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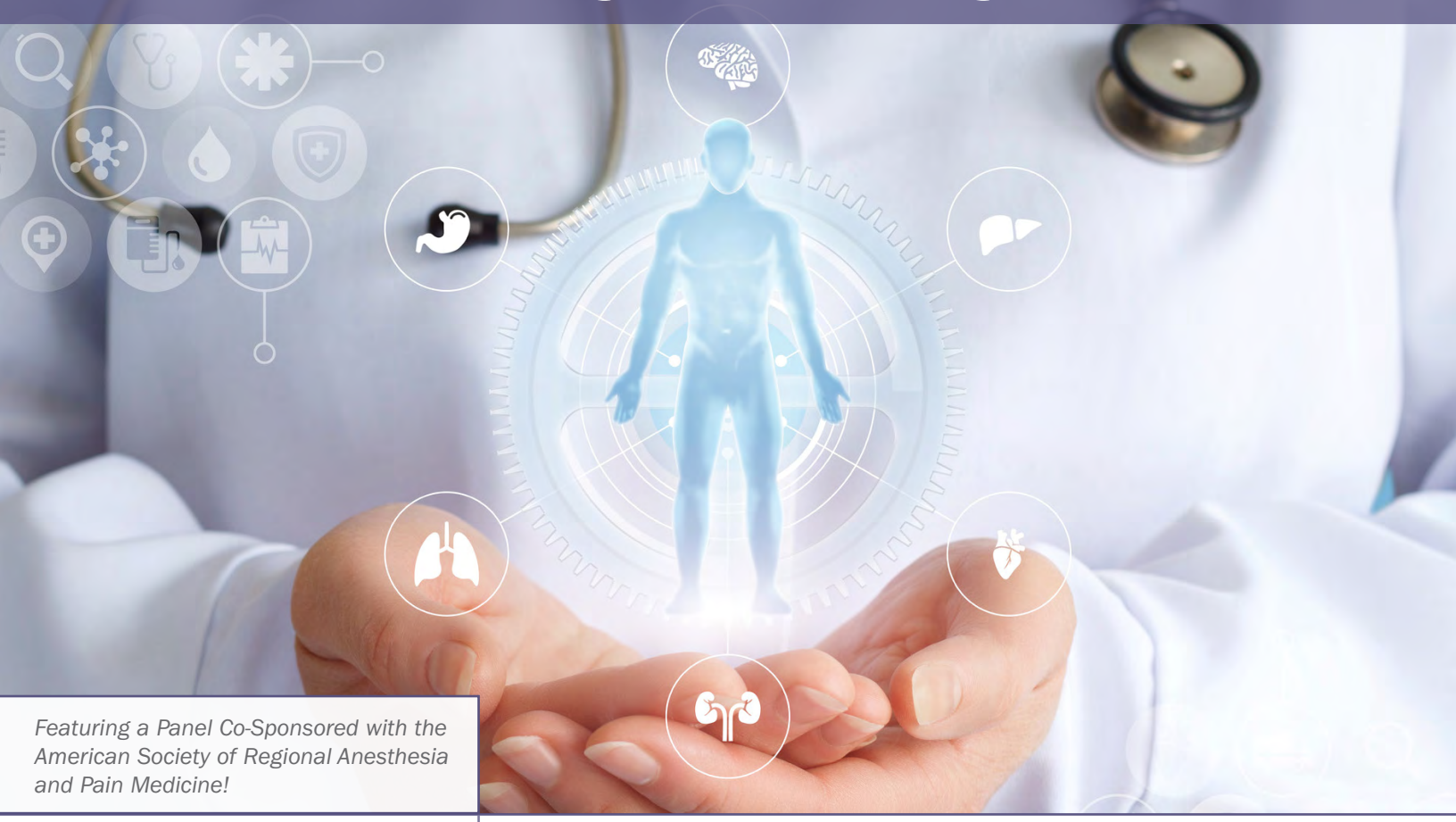

Featuring a Panel Co-Sponsored with the American Society of Regional Anesthesia and Pain Medicine!

ASRA Panel: Regional Anesthesia & Pain Management for the OSA Patient

Program Co-Chairs:
Krish Ramachandran, MD, MBBS, BIDMC, Harvard Medical School
Christine Won, MD, Yale University School of Medicine
Stephen Haskins, MD, Hospital for Special Surgery

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CALL FOR PAPERS - ANESTHESIA AND SLEEP MEDICINE

***Anesthesia & Analgesia* thematic issue for April 2021**

To highlight this growing area, *Anesthesia & Analgesia* is calling for papers focused on "Anesthesia and Sleep Medicine" for a thematic issue to be guest edited by Drs. David Hillman, Frances Chung, and Toby Weingarten. We invite authors to submit research manuscripts, review articles, technical communications, and Open Minds covering the fascinating interactions between anesthesia and sleep.

Authors can find the specific requirements for each manuscript type in the Journal's current Instructions for Authors at www.editorialmanager.com/aa.

The deadline for submission is October 1, 2020 with an anticipated date of final decision on January 1, 2021 and in print publication for the April 2021 issue of the journal.

Interested authors can contact Dr. Toby Weingarten at weingarten.toby@mayo.edu for additional information or to discuss specific topic proposals for the "Anesthesia and Sleep Medicine" thematic issue.

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ACCREDITATION INFORMATION

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:

1. Point-of-care ultrasound for assessment and management of the high-risk patient with Obstructive Sleep Apnea (OSA) is largely underutilized, primarily owing to gaps in the knowledge domain.
2. There is limited understanding of patient-centered approaches to management of perioperative sleep.
3. There is limited knowledge of implications of big data and artificial intelligence in the field of sleep and anesthesia.
4. Programmatic needs for in-hospital and post-discharge sleep management are not well defined.
5. There is a need to enhance understanding of high-risk populations within OSA.
6. There is need to study the impact of regional analgesia and pain management on outcomes in patients with Sleep Disordered Breathing (SDB).

LEARNING OBJECTIVES

1. Discuss and understand the use of ultrasound for assessment of the high-risk patient with OSA.
2. Discuss and understand the emerging technologies in sleep and anesthesia that are poised to impact patient care.
3. Discuss and understand the role of emerging pharmacological agents in the management and pathophysiology of SDB.
4. Discuss and understand patient-centered approaches and management of special populations with SDB.

ACCREDITATION STATEMENT

In support of improving patient care, this activity has been planned and implemented by Amedco, LLC and the Society of Anesthesia and Sleep Medicine (SASM). Amedco, LLC is jointly accredited by the American Council for Continuing Medical Education (ACCME), the Accreditation Council for Pharmacy Education (ACPE), and the American Nurses Credentialing Center (ANCC), to provide continuing education for the healthcare team.

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CREDIT DESIGNATION STATEMENT

Amedco, LLC designates this live activity for a maximum of **11 *AMA PRA Category 1 Credits™***. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

FACULTY DISCLOSURES

For a full list of disclosures, please see registration desk.

HOTEL INFORMATION

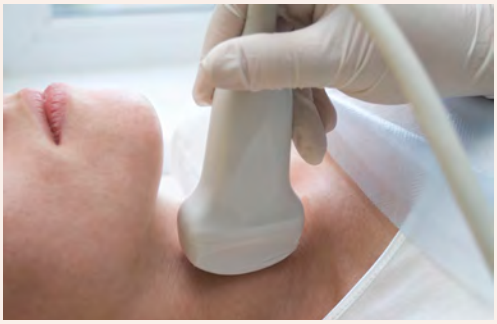
The Society of Anesthesia and Sleep Medicine 9th Annual Meeting will be taking place at the Hilton Orlando in Orlando, Florida.

SCHEDULE OF EVENTS

ULTRASOUND WORKSHOPS
THURSDAY, OCTOBER 17, 2019

1400-1800 **Point of Care Ultrasound for the OSA Patient Workshop**
Lead: Stephen Haskins, MD
Instructors: Nibras Bughrara, MD; Melissa Byrne, DO, MPH; Jemiel Nejim, MD; Oliver Panzer, MD
Learned Focused Cardiac, Lung and Gastric Ultrasound.
(Limit: 20 Registrants)

1400-1800 **Airway Ultrasound and Positive Airway Pressure Workshop**
Leads: Dennis Auckley, MD; Mandeep Singh, MBBS, MD, MSc, FRCPC
Instructors: Sarah McConville, MD; Peter Gay, MD; Nadia Hernandez, MD; William Manson, MD
Learn Diagnostic and Procedural Airway Ultrasound, Ultrasound Guided Regional Blocks and Positive Airway Pressure.
(Limit: 20 Registrants)



FRIDAY, OCTOBER 18, 2019

0700-0800 **Continental Breakfast with Exhibitors**

0800-0815 **Welcome Address: SASM Past, Present & Future**
Stavros Memtsoudis, MD, PhD

0815-0930 **ASRA Panel: Regional Anesthesia & Pain Management for the OSA Patient**
Moderator: Stephen Haskins, MD

0815-0835 **The Unique Challenges of Acute and Chronic Pain Management in the Sleep-Disordered Breathing Patient**
Eugene Viscusi, MD

0835-0855 **Opioid Epidemic and the OSA Patient – A Review of the Literature**
Edward Mariano, MD, MAS

0855-0915 **Regional Anesthesia for the OSA Patient – Is There a Benefit and When Should it Be Used?**
Crispiana Cozowicz, MD

0915-0930 **Panel Discussion**

0930-0945 **Break with Exhibitors & Abstract Poster Viewing**

0945-1015 **KEYNOTE ADDRESS: Artificial Intelligence and Sleep – The Next Frontiers**
Nate Watson, MD, MSc

1015-1200 **Emerging Technologies – Sleep & Anesthesia**
Moderator: Krish Ramachandran, MD, MBBS

1015-1035 **Top 5 Technologies in 2019 – Sleep & Anesthesia**
Jonathan Wanderer, MD, MPhil

1035-1055 **Can Big Data Analytics Support Personalized Sleep Medicine?**
Allan Pack, MBChB, PhD, FRCP

1055-1115 **Big Data in Postoperative Monitoring – What's Changing?**
Ashish Khanna, MD, FCCP, FCCM

1115-1135 **Wearables and Interactive Devices for Post-Discharge**
John Pearson, MD

1135-1200 **Panel Discussion**

1200-1230 **Break with Exhibitors & Abstract Poster Viewing**

1230-1330 **Annual General Meeting & Best Abstract Awards Luncheon**

1230-1300 **Annual General Meeting**
Stavros Memtsoudis, MD, PhD

1300-1330 **Best Abstract Awards Presentations**
Toby Weingarten, MD &
Malin Jonsson Fagerlund, MD, PhD

