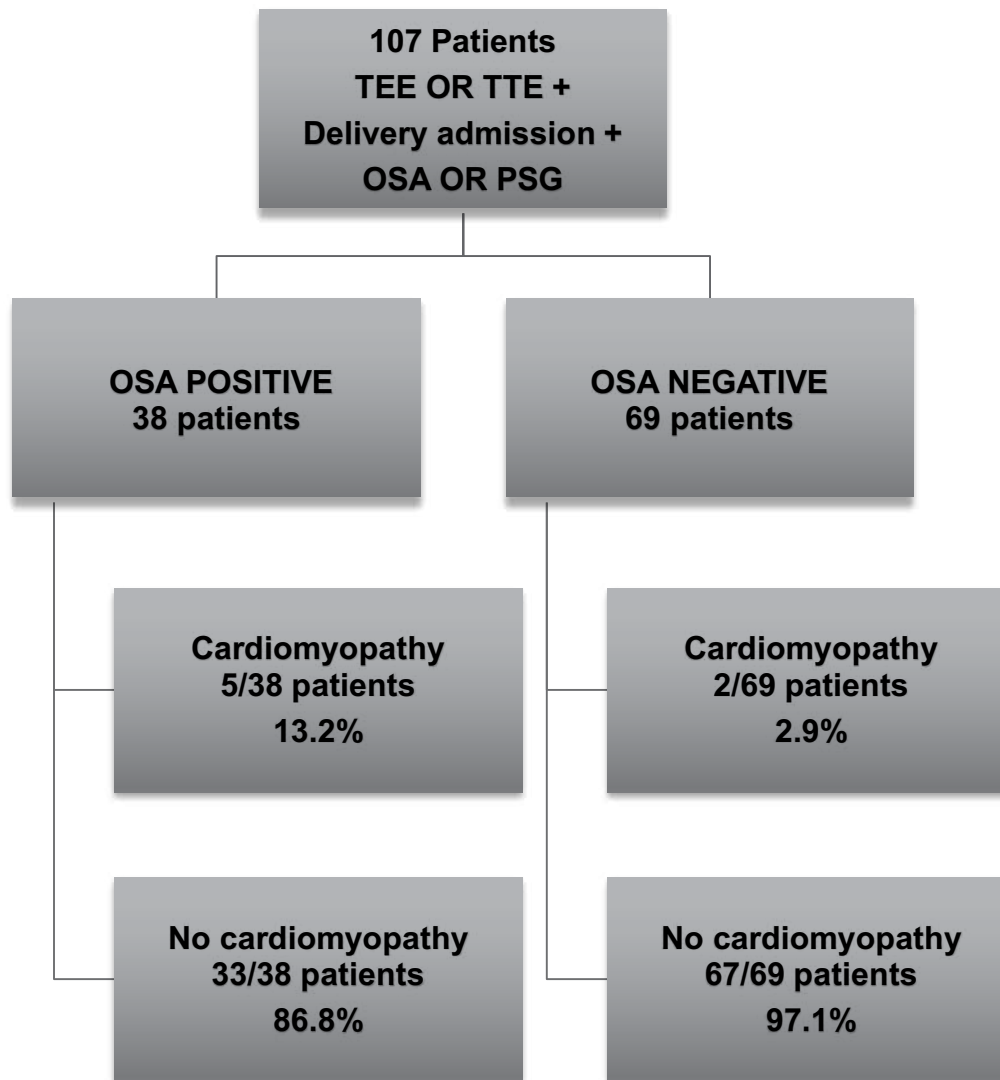
**Methods:** After IRB approval, we performed a retrospective database search to identify women treated at DUMC who had had an echocardiogram, at least one pregnancy admission, and either an OSA diagnosis (ICD-9/10 code) and/or overnight polysomnography (PSG) (by CPT code) from January 1, 2001 to December 31, 2015.

Within this cohort, we extracted data from the electronic medical record by ICD-9/10 codes to identify women that had a diagnosis of peripartum or other cardiomyopathy or congestive heart failure, and collected demographic information on these subjects.

**Results:** We identified 107 charts for review: n = 38 with OSA, and n = 69 with normal overnight polysomnography and no OSA diagnosis (Figure 1). Of the 38 patients with OSA, 5 women with either a history of cardiomyopathy or peripartum cardiomyopathy, or both were identified. Four of the five women had peripartum cardiomyopathy, and one woman had hypertrophic obstructive cardiomyopathy secondary to uncontrolled hypertension. These diagnoses were confirmed by chart review. 4/5 women were African-American, one was Caucasian; their mean

BMI = 47.6 kg.m<sup>-2</sup>; and mean age = 35 years old. In the OSA-negative group, 2 patients with peripartum cardiomyopathy were identified. One woman did have diagnosed obesity hypoventilation syndrome, but not OSA. The other patient had symptoms of OSA, but an inconclusive overnight polysomnography. Both women were African-American; their BMIs were 80 and 38 kg.m<sup>-2</sup>; and their mean age = 38 years old.

**Figure 1.** Database and chart review strategy and results



**Conclusions:** Women with cardiomyopathy and OSA during pregnancy that were identified by a retrospective database search over 14 years at DUMC were morbidly obese, predominantly African-American, and of advanced maternal age. Published data from our institution suggests a prevalence of cardiomyopathy among pregnant women of 0.16%; 80 cases of cardiomyopathy

would be expected at DUMC over 14 years. We identified 5 cases of cardiomyopathy in women with confirmed OSA. However, we only looked at OSA cases that also had an echocardiogram – which biased our sample. There were only 2 cases of cardiomyopathy in the group without an OSA diagnosis code, but both had symptoms suggestive of sleep-disordered breathing. We cannot draw conclusions about the incidence of cardiomyopathy among women with OSA in pregnancy from this study; however further studies are warranted. OSA may be a significant and modifiable risk factor for peripartum cardiomyopathy.

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## The Relationship Between Pre-Operative OSA Status and 30-Day Post-Surgical Outcomes in a General Surgical Population

**Presenting Author:** Jennifer Estrella Dominguez, MD, MHS

**Co-Authors:** Richard Moon, MD, Mary Cooter, MS, Ashraf S. Habib, MBBCh, Msc, MHSc, FRCA

**Background:** Obstructive sleep apnea (OSA) has been associated with adverse post-surgical outcomes in several studies (1, 2). To date, there is no care pathway at our institution for the pre-operative optimization of patients with either known OSA or high-risk for OSA.

**Aim:** The purpose of this study was to examine the impact of OSA status on post-operative care unit (PACU) and hospital length of stay (LOS), and on the incidence of 30-day post-operative complications among patients who underwent non-cardiac, non-ophthalmologic surgery.

**Methods:** After IRB approval, we performed a retrospective database analysis of the electronic medical records (EMRs) of adult patients that underwent non-cardiac, non-ophthalmologic outpatient and inpatient surgery at Duke University Medical Center (DUMC) between June 20, 2013 and December 15, 2015. We included patients that had either a pre-surgical diagnosis of OSA by ICD-9/10 code, OSA-positive status in the pre-operative assessment note or a polysomnography study (by procedure code). We extracted demographic information, surgery types, 30-day post-surgical outcomes by ICD-9/10 codes, and PACU/Hospital LOS. By chart review, we identified a subset of patients in this cohort that had negative polysomnography studies as our OSA-negative comparison group.

We evaluated the differences in baseline characteristics and 30-day outcomes between the 2 groups. Patients were allowed to contribute multiple surgeries to the analysis, unless they occurred within 30-days of each other in which case only the first surgery was included. Categorical baseline characteristics and binary outcome variables were reported with count (%) and compared with Chi-Square or Fisher's exact tests, and numeric variables were reported as median (IQR) and compared with Wilcoxon Rank Sum tests due to their skewed distributions. The alpha-level for significance was set at 0.05.

**Results:** Our database extraction yielded 18,799 surgeries for analysis. Exclusion for multiple surgeries within 30-days yielded 12,693 surgical events (1,210 OSA-negative and 11,483 OSA-positive patients). Baseline demographic characteristics between the OSA-positive and OSA-negative groups were significantly different; OSA-positive surgical patients were more likely to be male, older, and have a higher BMI and ASA score ( $p < 0.001$ ). Hospital LOS was significantly longer for patients in the OSA-positive vs. negative group [0.46(0.18, 2.31) vs. 0.29(0.16, 2.12)



days,  $p < 0.0001$ ]. There were no significant differences in PACU LOS. Thirty-day post-surgical outcomes are described in the Table.

**Conclusions:** We found that patients with preexisting OSA had more cardiac morbidity, but not mortality, within the first 30-days following surgery than patients without OSA. Patients with OSA were also more likely to have acute respiratory failure in the first 30-days after surgery, but there were no differences in overall mortality at 30-days. Due to the group size imbalance and differences in baseline characteristics identified in this preliminary analysis, we plan on using a matching algorithm to homogenize the OSA groups in future analyses. This study design did not allow us to examine the effect of OSA-treatment on post-surgical outcomes. Future studies will be aimed at examining the effect of OSA therapy and pre-operative care pathways designed to optimize patients with OSA on their post-surgical outcomes.

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**Table. Thirty-day post-surgical morbidity and mortality**

	OSA-negative (N=1,210)	OSA-positive (N=11,483)	Total (N=12,693)	P-value
<b>30-Day Mortality</b>				0.3700
No	1206 (99.67%)	11423 (99.48%)	12629 (99.50%)	
Yes	4 (0.33%)	60 (0.52%)	64 (0.50%)	
<b>30-Day Acute Renal Failure</b>				0.1577
No	1207 (99.75%)	11419 (99.44%)	12626 (99.47%)	
Yes	3 (0.25%)	64 (0.56%)	67 (0.53%)	
<b>30-Day Atrial Fibrillation/Flutter</b>				0.0001
No	1142 (94.38%)	10467 (91.15%)	11609 (91.46%)	
Yes	68 (5.62%)	1016 (8.85%)	1084 (8.54%)	

**Table. Thirty-day post-surgical morbidity and mortality**

	<b>OSA-negative</b> (N=1,210)	<b>OSA-positive</b> (N=11,483)	<b>Total</b> (N=12,693)	<b>P-value</b>
<b>30-Day Congestive Heart Failure</b>				0.0004
No	1149 (94.96%)	10578 (92.12%)	11727 (92.39%)	
Yes	61 (5.04%)	905 (7.88%)	966 (7.61%)	
<b>30-Day Myocardial Infarction</b>				0.0288
No	1176 (97.19%)	11012 (95.90%)	12188 (96.02%)	
Yes	34 (2.81%)	471 (4.10%)	505 (3.98%)	
<b>30-Day Pulmonary Embolism</b>				0.6328
No	1179 (97.44%)	11214 (97.66%)	12393 (97.64%)	
Yes	31 (2.56%)	269 (2.34%)	300 (2.36%)	
<b>30-Day Acute respiratory failure</b>				0.0325
No	1205 (99.59%)	11362 (98.95%)	12567 (99.01%)	
Yes	5 (0.41%)	121 (1.05%)	126 (0.99%)	
<b>30-Day Cardiac Arrest</b>				0.5137*
No	1209 (99.92%)	11456 (99.76%)	12665 (99.78%)	
Yes	1 (0.08%)	27 (0.24%)	28 (0.22%)	
<b>30-Day Pulmonary Edema</b>				0.2458*
No	1208 (99.83%)	11475 (99.93%)	12683 (99.92%)	
Yes	2 (0.17%)	8 (0.07%)	10 (0.08%)	
<b>30-Day Stroke</b>				0.2126*
No	1205 (99.59%)	11457 (99.77%)	12662 (99.76%)	
Yes	5 (0.41%)	26 (0.23%)	31 (0.24%)	

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**Table. Thirty-day post-surgical morbidity and mortality**

	<b>OSA-negative</b> (N=1,210)	<b>OSA-positive</b> (N=11,483)	<b>Total</b> (N=12,693)	<b>P-value</b>
Number (Percent); Numeric outcomes compared with Wilcoxon Rank Sum tests and binary outcomes compared with Chi-Square or Fisher's exact tests as appropriate.				
*Fisher's exact test used				

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## Using Non-Invasive Respiratory Volume Monitoring in the Post-Anesthesia Care Unit to Monitor Post-Operative Respiratory Depression in Patients Identified as At-Risk for Obstructive Sleep Apnea Utilizing the Flemon's Criteria

**Presenting Author:** Carmelina Gurrieri, MD, The Mayo Clinic

**Co-Authors:** Jordan Brayanov, PhD, Yvette Martin, MD, PhD, Alexandre Cavalcante, MD, Toby Weingarten, MD

The Mayo Clinic

**Background:** OSA has traditionally been associated with increased risk for post-operative respiratory complications. Surprisingly, previous research has shown that OSA is not a strong predictor of post-operative apnea (POA) or post-operative respiratory depression (RD). To identify patients in the pre-operative setting that may be at risk for obstructive sleep apnea (OSA), the Mayo Clinic utilizes Flemon's Criteria<sup>1</sup> to calculate a Sleep Apnea Clinical Score (SACS), where a value  $\geq 15$  is a good predictor for OSA.<sup>2</sup>

**General Aim:** This study used a respiratory volume monitor (RVM) to monitor patient respiratory status in the post-anesthesia care unit (PACU) and assess POA and the incidence of RD<sup>3</sup> in patients with High SACS (at-risk for OSA) vs. Low SACS (not-at-risk for OSA).

**Materials and Methods:** 56 patients, with approval from The Mayo Clinic IRB, were monitored post-operatively with a continuous bio-impedance RVM system (ExSpiron, Respiratory Motion, Waltham, MA). Patients were stratified by SACS: High SACS ( $\geq 15$ ) as 'at-risk' and Low SACS ( $< 15$ ) as 'not-at-risk'. Predicted MV ( $MV_{PRED}$ ) and Percent Predicted ( $MV_{MEASURED}/MV_{PRED} \times 100\%$ ) were calculated for each patient. Low MV (LMV) was defined as  $MV < 40\% MV_{PRED}$  sustained for  $> 1$  min. Multiple incidents of LMV within a 10-min period following the first LMV incident were considered a single LMV event (LMVe). RD was defined as  $\geq 1$  LMVe. LMV at Discharge (LMVD) was defined as  $MV < 40\% MV_{PRED} \geq 1/3$  of the 30 minutes prior to PACU discharge. SACS was evaluated as a predictor for RD and LMVD.

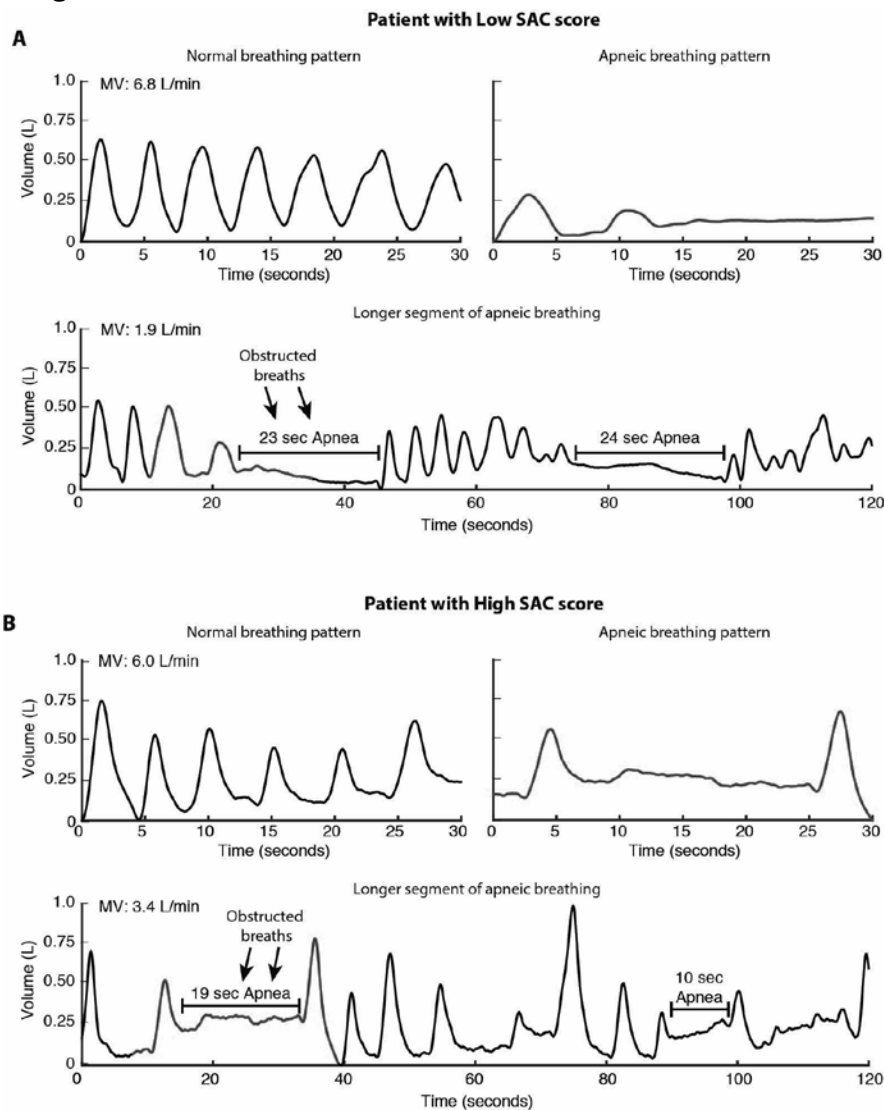
**Results:** Of 56 patients, 43 (77%) had Low SACS (mean: 5, range: 0-14; age: 57 yrs, 18-81; BMI:  $30.5 \text{ kg/m}^2$ , 19.8-66.9). No Low SACS patient had a previous OSA diagnosis. 13 (23%) patients had High SACS (mean 19, range 16-22; age: 57 yrs, 26-71; BMI:  $36.2 \text{ kg/m}^2$ , 21.6-56.9), of which 9 (69%) had a previous OSA diagnosis. OSA patients had BMIs significantly larger than those with Low SACS ( $40.2$  vs.  $30.5 \text{ kg/m}^2$ ,  $p < 0.05$ ).

The 43 Low SACS patients experienced more LMVe ( $3.5 \pm 0.4$  vs.  $2.3 \pm 0.5$  LMVe/hr) than the 13 High SACS patients. The average duration of LMV for Low SACS patients was  $14.5 \pm 2.2$  min/hr ( $24\% \pm 3.7\%$  of the time in the PACU) vs.  $6.3 \pm 2.2$  min/hr ( $10\% \pm 3.7\%$ ) for High SACS patients. Low SACS patients had a higher likelihood of LMVD than High SACS patients (26% vs. 0%; 11/43 vs. 0/13). Patients with Low SACS and LMVD experienced more LMVe ( $4.8 \pm 0.2$  vs  $2.3 \pm 0.5$  LMVe/hr,  $p < 0.05$ ) and had longer duration of time with LMVs ( $32.6 \pm 3.0$  vs  $6.3 \pm 2.2$  min/hr,  $p < 0.05$ ) than High SACS patients (all with no LMVD).

**Discussion:** High SACS patients, despite POA (Fig 1.), tend to have adequate MV, likely because they compensate for apneic pauses with larger rescue breaths whereas Low SACS patients do not.