SCHEDULE OF EVENTS

FRIDAY, OCTOBER 18, 2019 *continued*

1345-1415 **KEYNOTE ADDRESS: Postoperative Sleep as a Patient-Centered Outcome After Hospital Discharge – Implications for QOL and Safety**
Rebecca Aslakson, MD, FCCM, FAAHPM

1415-1545 **Emerging Pharmacology**
Moderator: Dennis Auckley, MD

1415-1435 **Sleep Promoting Pharmacologics – New Agents and Challenges**
Dennis Auckley, MD

1435-1455 **Alertness Promoting Pharmacologics – New Agents and Outcomes**
Lynn Trotti, MD, MSc

1455-1515 **Delirium and Sleep After Cardiac Surgery – New Avenues**
Balachunder Subramaniam, MD, MPH, FASA

1515-1535 **Gabapentin: ERAS Darling with a Dark Side: Do Associated Respiratory Depression Deaths Warrant Pathway Caution?**
Michael Pilla, MD

1535-1545 **Panel Discussion**

1545-1600 **Break with Exhibitors & Abstract Poster Viewing**

1600-1715 **Disease Mechanisms and Pathways**
Moderator: Christine Won, MD, MSc

1600-1620 **In-Hospital Sleep Program – Challenges & Success Stories**
Lauren Tobias, MD

1620-1635 **Postoperative Central Sleep Apnea to Treat or Not to Treat**
Christine Won, MD, MSc

1635-1655 **High Risk OB and SDB: Sleep Medicine & Anesthesia Update**
Jennifer Dominguez, MD, MHS & Judette Louis, MD, MPH

1655-1715 **Panel Discussion & Announcement of Giveaway**

1715-1815 **Cocktail Reception**

ABSTRACT AWARD WINNERS

FIRST PLACE AWARD

Abstract: The Effect of CPAP Treatment in Patients with Obstructive Sleep Apnea on the Global Gene Expression Profile in the Whole Blood

Co-Authors: E. Christensson, MD, DESA, S. Mkrtchian, MD, PhD, A. Ebberyd, BMA, L. I. Eriksson, MD, PhD, FRCA, M. Jonsson Fagerlund, MD, PhD, DESA, Karolinska Institutet, Stockholm, Sweden

SECOND PLACE AWARD

Abstract: Describing the Trends in Neck, Leg and Total Fluid Volumes in Patients Undergoing Non-Cardiac Surgery in the Perioperative Period in Surgical Patients – A Prospective Cohort Study

Co-Authors: Gincy Lukachan, MD, Azadeh Yadollahi, PhD, Nayeemur Rehman, MBBS, Stuart McCluskey, MD, Douglas Bradley, MD, Frances Chung, MBBS, Mandeep Singh, MD, University Health Network, University of Toronto, Toronto, Canada

THIRD PLACE AWARD

Abstract: Risk of Major Cardiovascular and Cerebrovascular Complications after Elective Surgery in Patients with Sleep Disordered Breathing

Co-Authors: Rabail Chaudhry MD, Colin Suen, MD, PhD, Talha Mubashir, MD, Jean Wong, MD, Frances Chung, MBBS, Department of Anesthesia, University Health Network, University of Toronto, Toronto, ON, Canada

IMPORTANT

CONTINUING MEDICAL EDUCATION (CME) CERTIFICATE
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Itamar Medical is engaged in research, development, sales and marketing of non-invasive medical devices for the diagnosis of respiratory sleep disorders with a focus on the cardiology market. The Company offers a Total Sleep Solution™ to help physicians provide comprehensive sleep apnea management in a variety of clinical environments to optimize patient care and reduce healthcare costs. Its flagship PAT-based product, the WatchPAT™ device, is a home-use diagnostic device for sleep breathing disorders. It also offers the EndoPAT™ system, an FDA-cleared device to test endothelial dysfunction and to evaluate the risk of heart disease and other cardiovascular diseases. For additional information visit www.itamar-medical.com.

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There are also a variety of serious comorbidities such as cardiovascular disease, diabetes and stroke that have a strong connection to sleep apnea.

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Home Monitoring of Post-Operative Ear, Nose & Throat (Ent) Patients for Opioid Induced Respiratory Depression – More Than OSA

Presenting Author: Kim Bennion MsHS, RRT, CHC, Intermountain Healthcare
Co-Author: Shaylynn Uresk BSRT, RRT, SDS, Uintah Basin Medical Center

Background: Opioid related deaths have been rapidly increasing[1]. A recent study suggested oxygen saturation (S_pO_2) & other overnight oximetry measurements may provide additional Opioid Induced Respiratory Depression (OIRD) risk stratification insight[2].

General Aim: Uintah Basin Medical Center is a 49-bed hospital located in eastern Utah. Following 3 unplanned home deaths in patients taking opioids as prescribed post-operatively, we piloted a home monitoring protocol to earlier identify patients at risk for OIRD.

Materials & Methods: With IRB approval, all ENT patients from 2017-2018 prescribed opiates were discharged with a monitor for 7 days. Patients were educated about opioid risks & the relationship between OIRD & falling S_pO_2. They were instructed to call/come to the hospital if the monitor alarmed/read out of limits. They were given a number to call with questions 24/7. Data was recorded/analyzed after device return.

Results: The first patient monitored required full resuscitation, 4 naloxone boluses & a naloxone drip taking half the prescribed pain medication dose. She was opioid naïve. Detailed outcomes are reported in Table One.

Table One: 2017-2018 ENT Patient Home Monitoring Results

Total Patients Monitored n=284	**Adult Patients # (%) n=100 (35)**	**Pediatric Patients # (%) n=184 (65)**
Previously Diagnosed OSA*	**26 (26)**	**5 (3)**
Pts on Opioids Prior to Surgery	8 (4)	0 (0)
Pre-op STOPBANG® Score ≥ 3 on non-previously diagnosed pts n=74	**18 (24)**	NA
# Patients with Oxygen Desaturation While Home Monitored	**26 (26) for 1.3-70% of nap/sleep time**	**26 (14) for 1.2-23.2% of nap/sleep time**
Total Pts Requiring Home Oxygen Due to Monitoring	**14 (14)**	**10 (5)**
Other Interventions Noted with Home Monitoring n=284		
Admitted for Observation/Inpatient	18 (6)	
Alarm Alert Noted Post Data Download *Pt Did Not Call or Come In as Instructed*	**127 (45)**	

*Obstructive Sleep Apnea

Discussion: We have identified the need for educating emergency department staff regarding protocol compliance & acknowledge relying on patients/caregivers to respond to alarms is not ideal. Remote monitoring is being considered.

With 276 (97%) patients being opioid naïve, we support guidelines from the CDC which recommends short- acting opioids for acute pain in opioid naïve patients. Other factors such as

age, gender, hepatic/renal impairment, comorbidities, poly-pharmacy with central nervous system depressants, & drug metabolism should be considered.

Conclusion: It is our impression that opioid related deaths are under diagnosed & reported as "pneumonia". We are pursuing activities to validate this. Normalization of discharging patients with oxygen who were not on it pre-operatively should be questioned. This work facilitated Utah SCR004 being signed into law March 2018 raising awareness about opioid risks & the need for home monitoring. Utah legislators requested more studies. A collaborating hospital is conducting a side-by-side study comparing SpO2 & end-tidal carbon dioxide in home monitoring of post-operative orthopedic patients.

References:

[1]CDC's report on opioid-related deaths located at:
https://www.cdc.gov/drugoverdose/epidemic/index.html
[2] Suen C, Ryan CM, Musbashir T, Ayas NT Abrahamyan L, Wong J, Mokhlesi B and Chang F (2019). Sleep study and oximetry parameters for predicting postoperative complications in patients with OSA. *Chest*; 155(4): 855-867.
We wish to acknowledge the work of Dr. Michael Catten on this project.

Oxygen (O_2) Discharges on Post-Operative Patients Not Requiring It Pre-Operatively…An Early Warning Sign of Potential Opioid Induced Respiratory Insufficiency?

Presenting Author: Gaylinn Breeze APRN, DNP Candidate, Intermountain Healthcare
Co-Authors: Kelly Jensen BSRT, RRT, Intermountain Healthcare; Vanessa Henriksen, MS, ATC, Intermountain Healthcare; Kim Bennion, MsHS, RRT, CHC, Intermountain Healthcare; Robert L. Mazzola, MD, MSPH, FCCP, Intermountain Healthcare

Background: Patients receiving opioid analgesics are at risk of morbidity & death due to respiratory arrest attributable opioid respiratory depression (OIRD). Patients with suspected/ previously diagnosed obstructive sleep apnea have been identified as high risk for OIRD; however, opioid naïve patients are also at risk. A recent study suggested pre-operative O_2 desaturations were associated with post-operative complications[1].

General Aim: The Orthopedic Specialty Hospital is one of 23-acute care hospitals of Intermountain Healthcare (IMH). IMH assisted a non-IMH hospital with a study where ear, nose and throat patients were discharged with 7-days of recorded continuous S_pO_2 monitoring post-operatively while sleeping/napping. They reported 26% & 14% of adult & pediatric patients respectively were discharged home on O_2 who did not require it pre-operatively. We sought to study any prevalence of this among orthopedic patients.

Materials & Methods: We are proceeding with a quantitative, prospective, non-randomized single cohort study using Masimo RAD 7® monitoring devices to test the feasibility of home S_pO_2 & capnography monitoring to estimate the incidence of post-discharge OIRD. To capture baseline data prior to the study, we concurrently tracked outcomes from March 26 – June 7, 2019 to include patient discharges with O_2.

Results: Of the 1,433 patients undergoing any orthopedic surgical procedure, 274 (19%) were discharged with O_2 who did not require it pre-operatively. The majority of these were total knee & shoulder surgeries with STOPBANG score < 3 as reported in Table One.

Table One: Documented STOPBANG Scores on Patients Discharged with Oxygen	**Score 0-2 # (%)**	**Score 3 # (%)**	**Score 4-5 # (%)**	**Score 6-8 # (%)**
n=118 (100%)	**63 (53)**	21 (18)	31 (26)	3 (3)

Discussion: It is our impression assuming some patients "just require discharge with O_2" who did not require it pre-operatively should not be normalized. Elevation may be a factor. TOSH (SLC, Ut 4226 ft elevation) receives patients throughout the intermountain west where the elevation can vary widely (e.g., 7000 ft in Park City, Ut, 6437 Ely, NV, and 2860 in St. George, Utah). Generally, hypoxia increases ventilation when O_2 pressure is reduced. The impact of opiates on **hypoxic ventilatory drive** may prove an important factor in OIRD as patients are discharged from a lower elevation but return home to higher elevations. We further suggest that O_2 may be masking the actual disruption in the patient's true ventilatory status & suggest a distinction between oxygenation & ventilation be recognized.

Conclusion: S_pO_2 desaturations & hypercapnia are indicators of early OIRD. This may prove more important in the home setting as patients are being discharged as same day discharges for total knees & hips. Capnography may provide an earlier warning of OIRD than oximetry[2]. We intend to study this comparative analysis in lieu of elevation & other variables.

[1]Suen C, Ryan CM, Mubashir T, Ayas NT, Abrahanyan L, Wong J, Babak M and Chung F (2019). Sleep study and oximetry parameters for predicting postoperative complications in patients with OSA. *Chest*; 155(4):855-867.
[2]Lam T, Nagappa M, Wong J, Singh M, Wond D and Chung F (2017). Continuous pulse oximetry and capnography monitoring for postoperative respiratory depression and adverse events: a systematic review and meta-analysis. *Respiratory and Sleep Med;* 125(6):2019-2019.

PACU Monitoring of End-Tidal CO_2 ($ETCO_{2)}$ for Bariatric Patients After Opioid Sparing Roux-en-Y Surgery

Presenting Author: Enrico M. Camporesi[1,2,3], Maha Balouch[2], Jin Deng[3], Garrett Enten[2],Devanand Mangar[1]

[1]TEAMHealth Anesthesia; Tampa, FL
[2]TEAMHealth Anesthesia Research Institute; Tampa, FL
[3]University of South Florida, Morsani College of Medicine; Tampa, FL

Introduction: Perioperative respiratory complications affect approximately 8% of bariatric surgery patients [1]. During admission to the PACU, pulse oximetry (SPO_2) is commonly utilized for respiratory monitoring. But the ability of pulse oximetry to detect hypoventilation is reduced when patients are provided supplemental oxygen to breathe [2]. Capnography gives healthcare providers a prompt access to additional respiratory measures such as $ETCO_2$ values, breathing rhythm, unexpected periodic apnea, and respiratory rate, which are not otherwise available through pulse oximetry or tracheal acoustic monitoring. These measurements provide an assessment of the ventilation status of patients during recovery and allow providers to maintain surveillance. We analyzed capnography in the PACU for an obese population post bariatric surgery.

Methods: IRB-approved consent was obtained from 31 Roux-en-Y gastric bypass surgery patients with an average body mass index of 45.9 kg/m^2 and a STOP-BANG score from 5-8. Anesthesia was induced with lidocaine and propofol. Patients were intubated with rocuronium. Sevoflurane (1/2 MAC) along with a continuous infusion of magnesium sulfate, ketamine, and dexmedtomidine was used to maintain anesthesia. Opioids were used sparingly: we administered an average of 200 mcg of Fentanyl in 23 of 31 patients. Sugammadex was used to reverse neuromuscular blockade. Patients were extubated and transferred to PACU where capnography traces were continuously monitored using a Microstream Smart CapnoLine® Plus O_2 Sampling Line (Medtronic: Dublin, Ireland) and IntelliVue MX700 monitor (Philips: Amsterdam, Netherlands) during recovery. The displayed $ETCO_2$ values were averaged during a 30 second interval and recorded at 5 min, 30 min, and at discharge from PACU, usually at 2 hours. Any hypercapnia events, respiratory arrhythmias, or respiratory complications were noted. Patients reporting persistent pain with a VAS-pain score >4 received titrated hydromorphone IV PRN.

Table 1: Summary Data obtained in PACU

Capnography and Other Respiratory Data for 31 Patients (Mean ± SD) During PACU Admission				
	5 minutes after PACU Admission	30 min after PACU Admission	At PACU Discharge (2 hr)	p-value
$ETCO_2$ (mmHg)	37.4 (±4.6)	37.3 (±4.0)	37.1 (±3.6)	N.S.
Respiratory Rate	18.1 (±3.1)	18.7 (±5.3)	18.4 (±5.1)	N.S.
SPO_2 (%)	95.5 (±3.2)	95.9 (±2.8)	96.0 (±2.4)	N.S.
Patients on Supplemental O_2 (2 L/min)	5 of 31	7 of 31	7 of 31	N.S.

Pain VAS	1.3 (±2.6)	2.7 (±3.4)	2.2 (±2.1)	N.S.

Results: No adverse respiratory events were noted and PACU respiratory measures were within normal limits, although several patients required supplemental oxygen (Table 1). Analysis of variance did not detect significant differences in $ETCO_2$, SPO_2, RR, or pain across the duration of the PACU stay.

Discussion: Continuous capnography via specialized nasal prongs monitors the partial pressure of CO_2 of an expired breath and can be used as a valid alert monitor of respiration. Patients undergoing bariatric surgery present a unique risk for pulmonary complications such as hypoventilation, hypercapnia, and apnea, in addition to possibly desaturation. Two-thirds of our study subjects carried an OSA diagnosis and the rest were marked high risk for developing postoperative apnea. However, none of our patients experienced any adverse respiratory events, which may be attributed to a number of factors, including the sparing use of opiate during anesthesia and in PACU.

References:

[1] Pouwels S. et al.: *Respir Med*. 2016;117:73-80.
[2] Fu ES et al.: *Chest J.* 2004;126:1552–1558.

Four Opioid-Free Anesthesia Protocols Evaluated for ENT Surgeries

Presenting Author: Enrico M. Camporesi[1,2]
Co-Authors: David Samuels[1], Hesham Abowali[2], Matteo Paganini[2,3], Maha Balouch[2]

[1]TEAMHealth Anesthesia; Tampa, FL
[2]TEAMHealth Anesthesia Research Institute; Tampa, FL
[3] University of Padova; Padova, Italy

Introduction: Opioids have been an integral part of general anesthesia and post-operative pain management for decades. Often, a patient's first exposure to opioids is during surgery. At times patients continue to use opioids for a prolonged period of time after healing [1]. Therefore, surgery can be the gateway to iatrogenic opioid dependence.
Multimodal opioid-free anesthesia (OFA) protocols have been developed for general anesthesia [2]. Often the multimodal agents eliminate or reduce the need for any opioid medications, reducing their unwanted side effects. Here we report on the changes in post-operative outcomes during four different OFA protocols developed over a 20-month period.

Methods: A retrospective chart review was conducted after approval from the local IRB. The study comprised 2663 adult patients who underwent electvie nasal/sinus, or middle ear or tonsillectomy/adenoidectomy surgeries from January 2016 through September 2017 at a surgery center (Table 1). During this time, four different opioid-free (OFA) anesthesia protocols were developed.
The first intra-operative OFA protocol (Group 1; control, 1248 patients) comprised: acetaminophen 1g PO 30 min pre-op, induction with propofol 3-5 mg/kg, 0.3mg/kg ketamine, (+ succinylcholine if endotracheal intubation), and maintenance with sevoflurane (1 MAC), IV magnesium sulfate 30mg-60mg/kg, IV Lidocaine 1.5mg/kg, IV decadron 10mg, and IV ondansetron 4mg (IV ketorolac 15-30mg was added if surgeon allowed). No IV opioid was ever administered post-op but oral opioids were provided in PACU if the patient requested. Group 2 comprised 961 patients after staff and patient education concerning the first-line use of Ibuprofen (800 mg PO) in PACU for management of pain. A further modification applied in Group 3 (pre-operative oral Gabapentin 300mg and intraoperative IV diphenhydramine) comprised 305 patients. Finally, Group 4 received no intra-operative ondansetron and comprised 149 patients.

Results: The table shows the percentage of patients requesting oral opioids in PACU and the percentage reporting nausea. A highly significant difference between all four groups is noted. In the control group we noticed the largest percentage of patients receiving post-operative oral opioids and reporting nausea. Group 2 showed a decrease in both post-operative opioids (to 13.2%, N.S.) and nausea (to 8.4%, significant). Group 3 resulted in a further decrease (non-significant) in opioid and nausea (10.5% and 3.3%). Group 4 lowered the post-operative intake of opioids to 9.4% and the incidence of nausea to 2%. Overall, a progressive significant reduction of PO opioids consumption and nausea were observed.

Discussion: There is an ongoing quest to define the most appropriate protocols to minimize the usage of opioids or even eliminate them from surgery. In this group of patients, we maintained surgeon and patient satisfaction, while patient use of postoperative oral opioid medication was continually reduced. Our educational efforts, combined with the use of multimodal analgesic therapies contributed to minimizing postoperative opioid requirements and nausea.

References:

[1] Bennett KG et al.: Plast Reconstr Surg. 2019;143(1):87-96.
[2] Samuels DJ et al.: Journal of Clinical Anesthesia and Pain Medicine. 2017;1(2):1-3.

Table: Description of 4 OFA groups comprising 2663 patients

	Groups	Group Description	Number of Patients	Mean age of Patients (SD)	% of post-op oral opioids	% of post-op nausea
	1	Control Group	1248	45.1(17.7)	42.3	12
p-value-Groups 1 vs 2					**0.0001***	**0.006***
	2	Ibuprofen eff. Education	961	40.1(21.8)	13.2	8.4
p-value-Groups 2 vs 3					**0.235***	**0.002***
	3	Pre-op Gaba and Bena	305	38.1(21.8)	10.5	3.3
p-value-Groups 3 vs 4					**0.869***	**0.560***
	4	No IV Zofran intra-op	149	38(22.4)	9.4	2
p-value-all Groups					**<0.0001***	**<0.0001***

***p-values were calculated by Exact Fisher test.**

Sleep Disordered Breathing as an Independent Risk Factor for Post-Operative Delirium in Elective Surgical Procedures

Presenting Author: Rabail Chaudhry MD[1]
Co-Authors: Rabail Chaudhry MD[1], Enoch Lam BSc[1], Talha Mubashir MD[1], Frances Chung MBBS[1], Jean Wong MD[1]

[1] Department of Anesthesia and Pain Management, University Health Network: Toronto Western Hospital, Toronto, ON, Canada

Background: Post-operative delirium (POD) is a common complication in older adults that is associated with increased morbidity, mortality and hospital stay.[1] Recently sleep disordered breathing (SDB) has been linked to POD in a few small studies.[2,3] As SDB is often underdiagnosed it is important to establish its relationship with POD. Our objective was to analyze the relationship between SDB and POD in a large population cohort using data collected for the National Inpatient Sample (NIS) in patients undergoing elective surgical procedures.