**Conclusion:** Our data shows that while SACS is a good predictor for OSA, it is a poor predictor of RD during PACU recovery. Since patients with no indication of respiratory risk by OSA or SACS demonstrated significant RD in the post-surgical setting, preoperative stratification may not be sufficient to safely direct care without additional respiratory monitoring postoperatively.

## Images



**Figure 1:** Example respiratory traces from two representative patients who demonstrated apnea and obstructed breaths in the PACU. (A) A patient with Low SAC score and (B) a patient with High SAC score and previously diagnosed OSA by polysomnography. Shown are 30 seconds of normal breathing (top left), 30-sec of apneic breathing (top right) and a longer period of cyclic apneic breathing (bottom). Minute ventilation is reduced in both patients during apneic breathing, but only in the Low SACS patient is apnea associated with respiratory depression as defined by Low MV, whereas the High SACS patient maintains adequate ventilation due to large tidal volume recovery breaths.

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## **Sleep for Inpatients: Empowering Staff To Act (Siesta): Impact on Hospital Staff Knowledge & Empowerment to Improve Inpatient Sleep**

**Presenting Author:** Mila N. Grossman, University of Chicago Pritzker School of Medicine

**Co-Authors:** William Marsack, MS<sup>1</sup>, Nimit Desai MD<sup>2</sup>, Babak Mokhlesi, MD, MSc<sup>2</sup>, Vineet M. Arora, MD, MAPP<sup>2</sup>

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**Background:** Although sleep is critical to recovery from acute illness, hospitalization is far from restful. Poor sleep while hospitalized can lead to cardiometabolic derangements and delirium, while also undermining patient satisfaction. In addition, 2 out of every 5 inpatients are at risk for undiagnosed obstructive sleep apnea (OSA), which can impact their overall health and recovery. SIESTA (Sleep for Inpatients: Empowering Staff to Act) is an NHLBI-funded educational program to empower hospital staff to assist patients in obtaining better sleep and improve their knowledge of sleep disorders. In previous work, we have shown patients reported fewer sleep disruptions and greater satisfaction with SIESTA.

**General Aim:** To assess the impact of SIESTA's targeted education on hospital staff's knowledge and perception of empowerment to improve inpatient sleep and screen for sleep disorders.

**Materials and Methods:** Before the intervention, staff nurses, hospitalists and internal medicine residents completed surveys that contained multiple-choice questions to assess knowledge of inpatient sleep disturbances and OSA screening tools (i.e. STOP-BANG) and Likert items to determine providers' perception of empowerment about improving the hospital sleep environment. All hospitalists and residents received targeted education via in-person seminars. Nurses in one general medicine unit that was designated as an intervention (SIESTA) unit received education, while nurses in another unit served as the control. Following the educational intervention, hospital staff, including nurses on the control unit, completed a post-survey with the same questions as the pre-survey. Percent correct for the multiple-choice style questions were calculated for each survey item pre and post-intervention. Results were compared by provider group via two-sample t-tests. To analyze the Likert items, data were dichotomized at a three-four cutpoint. Percent agreeing was calculated for each statement, and pre and post-intervention results were compared via Wilcoxon rank sum tests by provider group.

**Results:** Pre-intervention, 77 residents (82%) and 28 hospitalists (74%), 19 intervention unit nurses (83%) and 16 control unit nurses (84%) completed the survey. Post-intervention, 77 residents (82%), 25 hospitalists (60%), 22 intervention unit nurses (96%) and 15 control unit nurses (79%) completed the survey. Compared to residents, nurses on the intervention unit and hospitalists, were more likely to identify the correct OSA screening tool (STOP-BANG) post-education (33% vs. 91% intervention nurses, 26% vs. 65% hospitalists, 56% vs. 70% residents). In addition, nurses on the intervention unit were more likely to correctly identify the most common patient-reported noise source as staff conversation post-intervention (44 vs. 77%,  $p=0.02$ ), while the other groups remained largely unchanged. When examining staff empowerment to improve patient sleep, residents and hospitalists were more likely to report higher agreement post intervention (44% vs. 69% residents,  $p=0.01$ , and 25% vs. 60% hospitalists,  $p=0.02$ ). Likewise, physicians were also more likely than nurses to report increases in doing what they can to improve sleep.

**Conclusion:** A targeted education program aimed for hospital staff can result in improved staff knowledge and empowerment for improving inpatient sleep. The differences in what nurses and physicians gained may highlight differences in baseline education and empowerment among the groups and a need for tailoring the intervention to different provider groups.



## Postoperative Complications in Patients with Obstructive Sleep Apnea Undergoing Cardiac Surgery: A Meta-analysis of Comparative Studies

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**Background:** Obstructive sleep apnea (OSA) is a common co-morbidity in patients undergoing cardiac surgical procedures and may predispose them to postoperative complications.<sup>1</sup>

**Study Objective:** The objective of this meta-analysis is to determine whether patients with OSA undergoing cardiac surgery have an increased risk of postoperative complications compared to patients without OSA.

**Methods:** A literature search of Medline, Medline In-process, Web of Science, Scopus, EMBASE, Cochrane Database of Systematic Reviews, and Cochrane Central Register of Controlled Trials, and CINAHL up to March 2016 was conducted. The search was restricted to cohort studies of adult patients who were diagnosed with OSA by sleep studies, or screened as at “high-risk” for OSA undergoing cardiac surgery. Studies published in the English language that reported at least one postoperative complication were included. The postoperative outcomes included atrial fibrillation, re-intubation, myocardial infarction, cardiac arrest, intensive care unit (ICU) transfer, length of hospital stay, length of ICU stay and death. The analysis was planned in accordance with the Meta-analysis Of Observational Studies in Epidemiology<sup>2</sup> guideline for non-randomized studies. A Random-effects meta-analysis was conducted using Cochrane Review Manager 5.3 and comprehensive meta-analysis version 3 was used for meta-regression ( $p < 0.05$ , was significant).

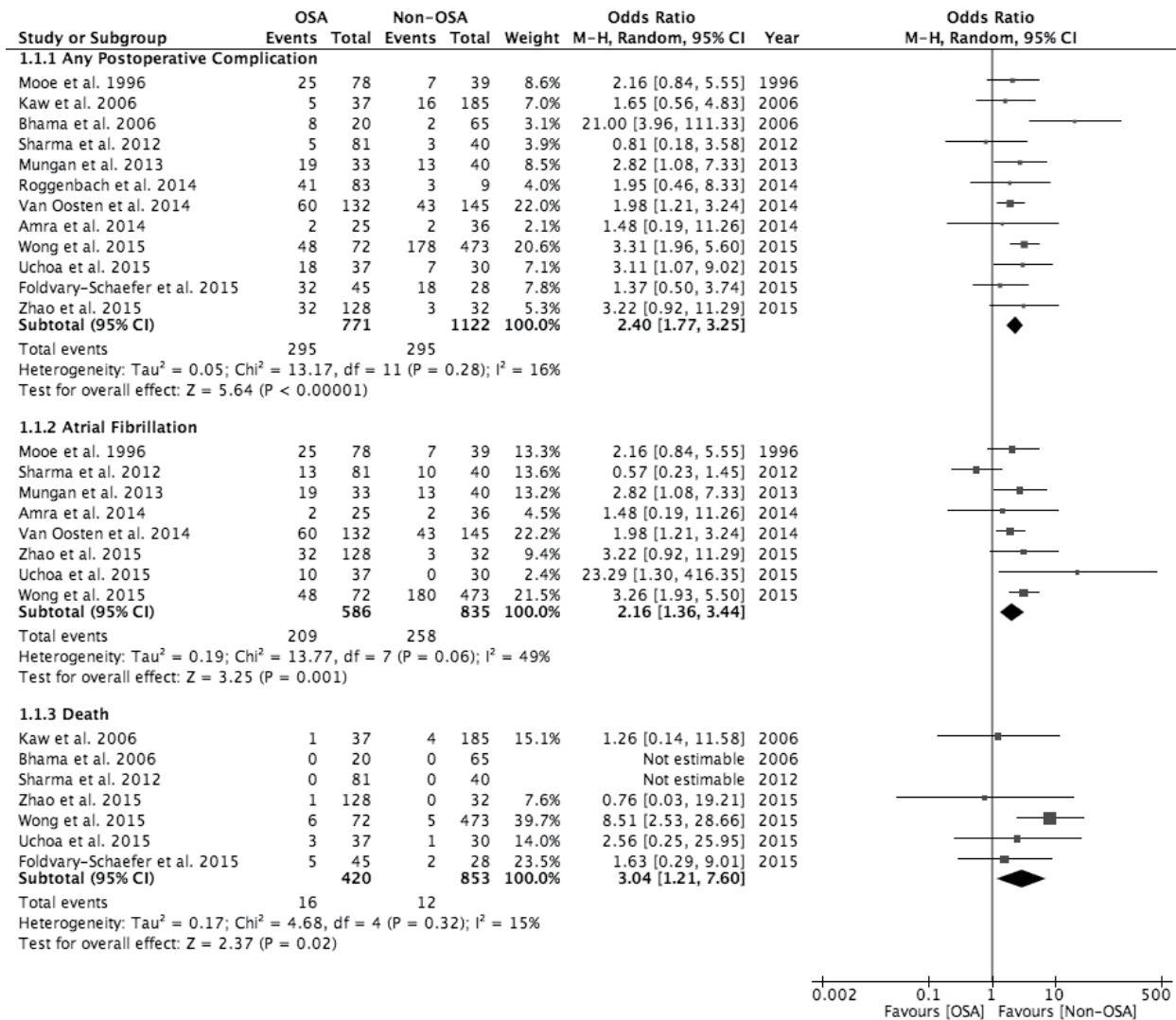
**Results:** Out of 3826 studies, twelve comparative studies were included in the final analysis ( $n=1893$  patients; OSA vs. Non-OSA: 771 vs. 1122). OSA was associated with a higher risk of postoperative complications (OSA vs. Non-OSA: 38% vs. 26%; OR 2.4; 95% CI: 1.77 – 3.25,  $P < 0.00001$ ; Heterogeneity  $I^2 = 16\%$ ), atrial fibrillation (OSA vs. Non-OSA: 35% vs. 30%; OR 2.16; 95% CI: 1.36 – 3.44,  $P = 0.001$ ; Heterogeneity  $I^2 = 49\%$ ), and death (OSA vs. Non-OSA: 3.8% vs. 1.4%; OR 3.04; 95% CI: 1.21 – 7.6,  $P = 0.02$ ; Heterogeneity  $I^2 = 15\%$ ). The ICU length of stay was

significantly prolonged in patients with OSA (Mean Difference 0.48 day; 95% CI: 0.09 – 0.88, P = 0.02; Heterogeneity  $I^2 = 0\%$ ) but the hospital length of stay was not different (Mean Difference 0.56 day, 95% CI: -0.19 – 1.3, P = 0.14; Heterogeneity  $I^2 = 21\%$ ). There was no significant difference in the number of re-intubations, ICU readmissions and myocardial infarctions. Meta-regression by baseline BMI, male gender, hypertension, diabetes mellitus and smoking did not impact the odds ratio of postoperative complications for OSA versus non-OSA groups.

**Conclusion:** This meta-analysis of twelve studies demonstrated that the incidence of postoperative complications, atrial fibrillation, death and ICU stay were higher in OSA versus non-OSA patients undergoing cardiac surgery.

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**Figure 1** – Meta-analysis of (1.1.1) any postoperative complications, (1.1.2) atrial fibrillation and (1.1.3) death between OSA and non-OSA patients undergoing cardiac surgery.

## Effect of a Recommended Practice Management Change (The Avoidance of Postoperative Opioids) on Desaturation Patterns in Tonsillectomies in Children Under 3: Nothing Changed

**Co-Authors:** Andreas Taenzer, Kelly Michaelsen, Peter Shapiro, Simon Hillier

**Presenting Author:** Matthew Hoyt

**Background:** Annually, >500,000 tonsillectomies are performed in the US, of which 80% are performed for Sleep Disordered Breathing (SDB). Recent data have highlighted the risk of deaths after tonsillectomies, documenting 86<sup>1</sup> and 38<sup>2</sup> deaths over recent years via polling members of professional societies (SPA and AAOHNS), albeit with poor response rates. While the actual death rate remains unknown, the majority appear to be related to post-operative respiratory depression, rather than hemorrhage.<sup>3</sup> Practice advisories recommend the avoidance of postoperative opioids. Using oxygen saturation data collected in one-second intervals<sup>4 5</sup> in the first postoperative night, we compare desaturation characteristics of patients with SDB who did or did not receive postoperative opioids following adenotonsillectomy (T&A).

**General Aim:** Determining whether the avoidance of postoperative opioids changes the desaturation characteristics of children <3yrs undergoing T&A for SDB.

**Materials and Methods:** With approval of the IRB, children who underwent T&A between January 1, 2012 to April 30, 2015 were identified. Patients were excluded if there was significant craniofacial abnormality, chronic pulmonary disease (other than RAD or asthma), congenital heart disease, PICU admission, genetic disorder, significant neurologic disease, or surgical indication other than OSA or SDB. Patients were also excluded if there was insufficient or incomplete pulse oximetry data. See Table 1 for population details.

Standard pulse oximetry based criteria for pediatric OSA (number of desaturations, cyclical desaturations, nadir, low oxygen saturation states) were identified by a signal processing algorithm written by our group (KM/AT) using the R programming language.

**Results:** There were no clinical differences between the two groups when comparing both the nadir (78.10 +/- 13.13 vs 79.43 +/- 7.55) and the number of desaturations per hour (24.05 +/- 18.71 vs 24.72 +/- 19.91). Cyclical desaturations were 1.33 +/- 1.5 with and 1.39 +/- 2.4 per hour without opioids. Patients who received opioids had more than twice as many low oxygenation data points (less than 90%) than those who did not (0.83 vs 0.36%)

**Discussion:** This is the first evaluation of the impact of practice advisories recommending postoperative opioid avoidance in children with SDB <3y undergoing T&A. Despite using high fidelity oximetry data and sophisticated signal processing methods we were unable to

demonstrate a significant effect of post-operative opioid avoidance. However, the small number of patients in this study limits the conclusions that can be drawn. It is unclear if desaturation characteristics in the first postoperative night predict subsequent patterns. Further work is required that could allow identification of children at risk by temporal correlation of postoperative opioid administration and desaturation patterns.

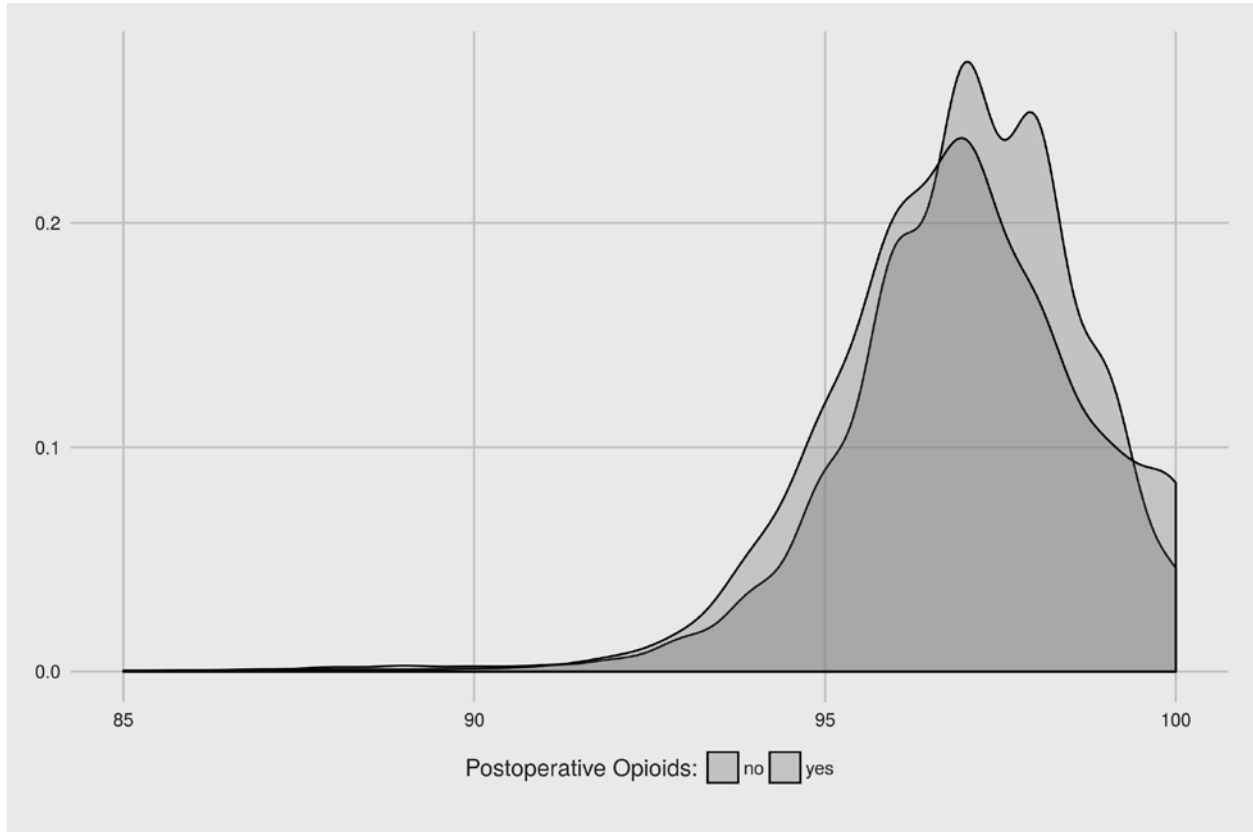
**Conclusions:** Based on our data, it seems unlikely that children benefit from the routine withholding of postoperative opioids with the exception of those who have alterations in opioid metabolism and/or sensitivity. Pharmacogenomic testing may allow identification of these patients in the future.

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**Table 1**

	<b>Exposed to Opioids</b>	<b>No Opioid Exposure</b>
Number of Patients	9	23
Males	6 (66%)	13 (50%)
Mean Age (yrs)	2.1 +/-0.32	2.3 +/-0.48
Mean BMI	19.26 +/-7.9	17.23 +/-3.6
ASA 1's	3	3

ASA 2's	4	20
ASA 3's	2	0
Mean Morphine Equivalents (mg kg <sup>-1</sup> )	5.99 +/-2.9	0



## **Anesthetic Management of Narcolepsy Patients During Surgery: A Systemic Review**

**Co-Authors:** Sally Hu<sup>1</sup>, Mandeep Singh<sup>2</sup>, Jean Wong<sup>2</sup>, Frances Chung<sup>2</sup>, SASM-Narcolepsy Network Collaborative Group.

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**Background:** Narcolepsy is characterized by excessive daytime sleepiness, cataplexy, hypnagogic hallucinations, and sleep paralysis<sup>1</sup>. Perioperative concerns unreliable response to anesthetic agents, respiratory failure, and status cataplecticus<sup>2,3</sup>. A systematic review was conducted to summarize current evidence regarding anesthetic consideration for narcolepsy patients.

**Methods:** An electronic literature search of major databases was conducted. Clinical reports of narcolepsy patients undergoing surgical procedures under anesthesia or sedation were included. Preoperative presentation, anesthetic technique, and perioperative complications were recorded. Screening, data extraction and summarization were conducted by two independent reviewers.