Methods: The Nationwide Inpatient Sample (years 2011-2014) was used to extract data for 1,441,284 elective surgeries on adults aged ≥ 18 yrs. Patients were stratified based on the ICD-9-CM codes for SDB. The primary outcome was the incidences of POD in patients with and without SDB, while secondary outcomes were mortality during hospitalization, mean length of stay (LOS), and total hospital charges between the two groups. Dichotomous and continuous variables were examined using chi-square and Student t-test analyses, respectively. Adjusted logistic and linear regression models were utilized to assess associations between SDB and outcomes of interest.

Results: SDB was reported in 169,234 (11.74%) patients undergoing the included elective surgeries. Patients with SDB were more likely to develop POD (0.47% vs 0.41%, P <0.001). Among patients with SDB, those undergoing cardiac surgery (OR, 14.23; P<0.001), abdominal surgery (OR, 5.08; P<0.001), or orthopedic surgery (OR, 2.54; P<0.001) had significantly higher odds of developing POD compared to patients undergoing uro-gynecological surgery. Overall In-hospital mortality was higher in patients who developed POD, however the mortality was lower in patients with SDB who developed POD versus non-SDB patients with POD (1.69% vs 3.05%, P=0.007). Similarly, among all patients that develop POD, patients with SDB had a lower mean LOS (10.3 vs 11.7; p<0.001) and lower total cost of hospital stay ($151,097 vs $162,122, P <0.001).

Conclusion: Using a large population database, we observed that SDB was independently associated with POD. The odds of developing POD in patients with SDB were significantly higher if they were undergoing elective cardiac, abdominal, or orthopedic surgical procedures. Similar to previous studies,[1-3] patients with POD had a significantly higher rate of in-hospital mortality, longer hospital stay, and higher costs. Interestingly, SDB patients with POD had significantly lower mortality rates, LOS, and healthcare associated costs compared to non-SDB patients with POD. This may either suggest the enormous health care burden of undiagnosed SDB or the benefit of increased post-operative monitoring or better management of SDB patient, e.g. positive airway pressure therapy. To further assess an association between SDB and POD, prospective studies are needed.

References:

1. Lancet 2014; 383:911-22.

2. Anesthesiology 2012; 116:788-96.
3. Anaesthesia 2017; 72:729-36

Table 1: A retrospective outcomes assessment by SDB in patients with and without POD that have undergone elective surgeries

Population		Mortality during hospitalization N (%)	Length of stay Mean days (95% CI)	Total charges Mean $ (95% CI)
POD	SDB	21 (1.69%)	10.3 (9.84-10.8)	151,097 (142,485-159,709)
	Non-SDB	322 (3.05%)	11.7 (11.5-11.9)	162,122 (158,126-166,118)
	P-value	0.007	<0.001	<0.001
No POD	SDB	881 (0.45%)	4.34 (4.32-4.36)	78,540 (78,179-78,901)
	Non-SDB	14,472 (0.90%)	4.56 (4.55-4.57)	77,890 (77,741-78,039)
	P-value	<0.001	<0.001	<0.001

Risk of Major Cardiovascular and Cerebrovascular Complications after Elective Surgery in Patients with Sleep Disordered Breathing

Presenting Author: Rabail Chaudhry MD[1]
Co-Authors: Rabail Chaudhry MD[1], Colin Suen MD PhD[1], Talha Mubashir MD[1], Jean Wong MD[1], Frances Chung MBBS[1]

[1]Department of Anesthesia, University Health Network, University of Toronto, Toronto, ON, Canada

Background: Sleep-disordered breathing (SDB) is a common comorbidity in the surgical population and has important perioperative implications. SDB disorders such as obstructive sleep apnea (OSA) are associated with increased incidence of cardiovascular diseases such as coronary artery disease, heart failure, hypertension, atrial fibrillation, pulmonary hypertension, cerebrovascular accidents and sudden death. Current literature suggests that SDB is associated with cardiovascular and respiratory postoperative complications. However, there is limited and conflicting data on mortality with studies reporting an increased[1] or decreased[2] in-hospital mortality among SDB patients undergoing surgery. The objective of this study was to determine whether SDB is associated with increased risk of post-operative major cardiovascular and cerebrovascular events, mortality and length of hospital stay using a large patient database.

Methods: Data was obtained from the Nationwide Inpatient Sample (NIS) between 2011-2014. We included adult patients who underwent elective abdominal, orthopedic, prostate, gynecologic, thoracic, transplant, vascular, and cardiac surgery. The primary outcome was the incidence of major adverse cardiac and cerebrovascular events (MACCE). Secondary outcomes included respiratory complications, mortality during hospitalization, and mean length of hospital stay (LOS). Linear regression and logistic regression models were constructed to determine the independent association between SDB and MACCE.

Results: The study cohort included 1,813,974 surgical patients of which 185,615 (10.23%) had SDB. In the overall surgical cohort, the incidence of MACCE (25.2% vs 19.9%, OR 1.20; P<0.001) and respiratory complications (11.7% vs 7.95%, OR 1.43; P<0.001) were significantly higher in patients with SDB when compared to non-SDB. More specifically, SDB was associated with higher incidence of atrial fibrillation (14.7% vs 10.8%, P<0.001), other arrhythmias (6.02% vs 5.35%, P<0.001), and congestive heart failure (9.75% vs. 7.05%, P<0.001). However, SDB patients had a lower incidence of myocardial infarction (3.05% vs 3.44%, OR 0.69; P<0.001), mortality (0.61% vs 1.25%, P<0.001), and shorter mean length of stay (4.83 vs 5.14 days, P<0.001).

Conclusion: In conclusion, SDB is associated with increased risk of MACCE and respiratory complications. Interestingly, a diagnosis of SDB was associated with lower incidence of in-hospital mortality and LOS. A lower mortality in the SDB population may result from heightened perioperative monitoring and/or SDB specific treatment. Also, undiagnosed SDB patients within the non-SDB group may influence postoperative outcomes.

References:

1. The Journal of Arthroplasty. 2012; 27:95-8.
2. Chest. 2013;144: 903-14.

Table 1: Regression Models to Estimate Adjusted Risk of Postoperative Complications Associated with Sleep Disordered Breathing.

Variables	Adjusted OR (95% CI)	P value
Primary Outcome		
MACCE[a]	1.20 (1.18-1.21)	<0.001
Atrial fibrillation	1.30 (1.28-1.32)	<0.001
Other arrhythmias	1.04 (1.02-1.07)	<0.001
Cardiac arrest	0.71 (0.66-0.76)	<0.001
Myocardial infarction	0.69 (0.67-0.71)	<0.001
Congestive heart failure	1.26 (1.24-1.29)	<0.001
Postoperative stroke	0.74 (0.65-0.84)	<0.001
Secondary Outcomes		
Respiratory complications	1.43 (1.41-1.45)	<0.001
Endotracheal intubation	0.87 (0.63-1.20)	0.394
CPAP/NIV	5.92 (5.73-6.11)	<0.001
Respiratory failure	1.07 (1.05-1.09)	<0.001
Tracheostomy	0.61 (0.56-0.66)	<0.001
Pneumonia	0.83 (0.80-0.85)	<0.001
Vascular complications	0.66 (0.63-0.68)	<0.001
Pulmonary embolism	0.99 (0.92-1.06)	0.722
Deep vein thrombosis	0.73 (0.62-0.87)	<0.001
Other vascular embolism	0.54 (0.51-0.57)	<0.001
End-organ infarct[b]	0.58 (0.52-0.65)	<0.001

Abbreviations: MACCE, Major Adverse Cardiac and Cerebrovascular Events; CPAP, Continuous Positive Airway Pressure; NIV, Noninvasive ventilation; VTE, Venous Thromboembolism

[a]MACCE includes any one of the following: atrial fibrillation, other cardiac arrhythmias, cardiac arrest, myocardial infarction, congestive heart failure, stroke.

[b]End-organ infarct includes any one of the following: hepatic, renal, or mesenteric ischemia.

The Effect of CPAP Treatment in Patients with Obstructive Sleep Apnea on the Global Gene Expression Profile in the Whole Blood

Presenting Author: E Christensson, MD, DESA [1,2]
Co-Authors: S Mkrtchian, MD, PhD [2], A Ebberyd, BMA [2], L I Eriksson, MD, PhD, FRCA [1,2], M Jonsson Fagerlund, MD, PhD, DESA[1,2]

[1] Function Perioperative Medicine and Intensive Care, Karolinska University Hospital, Stockholm, Sweden
[2] Department of Physiology and Pharmacology, Section for Anesthesiology and Intensive Care Medicine, Karolinska Institutet, Stockholm, Sweden

Background: The mechanisms and molecular diagnostics of obstructive sleep apnea (OSA) remain poorly investigated. Recently few groups analyzed the blood cells transcriptome in OSA patients, volunteers exposed to intermittent hypoxia and also the effect of continuous positive airway pressure (CPAP) treatment. However, these studies produced rather inconsistent sets if differentially expressed genes (DEGs) involved in a multitude of different pathways, such as systemic and vascular inflammation, neoplastic processes, induction of apoptosis, and cell adhesion and communication.

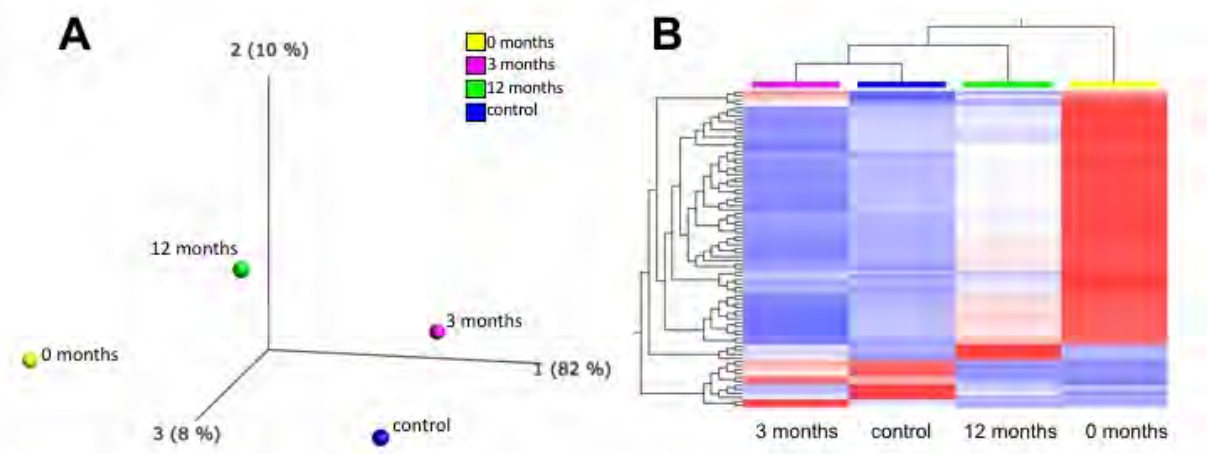
General Aim: To identify the whole blood gene expression signature in patients with at least moderate OSA and to what extent three and twelve months with nightly CPAP treatment effects the gene expression

Materials and Methods: The study was approved by the Regional Ethics Committee on Human Research at the Karolinska Institutet, Stockholm, Sweden. Oral and written consent was obtained from all study subject. Thirty patients with untreated moderate/severe OSA (apnea-hypopnea index (AHI) >15) were enrolled together with 20 matched controls. The whole blood transcriptome was analyzed by RNA sequencing (RNA-seq).