**Results:** Our search generated 3757 articles, of which 19 studies (16 case reports, 3 case series) involving 49 cases met the inclusion criteria. General anesthesia (GA) was used for 45/49 procedures. Reported complication rates were 44% for GA and 25% for RA, including autonomic changes (n=.6.), narcolepsy symptoms (n=2), and respiratory depression (n=2). (Table 1).

**Conclusion:** Regional anesthesia may have a lower complication rate than general anesthesia, although the number of patients having RA was low. More research is needed to better guide the perioperative management in these patients.

SASM-Narcolepsy Network Collaborative Group Authors: Shelley Hershner, Rahul Kakkar, Dennis Auckley, Michael J Thorpy

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**Table 1. Summary of important findings.** General Anesthesia (GA). Regional Anesthesia (RA). Caesarian-section (C-section). Not reported (NR). Post-anesthesia care unit (PACU). Left (L). Right (R).

Study Design	(n)	Narcolepsy Med. p.o. before Surgery	Type of Anesthesia	Perioperative Complications	Postoperative Complications
<b>Ajayi 2012</b> Case report	1	No	Spinal	NR	NR
<b>Bohringer 2000</b> Case report	1	NR	GA	Hypotension, Rx with frequent phenylephrine boluses	PACU: Hypotension during emergence; severe pain.
<b>Burrow 2005</b> Retrospective case series	27	Yes	GA	Intraoperative hypotension (n=1). Misplaced endotracheal tube requiring reintubation (n=1).	PACU: Pain (n=12), postoperative nausea and vomiting (n=3); hypersomnolence (n=2); postoperative fever (n=3); ST segment depression (n=1), O <sub>2</sub> desaturation (n=1), agitation (n=1), respiratory support via nasal airway (n=1)
<b>Dahaba 2009</b> Case report	1	NR	Regional – Femoral Block	Narcolepsy-cataplexy episode 20 minutes into BIS monitoring, emerged from episode at end of the surgery	NR
<b>Doyle 2008</b> Case report	1	No	GA	Brief bradycardia (HR 55), followed by brief tachycardia (HR 109)	NR
<b>Fischer 2000</b> Case report	1	Yes	GA	Brief hypertension (190/110) during laryngoscopy and tracheal intubation	NR
<b>Fischer 2006</b> Case series	4	Yes	GA	NR	PACU: 3/8 patients had moderate pain and 2/8 patients severe pain.
<b>Honca 2013</b> Case report	1	NR	GA	NR	NR
<b>Kamekura 2014</b> Case report	1	Yes	GA	NR	NR



<b>Mesa 2000</b> Case report	1	Yes	GA	NR	NR
<b>Morimoto 2011</b> Case report	1	Yes	GA	NR	NR
<b>Neustein 2009</b> Case report	1	No	GA	NR	NR
<b>Ozkose 2007</b> Case report	1	NR	GA	NR	NR
<b>Pelaez 2004</b> Case report	1	Yes	GA	NR	NR
<b>Soltanifar 2010</b>	1	No	Epidural	NR	NR
<b>Staikou 2007</b> Case report	1	NR	GA	Hypertension at BP 190/110 for 35 minutes.	NR
<b>Spector 1977</b> Case report	1	NR	GA	NR	PACU: 2 episodes of sleep paralysis and irregular respirations with alternating periods of apnea
<b>Stoicea 2014</b> Case series	2	Yes	GA	NR	NR
<b>Williams 2008</b> Case report	1	Yes	Spinal	NR	NR

## Apneic Oxygenation in Adults During General Anesthesia Using THRIVE

**Background:** Apneic oxygenation is safe for oxygenation during anesthesia, but limited by rise of carbon dioxide. Apneic oxygenation using Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE) technique has recently been used when handling difficult airways and a slower rise in carbon dioxide than earlier studies was seen.

Apneic oxygenation using THRIVE has not been evaluated with arterial blood gases. Thus, the primary aim of this study was to characterize changes in arterial  $PO_2$ ,  $PCO_2$  and pH during apneic oxygenation using THRIVE under general anesthesia. The secondary aim was to evaluate if hyperventilation during pre-oxygenation prolongs the apneic window.

**Materials and Methods:** Adult patients, (ASA 1-2), undergoing shorter laryngeal surgery in general anesthesia were pre-oxygenated and oxygenated during apnea under general anesthesia using THRIVE, 100 % oxygen, 70 L/min. 20 patients were randomized to hyperventilation or normoventilation during pre-oxygenation. Vital parameters and blood gases were monitored.

**Results and discussion:** Thirty patients, age  $52 \pm 13$  years, BMI  $25 \pm 4$  were included. Mean apnea time was  $22 \pm 4$  min. Patients were well oxygenated,  $SpO_2$  was never below 92%. Arterial  $PO_2$ ,  $PCO_2$  and pH are presented in Figure 1. The rise in  $PaCO_2$  during apnea was  $0.24 \pm 0.04$  kPa/min. Hyperventilation during preoxygenation generated no difference in  $PaCO_2$  at the end of apnea compared to normoventilation.

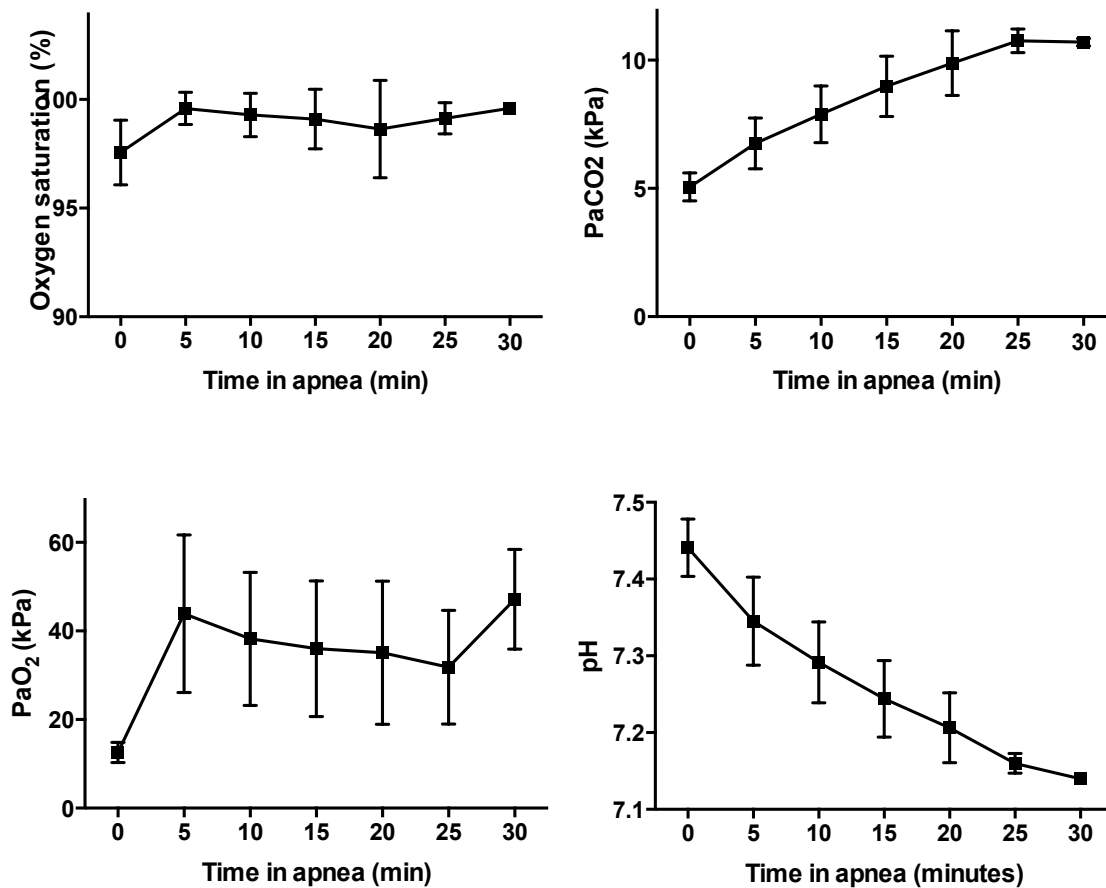


Figure 1: Overview of the oxygenation and gas exchange during apnea (n=30). Data are presented as mean  $\pm$  SD.

**Conclusion:** All patients were well oxygenated during apneic oxygenation using THRIVE and the rise in PaCO<sub>2</sub> was lower than average values traditionally presented. Based on these results THRIVE is a useful tool for oxygenation in anesthetized patients during apnea and the lower rise in carbon dioxide compared to the classical studies extends the apneic window.

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## Implementation of an Outpatient Respiratory Risk Protocol to Reduce the Incidence of Sedative Related Respiratory-related Events

**Author:** Kathryn Lauer, MD, Medical College of Wisconsin

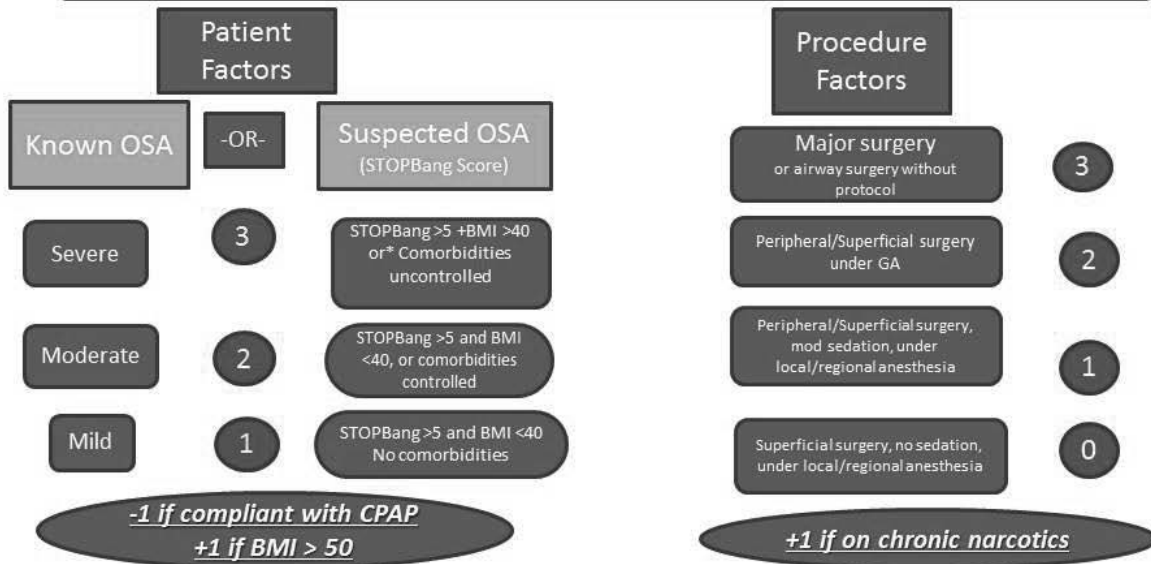
**Introduction:** Respiratory-related adverse events caused by opioid or sedative-induced ventilatory impairment (OIVI) remains a significant concern and cause of iatrogenic injury in the postprocedural period, particularly for patients with obstructive sleep apnea (OSA).<sup>1,2</sup> We recently implemented a protocol for our health care system (2 community hospitals and one academic hospital) which strategizes which patients need extended monitoring postprocedure and have imbedded it into our EMR, based on the algorithm suggested by STOPBang.ca.

**Methods:** All patients scheduled for procedures or surgeries as outpatients have STOPBang scores performed and based on their co-morbidities, the procedure planned and narcotic use, have suggested monitoring postprocedure. (See figure)The Respiratory Risk Score is utilized to plan for their postprocedure disposition. Each department of the hospitals were given the responsibility to develop their workflow and educational materials for providers and patients to facilitate the implementation. For many areas, this risk scoring was performed by the RNs and if they scored a 4, enhanced monitoring was performed using capnography postprocedure to insure safety after the procedure.

**Results:** Outcome data is being gathered. This includes compliance with the scoring system, the number of patients with high risk scores being discharged after the procedure and the impact of this protocol on patient flow.

References: STOPBANG.ca VADA Postoperative Risk Prediction OSA

## Scoring System for the Management of Outpatients with OSA



Baseline Risk Score	Postoperative Risk	Minimum Observation Level
5/6 or greater	Increased risk	Overnight observation = admission
4-5	May be at increased risk	Prolonged/Enhanced monitoring
2-3	Probably no increased risk	Home

## Implementation of an Inpatient Respiratory Risk Protocol to Reduce the Incidence of Sedative Related Respiratory-related Events

**Author:** Kathryn Lauer, MD, Medical College of Wisconsin

**Background:** Respiratory-related adverse events caused by opioid, or sedative-induced ventilatory impairment (OIVI), remains a significant concern and cause of iatrogenic injury, particularly for patients with obstructive sleep apnea (OSA).<sup>1,2</sup> It is impractical for most institutions to continuously monitor all patients receiving narcotics, so rational risk stratification to match those identified to be at risk with monitoring may improve outcome. We recently developed and adopted a protocol for our health care system (2 community hospitals and one academic hospital) which prompted clinicians to order continuous respiratory monitoring for patients considered at risk.

**General Aim:** This study analyzed the results of a 3 hospital (2 community and 1 academic) protocol implementation of a respiratory risk tool on RRT (rapid response team) events and those due to respiratory events.

**Materials and Methods:** We constructed a risk tool that linked STOPBang evaluated on admission to a protocol that prompted an order for continuous respiratory monitoring (pulse oximetry and/or capnography) if a sedative or narcotic was ordered or administered. After implementation, we measured the compliance with the protocol at both community hospitals and an academic hospital. We evaluated the incidence of RRT events at all 3 hospitals and correlated this with the STOPBang Score. We led a limited chart review of all RRT events 5 months pre- and postimplementation at the academic medical center to evaluate the outcome from those patients who had respiratory related RRT events.

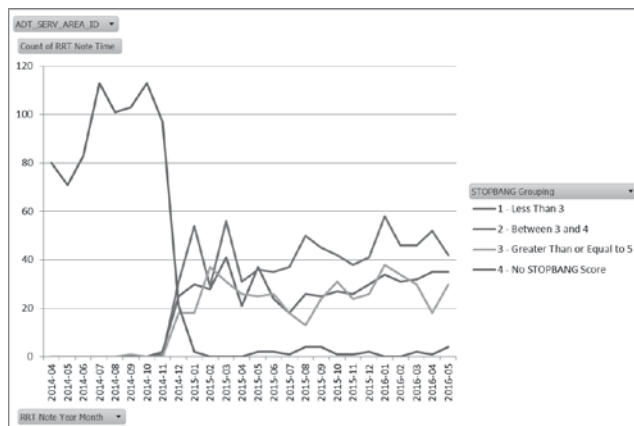
**Results:** The compliance of the protocol was high at all 3 hospitals (85-99%) in screening patients on all patients (52,804) on admission with STOPBang. Compliance was highest at the academic medical center (98-99% of 37,730 patients) and lowest (85-93%) at the smallest community hospital. The compliance with monitoring patients was only slightly higher at the academic hospital (87% vs. 83%) at the community hospitals for those with a STOPBang > 5. There was no decrease in the rate of RRT events after the development of the protocol and an increase in RRT events in patients with STOPBangs of < 3 (see figure). For patients who sustained respiratory related RRT events with a STOPBang of > 3, the mortality after the RRT event was 12.9% preimplementation and 5.7% postimplementation.

**Discussion:** In this study, we found that there was a higher rate of compliance with scoring and protocol implementation and less recidivism in the academic medical center. Though no change in the RRT event rate was seen, RRT events occur with non-respiratory problems as well. Overall, the relative increase in RRT events in patients with STOPBang < 3, may reflect a protective effect of the protocol. For patients with potential risk and respiratory events occurred, monitoring seemed to have improved their outcome.

**Conclusion:** The implementation of a process to improve monitoring for patients at risk by STOPBang score can be accomplished across a hospital system with both community and academic medical hospitals. It may improve outcome.

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## Symptomless-Multivariable Apnea Prediction Index Assesses Obstructive Sleep Apnea Risk and Adverse Outcomes in Elective Surgery

### Presenting Author:

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University of Pennsylvania, Philadelphia

**Background:** Obstructive sleep apnea (OSA) increases the risk of postoperative complications.<sup>1-9</sup> With the exception of bariatric surgery,<sup>10</sup> routine preoperative screening for OSA is not prevalent in the Penn Medicine network. Combining body mass index (BMI), age and gender, the symptomless-multivariable apnea prediction (sMVAP) score assesses OSA risk.

**General Aim:** We examined whether sMVAP is associated with adverse post-surgical outcomes, and compared bariatric surgery with other surgical groups.

**Material and Methods:** We reviewed 2011-2014 data from 40,432 elective-in-patient surgeries within Penn Medicine. We performed logistic regression, conditional on hospital and surgery type, to assess association between sMVAP and: previous diagnosed OSA; hypertension; extended length of stay (ELOS; top 10%); intensive-care-unit stay (ICU); and pulmonary embolism, acute respiratory distress syndrome (ARDS) and/or aspiration pneumonia (AP) [respiratory complications (RC)].

**Results:** The sample had 51.6% men, with mean±SD age and BMI of 59.0±15.1 years and 30.0±7.8 kg/m<sup>2</sup>, respectively. sMVAP was associated with a higher likelihood of diagnosed OSA (p<0.0001), validating its utility, as well as hypertension (p<0.0001) and all adverse outcomes (p<0.0001). Compared against the bottom quintile, the top sMVAP quintile had higher odds of adverse outcomes (all p<0.0001). For ELOS, ICU, and RC, the respective odds ratios (95% CIs) were: 1.83 (1.62-2.07), 1.44 (1.32-1.58), and 1.85 (1.37-2.49). Compared to age-, gender- and BMI matched patients having bariatric surgery, sMVAP was more strongly associated with adverse outcomes in non-bariatric surgical groups, including: (1) ELOS in orthopedics (p<0.0001), gastrointestinal (p=0.024), neurosurgery (p=0.016), and spine (p=0.016); (2) any ICU in orthopedics (p=0.0004), gastrointestinal (p<0.0001), and ORL/OMS/ENT (p=0.0102); and (3) RC in orthopedics (p=0.037) and ORL/OMS/ENT (p=.011).



**Discussion:** A major strength of the study is the use of the sMVAP,<sup>11,12</sup> which relies on three established<sup>13-15</sup> and easily-available variables (age, gender and BMI) to quantify OSA risk. A past study from our group within commercial truck drivers<sup>11</sup> observed that the sMVAP is a valid pre-screening tool in conjunction with confirmation of OSA by the gold-standard polysomnography.<sup>13</sup> The strong association between sMVAP and the diagnosis of OSA found in our analysis further confirms the utility of sMVAP for potential OSA-screening. Additionally, we confirm that the sMVAP index was associated with established OSA-related cardiovascular risk,<sup>16,17</sup> hypertension. Our finding between sMVAP and all three postoperative complications are consistent with prior studies<sup>6,7</sup> that found OSA patients were at increased risk for developing postoperative AP, ARDS, and experienced increased intubation/mechanical ventilation, ICU days and ELOS compared to patients without OSA. Last, we observed that the associations between OSA risk and postoperative complications to be lower in the Bariatric surgery<sup>10</sup> group compared to surgical subgroups in which pre-operative OSA screening is not routinely performed. Given these associations, future research should examine the utility of both implementing a pre-operative OSA screening and management program for certain subgroups of surgeries that contains patients with particularly increased OSA-risk.

**Conclusion:** Higher sMVAP scores correlate with increased risk for select adverse post-surgical outcomes. Stronger associations for specific surgery groups, in particular orthopedics, when compared to bariatric surgery suggest that preoperative screening and treatment for OSA may be appropriate.

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Demographics, Overall and by sMVAP Prediction Quintiles								
Sample Characteristics	Overall	sMVAP Quintiles					P	P <sub>trend</sub>
		Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5		
Age, years	59.0±15.1	47.8±16.1	59.1±13.8	62.5±12.9	64.3±12.9	61.2±13.4	<0.0001	<0.0001
Male, %	51.6	22.3	47.6	62.9	67.5	58.0	<0.0001	<0.0001
BMI, kg/m <sup>2</sup>	30.0±7.8	22.8±3.0	26.1±3.3	28.5±3.5	31.7±3.9	40.9±8.0	<0.0001	<0.0001
sMVAP <sup>a</sup>	0.24±0.23	0.02±0.01	0.08±0.02	0.16±0.03	0.29±0.05	0.63±0.18	<0.0001	<0.0001
Previous OSA, %	9.3	1.5	3.4	5.5	9.9	26.2	<0.0001	<0.0001
Current Hypertension, %	54.5	25.1	47.6	58.6	67.6	73.7	<0.0001	<0.0001
Adjusted <sup>b</sup> Relationship Between sMVAP Prediction Quintiles and Adverse Postsurgical Outcomes <sup>c</sup>								
Outcomes	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	P <sup>e</sup>	P <sub>trend</sub> <sup>f</sup>	
		OR (95%CI) <sup>d</sup>	OR (95%CI) <sup>d</sup>	OR (95%CI) <sup>d</sup>	OR (95%CI) <sup>d</sup>			
Extended Length of Stay, %	1.00 Reference	1.21 (1.06, 1.37)	1.29 (1.14, 1.47)	1.29 (1.13, 1.46)	1.83 (1.62, 2.07)	0.0041- <u>&lt;0.0001</u>	<0.0001	
Any Stay in ICU, %	1.00 Reference	1.17 (1.08, 1.28)	1.21 (1.11, 1.32)	1.16 (1.06, 1.27)	1.44 (1.32, 1.58)	0.0008- <u>&lt;0.0001</u>	<0.0001	
Any Respiratory Complications, %	1.00 Reference	1.43 (1.06, 1.93)	1.38 (1.02, 1.87)	<u>1.25</u> (0.91, 1.70)	1.85 (1.37, 2.49)	<0.0001- <u>0.1643</u>	<0.0014	
<sup>a</sup> sMVAP calculated as $ex/(1+ex)$ , where $x = -10.784 + (0.203 \times \text{BMI}) + (0.043 \times \text{Age}) + (1.004 \times \text{Male})$ . <sup>b</sup> Conditional logistic model controlled for Surgical Category and Hospital. <sup>c</sup> ANOVA overall P-value testing whether there is any relationship between sMVAP Quintile and surgical outcome. <sup>d</sup> Estimates presented as odds ratio (OR) estimates (compared to Quintile 1) and 95% confidence intervals (CI). <sup>e</sup> P-value from logistic regression model comparing sMVAP Quintiles 2-5 versus Quintile 1. <sup>f</sup> P-value from regression model with group fit as an ordinal variable, examining the evidence for a linear change in risk across groups. <i>Abbreviations:</i> Any ICU-Stay, Any Stay in Intensive Care Unit; Any Respiratory Complications, diagnosis of Pulmonary Embolus, Acute Respiratory Distress Syndrome and/or Aspiration Pneumonia; Extended Length Of Stay defined as a length of stay >90 <sup>th</sup> percentile for given procedure code; OSA, Obstructive Sleep Apnea; sMVAP, Symptomless Multi-Variable Apnea Prediction.								

**Table 1: Demographics by sMVAP Prediction Quintile and Adjusted Relationship Between sMVAP Prediction Quintiles and Adverse Postsurgical Outcomes**

## **Children with Obstructive Sleep Apnea Undergoing Diagnostic or Surgical Procedures: Topics of Interest in Need of Systematic Review**

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**Background:** Obstructive sleep apnea (OSA) is the most extreme type of sleep disordered breathing and affects 2-4% of children in North America. Adenotonsillectomy (AT) is the first-line treatment for OSA and is one of the most common pediatric surgeries in NA. OSA increases perioperative risk for respiratory complications in children. Unfortunately, less than 12% of children have a definitive OSA diagnosis on polysomnography before surgery.

**General Aim:** The goal of this study was to identify the top three controversial issues related to the management of children at risk for OSA undergoing sedation/general anesthesia for a diagnostic/therapeutic procedure.

**Materials & Methods:** This study received research ethics board approval. Two rounds of a Delphi approach were used to obtain feedback from an interdisciplinary panel of NA pediatric OSA experts. Twenty-one committee and resource members of the Society for Anesthesia and Sleep Medicine (SASM) Pediatric Committee identified 38 colleagues considered experts in the care of children with OSA. Specialty representation included anesthesiology, otolaryngology, pulmonology and sleep medicine. Participants were surveyed using REDCap™ database technology. Each participant provided their top three controversial topics of interest in rank order. Topics were collated, presented in descending order of importance and rated by the same clinicians during the second round. Each participant was aware of how their first round choices ranked in comparison with the group. Participants rated each of the topics on a Likert scale from 1 (minimal importance) to 5 (greatest importance). Consensus was pre-determined to be 75% of participants selecting a value  $\geq 4$  (major importance) for a topic.

**Results:** In the first Delphi round, 24 clinicians [anesthesiologists (n=12), otolaryngologists (n=4), pulmonologists (n=4), and sleep medicine specialists (n=4)] participated. Seven topics were identified: 1) postoperative disposition, 2) preoperative screening, 3) pain management,

4) alternative surgical techniques, 5) sleep endoscopy and OSA diagnosis, 6) sleep endoscopy and anesthetic technique, and 7) sedative use. Topics were collated and presented in descending order of importance and rated by 23 of the same clinicians during the second round (dropout n=1). Two topics met the criteria for consensus. The majority (96%) of respondents selected “postoperative disposition” related to postoperative risk assessment for respiratory complications requiring additional monitoring. Eighty-three percent selected “preoperative screening” related to identifying preoperative means to diagnose OSA other than polysomnography. Although “pain management” related to prescribing analgesics including opioids to children with OSA did not achieve consensus (74%), it was considered the third controversial topic due to its rank order (3<sup>rd</sup>) and a lower level of importance (61%) attributed to the 4<sup>th</sup> ranked topic “sedative use”.

**Discussion:** A consensus was reached by a panel of pediatric OSA experts on the top three controversial topics related to the perioperative care of children with OSA. In descending order of importance they were: 1) postoperative disposition, 2) preoperative screening, and 3) pain management.

**Conclusion:** These three topics are prime candidates for systematic review and will guide future SASM-related research endeavors.

## Factors Influencing Hospital Admission Following Elective Adenotonsillectomy in Children: A North American Survey

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**Background:** Adenotonsillectomy (AT) is one of the most common pediatric surgeries in North America (NA)<sup>1</sup>. The usual indication for AT is obstructive sleep apnea (OSA)<sup>2</sup>. However, diagnosis of OSA and disease severity is unreliable by history and physical alone, and screening questionnaires have limited practical application<sup>4</sup>.

**General Aim:** Our goals were to describe the factors used by NA pediatric anesthesiologists and otolaryngologists to warrant overnight observation following elective AT, and to determine the level of confidence in related decision-making processes.

**Materials & Methods:** This study was approved by the Research Ethics Board. The survey was deployed using SurveyMonkey™ to members affiliated with the following societies: American Society of Pediatric Otolaryngologists, Canadian Pediatric Anesthesia Society (CPAS), Canadian Society of Otolaryngology - Head and Neck Surgery and the Society for Pediatric Anesthesia. Due to a low response from CPAS, additional surveys were deployed to anesthesiologists at all 16 Canadian pediatric tertiary care centers via the Society of Anesthesia and Sleep Medicine. Confidence in clinical practice and perceived usefulness of published clinical guidelines were assessed using a 5-item Likert scale ranging from “strongly agree” to “strongly disagree”. Other AT questions were associated with three themes (preoperative evaluation, OSA diagnosis and factors determining need for planned overnight hospital admission/referral). The survey design accounted for reliability and content validity. To achieve a  $\pm 3\%$  sampling error for a 95% confidence level, 588 (13.9%) responses were required.<sup>5</sup> All data are reported as proportions or medians.

**Results:** The overall survey response rate was 14.7% (623/4238) with a range of 11.5-61% by group. Most respondents were pediatric anesthesiologists (78.5%) from the United States, were

within 15 years from completing their residency (56.4%), had undergone pediatric subspecialty training (88.6%) and practiced in a pediatric tertiary care setting (57.2%). US compared with Canadian physicians were more confident in their process to determine appropriate postoperative care (Table 1). Canadian anesthesiologists were the least confident in their ability to diagnose severe OSA based on history and physical alone. The top three tools reported to diagnose OSA preoperatively were polysomnography (PSG-23.4%), sleep questionnaire (13.4%) and nasal endoscopy/history (7.6%). The top three reported preoperative symptoms/signs to warrant overnight observation or hospital referral for planned AT were witnessed apneas (13.9%), obesity (8.2%) and fatigue (7.2%). The threshold to warrant overnight observation for PSG-diagnosed OSA severity was split between “moderate-severe” (40.0%) and “severe” (40.2%) with Canadian physicians favoring the former and US surgeons the latter; oxygen-saturation nadir threshold favoring admission was 80-85%. The majority (61%) of respondents indicated 1-3 hours of monitoring after uncomplicated ambulatory surgery was appropriate; however, Canadian anesthesiologists were the most conservative requiring 3-4 hours.

**Discussion:** Preoperative PSG and witnessed apneas were key determinants of postoperative disposition after AT. Respondents were divided as to what threshold of PSG-determined OSA severity warranted an overnight stay.

**Conclusion:** Canadian pediatric physicians, particularly anesthesiologists, appeared more conservative in their perioperative care of children undergoing AT compared with their US counterparts.

**Table 1. Respondents in agreement to questions related to perioperative care of children undergoing adenotonsillectomy for OSA, by specialty and country sub-groups**

Statement	Anesthesiologists “Somewhat/strongly agree with statement” (%)			Otolaryngologists “Somewhat/strongly agree with statement” (%)		
	Canadian	U.S.A	p value	Canadian	U.S.A	p value
<b>Q3. Published guidelines are helpful to determine post-op disposition*</b>	70.2	76.5	p=0.12	85.7	88.6	p=0.68

<b>Q4. Confident in local process to determine overnight admission*</b>	67.4	82.3	p=0.0003	67.9	95.2	p<0.0001
<b>Q5. Confident to diagnose severe OSA based on Hx/Px*</b>	36.2	54.8	p=0.0002	60.7	51.4	p=0.38
<b>Q11. 3 yo healthy child with moderate OSA (AHI &lt;10) is suitable for ambulatory AT**</b>	58.8	72.5	p=0.004	42.9	67.3	p=0.02

Note : AT = adenotonsillectomy; AHI = Apnea Hypopnea Index; Hx = History; OSA = Obstructive Sleep Apnea; Post-op= postoperative; Px = Physical Exam; Q=question; USA=United States of America; yo=year-old;

\*For Q3-5 Anesthesiologist and Otolaryngologist, n=475 and 133, respectively

\*\*For Q11 Anesthesiologist and Otolaryngologist, n=445 and 126, respectively

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## Association of Sleep Disordered Breathing Symptoms With Early Postoperative Analgesic Requirement in Pediatric Ambulatory Surgical Patients

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**Background:** Sleep disordered breathing (SDB), the most severe form of which is obstructive sleep apnea (OSA), present unique challenges in the ambulatory surgical setting because as many as 80% of patients with OSA are undiagnosed and it is known to be associated with a number of perioperative complications (1). One of the enduring dilemmas in the care of the SDB patient is the observation that it is associated with enhanced nociception as well as increased rates of opioid-induced respiratory depression (2). Consequently, practitioners often withhold or administer lower intraoperative doses of opioids out of concern for delayed recovery from general anesthesia or opioid-induced respiratory depression (2). One unintended consequence of this pervasive culture of “opio-phobia” is that patients with OSA are at increased risk of early postoperative pain requiring treatment upon recovery from anesthesia in the post-anesthesia care unit (PACU). SDB as a predictor of clinically important PACU pain following ambulatory surgery in children has not been systematically examined. Therefore, we sought to determine whether children with preoperative SDB symptom (exposure variable) were at increased risk of PACU pain requiring opioid administration (outcome variable).

**Methods:** Using prospectively collected data, 985 children aged 4-17yr who underwent elective ambulatory operations were grouped into two categories based on the presence or otherwise of symptoms of SDB (habitual snoring, witnessed apnea and history of OSA diagnosis). The primary outcome variable was PACU administration of morphine (a proxy for clinically important pain). Perioperative variables were compared between the exposed and control groups using Chi-squared test for categorical or t-test for continuous variables. Logistic regression analysis was used to calculate the adjusted odds of requiring PACU IV morphine.

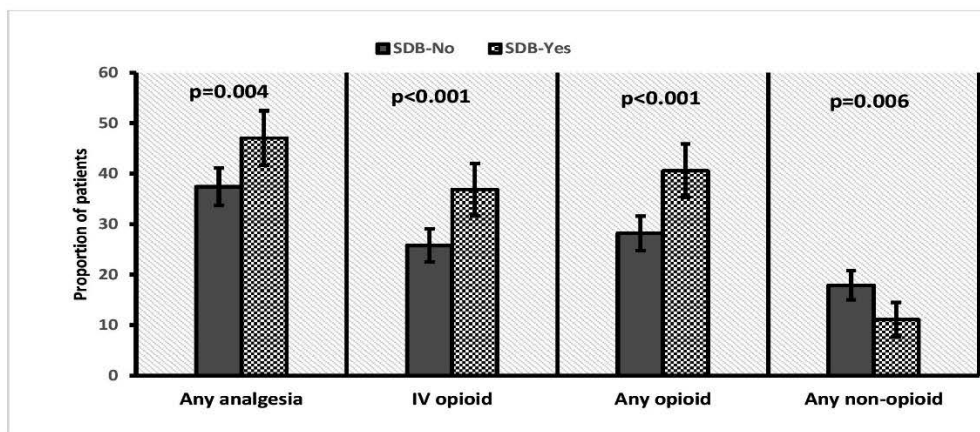
**Results:** Among 985 children 325(32.9%) had preoperative symptoms of SDB. All the patients received at least one or more intraoperative opioid (Fentanyl 68.2% and morphine 33.4%). Multimodal analgesia was used in only 69.8% of patients. Children with SDB symptoms were more likely than controls to have received intraoperative multimodal analgesia (75.7% vs. 67.0%; OR =1.54, 95% CI = 1.14-2.07; p = 0.005). Overall, 400 patients (40.6%) received some analgesia in the PACU. Furthermore, 29.4% received IV opioid, 32.3% received some form of

opioid (IV or oral) while 15.6% of subjects received a non-opioids in the PACU. There was a statistically significant difference between cases and controls in the proportions of patients requiring any PACU analgesia, PACU IV opioids, and any PACU opioids (IV or oral) (Fig 1). Logistic regression model (to predict the odds of requiring PACU IV morphine) adjusted for age, gender, race, ASA status (1&2 vs. 3), SDB diagnosis, and intraoperative use of multimodal analgesia confirmed the importance of SDB as an independent predictor of PACU IV morphine requirement (aOR = 2.01, 95% CI =1.29-3.12; p= 0.002).

**Conclusion:** Among children undergoing elective outpatient operations, SDB symptoms is a significant predictor of clinically important pain in the PACU. Given the potential for opioid-induced respiratory depression in children with SDB, these findings represent an important clinical dilemma. Mechanisms underlying this enhanced pain experience deserve further elucidation.

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**Fig. 1.** Proportion of patients receiving PACU analgesia (any, IV or oral opioid and any non-opioid) by SDB category. Abbreviations: PACU = Post anesthesia care unit; IV= intravenous

## Comparison of Perioperative Complications Between High STOP-Bang score (>3) and Low STOP-Bang Score (0-2) Patients: A Systematic Review and Meta-Analysis

**Introduction:** Surgical patients with obstructive sleep apnea (OSA) are associated with increased risk of perioperative complications. The STOP-Bang questionnaire are useful tools to identify the high-risk OSA (STOP-Bang  $\geq 3$ ) patients during the perioperative period. We conducted this meta-analysis to compare the perioperative complications in patients with high STOP-Bang score ( $\geq 3$ ) versus low STOP-Bang score (0-2).

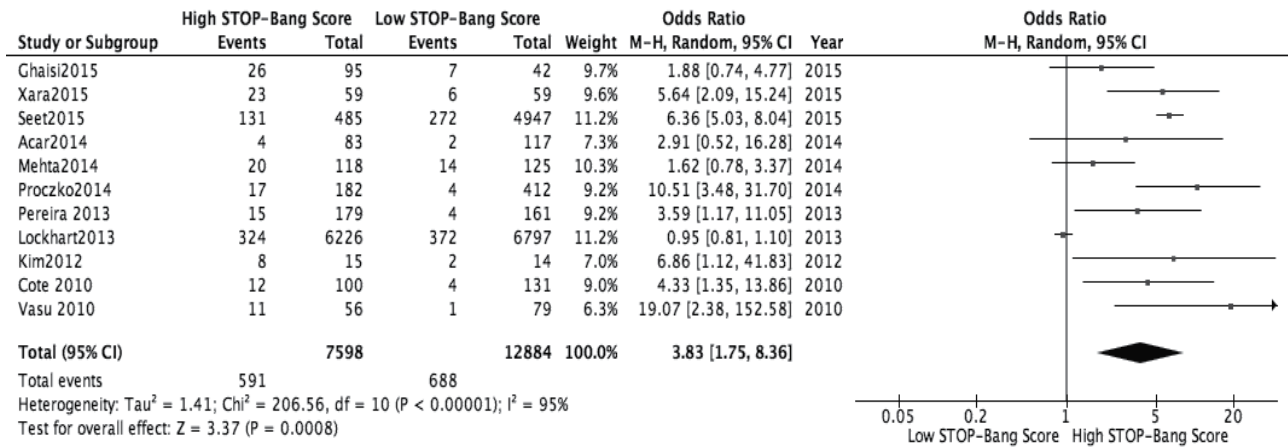
**Methods:** A search of the literature databases MEDLINE (from 2008 to January 2016), Medline-in-Process & other non-indexed citations (up to January 2016), Embase (from 2008 to January 2016), Cochrane Central Register of Controlled Trials (up to January 2016), Cochrane Databases of Systematic Reviews (from 2008 to January 2016), Google Scholar, Web of Sciences (from 2008 to January 2016), Scopus (2008 to January 2016) and PubMed (from 2008 to January 2016) was carried out. The search yielded 119 citations. Irrelevant papers were excluded by title, abstract and full-text review, leaving 11 manuscripts for analysis. Inclusion criteria were: 1) Studies that used STOP-Bang questionnaire as a screening tool to identify the high-risk and low-risk for OSA in adult surgical population (>18 year); 2) studies that mentioned the perioperative complications associated with high STOP-Bang score ( $\geq 3$ ) and low STOP-Bang score (0-2). 3) Publications in the English language. The perioperative complications were cardiac events or respiratory events or any complication requiring ICU admission. The study quality was evaluated using the Cochrane risk of bias tool. Statistical analysis was carried out using the Review Manager 5.3 software. The pooled odds ratio for perioperative complications was estimated.