Results: Seven (7) OSA patients that demonstrated substantial improvement after CPAP treatment together with 6 matched controls were selected for the transcriptome analysis. Patient median AHI was 70.5 (57.3), 1.4 (3.0) and 2.5 (4.0), at 0, 3 and 12 months respectively and their median CPAP usage, hrs/night were 6.6 (3.4) and 7.5 (1.8) and % of possible nights were 100 (20.8) and 99.6 (3.5) at 3 and 12 months respectively. The mean BMI was 31.4 (4.5), mean age was 45.6 (12.9) years and 57% were males. Matched controls had a median AHI of 2.3 (4.4), mean BMI of 27.2 (2.2), mean age of 49.5 (15.5) years and 50% were males.

Principal component analysis (Fig. 1A) and hierarchical clustering of DEGs (Fig. 1B) revealed explicit separation of the control group from the untreated OSA patients (0 months). Analysis of 60 DEGs in the latter group (fold change cut-off ≥ 2, adjusted $p \leq 0.05$) shows remarkable prevalence of various immunoglobulins among the downregulated genes including also IL3RA, interleukin 3 receptor. Clustering of the control group with the three months CPAP treatment group speaks in favor of partial recovery of OSA patients (Fig. 1B), consistent with normalization of AHI. This is also reflected by the reduction of the number of DEGs from 60 to 13. Surprisingly, despite still substantially lower (as compared to the control) number of DEGs after 12 months of CPAP treatment, the overall gene expression profile remains rather different from the control (Fig. 1A, B). The changes in the expression of DEGs as revealed by RNA-seq were validated by qPCR.

Figure 1



Differentially expressed genes in the whole blood of 7 OSA patients with high AHI index at 0 months (adjusted p≤0.05)

Conclusions: Untreated OSA leads to the substantial modification of the whole blood transcriptome, which is partially recovered after three months of CPAP treatment. Gene expression recovery correlates with the positive AHI dynamics. Functional analysis of the DEGs in untreated OSA patients indicates decline in the immune-related functions as reflected by the lower immunoglobulins' and IL3RA expression.

Obstructive Sleep Apnea is Prevalent Among Pregnant Women with Chronic Hypertension

Presenting Author: Jennifer E. Dominguez, MD, MHS
Co-Authors: Chad A. Grotegut, MD, MHS, Mary Cooter, MS, & Ashraf S. Habib

Background: Chronic hypertension (cHTN) is an important co-morbidity for obstructive sleep apnea (OSA). OSA is also associated with peripartum complications. Identifying pregnant women with OSA is difficult given the poor reliability of OSA screening tools. The purpose of this study was to determine if pregnant women with cHTN are at significantly higher risk of having undiagnosed OSA than BMI-matched normotensive pregnant controls. Our secondary aim was to examine the predictive value of the OSA prediction score proposed by Facco et al.[1], the Berlin questionnaire, and the Epworth Sleepiness Scale in this cohort of second trimester pregnant women.

Methods: After IRB approval, recruitment began in May 2017 and was completed in April 2019. Two groups of adult gravidas between 10-20 weeks gestation were recruited: 1) those with cHTN (on medication or elevated blood pressures documented on two clinic visits); 2) those with normal blood pressure, no treatment for/history of cHTN, and matched for BMI ($\pm$ 3 kg/m^2) with the cHTN group to control for the effect of obesity on OSA diagnosis and cHTN. Target enrollment was 50 subjects/group. Exclusion criteria included: OSA therapy; opioid or alpha-blockers use (can interfere with the home sleep test); secondary HTN; or non-English speaking. Following informed consent, subjects answered a set of self-reported sleep questions and were followed for pregnancy outcomes. Subjects underwent home sleep testing using an FDA-approved WatchPAT™ device (Itamar Medical Ltd., Caesarea, Israel) during one night of sleep. OSA positive was defined as apnea hypopnea index $\geq$ 5 events/hour.

Results: 100 subjects underwent home sleep testing (50 cHTN, 50 controls). All 100 subjects had valid sleep studies of more than 2 hours. There was no significant difference in the mean BMI or gestational age of the two groups, but the cHTN group was significantly older than the controls (34.3 vs. 29.6 years, $p < 0.001$). The prevalence of OSA among gravidas with cHTN is significantly higher than among BMI-matched normotensive gravidas (64% vs. 38%, $p = 0.009$). Moderate to severe OSA was also significantly more prevalent in the cHTN group. The Facco et al. OSA in pregnancy prediction score was high risk for 88% of women in the cHTN group compared to 44% of the control group ($p < 0.001$).

Conclusions: This observational, prospective study suggests that cHTN is an important independent risk factor for OSA in pregnant women, and that OSA may be more severe when co-morbid with cHTN. The Facco et al. score may be useful in identifying pregnant women at high risk for OSA.

1. Facco FL, Ouyang DW, Zee PC, Grobman WA. Development of a pregnancy-specific screening tool for sleep apnea. *J Clin Sleep Med.* 2012;8(4):389-394.

Transitional Care Unit Implementation Following Ear, Nose, and Throat Procedures to Improve Hospital Floor Bed Utilization

Presenting Author: Sujana Dontukurthy, MD
Co-Authors: Shafy Shabana, MBBS, Joseph D Tobias, MD, Vidya Raman, MD

Introduction: We implemented our perioperative surgical home (PSH) project for Tonsillectomy in 2014 and then expanded this program to involve adenotonsillectomy in 2018. Using the framework established in our PSH project, our institution implemented the Transitional Care Unit (TCU) in May 2018, with the goal of improving inpatient hospital bed utilization following Ear, Nose, and Throat (ENT) procedures. ENT surgeons selected patients for the TCU who would benefit from an intermediate period of monitoring, but did not necessarily need overnight floor bed admission. TCU patients are monitored for at least 3 hours, rather than going directly home post-procedure or being admitted to the inpatient ward, allowing intermediate observation. We examined whether the TCU improved hospital bed utilization by evaluating length of stay (LOS) among patients who completed the TCU process and those that did not.

Methods: This study was exempt from Institutional Review Board approval as a Quality Assurance project. We identified patients who were eligible to stay in the TCU following surgery, among patients who underwent ENT procedures at Nationwide Children's Hospital in May 2019. Among qualifying patients, we compared the post-anesthesia care unit (PACU) length of stay (LOS) and overall LOS according to recovery in the TCU, using rank sum tests.

Results: We identified 837 patients who underwent ENT procedures at Nationwide Children's Hospital in May 2019, of whom 64 were scheduled for recovery in the TCU. Among the 64 TCU-eligible patients, 56 were discharged from the TCU to home, 3 went from the TCU to the inpatient floor, 4 (8%) went from PACU to the inpatient floor, and 1 was changed to an ambulatory procedure. Among the 56 patients who where discharged home from the TCU, the median post-operative LOS (phase II to discharge) was 237 minutes (IQR: 191, 264. The median PACU LOS was 57 minutes (IQR: 48, 66) among patients who were discharged home from the TCU compared to 82 minutes (59, 111) among patients who were not (p=0.024).

Discussion: At our institution, we found that time spent in the PACU was significantly shorter among patients who were discharged home from TCU compared to those who were not. Because patients in the TCU are only sent to the inpatient floor if they require overnight observation, the overall LOS was longer among patients who were not discharged from the TCU. The use of the TCU allows for customization of care for patients requiring an intermediate observation period after tonsillectomy, so that floor beds are only used for those who require overnight observation. Our findings suggest the use of the TCU has resulted in improved bed utilization and potential cost savings.

Conclusion: The concept of a TCU can reduce hospital inpatient floor bed use for patients requiring an intermediate observation period after ENT surgery.

References:

1. Shay S, et al. Laryngoscope 2015; 125:457-61.
2. Tumin D, et al. Int J Pediatr Otorhinolaryngol 2017; 94:17-22.

Table. Characteristics and outcomes among patients eligible for recovery in the TCU, according to whether they were discharged from the TCU

Patient characteristics	Discharged home from TCU (N=44)	Not Discharged from TCU (N=8)	P value
	Median (IQR) or N (%)	Median (IQR) or N (%)	
Outcomes			
PACU LOS (minutes)	57 (48, 66)	82 (59, 111)	**0.024**
LOS (hours)	7 (7, 8)	27 (18, 28)	**0.001**
Characteristics			
Female	23 (52%)	3 (38%)	0.703
Age (years)	4 (1, 6)	4 (3, 5)	0.652
Procedure type			
Tonsillectomy ± adenoidectomy	18 (41%)	4 (50%)	0.202
Adenoidectomy	22 (50%)	2 (25%)	
Other	4 (9%)	2 (25%)	

IQR = interquartile range, LOS = length of stay, PACU = post-anesthesia care unit, TCU = Transitional Care Unit

Treatment Emergent Central Sleep Apnea and Anesthesia

Presenting Author: Amanda R Fields M.D.
Co-Authors: Meghna P Mansukhani, M.D., Bhargavi Gali, M.D., Juraj Sprung, M.D., PhD, Toby N Weingarten, M.D.
Mayo Clinic – Rochester, MN

Introduction: Treatment emergent central sleep apnea (TECSA) is a rare central sleep-related breathing disorder, characterized by persistence or emergence of central sleep apnea during the initiation of CPAP therapy for suspected obstructive sleep apnea. Positive pressure treatment relieves upper airway obstruction but does not correct the central ventilatory disturbance[1]. The perioperative course of these patients has not been described. The purpose of this study was to describe the perioperative course of TECSA patients who underwent procedures requiring anesthetic management.

Methods: Patients who received a diagnosis of TECSA at our institution and required procedural anesthesia between January 1, 2009, and May 1, 2018, underwent a comprehensive review of their health records with a focus on identifying perioperative risk factors and complications.