**Results:** The meta-analysis was carried out in 11 studies including a total of 20,482 patients (High STOP-Bang score group,  $n=7,598$  and low STOP-Bang score group,  $n=12,884$ ). Overall, the odds of having perioperative complications was higher in high STOP-Bang score patients compared to low STOP-Bang score patients (OR 3.83; 95% CI: 1.75-8.36;  $P=0.0008$ )

**Conclusion:** This meta-analysis suggests that patients with high STOP-Bang score (>3) are associated with increased risk of perioperative complications. This further justifies the implementation of STOP-Bang tool as a screening tool to identify the high-risk OSA patients during the perioperative period.

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**Figure 1 – Forrest plot comparing the association of Perioperative complications between High STOP-Bang score ≥3 vs. Low STOP-Bang score 0-2**

## **Counterintuitively, Higher Continuous Infusion Rate of Dexmedetomidine Shows the Tendency to Retain both Hypoglossal and Phrenic Nerve Activities Compared to Lower Rate in Anesthetized Rabbits**

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**Background:** In clinical practice sedation with dexmedetomidine (Dx) shows the tendency to maintain the upper airway patency compared to other sedatives, such as propofol and benzodiazepines. We have reported that bolus injections of step-increased doses of Dx retrain carotid respiratory reflex, and reduce both hypoglossal and phrenic nerve activities (HGA; keeping upper airway patency and PNA; making inspiratory negative force) in anesthetized rabbits at SASM2015. These are thought to be the main reasons for sedation with Dx achieved without serious pharyngeal collapse.

This study is designed to assess the effects of continuous infusion of Dx on HGA and PNA in anesthetized rabbits.

**Methods:** The studies were approved by the Saitama Medical University Animal Care Committee. Experiments were done on adult rabbits that were vagotomized, paralyzed and artificially ventilated with 50%N<sub>2</sub>O, 50%O<sub>2</sub> and 0.5%sevoflurane to prevent any nociceptive pain during the experiments.

Animals were administered two infusion rates of Dx (Low rate; 10 mcg/kg/hr, Dx10, n=6; High; 30 mcg/kg/hr, Dx30, n=5) until 10 mcg/kg Dx was reached, or severe hypotension would occur.

We measured the following parameters on the integrated neurogram before and after Dx infusion (control, 2.5, 5.0, 7.5 and 10.0 mcg/kg Dx in total): the peak amplitude (AMP) and the root mean square (RMS) in both HGA and PNA, and the neural respiratory cycle. Other parameters including mean arterial blood pressure (mABP), heart rate (HR), end-tidal CO<sub>2</sub> and rectal temperature were also continuously monitored.

Statistical analyses were performed by ANOVA with Dunett's test; P<0.05 was considered significant.

**Results:** Under the conditions of this study, Dx produced infusing-dose-depended inhibition in both HGA and PNA in a same magnitude without profound hemodynamic changes (refer to the table).

1.) Effects of Dx on cardiovascular functions: Dx10 and Dx30 decreased HR and there was no significant difference between both groups during experiments. Dx30 decreased mABP in a dose dependent way, but Dx10 did not show a dose-dependent inhibition. At the 10.0 mcg/kg dose of Dx, there was a significant difference in mABP between both Dx10 and Dx30 (80.8 mmHg vs. 50.3 mmHg;  $p<0.05$ ).

2.) Effects of Dx on respiratory functions: In Dx10 significant depression in HGA and PNA were observed from the first 2.5 mcg/kg to the final 10.0 mcg/kg Dx, whereas Dx30 did not cause significant changes at the first and 5.0 mcg/kg doses. And there was no significant difference between both groups, except for at the 2.5 mcg/kg Dx where both HGA and PNA were inhibited more in Dx10 than in Dx30 (90.6% vs. 102.2% for HGA, 90.3% vs. 98.4% for PNA;  $p<0.05$ ).

**Conclusion:** These results show that respiratory depression and changes in blood pressure can be differentially affected by the infusion rates of Dx.

These findings may implicate that it is more useful, for safely accomplishing the same loading dosage of Dx without any respiratory depression, to select the relative higher infusion rate with vigilance against potential hypotension.

## Effects of Dx on Measured Parameters

		Control	2.5 mcg/kg	5.0 mcg/kg	7.5 mcg/kg	10.0 mcg/kg
HR (bpm)	Dx10	324.7 ± 39.4	319.2 ± 43.7	297.8 ± 46.2**	300.9 ± 60.2**	293.4 ± 68.6**
	Dx30	332.8 ± 26.1	328.3 ± 26.8	300.5 ± 17.7**	298.2 ± 26.7**	279.0 ± 17.3**
mABP (mmHg)	Dx10	115.3 ± 24.8	102.3 ± 28.1	74.9 ± 34.7**	91.4 ± 16.1	80.8 ± 19.7* <sup>+</sup>
	Dx30	114.3 ± 15.4	110.6 ± 17.7	87.9 ± 17.1**	66.3 ± 23.2**	50.3 ± 21.3**
HGA (% of Control)	Dx10	100.0	90.6 ± 7.2** <sup>+</sup>	78.1 ± 13.3**	69.7 ± 7.2**	62.3 ± 6.2**
	Dx30	100.0	102.2 ± 10.5	83.8 ± 8.6	68.5 ± 8.8**	46.8 ± 27.9**
PNA (% of Control)	Dx10	100.0	90.3 ± 5.9** <sup>+</sup>	75.7 ± 17.2**	68.1 ± 11.0**	65.9 ± 12.6**
	Dx30	100.0	98.4 ± 0.7	84.9 ± 6.2	75.7 ± 10.9**	57.8 ± 34.5**

Mean ± S.D \*: $p<0.05$  vs. control \*\*: $p<0.01$  vs. control +: $p<0.05$  vs. between Dx10 and Dx30

**Summary:** We investigated the effects of the low and high infusion rates of dexmedetomidine (Dx10 and Dx30) on hypoglossal and phrenic nerve activity (HGA and PNA), and cardiovascular functions in anesthetized rabbits. Dx30 unexpectedly preserved HGA and PNA compared to Dx10, without causing more severe hypotension while within lower doses.

## Derivation and Validation of an Automated Electronic Search Algorithm to Identify Patients at Risk for Obstructive Sleep Apnea

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**Co-Authors:** Gregory A. Wilson, RRT., Alexandre Cavalcante MD, Juraj Sprung MD, PhD., Toby N. Weingarten MD

**Background:** Patients undergoing surgery with a diagnosis of or high-risk for obstructive sleep apnea (OSA) have been recognized to be at increased risk for postoperative complications (1). Reliable data in this subset of patients is useful for outcomes research, but manual extraction from large cohorts is impractical. Automated data extraction from electronic medical records is a useful tool for conducting retrospective analysis on large cohorts (2). There is limited evidence on the derivation and validation of an electronic search technique used to identify patients at risk for OSA.

**Aim:** The primary aim was to derive and validate an automated electronic search algorithm used to identify patients with a diagnosis of or at high risk for OSA. The secondary objective was to calculate the sensitivity and specificity of this algorithm.

**Material and Methods:** This study was approved by the Mayo Clinic IRB. Subjects for this study were from an unrelated retrospective study of 558 adult surgical patients who underwent general anesthesia from January 2011 through December 2015. A cohort of 100 subjects was randomly constructed to derive an automated OSA digital search algorithm. This algorithm searched the text of diagnoses and results of a preoperative check list which queried OSA history and screened for OSA risk using Flemons' criteria (3). The records of the derivation cohort subjects were manually reviewed for OSA risk and used to develop and refine the algorithm. The algorithm was then validated on the entire cohort compared to manual chart review.

**Results:** In the derivation cohort, the automated algorithm achieved a sensitivity of 98.2% and a specificity of 100% compared to manual review. In the validation cohort, the algorithm achieved a sensitivity of 99.3%, a specificity of 98.6%, a positive predictive value of 95.7%, and a negative predictive value of 99.8%.

**Discussion:** This study showed that an automated search algorithm can be developed to interrogate the electronic medical record to identify surgical patients with a diagnosis or are at high risk for OSA. The comparison between this algorithm and manual chart review shows that this automated strategy performs with a high degree of accuracy. This study has all inherent limitations of a retrospective study.

**Conclusion:** This study shows the development of an automated digital search algorithm that interrogates electronic medical records to identify patients with a diagnosis of and those at high risk for OSA.

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## Non-Invasive Assessment of Low Minute Ventilation in the Post-Anesthesia Care Unit and General Hospital Floor

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**Background:** Patients with high STOP-Bang (SB) scores have a high probability of obstructive sleep apnea (OSA) and are considered at greater risk for post-operative respiratory complications.<sup>1</sup>

**General Aim:** We used a non-invasive respiratory volume monitor (RVM, ExSpirom, Respiratory Motion, Inc, Waltham, MA) to quantitatively measure minute ventilation (MV), tidal volume (TV) & respiratory rate (RR) in the post anesthesia care unit (PACU) & through the first post-operative night (PON1) on the general hospital floor (GHF) in order to compare the incidence of Low MV events in patients with high vs low SB risk scores.

**Materials and Methods:** Following IRB approval and written informed consent, RVM data from 35 patients undergoing general surgery were collected in the PACU & during PON1. MV was expressed as percent of MV predicted ( $MV_{PRED}$ ), estimated for each patient based on body surface area and sex.<sup>2</sup> Low MV events (LMVe) were identified as  $MV < 40\% MV_{PRED}$  sustained  $\geq 2$  min. The Mean Time between LMVe (MTBe) was calculated for each patient as the duration of monitoring in seconds divided by the number of LMVe. Patients were divided into two groups based on SB score: “Low SB” ( $SB < 5$ ) and “High SB” ( $SB \geq 5$ ). The t-test or  $\chi^2$  test were used for comparison, a  $p < 0.05$  was significant.

**Results:** 35 patients (9 males), BMI of 32.6 (range 21.5-54.7)  $kg/m^2$ , age 58.0 (range: 28-81) were monitored for  $18.4 \pm 2.5$ hr (PACU:  $4.4 \pm 2.7$  hr; GHF:  $14.0 \pm 3.3$  hr). Ten patients (29%) experienced no LMVe and 86% of all monitored hours were LMVe free. High SB patients experienced a significantly longer interval between LMVe and a trend towards a shorter LMVe duration (5.8 vs 4.0 min,  $p = 0.37$ ) than Low SB patients (Table 1). The incidence of LMVe for all patients was similar in the PACU (MTBe=1.2hr) and the GHF (MTBL=1.4hr). During LMVe, MV decreased by 70% from  $91.3 \pm 6.2\%$  of  $MV_{PRED}$  to  $27.7 \pm 0.8\%$  of  $MV_{PRED}$ , mostly based on a 63% decrease in TV from  $442 \pm 35$  mL to  $161 \pm 9$  mL and a 14% decrease in RR from  $15.6 \pm 0.6$  bpm to  $13.4 \pm 0.8$  bpm ( $p < 0.05$  for all comparisons).

**Discussion and Conclusion:** 86% of monitored hours were LMVe free, indicating a relatively low occurrence in a general surgical population. Patients with high SB scores had less frequent and shorter LMVe than low SB scoring patients. These findings suggest that the low SB population should be monitored at least as closely as their high SB counterparts. LMVe demonstrated significantly lower TVs and a modest RR decrease. A postoperative monitoring algorithm based on RVM data could be created to identify patients requiring additional monitoring to ensure patient safety.<sup>3</sup>

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**Table 1.** Demographics and Low Minute Ventilation event characteristics for Low SB patients considered not-at-risk for OSA and High SB patients considered at-risk for OSA.

Group	Low SB SB < 5	High SB SB ≥ 5	P-value
OSA Risk	Low	Moderate/Severe	
Number of Patients	24	11	
STOP-BANG (SD)	2.2 (1.5)	5.4 (0.7)	< 0.0001
Height, cm (SD)	163 (10)	166 (9)	0.43
Weight, kg (SD)	80 (16)	106 (26)	0.0006
BMI, kg/m <sup>2</sup> (SD)	30.0 (6.1)	38.5 (9.0)	0.002
Length of Monitoring, hr, (SD)	18.9 (2.4)	17.1 (2.4)	0.045
Average Percent MV <sub>PRED</sub> (SEM)	87.1 (6.7)	94.3 (14.5)	0.61
Mean Time Between LMVe, hr	1.1	2.6	< 0.0001
Mean LMVe Duration (min)	5.8	4.0	0.37

## Mobile Phone App-Based Novel Oximetry System

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**Introduction:** Obstructive sleep apnea (OSA) is a disorder characterized by repetitive episodes of breathing cessation due to upper airway obstruction during sleep. Substantial number of surgical patients presenting for major elective procedures are unrecognized.<sup>1</sup> The problem of postoperative respiratory depression during sleep in susceptible OSA patients is compounded by parenteral opioids used to ameliorate postoperative pain.<sup>2</sup> Monitoring these patients in high acuity areas may not be always possible due to resource limitations.

**Method:** Utilising a peer-reviewed grant (AHEG/FY2014), Anesthesia Department and Transformation Office from Alexandra Health System Singapore innovated a novel mobile phone and app-based system and filed patent (No.10201500967S) for the “Telemedicine Oximetry System”. This application is able to continuously monitor pulse oximetry, baseline and lowest capillary oxygen saturation, and oxygen desaturation index (ODI 4%). This information may be wirelessly transferred to a secure server. A bar-code scanner captures patients’ particulars and user can set start and end time for data collection (e.g. 12mn to 6am). Alarms may be customised to alert caregivers when the patient desaturates to a pre-stipulated critical level (i.e. SpO<sub>2</sub><70%).

**Results:** Institutional research board endorsed a validation study in ten consenting healthy staff volunteers comparing the novel mobile phone app-based oximetry system with a commercially available level 4 home sleep apnea testing device (Konica-Minolta Pulsox 300i).

	Konica-Minolta Pulsox 300i	Mobile Phone App-Based Oximetry
Lowest SpO <sub>2</sub> (%)	81.7±4.7	85.6±3.8
Lowest Pulse Rate	49.3±7.8	54.1±11.6
Highest Pulse Rate	119.8±43.9	101.4±10.0
ODI 4%	1.21±0.95	0.29±0.25

**Conclusion:** The Telemedicine Oximetry System has a user-friendly and an automated mobile system which has the potential to reduce healthcare cost, enhance patient safety and improve management of susceptible perioperative OSA patients. Its commercial potential is promising although future clinical studies are required using this novel device.

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## Role of an Ancestral Protein in the Mechanism of Restorative Sleep

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**Background:** Post-operative sleep disturbance is common in the first six nights [1], with patients exhibiting sleep deprivation in the form of total sleep decline with REM (rapid eye movement) and SWS (slow wave sleep) impairment. While REM and SWS normally rebound, 25% of patients exhibited sleep quality changes lasting more than two weeks. Anesthesia's effect on brain chemistry may contribute to sleep disturbances.

**General Aim:** Using a bioinformatics approach, we developed a molecular model for the restorative properties of sleep, involving the highly abundant protein, glyceraldehyde 3-phosphate dehydrogenase (GAPDH). Additionally, using zebrafish, we examined the effects of an anesthetic, trifluoroethanol (TFE), on nuclear-translocation of GAPDH, an indicator of oxidative stress.

**Materials and Methods:** We performed sequence alignment of human and zebrafish GAPDH and determined the relative proximity of all cysteine residues in the 3D crystal structure. Experimentally, adult zebrafish (IACUC- and IBC-approved) were exposed (0.1mM for 3hr) to TFE, telencephalons removed, cytosolic/nuclear fractions isolated, GAPDH activities determined and compared with controls.

**Results:** We found that the human and zebrafish GAPDH are 93% homologous, each containing two highly-conserved cysteine residues. Zebrafish GAPDH has two additional cysteine residues; human, one. Inter-atomic distances of the cysteine sulfur atoms suggest a susceptibility to disulfide linkages. Experimentally, we observed that TFE-treated fish had a greater amount of nuclear-translocated GAPDH than controls, suggesting chemical modification. Nuclear translocation of cytosolic GAPDH depends on cysteine modification [3], a redox sensitive event.

**Discussion:** S-Nitrosylated GAPDH, which has been shown to be translocated to the nucleus, is a measure of oxidative modification. Our model links redox cycles with protein disposal, repair and regeneration, implicating GAPDH, which is affected by anesthetic agents [2], as the pivotal redox sensor. The four cysteine residues in the highly abundant zebrafish neuronal GAPDH are modulatable. The sulfhydryl group on cysteine residues is capable of undergoing nitrosylation, oxidation, and succination. Some of these reactions are reversible, resulting in damaged protein that must be disposed. Additionally, protective reactions (i.e. glutathionation and sulfhydration) are capable of forming adducts on cysteine residues, blocking them from damaging reactions.

**Conclusion:** We propose that GAPDH acts as a neuronal redox sensor and plays a role in the restorative properties of sleep by directing cellular repair and regenerative processes. The present findings show that GAPDH becomes re-compartmentalized in telencephalon of zebrafish exposed to anesthetic agent. This agent-induced event may disrupt the restorative cellular processes in brain.

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## The Obese Patient in the Post-Anesthesia Care Unit

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**Background:** Obese patients with diagnosed or presumed Obstructive Sleep Apnea (OSA) are at risk for adverse respiratory events postoperatively, related to anatomic and physiologic derangements, underlying comorbidities, and perioperative events. Decision-making in the Post-Anesthesia Care Unit (PACU) regarding the postoperative disposition of such patients remains a challenge, but new data has emerged to guide the process (1).

**Aim:** The goal was to create an algorithm for use in the PACU to guide the decision-making process. It would lend itself to ease of use, while remaining true to current findings and recommendations (2,3). Data regarding those patients' outcomes will be gathered.

**Materials and Methods:** After review of the literature, and discussion with our perioperative physicians and nurses, an algorithm to guide the care of the obese patient in the PACU was devised (figure 1).

**Results:** Obese patients are now being screened preoperatively using the STOP-BANG questionnaire (4). Those patients scoring 5 or more are presumed to have OSA. If signs or symptoms of additional comorbidities are discovered on history and physical examination, the patient is referred to the pulmonology service for further evaluation (5). All patients scoring 5 or more are considered for pulmonology evaluation depending upon the urgency of their planned surgery. In the PACU, the algorithm is used. Data is now being gathered to follow up on the postoperative hospital course of obese patients with OSA.

**Discussion:** Patients who experience recurrent respiratory events in the PACU are known to be at high risk for further such events beyond the PACU (1). Such patients are then transferred to a monitored setting where continuous pulse oximetry is performed (6). Patients who experience no or one respiratory event in the PACU are assessed and a clinical judgment is made regarding their disposition beyond the PACU; this still remains a somewhat arbitrary process.

**Conclusion:** The clinical assessment and decision-making process as to level of care beyond the PACU for obese patients with diagnosed or presumed OSA remains a challenge. Patients with severe OSA or those with a complex perioperative course appear to be at highest risk. Data is still needed with regard to those patients whose screening or perioperative course are less severe or complex, but may still be at risk.

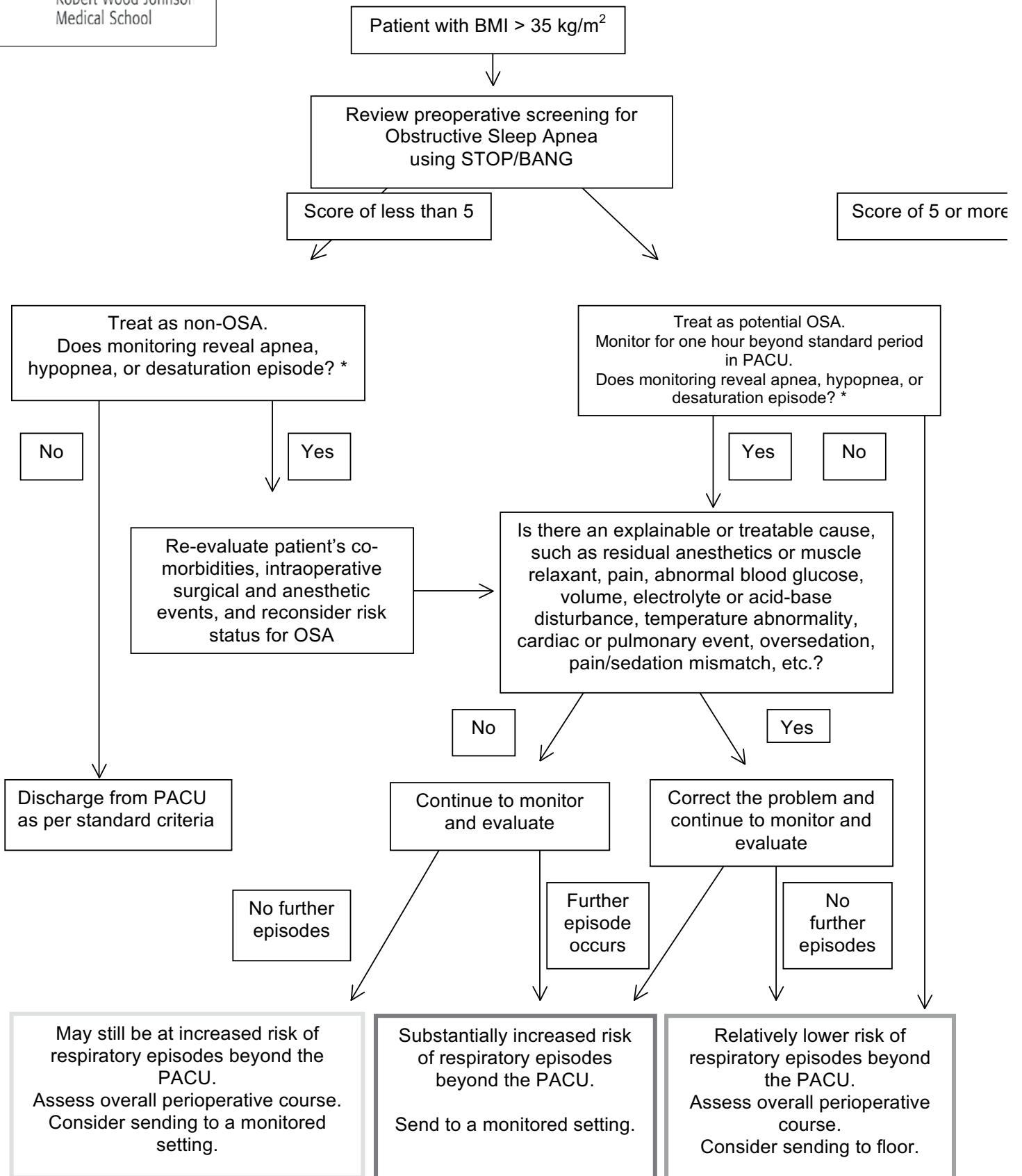
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Figure 1



**The Obese Patient in the Post-Anesthesia Care Unit**



\*Apnea is defined as complete cessation of breathing for more than 9 seconds. Hypopnea is defined as respiratory rate less than 8 breaths per minute. Desaturation is defined as saturation less than 90% for 30 seconds while on nasal cannula of 4 LPM.

## **A Review of Phenotypes of Obstructive Sleep Apnea: Applications in Anesthesia, Surgery and Perioperative Medicine**

**Co-Authors:** Yamini Subramani MD, Mandeep Singh FRCPC, Jean Wong FRCPC, Frances Chung MBBS

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**Introduction:** Obstructive Sleep Apnea (OSA) is a common sleep-related breathing disorder affecting up to 27% of women and 43% of men aged 50-70 years and 9% of women and 26% of men in the 30-49 years old category.<sup>1</sup> OSA is a complex polygenic disease with a plethora of clinical phenotypes. OSA is known to comprise of various anatomical and physiological determinants which interact in different dimensions to produce a single overall phenotype at a given point in time. Although CPAP is the gold standard treatment for OSA, it can be unsatisfactory due to non-compliance. Hence there is a need to individualize treatment of OSA to particular phenotypes. The purpose of this review is to educate anesthesiologists on the different phenotypes of OSA to facilitate optimal perioperative management of these patients.

**Methods:** A search of the literature databases Medline, Medline-in-Process & other non-indexed citations (1946 to present) was carried out. The search yielded 237 citations. Irrelevant papers were excluded by title and abstract review. Eighteen relevant publications which described the various OSA phenotypes in adult males and females were reviewed.

**Discussion:** We have characterized OSA patients into various endotypes and phenotypes to address the complexity of the disorder. A 'phenotype' is defined as an observable expression of an individual's observable characteristics without any implication of a mechanism, whereas 'endotype' is by a unique pathophysiological mechanism. Presently, there is no consensus for classifying OSA into the various phenotypes. We have suggested a classification of OSA phenotypes with a link to their corresponding predominant endotypes, based on the underlying mechanism (Table 1).

Pathogenic mechanisms of OSA based on craniofacial morphology, obesity, arousal functions, upper airway muscle activity and ventilatory control stability constitute the endotypes of OSA. A specific OSA phenotype may encompass several endotypes (Table 1). For example, OSA in elderly patients is a unique phenotype with several underlying pathophysiological mechanisms (endotypes), the relative dominance of which varies between individuals. It may be useful to understand the clinically important endotypes and phenotypes of OSA to target treatment



based on the mechanism. This knowledge can also guide the perioperative health care team in the optimal management of surgical patients with OSA.

Obstructive events are known to increase in frequency and severity of hypoxemia during REM sleep due to hypotonia and reduced responsiveness of the genioglossus muscle to negative intrapharyngeal pressure. The recovery of REM sleep around the third postoperative night may contribute to breathing disturbances. The REM-related OSA phenotype is amenable to treatment measures such as hypoglossal nerve stimulation to improve the tone of genioglossus muscle apart from empirical CPAP therapy. Supine-related OSA is a clinical phenotype characterized by appearance of features of sleep apnea during supine sleep, and little or no sleep apnea during non-supine sleep. This phenotype can be attributable to underlying pathophysiological endotypes such as unfavorable upper airway anatomy and dysfunctional upper airway dilator muscles. Anesthetizing and recovering patients without OSA in the head elevated position up to 6 cm from horizontal increases the stability of the airway in these patients.

Certain surgical patients with OSA have a high arousal threshold and may be more sensitive to opioids and sedatives with a higher risk of respiratory arrest. Regional anesthesia, by an opioid sparing effect, decreases airway collapsibility and respiratory depression and is beneficial in these patients. These patients may also require prolonged continuous postoperative monitoring with high resolution pulse oximetry and capnography.

**Summary:** In conclusion, OSA is a complex multifactorial disease with distinct endotypes and phenotypes. This knowledge is of particular importance in providing the optimal perioperative care to OSA patients. Understanding the pathophysiological mechanisms of OSA is also critical to the success of individualized therapeutic approaches.

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1. Heinzer R et al. *Lancet Respir Med* 2015;3:310–8.

**Table 1. OSA phenotypes and corresponding endotypes (Linking underlying pathological mechanisms with phenotypes of OSA):**

<b>OSA Phenotypes</b>	<b>Predominant Endotypes</b>		
<b>OSA in elderly patients</b>	Low arousal threshold Rostral fluid shift	Hyporesponsive genioglossus	Anatomical (abnormal fat distribution)
<b>OSA in males</b>	Anatomical (android obesity)	Rostral fluid shift (age more than 40 years)	
<b>OSA in fluid overloaded states</b>	Rostral fluid shift		
<b>OSA in menopausal women</b>	Anatomical (abnormal fat distribution)		
<b>Ethnic OSA phenotypes</b>			
African Americans	Anatomical (obesity)		
Asians	Anatomical (abnormal craniofacial morphology)		
Caucasians	Anatomical (both obesity and abnormal craniofacial morphology)		
<b>REM-related OSA phenotype</b>	Hyporesponsive genioglossus		
<b>Supine-related OSA phenotype</b>	Anatomical	Hyporesponsive genioglossus	

OSA – Obstructive sleep apnea

REM – Rapid eye movement

## Isoflurane and Postoperative Respiratory Depression

**Presenting Author:** Carmelina Gurrieri, MD

**Co-Authors:** Alexandre N. Cavalcante, MD, Juraj Sprung, MD, PhD, Toby N. Weingarten, MD

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**Background:** Studies have showed that desflurane provides a faster and more predictable anesthesia recover than isoflurane in a substantial fraction of surgical population accounting for obese and elderly patients. (1, 2) Early recovery improves active airway control by the patients and may decrease the risk of respiratory depression in the Post Anesthesia Care Unit.

**General Aim:** The primary aim of this study was to determine if isoflurane was associated with respiratory depression during Phase I anesthesia recovery in the Post Anesthesia Care Unit following major laparoscopic procedures.

**Materials and Methods:** The electronic medical records of 8,567 patients who underwent laparoscopic procedures  $\geq 90$  minutes from January 1, 2010 to July 31, 2014 were retrospectively reviewed to assess for potential associations between patient and perioperative variables and episodes of respiratory depression in the Post anesthesia Care Unit. Multivariable and propensity matched analyses were performed to assess for potential association between intraoperative isoflurane use and postoperative respiratory depression.

**Results:** The incidence of respiratory depression was 18.1% in the isoflurane subgroup, 13.2% in the isoflurane free subgroup (95%CI 1.29–1.63),  $P < 0.001$ . From multivariable analysis isoflurane was associated with respiratory depression, odds ratio 1.32 (95% CI 1.16, 1.49),  $P < 0.001$ . These results were confirmed by propensity matched analysis, 1.31 (CI 1.15, 1.50),  $P < 0.001$ .

**Discussion:** Isoflurane used as the primary inhalational anesthetic was associated with increased respiratory depression in the Post Anesthesia Care Unit. The rate was higher in obese and in Obstructive Sleep Apnea patients and when sustained release opioids, gabapentin and midazolam were used peri-operatively. (3,4)

**Conclusion:** Isoflurane increases the risk of postoperative respiratory depression especially when used in conjunction with sustained release opioids, gabapentinoids and midazolam. Anesthesia practice improvement should be considered in order to reduce the time to emergence from anesthesia and to avoid over sedation, which can lead to postoperative respiratory depression. (5)

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- 3) Weingarten TN. Reg Anesth Pain Med 2015;40: 330–336
- 4) Weingarten TN. Obes Surg 2015;25:1024-30
- 5) Weingarten TN. BMC Anesthesiol. 2015 Apr 23;15:54

## Multimodal Analgesic Therapy with Gabapentin and Postoperative Respiratory Depression

**Presenting Author:** Carmelina Gurrieri, MD

**Co-Authors:** Alexandre N. Cavalcante, MD, Juraj Sprung, MD, PhD, Toby N. Weingarten, MD

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**Background:** Multimodal analgesic therapies have become popular for acute postoperative pain treatment. (1) Gabapentinoids are frequently included in multimodal analgesic regimens and recent meta-analyses have demonstrated that their use reduces the need for opioids and improve postoperative pain, but may induce sedation and can be associated with respiratory depression during postanesthesia recovery. (2)

**General Aim:** The primary aim of this study was to determine if gabapentin was associated with respiratory depression during Phase I anesthesia recovery in the Post Anesthesia Care Unit following major laparoscopic procedures.

**Materials and Methods:** The electronic medical records of 8,567 patients who underwent laparoscopic procedures  $\geq 90$  minutes from January 1, 2010 to July 31, 2014 were retrospectively reviewed to assess for potential associations between patient and perioperative variables and episodes of respiratory depression during Phase I recovery. Multivariable and propensity matched analyses were performed to assess for potential association between preoperative gabapentin use and postoperative respiratory depression.

**Results:** The incidence of respiratory depression was 153 (95%CI 146–161) per 1,000 cases. From multivariable analysis gabapentin was associated with respiratory depression, odds ratio 1.46 (95% CI 1.22–1.75),  $P < 0.001$ . These results were confirmed by propensity matched analysis among a subgroup of patients who did not receive neuroaxial opioids, 1.34 (1.07–1.68),  $P = 0.012$ .

**Discussion:** Gabapentin used in conjunction with opioids increased the incidence of respiratory depression during anesthesia recovery in the Post Anesthesia Care Unit. The overall rate varies according to the different anesthesia techniques, being higher when sustained release opioids are used as part of multimodal protocol (3) and when isoflurane is used more frequently. (4)

**Conclusion:** Gabapentinoids increase the rate of postoperative respiratory depression when used as part of multimodal analgesia regimen. An opioid-sparing effect of gabapentinoids should be considered when constructing multimodal analgesic regimens, and increased vigilance for respiratory depression is warranted.

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## Sleep-disordered Breathing and Delirium

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**Background:** Sleep-disordered breathing (SDB) affects a large portion of the general population and has been associated with cognitive impairment in older individuals. Delirium is an acute change in mental function and attention that fluctuates throughout the day and often occurs after surgery. Several studies suggest a relationship between SDB and postoperative delirium.

**General Aim:** The aim of this systematic review is to evaluate the literature on SDB, delirium, and cognitive impairment, and discuss the pathophysiology and perioperative considerations.

**Materials and Methods:** A literature search was performed of Medline (1946 - 2016), Medline In-Process (June 2016), Embase (1947-2016), Cochrane Central Register of Controlled Trials (May 2016), Cochrane Database of Systematic Reviews (2005 - June 2016). Inclusion criteria for studies were: a) SDB confirmed by polysomnography, b) delirium or cognitive impairment confirmed by a validated diagnostic tool, and c) publications in the English language. All study designs including randomized controlled trials, observational studies and case reports were included.

**Results:** The literature search identified three studies and eleven case reports on SDB and delirium (Table 1), twenty studies on SDB and cognitive impairment, and five studies on the effect of continuous positive airway pressure (CPAP) on cognitive impairment and delirium in elderly patients. The studies found a correlation between SDB and delirium (Table 1). Roggenbach et al.<sup>1</sup> found that an AHI > 19 event/h was associated with a six-fold increase of postoperative delirium while Flink et al.<sup>2</sup> reported patients with obstructive sleep apnea had 2.5 times greater chance of delirium. In all case reports, SDB was associated with delirium, with one patient developing delirium after receiving opioids, and when CPAP or Bilevel Positive Airway Pressure was utilized, all cases of delirium resolved.<sup>3</sup> Other successful treatments include mandible surgery in one patient with retrognathia, and tonsillectomy in a patient with enlarged tonsils.<sup>4,5</sup>

The twenty studies on SDB and cognitive impairment show that SDB is strongly correlated to cognitive impairment. Of the five studies on CPAP therapy in elderly patients, all showed an

improvement in cognitive function when patients used CPAP for > 4h/day. The studies used varied cognitive tests but all studies with memory tests showed CPAP has a positive effect on memory.

**Discussion:** SDB is associated with cognitive impairment and this systematic review revealed that patients with SDB may have a greater risk of delirium. The pathophysiology of SDB and delirium is unclear, but SDB is thought to affect the brain by causing repetitive nocturnal hypoxia, reducing cerebral blood flow, increasing cortisol levels, and causing systemic inflammation. Preliminary evidence suggests that CPAP therapy may lower the risk of delirium and improve cognitive function, but effective treatments for SDB to reduce the incidence of delirium have not been studied extensively.

**Conclusion:** Health care professionals need to be aware that undiagnosed SDB may contribute to postoperative delirium and they should consider preoperatively screening patients for SDB. By managing the effects of SDB, patients may have a reduced risk of postoperative delirium. Further studies are needed to clarify the relationship between SDB and delirium.

Table 1. Studies and Case Reports on the Association between Sleep Disordered Breathing and Delirium

Studies										
Author, year, Population type	Study type	SDB	Delirium	n	Mean age (yrs)	Severity of sleep disordered breathing			p-value	Comments
						Prevalence of delirium	w/delirium	w/o delirium		
Roggenbach 2014 <sup>1</sup> Cardiac surgery	Prospective observational	PSG	CAM	92	67.5 ± 9	48%	AHI: 27.7	AHI: 13.2	0.001	Patients with delirium: higher AHI
Author, year, Population type	Study type	SDB	Delirium	n	Mean age	Prevalence and severity of delirium			p-value	Comments
						Prevalence of delirium	w/SDB	w/o SDB		
Flink 2012 <sup>2</sup> Knee replacement	Prospective observational	PSG medical records	CAM DRS-R98	106	≥ 65	25%	w/delirium: 53% DRS-R-98 Total: 16 ± 6 Severity: 11	w/o delirium: 20.9% DSR-R-98 Total: 3.7 ± 4	0.0123	Patients with SDB: 2.5 fold higher risk of delirium; more

							± 5	Severity: 2.1 ± 2.0		severe delirium
Sandberg 2001 <sup>7</sup> Stroke patients	Cross-sectional study	PSG	DSM-IV criteria for delirium	133	77 ± 8	66%	AHI ≥ 10: 75.3% w/delirium	AHI ≤ 10: 55.6% w/delirium	0.018	Patients with AHI ≥ 10: higher risk of delirium
Case Reports										
Author, Year	Patient characteristics	Reason for admission		Diagnostic tool/tests		Diagnosis and Treatment		Outcome		
Becker 2010 <sup>8</sup>	Male Age: 82  BMI: NA	Delirium, difficulty sleeping, weight loss, apneic episodes		PSG MMSE: 19		CSA + Cheyne-Stokes breathing + delirium  Rx: BPAP		Improved sleep, MMSE score, and delirium		
Reddy 2008 <sup>3</sup>	Male Age: 72 BMI: NA	Delirious, agitated, hypertensive, and drowsy		Previously diagnosed but not compliant with CPAP		OSA + opioid induced delirium  Rx: CPAP		Delirium induced by opioids resolved rapidly after CPAP resumed		
Munoz 1998 <sup>9</sup>	Male Age: 72 BMI: 34.2	Confusional state, agitation, disorientation, fabulation, apneas, fluctuations in consciousness		PSG AHI: 81		OSA+ delirium  Rx: CPAP		Delirium + confusion resolved		



Tergazhi 2014 <sup>10</sup>	Male Age: 69 yrs BMI: 27.6	Agitation, confusion, insomnia, hallucinations, snoring, apneas, restless sleep, nocturia	PSG AHI: 18.8 MMSE = 24.9	OSA + delirium  Rx: not reported	Not reported
Dagan 2001 <sup>11</sup>	Male Age: 68 BMI: 31.4	Severe sleepiness, mental fatigue, nervousness, and difficulties in memory, attention and concentration	PSG AHI 58.3	OSA and Laron syndrome*  Rx: CPAP	Improvement in sleep, alertness, mood, and cognitive functioning
Lombardi 2009 <sup>12</sup>	Male Age: 52 BMI: 34	Agitation, aggressive and disorganized behavior, clouding of consciousness, hallucinations, fluctuations in alertness	Previously diagnosed but not compliant with CPAP PSG AHI: 45	OSA + delirium  Rx: CPAP	No reoccurrence of delirium
Whitney 1996 <sup>13</sup>	Male Age: 47 BMI: NA	Agitation, restlessness, incoherent rambling, periods of lucidness	PSG MMSE	OSA + delirium  Rx: CPAP	Delirium resolved 1 day after CPAP instituted
Lee 1998 <sup>14</sup>	Male Age: 43 BMI: 71	Agitation, aggressive and disorganized behavior, clouding of consciousness, snoring, somnolence	PSG DRS: 29/32	OSA + delirium Rx: Haloperidol CPAP Weight loss after vertical band gastroplasty	Recurrent episodes of delirium, inconsistent compliance with CPAP, delirium resolved after losing 85 kg following a gastroplasty
Neal 2012 <sup>15</sup>	Male Age: 32	Fatigue, hallucinations, headache	PSG AHI: 61.5	OSA + hypothyroid	Discharged after 2 days

	BMI: 35	agitation, delirium, snoring	RDI: 96.5	psychosis  Rx: Levothyroxine IV hydration CPAP	
Lee 1989 <sup>5</sup>	Male Age: 30 BMI: 31.1	Sudden onsets of confused behavior, fluctuating sleepiness, disorientation, irrational behavior, and paranoid delusions	PSG	OSA + psychosis Rx: tonsillectomy	Remission of psychosis and resolution of apneas. No intellectual improvement
Martin 1981 <sup>4</sup>	Male Age: 13.5 BMI: NA	Decreased concentration and short-term memory, chronic fatigue, mild cognitive delay	PSG	OSA + psychosis due to congenital retrognathia  Rx: mandible surgery	Psychosis resolved. Increased concentration, no daytime somnolence.