Results: Ninety-four patients (71 males, 23 female) underwent procedures requiring anesthetic management; 85 (90.4%) general anesthetic, 2 (2.1%) monitored anesthetic care, and 7 (7.4%) regional anesthetic (See table for clinical characteristics). Eighty-seven patients had anesthesia recovery in the postanesthesia care unit, of which 25 (28.7%) had moderate – profound sedation, 14 (16.1%) episodes of respiratory depression, 11 (12.6%) had cardiac events (all arrhythmias), and 8 (9.2%) agitation. Postoperative complications included death secondary to a myocardial infarction, aphasia, hyperactive delirium, hypotension requiring ICU transfer, and two profound syncopal episodes. One patient died with 30 days of hospital discharge from cardiac arrest.

Conclusion: Patients with TECSA have complicated anesthesia recovery with substantial deviations from the expected clinical course. Anesthesiologists should be prepared that these patients may require extra support in the PACU.

References:

1. Khan, M. and Franco, R. (2014). Complex Sleep Apnea Syndrome. *Sleep Disorders*, 2014, pp.1-6.

Table 1. Anesthetic Outcomes of 94 Procedures	
Surgical/Anesthetic Characteristics and Complications (N=94)	**Value**
Age	72 [65-79]
BMI	32.38 [27.95-36.67]
Polysomnography	
AHI*	29 [16.25, 51.75]
CAI**	2 [0,8.75]
Minimum SpO_2	85 [80-88]
Charlson Comorbidity Index	6 [4-8]
Type of surgery, No. (%)	
General	27 (28.7)
Orthopedic	37 (39.4)
Neuro	8 (8.5)
Vascular	7 (7.4)
Cardiac	5 (5.3)
Urology	4 (4.3)
Miscellaneous (ENT,OMFS,Transplant,Plastics)	6 (6.4)
Duration, median (range), min	167 (58 – 483)
Type of Anesthesia, No. (%)	
General	85 (90.4)
Monitored Anesthesia Care	2 (2.1)
Regional	7 (7.4)
Opioid IV morphine equivalents, median	25 [20,35]
Intraoperative course	
Self-limited myocardial ischemia	1
Loss of consciousness during regional	1
Desaturation during masking	1
PACU Course (n=87)	
Duration, median (range), min	86 [22, 300]
RASS ≤ -2, No. (%)	25 (28.7)
Respiratory events, No. (%)	14 (16.1)
Cardiac events, No. (%)	12 (13.8)
Agitation, No. (%)	8 (9.2)
Postoperative events (n=94), No. (%)	6 (6.4)
Readmission < 30 d after procedure, No. (%)	14 (14.9)
Death <30 d after procedure, No. (%)	2 (2.1)

*Apnea-Hypopnea (events per hour)

**Central Apnea Index (events per hour)

Risk Factors and Outcomes of Postoperative Emergency Team Activation: A Matched Case-Control Study

Presenting Author: Michelle R. Schmugge, MD
Co-Authors: Matthew I. Hardman, DO, Jeffrey B. Jensen, MD, Juraj Sprung, MD, PhD, Toby N. Weingarten, MD. Department of Anesthesiology and Perioperative Medicine, Mayo Clinic. Rochester MN, USA.

Background: Emergency response teams (ERTs) are beneficial for the evaluation and treatment of patients with acute clinical deterioration. In the present study, we used postoperative ERT activations as a marker of acute clinical deterioration, and we examined patient and procedural risk factors.

Methods: We identified ERT activations within the first 48 postoperative hours for patients who underwent operations with general anesthesia and were discharged to regular wards between January 1, 2013, and December 31, 2015. To assess risk factors for ERT activation, we matched cases 2 to 1 with patients on the basis of sex, age, and type of operation but who did not require ERT.

Results: Among 105,345 patients, 797 had postoperative ERT calls with a rate of 7.6 (95% CI, 7.1-8.1) calls per 1,000 anesthetics (0.76%). For 266 patients (34.4%) ERT activations occurred within the first 12 postoperative hours; for 470 patients (59.0%), within the first 24 hours. The indications for ERT activations were cardiac (n=245, 30.7%), hypotension (n=216, 27.1%), neurologic (n=83, 10.4%), pulmonary (n=172, 21.6%), and miscellaneous (n=81, 10.2%) causes. Multiple logistic regression analysis showed the following risk factors for postoperative ERT: cardiovascular disease (odds ratio [OR], 1.61; 95% CI, 1.18-2.18), neurologic disease (OR, 1.57; 95% CI, 1.11-2.22), preoperative gabapentin (OR, 1.60; 95% CI, 1.17-2.20), longer surgical duration (OR, 1.06; 95% CI, 1.02-1.11 per 30 minutes), emergency procedure (OR, 1.54; 95% CI, 1.09-2.18), intraoperative ketamine (OR, 1.49; 95% CI, 1.20-1.84), colloids (OR, 1.50; 95% CI, 1.17-1.92), and nondepolarizing muscle relaxants (OR, 1.46; 95% CI, 1.08-1.96). Secondary multivariate association of clinical characteristics with ERT activation as indications was assessed and presented in the Table. Compared with control participants, ERT patients had a longer hospital stay, a higher rate of admissions to critical care (55.5%), increased postoperative complications, and a higher 30-day mortality rate.

Discussion: We identified several patient and procedural characteristics associated with increased likelihood of postoperative ERT activation. ERT intervention is a marker for increased rates of postoperative complications and death.

Table. Multivariate Analysis of Patient- and Procedure-Related Factors as Potential Risk for Postoperative ERT Activation According to Clinical Indications

Indication for ERT Activation	OR (95% CI)	P Value
Cardiac indication (n=245)		
Surgical duration	1.09 (1.00-1.19)	.04
Ketamine intraoperative	1.94 (1.30-2.90)	.001
Nondepolarizing muscle relaxants	1.96 (1.12-3.44)	.02
Antihypertensives intraoperative	2.19 (1.34-3.59)	.002
Hypotension indication (n=216)		
Cardiovascular disease	2.08 (1.14-3.78)	.02
Surgical duration	1.12 (1.02-1.22)	.02
Ketamine intraoperative	1.78 (1.16-2.74)	.008
Gabapentin preoperative	2.07 (1.17-3.66)	.01
Neurologic indication (n=83)		
Central neurologic disease	3.43 (1.04-11.29)	.04
Vasopressors intraoperative	4.08 (1.17-14.27)	.03
Pulmonary indication (n=172)		
Obstructive sleep apnea	1.82 (1.12-2.95)	.02
Central neurologic disease	2.79 (1.15-6.82)	.02
Gabapentin preoperative	2.81 (1.20-6.60)	.02
Colloid administration	2.15 (1.26-3.67)	.005
Vasopressors intraoperative	2.08 (1.08-4.02)	.03

Abbreviations: ERT, emergency response team; OR, odds ratio.

A Simple Modified Infant Face Mask Provided Nasal CPAP and Immediate Pressure-Control Nasal Ventilation and Oxygenation In an Obese Patient with Asthma and Suspected OSA During Outpatient EGD

Presenting Author: Bradley T. Fong, M.D., Anesthesiology and Perioperative Medicine, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ, USA.
Co-Authors: Avanti Suresh, B.A., Jennifer Cowell, M.D., James T. Tse, M.D. Anesthesiology and Perioperative Medicine, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ, USA.

Background: Obese patients undergoing procedural sedation in the endoscopy suite are at increased risk of airway obstruction and oxygen desaturation. Basic interventions such as chin lifts, jaw thrusts, or placement of a nasopharyngeal airway are often effective remedies, but may interrupt a procedure at an inopportune moment. One solution is to provide pressure controlled ventilation via a modified infant mask placed over the nose of an adult patient. This novel assembly has been shown to improve oxygenation in obese patients during deep sedation. We describe its use in an obese patient who had difficulty oxygenating during an endoscopic procedure.

Case description: 54-year-old obese female (BMI 36.2kg/m2) with HTN, breast cancer, GERD and asthma presented for EGD. She had OSA, bilateral mild wheezes and 93-95%SpO2. Following albuterol inhalation treatment, a modified infant mask was secured over her nose with head-straps and connected to anesthesia circuit/machine (Fig. 1). APLvalve adjusted to deliver CPAP (6-8cm H2O) with 4LO2/min. Deep sedation was titrated with lidocaine/propofol boluses/infusion. She maintained spontaneous nasal ventilation and 100%SpO2. Her airway was obstructed during difficult endoscope insertion. Nasal pressure-control ventilation (PIP 19cm H2O, PEEP 5cm H2O, RR 10/min) was immediately started and weaned-off to CPAP. She maintained 99-100%SpO2 without procedure interruption.

Discussion: This simple modified infant mask assembly is a cost effective way to provide CPAP or pressure control ventilation to an obese patient with OSA during procedural sedation. It can be used to improve oxygenation and avoid intubation in a patient with a difficult airway who may not tolerate endoscopy with supplemental oxygen via nasal cannula alone. The device takes under a minute to assemble and uses existing anesthesia equipment and machine. Overall, using this modified infant mask may improve patient safety at a low cost.

Fig. 1. A a modified infant mask secured over the patient's nose with head-straps and connected to anesthesia circuit/machine to provide nasal CPAP or pressure controlled ventilation.

Patient Awareness of Obstructive Sleep Apnea as a Risk Factor for Opioid Adverse Effects

Presenting Author: Jean Wong, MD, FRCPC[1,2]
Co-Authors: Enoch Lam, BHSc[1]; Maria Garstka, MBBS[1]; Frances Chung, MBBS[1]; Jean Wong, MD, FRCPC[1,2]

[1]Department of Anesthesia, Toronto Western Hospital, University Health Network, University of Toronto; [2] Department of Anesthesia & Pain Management, Women's College Hospital, University of Toronto

Background: Opioids are frequently prescribed to treat pain after surgery, however, opioids can be associated with serious adverse effects including impaired breathing and death. Opioids may worsen postoperative sleep disordered breathing in patients with obstructive sleep apnea (OSA)[1] and put patients with OSA at higher risk for respiratory depression and death.[2] Although there is a serious risk of adverse effects, it is not routine practice to provide written information about opioids to patients before surgery. A lack of information regarding the safe use of opioids may cause avoidable side effects in surgical patients. The aim of this study is to determine levels of patient knowledge on sleep apnea as a risk factor for opioid related side effects.