CAM = confusion assessment method; PSG = Polysomnography; AHI = apnea-hypopnea index; SDB = sleep-disordered breathing  
 DRS-R-98 = delirium rating scale-revised-9; DSM-IV = Diagnostic and Statistical Manual of Mental Disorders; NA = not available; OSA = obstructive sleep apnea; CSA = central sleep apnea; ODI = oxygen desaturation index; MMSE = mini-mental state examination; RDI = respiratory distress index; Rx = treatment

\* Laron syndrome: a rare form of short stature resulting from a genetic condition that causes growth hormone resistance. Signs and symptoms include distinctive facial features, obesity, shorter limbs, small genitals, fragile hair, hypoglycemia in infancy, and reduced muscle strength and endurance.

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## Obstructive Sleep Apnea in Patients Undergoing Hysterectomy Increases the Odds for Perioperative Complications

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**Co-Authors:** Nicole Zubizarreta, MPH, Crispiana Cozowicz, MD, Jashvant Poeran, MD PhD, Stavros G. Memtsoudis, MD, PhD, FCCP

**Background:** Obstructive sleep apnea (OSA) has been identified as a risk factor for perioperative complications in various patient cohorts<sup>1</sup>. However, there is a lack of data on the prevalence of OSA and its association with outcomes in patients undergoing hysterectomies, one of the most frequently performed surgeries among women<sup>2</sup>.

**General Aim:** We analyzed the impact of OSA on perioperative outcomes among patients undergoing hysterectomy. Analogous to other surgeries, we hypothesized that OSA in patients undergoing hysterectomy would be associated with an increased risk of perioperative complications as well as with increased cost of hospitalization and length of stay.

**Material and Methods:** We extracted a sample of patients who underwent a hysterectomy between 2006 and 2014 from a large nationwide administrative database (Premier Perspective Database, Premier Inc., Charlotte, North Carolina). Among this patient sample we identified OSA-patients by using ICD-9 CM codes and subsequently compared them for perioperative outcomes with those patients who had no diagnosis of OSA. These perioperative outcomes included opioid utilization (assessed by billing data), cost of hospitalization and length of stay, need for blood transfusion, ICU admission as well as cardiac, central-nervous, gastrointestinal, genitourinary, renal, respiratory and thromboembolic complications. Multilevel multivariable models were fitted to determine associations between OSA status and outcomes. Odds ratios (OR) and 95% confidence intervals (CI) are reported. Since only de-identified data was used, this study was exempt from patient consent by the Institutional Review Boards of the Hospital for Special Surgery and Icahn School of Medicine at Mount Sinai.

**Results:** Of N = 459,508 patients undergoing hysterectomy, n = 11936 (2.6%) had a diagnosis code for OSA listed. On average, OSA-patients were older ( $52.3 \pm 11.4$  years vs.  $48.4 \pm 12.1$  years;  $p < 0.0001$ ) and had a higher Deyo-Charlson comorbidity score ( $1.13 \pm 1.79$  vs.  $0.55 \pm 1.49$ ;  $p < 0.0001$ ) than non-OSA patients. When controlling for relevant covariates, OSA status was associated with increased cost of hospitalization (+6.24%;  $p < 0.0001$ ) and longer length of stay (+2.58%;  $p < 0.0001$ ) compared to patients without OSA. In addition, OSA-patients had higher opioid utilization than non-OSA patients (+1.24%;  $p = 0.04$ ). A similar pattern was seen

for complications: OSA (compared to non-OSA) was associated with substantially higher odds for ICU admission (OR 2.28; CI 1.77 – 2.94) and renal (OR 1.98; CI 1.70 – 2.31) or respiratory complications (OR 3.25; CI 2.97 – 3.56).

**Conclusion:** In this cohort of patients undergoing hysterectomies, OSA prevalence was low but associated with substantially (up to >300%) increased risk of complications. Given that opioid consumption is an important modifier of outcomes in OSA patients, further research is needed to assess currently used strategies for OSA patients undergoing hysterectomies.

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## Association of Opioid Prescription and Perioperative Complications in OSA-Patients Undergoing Total Joint Arthroplasties

**Presenting Author:** Eva E. Mörwald, MD

**Co-Authors:** Ashley Olson, MA, Crispiana Cozowicz, MD, Jashvant Poeran, MD, PhD, Stavros G. Memtsoudis, MD, PhD, FCCP

**Background:** Obstructive sleep apnea (OSA) has been linked to higher rates of perioperative complications<sup>1</sup>. Especially pulmonary complications have been suggested to be more common among patients with OSA<sup>2</sup>. Therefore, practice guidelines recommend minimizing the use of respiratory depressant drugs, specifically opioids, among individuals with OSA, because they potentially worsen pathophysiologic processes associated with OSA<sup>3</sup>. However, a paucity of evidence exists relating different levels of opioid prescription to perioperative complications.

**General Aim:** Our aim was to investigate if different levels of opioid prescription are related to perioperative complication risk in patients with OSA. We hypothesized that higher opioid prescription would be associated with higher odds of perioperative complications.

**Material and Methods:** 107,610 OSA-patients undergoing total knee or hip arthroplasty between 2006 and 2013 were identified in a nationwide database (Premier Perspective Database, Premier Inc., Charlotte, North Carolina) and divided into quartiles according to the amount of opioids prescribed. We then compared those quartiles for odds of perioperative complications using multilevel multivariable logistic regression models. Since only de-identified data was used, this study was exempt from patient consent by the Institutional Review Boards of the Hospital for Special Surgery and Icahn School of Medicine at Mount Sinai.

**Results:** OSA-patients with higher levels of opioid prescription had increased odds for gastrointestinal complications (OR 1.90, 95% CI 1.47 – 2.46), prolonged length of stay (OR 1.64, 95% CI 1.57 – 1.72) and increased cost of care (OR 1.48, 95% CI 1.40 – 1.57). However, we found lower odds for pulmonary complications (OR 0.85, 95% CI 0.74 – 0.96) for the high prescription quartile.

**Conclusion:** Higher levels of opioid prescription were associated with higher odds for gastrointestinal complications and adverse effects on cost and length of stay but lower odds for pulmonary complications in OSA-patients undergoing joint arthroplasties. The latter finding is unlikely causal but may indicate the growing awareness among practitioners about potential respiratory complications of OSA in the perioperative setting and how these complications may be aggravated by opioid side effects. It should not be viewed as a finding suggesting that administering high doses of opioids are recommended in an unmonitored setting. Attempts to further reduce opioid prescription in patients with OSA should be

continued. Furthermore, since implementation of practice guidelines, institutional policies and utilization of resources for OSA-patients is still suboptimal<sup>4,5</sup>, further sensitization for risks and possible complications is needed to improve quality and safety of this challenging cohort in the perioperative setting.

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## Are Sleep Apnea Patients at Increased Risk for Opioid Induced Respiratory Depression After Surgery Compared to Controls? – A Pilot Study

**Authors:** Crispiana Cozowicz, MD; Eva Mörwald, MD; Natasha Desai, BA; Bhumika Rana, MSc; Stavros Memtsoudis, MD, PhD

**Background:** Obstructive sleep apnea (OSA) has been associated with higher perioperative complication rates.<sup>1</sup> It has been hypothesized that many major complications in this patient population are related to increased sensitivity to opioids, which has led to recommendations that OSA patients be routinely observed in a monitored setting<sup>2</sup>. However, the current literature does neither provide sufficient evidence supporting this hypothesis nor the resulting practice, which is associated with an increased burden on healthcare resources. In this context, few studies have investigated the comparative impact of opioid use on respiratory depression, in those suffering from OSA versus those that are not. The objective of this proof of concept study was to identify the incidence, severity, and duration of decrease in minute volume (MV) occurring in response to opioid administration postoperatively in OSA patients and compare this effect to controls. We hypothesized that respiratory depression, as measured by a reduction in MV from baseline, would occur to a larger extent in OSA patients.

**Methods:** Following institutional IRB approval, 14 patients with known OSA and 15 patients without OSA undergoing elective lumbar spine fusion surgery were enrolled. All patients underwent general anesthesia (GA) and received standardized opioid doses via intravenous patient-controlled analgesia (PCA) postoperatively. Respiratory data, including MV, tidal volume (TV), and respiratory rate (RR), were continuously measured using an impedance-based respiratory volume monitor (RVM, ExSpirom, Respiratory Motion, Inc., Waltham, MA) intraoperatively and up to 4 hours postoperatively in the post-anesthesia care unit (PACU).

**Results:** Following preliminary analysis, the value of absolute MV change following postoperative administration of opioids from the preoperative baseline MV value was higher by trend in OSA patients ( $4.86 \pm 2.46$  liters/min in OSA vs  $3.11 \pm 2.41$  liters/min in controls, respectively), but no statistical difference was achieved ( $P=0.156$ ). This related to a mean percentage change in MV of  $52.93 \pm 21.40\%$  in OSA vs  $47.65 \pm 32.24\%$  in control patients, respectively. This trend in OSA patients was observed while OSA patients used on average less opioids/hour ( $8.04 \pm 3.83$  vs  $12.68 \pm 5.09$  as measured in oral morphine equivalents, respectively). Interestingly, 71% of OSA patients spent more than 1/3 of the time breathing less



than 40% of their predicted MV while this proportion was 36% for controls. No major respiratory complications were observed in this cohort.

**Discussion:** In this proof of concept study comparing OSA vs non-OSA patients, preliminary results showed a trend towards a more pronounced reduction in MV when exposed to standard opioid dosing using a PCA in the postoperative period among those suffering from the disease. Further, OSA patients consumed less opioids and were more likely to spend significant amounts of time hypoventilating compared to their non-OSA counterparts.

While analysis is ongoing, this data may indeed suggest that patients suffering from OSA are more prone to respiratory depression by standard postoperative opioid administration. If substantiated, this finding supports the implementation of strategies to reduce the use of opioids and if not possible increase surveillance to avoid respiratory complications in this patient population.

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#### Tables:

**Table 1: Outcomes**

Outcome	OSA	Control	P-Value
Absolute MV Change liters/min	4.86 ( $\pm$ 2.46)	3.11 ( $\pm$ 2.41)	0.156
% MV Change	52.9 ( $\pm$ 21.4)	47.7 ( $\pm$ 32.2)	
Average Opioids/hour	8.04 ( $\pm$ 3.83)	12.68 ( $\pm$ 5.09)	0.056
% patients LMV at discharge*	71.4 ( $\pm$ 48.8)	36.4 ( $\pm$ 50.5)	
PACU LOS (hours)	4.07 ( $\pm$ 0.42)	3.75 ( $\pm$ 0.73)	0.326

\* percent of patients that spent more than 30% of the time breathing below 40% of predicted MV

## The Importance of Continuous Patient Surveillance Systems in Detection of Respiratory Events in the Postoperative Period – Two Case Reports

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**Co-Authors:** Vina Meliana, MBBS, FANZCA, Frances Chung, MBBS, FRCPC, Jean Wong, MD, David Wong, MD, Mandeep Singh, MD

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**Background:** High dose opioids remain an essential component of acute pain management postoperatively however; opioid induced respiratory depression is a life threatening side effect, contributing to one-third of code-blue arrests in hospitals<sup>1</sup>. In fact, naloxone is administered in 0.2 – 0.7 % of patients receiving postoperative opioids<sup>2,3</sup>. These risks are especially compounded in obese patients and those on high doses of intravenous opioids.

There is increasing consensus supporting the use of surveillance systems that utilize oximetry, respiratory rate monitoring with telemetry and automatic paging capabilities.

**Case presentation :** We present two cases where continuous pulse oximetry and acoustic respiratory rate monitoring of patients resulted in timely aversion of serious complications. Consent for publication of de-identified data was obtained from both patients.

Case 1 – A 56 year old female underwent bilateral knee replacements under adductor canal block and spinal anesthesia with intrathecal morphine. She was morbidly obese (142 kg, BMI 51.5kg/m<sup>2</sup>, STOP-Bang score 4) and was never tested with a sleep study for obstructive sleep apnea. Her postoperative pain was managed with intravenous hydromorphone patient controlled analgesia (IVPCA) and multimodal analgesia. Based on clinical suspicion she was placed on postoperative surveillance system (Masimo Patient SafetyNet, RAD-87 Rainbow Pulse, Irvine, California). Overnight, monitoring indicated significant nocturnal hypoxemia with frequent episodes of desaturation below 88% that alerted the nurse and treating physicians. She declined continuous positive pressure ventilation (CPAP) and was placed on oxygen therapy and semi-upright position. Postoperative complications were avoided and she had an uneventful stay. Formal sleep study and follow-up was arranged for this patient.

Case 2 – A 57 year old male with metastatic gastrointestinal adenocarcinoma and duodenal obstruction, underwent a palliative jejunogastric bypass procedure. The acute pain service was consulted as the patient was having uncontrolled pain from new onset bowel obstruction, despite being on continuous intravenous home infusion of hydromorphone at 100mcg/hour. An IVPCA was initiated in addition to the opioid infusion. He was placed on postoperative surveillance system (Masimo Patient SafetyNet, RAD-87 Rainbow Pulse). Interestingly, as soon as the bowel obstruction was relieved and he did not require more opioids, the surveillance system detected overnight respiratory depression (recurrent bradypnea, RR ~6 breaths/minute). The respiratory rate was the first alarm to get activated, despite normal oxygen saturations and intermittent sedation checks by the nursing staff. The opioids were withheld temporarily and monitoring continued overnight with no subsequent alarms. The patient was discharged after two days.

**Discussion:** The Anesthesia Patient Safety Foundation (APSF) strongly encourages the use of enhanced monitoring devices to avoid harm related to opioid-induced respiratory depression<sup>4,5</sup>. Taenzer et al<sup>6</sup> found a significant reduction in ICU admission and rescue events in patient by using continuous pulse oximetry compared to intermittent monitoring of vital signs. Surveillance systems can provide real-time, continuous, distant respiratory monitoring of these patients and alert clinicians to the signs of deterioration. These two cases demonstrate that the use of such technology improves safety and allows timely intervention and management, to avoid adverse events.

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## Sleep for Inpatients: Empowering Staff to Act (SIESTA) - Impact of SIESTA on Objective and Subjective Nocturnal Disruptions

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**Co-Authors:** Samantha Anderson, BA, University of Chicago Medicine; Babak Mokhlesi MD, MSc, University of Chicago Medicine; Vineet M. Arora, MD, MAPP, University of Chicago Medicine

**Background and General Aim:** Due to the importance of sleep in improving patient health in the hospital, the American Academy of Nursing has recommended in the ABIM Foundation's *Choosing Wisely*<sup>®</sup> initiative to help preserve patient sleep by reducing unnecessary nocturnal care.<sup>1</sup> Prior interventions have not been successful due to lack of sustained behavior change by staff. We designed, implemented, and studied the effectiveness of SIESTA, which combined hospital staff education based on adult learning theory with the behavioral economics concept of "nudges" designed to reinforce behavioral change<sup>2</sup>

**Materials and Methods:** This was a pre-post study conducted at the University of Chicago Medicine and approved by the University of Chicago IRB. SIESTA was implemented in September 2015, when general medicine residents, nurses, and hospitalists were educated on how to help preserve inpatient sleep.

To reinforce this education, behavioral nudges were embedded within the default order sets of the EMR system, Epic. A required question was added to the default q4h vitals setting, asking whether vitals need to be continued throughout the night. In addition, to minimize sleep disruptions due to heparin administration, heparin q12h was added as an option for VTE prophylaxis. From Epic Clarity reports, physicians' use of these sleep-promoting orders was measured and analyzed in a two sample test for proportions.

Nocturnal staff entries into patient rooms were measured via heat sensors provided by GOJO SMARTLINK<sup>™</sup> and analyzed in using interrupted time-series analyses.

Patients were surveyed on perceived sleep disruptions due to vitals and medications. This questionnaire was created via modification of assessments developed by Topf for sleep disruption and noise sensitivity.<sup>3,4</sup>

**Results:** From March 2015-March 2016, 612 Epic GM orders were reviewed; from June 2015-March 2016, 116 patient surveys were collected.

Following SIESTA, orders that were sleep-promoting increased: admit orders without overnight vitals rose from 3% to 34% ( $p < .001$ ), and admit orders with q12h heparin or qd enoxaparin (vs q8h heparin) rose from 15% to 42% ( $p < .001$ ).

Using heat sensor data, nocturnal staff entries into patient rooms initially dropped 44% after the launch of SIESTA but rebounded over the next four months. However, a sustained decrease was obtained once SIESTA was added to the nurses' safety huddles in January. Patient-reported sleep disruptions due to vitals and medications decreased from 59% to 34% ( $p = 0.01$ ) and 42% to 23% ( $p = 0.049$ ), respectively.

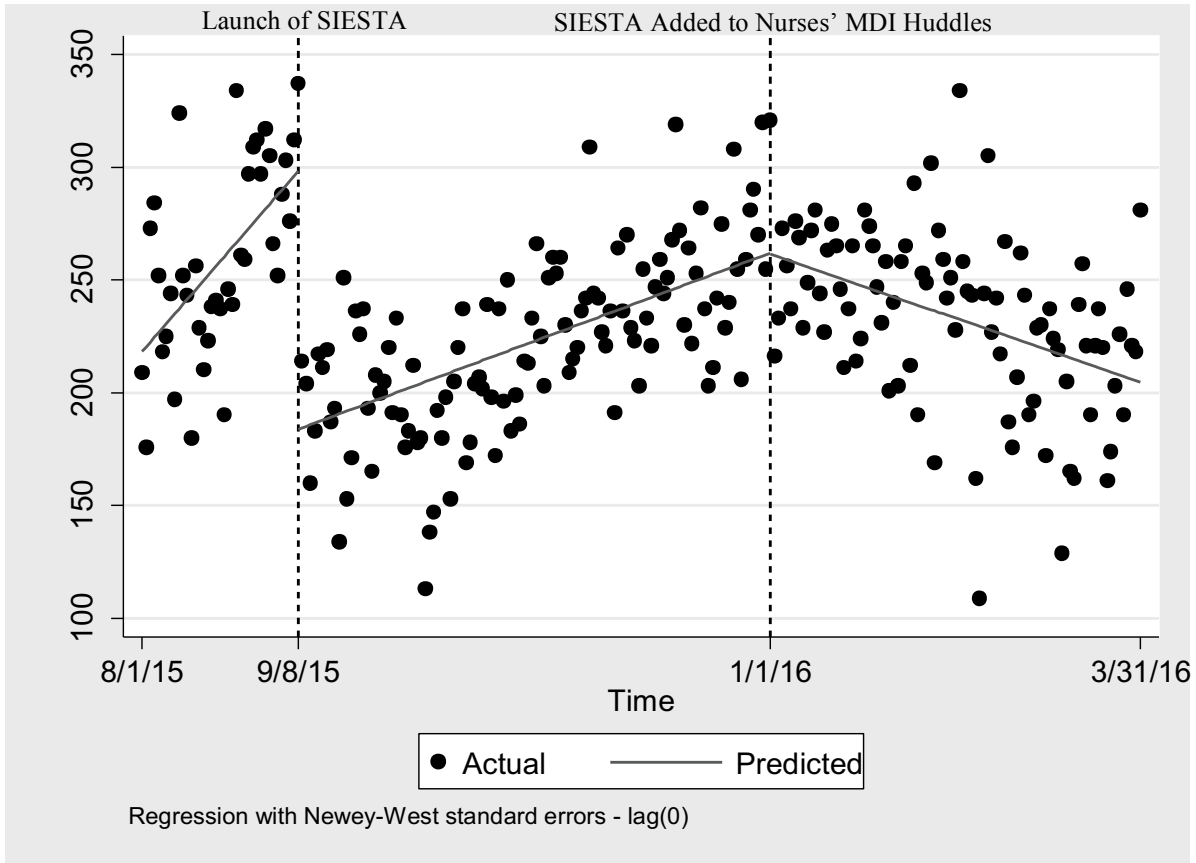
**Discussion and Conclusion:** The SIESTA program is the first sleep intervention to quantitatively and qualitatively assess the combined ability for behavioral nudges and hospital staff education to reduce nocturnal disruptions for patients and improve inpatient sleep quality. SIESTA resulted in a significant reduction in disruptions caused by overnight vitals, medications, and staff entries into patient rooms. In addition, the decrease in patient-reported sleep disruptions indicates that the objective decreases in nocturnal disruptions translated to improvements in patient experience.

While data collection is ongoing to further determine the impact of SIESTA on patient sleep, SIESTA shows promise for improvement in staff use of sleep-promoting behaviors and a corresponding increase in patient experience.

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**Figure 1. Interrupted Time-Series Showing Total Patient Room Disruptions per Night in the SIESTA Unit**



Note: Using GOJO Activity Counters to measure entries into patient rooms over 244 nights, total disruptions per night were summed across the 18 patient rooms of the SIESTA unit.

## Polysomnography: What an Anesthesiologist and Perioperative Physicians Should Learn from the Sleep Studies?

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**Background:** Obstructive sleep apnea (OSA) is the most prevalent sleep disordered breathing anesthesiologists and perioperative physicians encounter in their clinical practice.<sup>1</sup> There is a growing body of evidence showing that patients with OSA have worse outcomes in the perioperative period.<sup>2</sup> Polysomnography (PSG) is essential to establish the diagnosis, assess disease severity and evaluate effectiveness of a proposed treatment plan.<sup>3</sup> Knowledge of the technical aspect and understanding key contents of a sleep study report would be beneficial for health care professionals in the perioperative setting.

**General aim:** We sought to highlight salient features of a typical sleep study report relevant to the anesthesiologist and perioperative physicians. In addition, we reviewed clinical indications for polysomnography, types of laboratory-based studies and monitors, collection of raw data and scoring system according to the American Academy of Sleep Medicine Scoring Guidelines.

**Principal Findings:** Large cohort studies have shown significant positive association between OSA severity as defined by the apnea-hypopnea index with morbidity and mortality relevant to the general and surgical population.<sup>4-8</sup> Other indices of OSA severity such as oxygen desaturation index, mean arterial oxygen saturation, oxygen-nadir and total overnight duration of oxygen saturation < 90% are important to further risk stratify patients in the perioperative setting.<sup>9</sup> Furthermore, in morbidly obese patients with severe OSA, a high level of vigilance is required to diagnose underlying obesity hypoventilation syndrome, which poses a considerable risk of postoperative complications.<sup>10</sup> Routine screening with serum bicarbonate should be performed in patients deemed to be at high risk.<sup>11</sup>

**Conclusion:** Understanding polysomnography report is an essential component of the perioperative assessment of patients with sleep-disordered breathing. OSA is a heterogeneous disorder and risk stratification is crucial in order to tailor individualized management plan, make informed decision about further investigations, optimization and monitoring of patients at high risk of cardiorespiratory events.

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## The Relation Between Effects of Postoperative Oxygen Therapy and Preoperative Severity of Sleep Apnea

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**Background:** Sleep apnea may get exacerbated after surgery. Untreated obstructive sleep apnea (OSA) is associated with an increased incidence of postoperative complications. Postoperative supplemental oxygen is commonly used in surgical patients. The objective of this study is to examine the relation between the preoperative severity of OSA and the effect of postoperative supplemental oxygen.

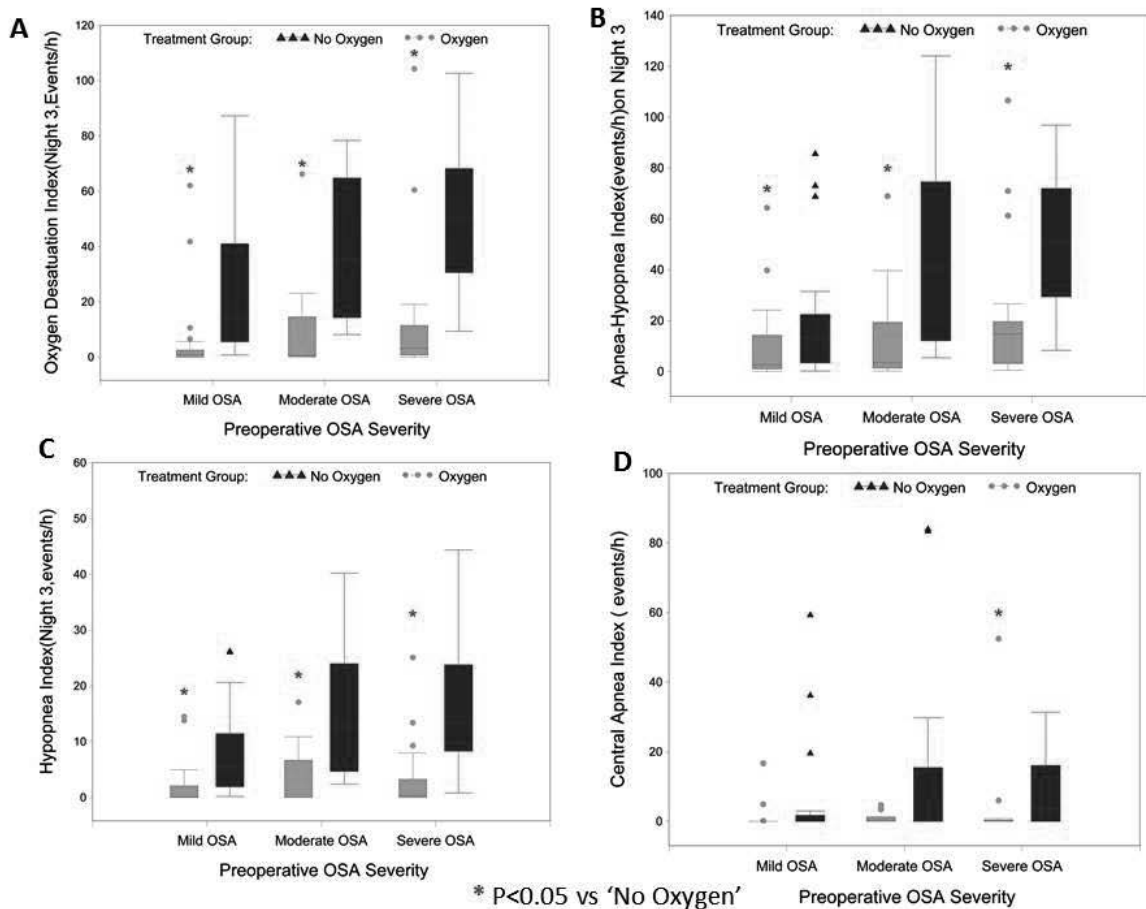
**Methods:** After hospital ethics approval, preoperative patients over 18 years were approached for consent. Patients underwent a home polysomnography (PSG) with a 10-channel portable device (Embeltta X-100). The PSG recordings were scored by a certified PSG technologist. Patients with  $AHI > 5$  were randomized into oxygen therapy ( $O_2$  group) or no oxygen therapy (Control group). Patients in  $O_2$  group received oxygen at 3 l/min by nasal prongs for 3 postoperative nights. In both groups, patients were managed according to their routine care. Perioperative care team could give study patients oxygen or CPAP therapy as needed clinically. Patients who underwent an overnight PSG on the third postoperative night were included in this report. The effect of supplemental oxygen was compared among patients with different preoperative severity of OSA.

**Results:** 123 patients with  $AHI > 5$  were randomized,  $O_2$  group: 62 and Control group: 61. Due to the drop-out from pain, nausea and vomiting, 103 underwent PSG on postoperative night 3. Of 103 patients, 59 patients received oxygen (Oxygen) and 44 patients did not receive oxygen (No-Oxygen) on postoperative night 3 while undergoing PSG. There was no significant difference in gender, age, BMI, neck circumference, ASA physical status, type of surgery, and anesthesia between Oxygen and No-Oxygen group.

There was no difference in preoperative baseline AHI and the distribution of OSA severity between Oxygen and No-Oxygen group. The baseline AHI was similar in No-Oxygen vs Oxygen group: 13.0 (9.1, 28.1, median 25<sup>th</sup>, 75<sup>th</sup> Percentile) vs 17.1 (8.8, 32.8),  $p=0.400$ . Preoperatively, in No-Oxygen group, 22(50%), 12(27%) and 10(23%) patients had mild ( $AHI: 5-15$ ), moderate ( $AHI:15-30$ ), and severe ( $AHI > 30$ ) OSA respectively. In Oxygen group, 24(41%), 17(29%) and 18(30%) patients had mild ( $AHI: 5-15$ ), moderate ( $AHI:15-30$ ), and severe ( $AHI > 30$ ) OSA respectively. On postoperative night 3, as shown in Figure 1, supplemental oxygen significantly decreased oxygen desaturation index (Panel A), apnea-hypopnea index (Panel B), and hypopnea index (Panel C) in patients with mild, moderate or severe OSA. More profound decrease in these indexes was observed in patients with moderate and severe OSA, almost returning the oxygen desaturation index, apnea-hypopnea index, and hypopnea index to normal range.

However, a significant decrease in central apnea index was observed in patients with severe OSA (Panel D).

**Conclusions:** Postoperative supplemental oxygen significantly improved oxygen saturation, decreased the frequency of sleep disordered breathing events in patients with mild, moderate or severe OSA. A more profound decrease in oxygen desaturation index, apnea-hypopnea index, hypopnea index was observed in patients with moderate and severe obstructive sleep apnea.



**Figure 1** Boxplot depicting effect of supplemental oxygen on oxygen desaturation index (Panel A), apnea-hypopnea index (Panel B), hypopnea index (Panel C) and central apnea index (Panel D) in patients with mild, moderate or severe OSA.

## Neck Fluid Volume Increases in the Immediate Postoperative Period in Patients Undergoing Non-cardiac Surgery

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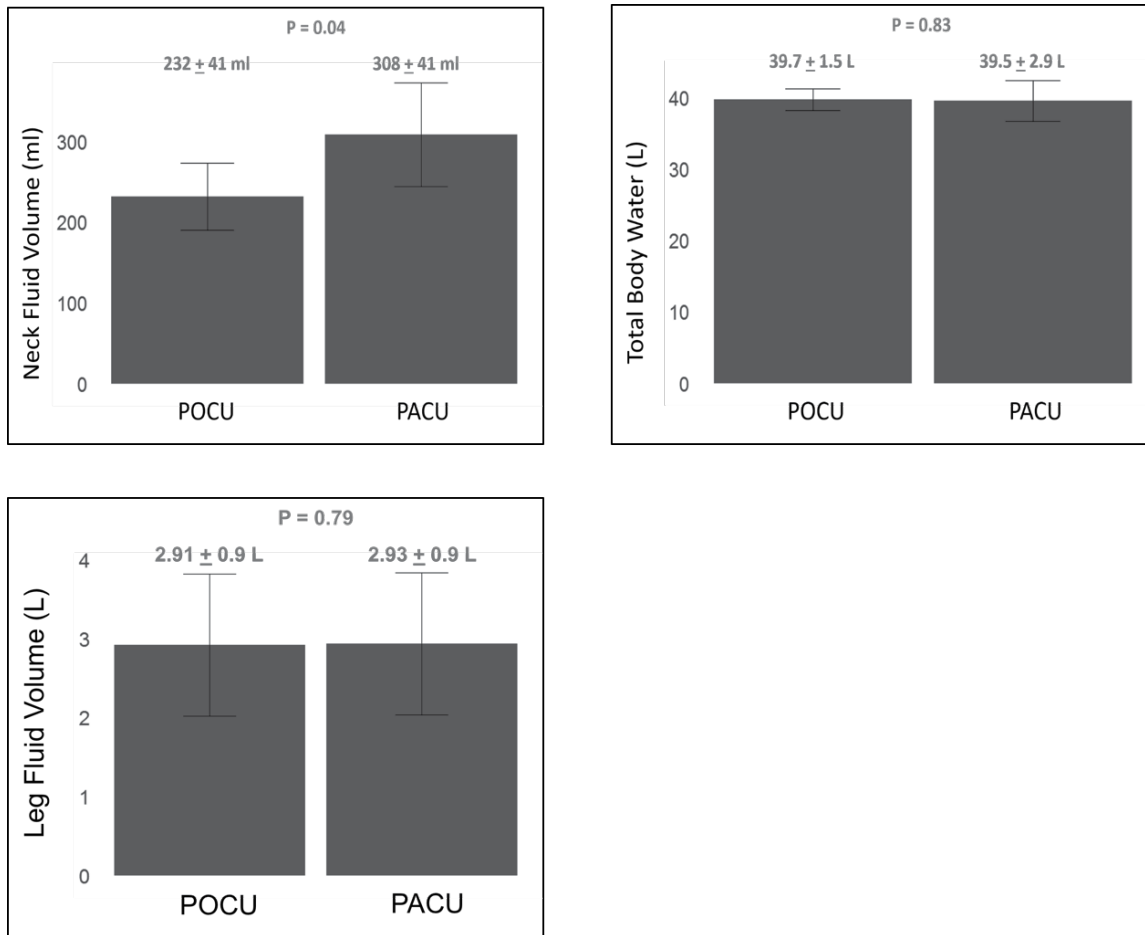
**Background:** The severity of obstructive sleep apnea (OSA) has been shown to increase postoperatively.[1] Intravenous (IV) administration of crystalloids has been shown to increase neck fluid volume and upper airway collapse, especially in patients with OSA.[2] Understanding the impact of IV fluid administration on rostral fluid shift and neck fluid volume may help identify the physiological determinants of upper airway collapse in patients with OSA following surgery.[3] In this study, we hypothesized neck fluid volume increases from preoperative to immediate postoperative period, in patients receiving general anesthesia (GA) for non-cardiac surgery.

**Methods:** Following research ethics board (REB) approval, adult patients ( $\geq 18$  yrs), ASA I-IV, undergoing elective inpatient surgery, were consented for this prospective cohort study. Patients underwent preoperative and postoperative fluid measurements for total body water (TBW), neck fluid volume (NFV) and leg fluid volume (LFV) using bioelectrical impedance analysis (BIA). All measurements were conducted with the patient in supine position in the preoperative care unit (POCU) before surgery, and the post-anesthesia care unit (PACU). Total fluid balance, GA medications and duration of surgery were recorded. Paired t-test (2-sided) was used to compare change in NFV, LFV, and TBW from preoperative value to the PACU.

**Results:** Seventeen of 76 screened patients consented for the study. Six patients undergoing general abdominal surgery with complete data were included in this analysis. There was no difference in baseline demographics (age: mean  $58 \pm SD 15$  yrs; gender (F/M: 4/2); body mass index  $35 \pm 13$  kg/m<sup>2</sup>; STOP-Bang score  $3.7 \pm 0.5$ ), comorbidities, duration of surgery ( $205 \pm 40$  min), GA dosage, opioid medication and total fluid balance for all patients. The NFV increased from  $232 \pm 41$  ml in POCU, to  $308 \pm 64$  ml in the PACU ( $p=0.04$ ). There was no significant difference in the TBW ( $39.7 \pm 1.5$  L and  $39.5 \pm 2.9$  L,  $p=0.83$ ) and LFV ( $39.7 \pm 1.5$  L and  $39.5 \pm 2.9$  L,  $p=0.83$ ) from POCU to PACU. (Figure 1)

**Conclusion:** This novel study demonstrated feasibility of use of BIA for the measurement of TBW, NFV and LFV in the surgical setting. The neck fluid volume increased in the immediate postoperative period independent of an increase in TBW or LFV, indicating a possible physiological mechanism leading to upper airway collapse following GA and IV fluid administration. Future studies will focus on change in neck fluid volume over time, and its impact on patients with OSA after surgery.

**References:** 1. Anesthesiology 2014;120:287-98. 2. Sleep 2014;37:1699-705. 3. Anesth Analg 2016;122:1335-9.



**Figure 1.** Postoperative changes in the neck fluid, total body water and leg fluid volume following general anesthesia. The neck fluid volume increased significantly despite no changes in total body water ( $P < 0.05$ ).

**Legend:** Pre-operative care unit: POCU; Post-anesthesia care unit: P