Materials and Methods: This prospective randomized controlled trial was conducted at Women's College Hospital in Toronto, Ontario, Canada. Surgical patients at the pre-admission clinic were approached by a research assistant to complete a questionnaire on various key concepts regarding the safe use of opioids. The inclusion criteria included English speaking adults ≥18 years of age. The exclusion criteria were 1) patients unable to understand English, 2) patients on opioids for chronic pain, and 3) patients who had taken opioids in the past 30 days. The study was reviewed and approved by the Women's College Hospital (WCH) Research Ethics Board and informed consent was obtained from all participants.

Results: A total of 50 patients were recruited for this study. The average age of the patient population was 39.1 ± 12.7 years, 60% of the participants were female, and the level of education was high with 39/50 participants completing tertiary education and 7/50 completing secondary education. The questionnaire given to patients had a Flesch Kincaid readability test score of 5.21, meaning a person with a grade 5 level of education can understand the questionnaire. The results show that 14/50 patients were unaware of sleep apnea as a potential risk factor for increasing the risk of side effects of opioids. Of the four patients diagnosed with sleep apnea, only 1 patient with sleep apnea did not think sleep apnea was a risk factor. Side effects such as slow or shallow breathing (46/50) and nausea (43/50) were widely recognized as potential side effects by patients.

Discussion: The results show that in a low risk pre-surgical patient population with a higher than average level of education, many patients identify sleep apnea as a potential risk factor for increased opioid side effects and recognize common side effects such as shallow breathing and nausea. The percentage of people recognizing OSA as a risk factor did not differ between patients with and without a diagnosis of sleep apnea, but there were few patients with sleep apnea.

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Results From 349 Drug Induced Sleep Endoscopies with Probability Ramp Control – Lessons for Pharmacokinetic Design of DISE Protocols

Presenting Author: Jeff E Mandel MD MS, Assistant Professor of Clinical Anesthesia, Hospital of the University of Pennsylvania
Co-Author: Joshua H Atkins MD PhD, Associate Professor of Anesthesiology & Critical Care, Perelman School of Medicine at the University of Pennsylvania

Background: Drug-induced sleep endoscopy (DISE) employs a sedative such as propofol to allow observation of airway collapse to predict success in surgical interventions for obstructive sleep apnea (OSA) [1]. A number of protocols have been published for the administration of propofol during DISE. We analyze the results of applying our protocol, probability ramp control (PRC) [2], to 349 patients, and utilize the resulting probability distribution to examine how other published protocols might be improved.

Methods: IRB approval was obtained for analysis of deidentified data from 349 patients sedated with PRC. The estimated effect site concentrations at time of airway collapse (EC_{ac}) were estimated using the model of Cortinez [3] and fit to a gamma distribution. Correlation between EC_{ac} and age/weight were performed using Spearman's rho. This distribution was used to devise a bolus sequence that would yield a mean time to airway collapse of 4 minutes in simulated delivery to a 96 kg, 55 year old patient (the mean values for our cohort). All calculations were performed using MATLAB 2019a (Mathworks, Natick, MA).

Results: The parameters of the gamma distribution were a = 8.67 (95% CI 7.4 –10.1), b = 0.53 (95% CI 0.45 – 0.63). The mean EC_{ac} was 4.6 ± 1.6 μg/ml; 95% of EC_{ac} fell in the range 1.9 – 8.4 μg/ml. EC_{ac} was uncorrelated with age (ρ = -0.05, p = 0.41) and weight (ρ = -0.06, p = 0.29). A sequence of 10 boluses of 29.75 mg at diminishing intervals achieved the effect site concentrations associated with airway collapse in the specified average time, as depicted in Figure 1. While this sequence is specific to this hypothetical patient, it can be implemented with a 3 cc syringe and a smartphone app.

Conclusions: There are two important observations from this study. First, the lack of correlation between EC_{ac} and age or weight suggests that effects site estimates are sufficient to guide propofol delivery during DISE. Second, effect site concentrations span a wide range, and published protocols may not be adequate for coverage of the full range of propofol requirements we observed. Use of pharmacokinetic design may be useful in improving outcomes during DISE.

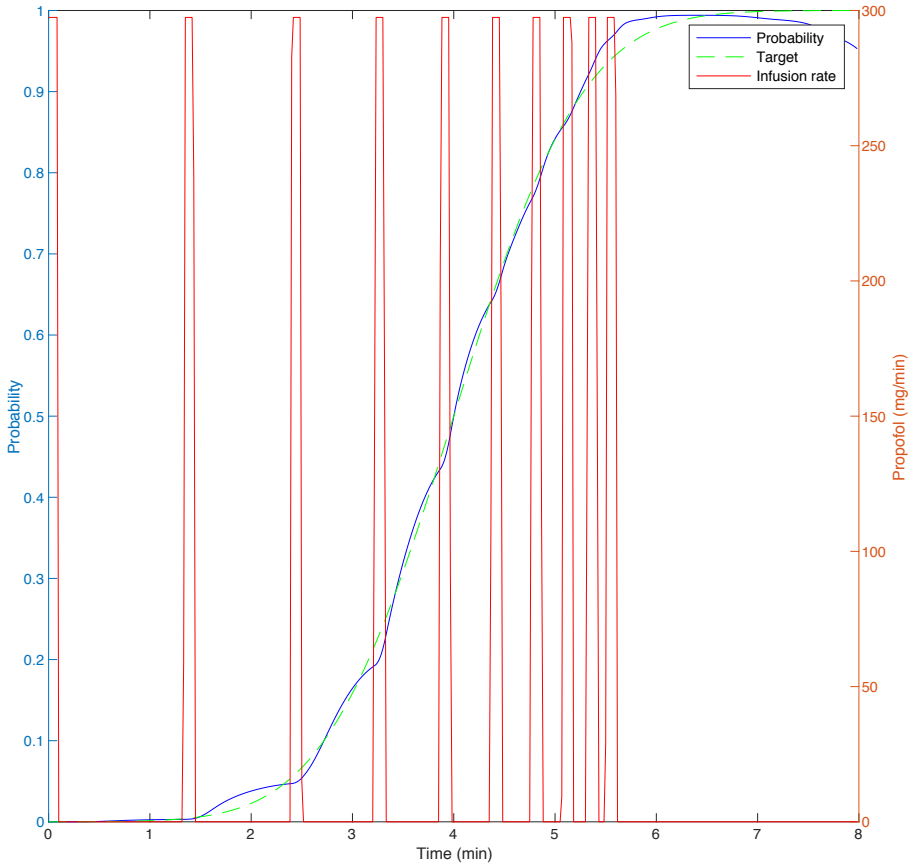

Figure 1 – Simulated administration of a bolus sequence designed to produce a mean time to airway collapse of 4 minutes in a 96 kg, 55 year old patient

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Effects of Bariatric Surgery on Obstructive Sleep Apnea

Presenting Author: Francisco Marquez MD University of Arizona-Phoenix
Co-Authors: Joyce Lee-Iannotti MD University of Arizona-Phoenix, Robin Blackstone MD University of Arizona-Phoenix

Background: Obesity is one of the most important factors for the development of obstructive sleep apnea (OSA). Untreated OSA is associated with an increased incidence of hypertension, heart attacks, strokes, diabetes, motor vehicle collisions and all cause mortality. Though continuous positive airway pressure (CPAP) is an effective treatment for OSA, not all patients can use CPAP. We also know that CPAP compliance is low, with less than 50% of patients using the device regularly. Bariatric surgery may be the most effective treatment for OSA in morbidly obese patients, especially for those who have such severe OSA that CPAP helps, but does not completely resolve apneas.
Reports of bariatric surgery effects on OSA have been limited by studies that were not designed to identify sleep apnea outcomes.

General Aim: To assess changes in the apnea-hypopnea index (AHI) before and after weight-loss surgery with secondary aims evaluating changes in Epworth Sleepiness Scale (ESS), HgbA1c, blood pressure, and BMI.

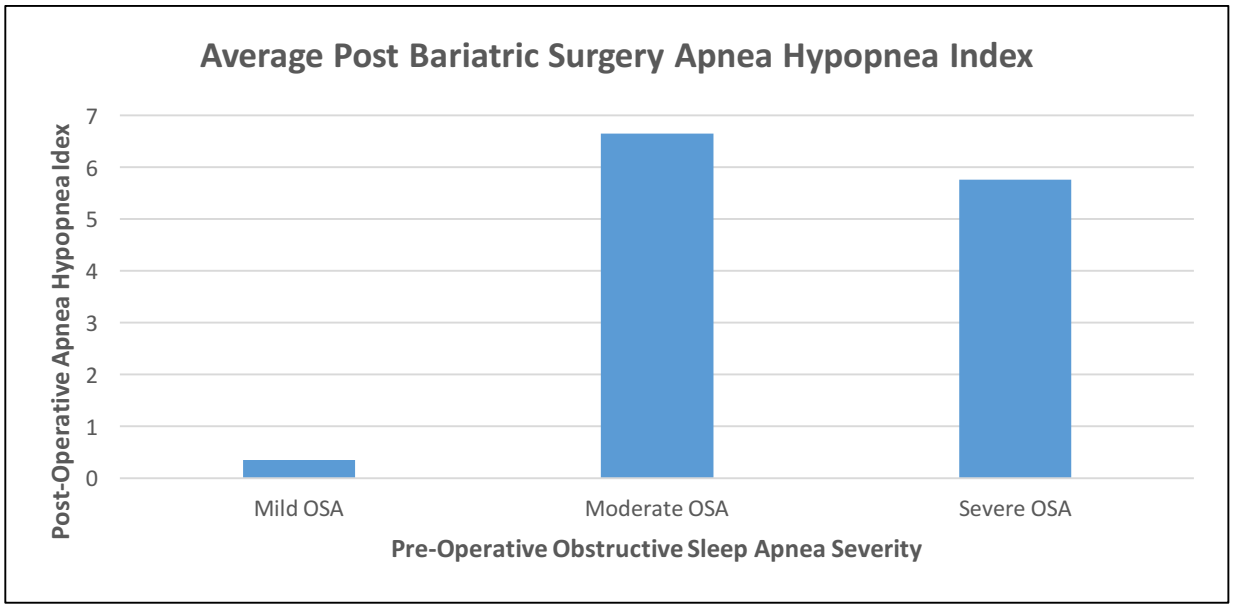
Materials and Methods: Electronic medical records were retrieved from Cerner Powerchart for patients evaluated by the Sleep Medicine Department at Banner University Medical Center, Phoenix from 03/2018 to 03/2019 with a history of bariatric surgery including laparoscopic Roux-en-Y gastric bypass and sleeve gastrectomy. This process resulted in 81 patient encounters. Each chart was independently reviewed, and ultimately 13 patients had full sleep studies conducted before and after their surgical intervention. These charts were then evaluated in depth to produce the results summarized below. P values were obtained by chi-squared analysis.

Results: Mean age was 56.8±3.4, with pre AHI 32.1±7.7 ($p < 0.0001$) and post AHI 8.2±2.9 ($p < 0.0001$). Pre ESS 8.4±1.6 ($p < 0.0001$) with post ESS 3.1±0.7 ($p < 0.03$). Pre BMI 43.6±2.4 ($p = 0.08$) with post BMI 34.2±1.6 ($p < 0.32$). Pre HgbA1c 8.0±0.5 ($p = 0.97$) with post HgbA1c 6.9±0.4 ($p = 0.98$). Pre systolic blood pressure 131.2±3.0 ($p = 0.60$) with post systolic blood pressure 124.4±2.9 ($p = 0.62$).

Discussion: Our study reveals significant objective improvement in obstructive sleep apnea after bariatric surgery intervention. Furthermore, we found that patient's daytime sleepiness (ESS) also improved.

Though improvement was not found for other parameters of obesity including BMI, HgbA1c nor blood pressure there are likely multiple factors at play. First, the sample size was limited by the short time period assessed. Furthermore, of those patients studied throughout the year, the time when subsequent sleep studies were performed after bariatric surgery varied drastically. Lastly, multiple patients did not have follow-up sleep studies performed, likely suggesting that our evaluation is underestimating improvements.

Conclusion: OSA was present in most patients undergoing weight loss surgery. Bariatric surgery resulted in significant improvement in subjective and objective measures of OSA.



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Home Monitoring of High-Risk Opioid Patients

Presenting Author: Robert L. Mazzola, MD, MSPH, FCCP, Intermountain Healthcare
Co-Authors: Kim Bennion MsHS, RRT, CHC, Intermountain Healthcare, Gaylinn Breeze, APRN, DNP Candidate, Intermountain Healthcare, Tom Cloward, MD, Intermountain Healthcare

Background: Patients receiving opioid analgesics are at risk of morbidity & death due to respiratory arrest attributable to opioid induced respiratory depression (OIRD). This may occur in patients with sleep apnea, which is often undiagnosed; but may occur in patients without sleep apnea. Multiple society guidelines advocate electronic monitoring during postoperative hospitalization. Time to discharge is decreasing pushing these risks into the post-discharge setting. Monitoring systems with alarm features may avert post-discharge respiratory failure & arrest, but the feasibility of such systems, & acceptability to patients, has had little study.

General Aim: The Orthopedic Specialty Hospital (TOSH) is one of the country's premier facilities for orthopedic care. The main aims of this study are: (1) determine the feasibility of home side-by-side non-invasive oxygen saturation (S_pO_2) & capnography ($ETCO_2$) monitoring to detect OIRD in patients after hospital discharge following orthopedic surgery, (2) determine the rate or OIRD associated morbidity, (3) rate & range of device alarms, (4) rate/dose of naloxone use, (5) percent of time spent with pulse oximetry saturation $\leq$ 85%, (6) emergency department visits during the monitoring period, & (7) assessment of patient understanding of the risk of OIRD.

Materials & Methods: We are proceeding with a quantitative, prospective, non-randomized single cohort study using Masimo Rad 7® monitoring devices to test the feasibility of use in the home setting & estimate the incidence of post-discharge OIRD. Orthopedic surgery patients meeting high-risk opioid inclusion criteria & prescribed opioids will be discharged with a side-by-side, non-invasive pulse oximeter & capnography monitor for 4 days post-operatively. Electronic monitoring of heart rate, respiratory rate, S_pO_2 & $ETCO_2$ while patients are napping/sleeping will be stored. Patients will be educated about opioid risks & the relationship with OIRD, falling S_pO_2 & $ETCO_2$, & risks of taking other sedative medications with opioids. Patients will also be discharged with Naloxone nasal spray following administration education. Patients will be instructed on how to respond to alarms & given a number to call with questions or concerns 24 hours/7 days. Upon device return, all recorded data will be analyzed.

Results: 500 patients or 6-months, whichever comes first.

Discussion: In orthopedic patient's analgesia frequently requires opioids exposing patients to the risk of OIRD. OIRD risks have been shown to be greatest within the first 24 hours after surgery[1,2,3,4]. Other studies have shown day 3 as the greatest risk for respiratory events and hypoxemia[5]. With the prevalence of time to discharge in under 24 hours, the risk for OIRD may now be unidentified until the patient is home. We propose that protocolized use of capnography and oximetry in the home setting will allow early intervention to evolving OIRD preventing poor outcome.

Conclusion: Preliminary data from this study will be reported at the time of poster presentation with conclusions and recommendations. This study will answer the call by Utah legislators (Utah's 2018 SCR004: Parker's Bill) encouraging research on the use of home monitoring and a heightened level of awareness in the prescription of opiates.

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A Modified Pediatric Face Mask Provided Pressure-Support and Pressure-Control Nasal Ventilation/Oxygenation in a Morbidly Obese Patient with Severe OSA and Asthma during Hysteroscopy

Presenting Author: Vrajesh Mehta, MD, Rutgers Robert Wood Johnson Medical School, New Brunswick, New Jersey
Co-Author: James Tse, MD, PhD, Rutgers Robert Wood Johnson Medical School, New Brunswick, New Jersey

Background: Patients under procedure sedation often receive supplemental O_2 via a nasal cannula. Over-sedation or airway obstruction may cause severe O_2 desaturation, especially in obese patients with OSA. These patients may desaturate rapidly due to decreased functional residual capacity specifically expiratory reserve volume. A novel nasal PAP mask assembly using a pediatric mask has been shown to provide CPAP to maintain spontaneous ventilation and continuous oxygenation in obese patients under procedure sedation. We used a modified infant mask to provide pressure-support/control nasal ventilation in a morbidly obese patient undergoing hysteroscopy.

Case Description: A 57 y/o female, 5'4", 260 lbs, BMI 45 kg/m^2, with HTN, NIDDM, hypothyroidism, severe OSA on CPAP, asthma, herniated C5-C6 disc and endometrial polyp presented for outpatient hysteroscopy. She was very concerned about anesthesia because of prior anesthesia-related complications. She reportedly had "a near respiratory arrest" under propofol sedation for colonoscopy and required assisted face mask ventilation which resulted in vomiting and aspiration pneumonitis. She also reported developing post-extubation respiratory failure requiring re-intubation after knee arthroscopy. Her last hysteroscopy was done under spinal anesthesia with minimum sedation and a nasal PAP mask by the same anesthesia team without any complication.

She had a Mallampati IV airway, limited range of neck motion and thyromental distance <7cm. A modified infant mask was secured over her nose with elastic head straps and connected to the anesthesia machine/circuit. The APL valve was adjusted to deliver nasal 8-10 cm H_2O CPAP with 4L/min O_2 flow. Deep sedation was then induced with dexmedetomidine and propofol. Her respiration was maintained with pressure-support nasal ventilation (PS 18 cm H_2O PEEP 10 cm H_2O and RR 10/min). Subsequently, 50% nitrous oxide was added during polypectomy/D&C and her respiration was maintained with pressure-control nasal ventilation (PIP 23 cm H_2O, PEEP 12 cm H_2O, RR 10/min). She tolerated procedure well without any movement and maintained 97-100% SpO_2 throughout the procedure. The patient was elated that the procedure was completed without any complication. She was discharged home without delay.

Discussion: This modified infant face mask provided nasal CPAP pre-oxygenation, pressure-support/control ventilation and continuous oxygenation in a morbidly obese patient with severe OSA during hysteroscopy. It allowed deep sedation and avoided O_2 desaturation in a patient with difficult airway. It also avoided the need to intubate the patient and post-extubation complications.

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Fig. 1

Diazepam-Induced Respiratory Inhibition on Hypoglossal Nerve Activity Seems to be Decreased During Oxygen-Rich Moderate Hypercapnic Ventilation in Anesthetized Rabbits

Presenting Author: Haruka Maeda, MD, Saitama Medical University, Hidaka, Japan

Co-Authors: Kimie Terayama, MD, Kumagaya General Hospital, Kumagaya, Japan; Haruka Maeda, MD, Saitama Medical University, Hidaka, Japan; Wakana Ugajin, MD, Kumagaya General Hospital, Kumagaya, Japan; Kaoru Miyazaki, MD, DMU Saitama Medical Center, Koshigaya, Saitama; Shin-Chan Nakamura, MD, Kumagaya General Hospital, Kumagaya, Japan

Kumagaya General Hospital, Kumagaya, Japan, Saitama Medical University, Hidaka, Japan, DMU Saitama Medical Center, Koshigaya, Saitama

Background: During sedation with benzodiazepines, propofol and other sedatives often occurs the respiratory inhibition, such as upper airway obstruction and inadequate ventilation. Since under these conditions decreased CO_2 responsibility is considered a key component in the cause of respiratory depression, we studied how oxygen-rich moderate hyper-capneic ventilation effects on propofol (Pp)- or diazepam (Dz)-induced respiratory inhibition on hypoglossal nerve innervating upper airway muscles and phrenic nerve controlling diaphragm contraction activities (HGA and PNA) in anesthetized rabbits.

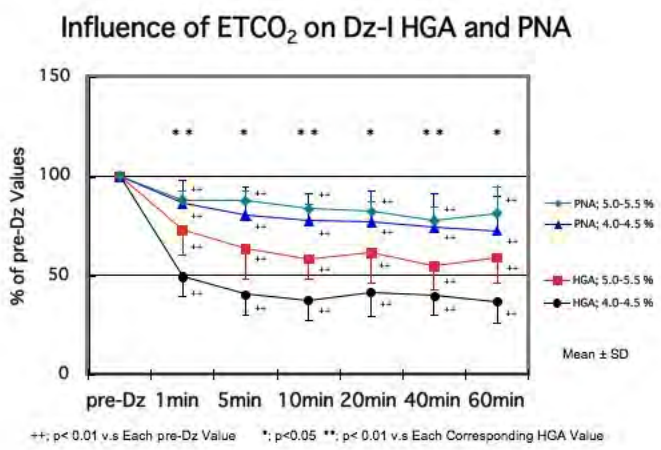
Methods: Experiments were approved by the Saitama Medical University Animal Care Committee. Studies were carried out in adult rabbits (n=19) that were vagotomized, paralyzed and artificially ventilated with 50 % N_2O, 50 % oxygen and 0.5 % sevoflurane.
Effects of Dz 1 mg/kg iv on HGA and PNA were examined in different end-tidal CO_2 concentrations (ETCO2), normo-capneia (ETCO2; 4.0-4.5%) and moderate hyper-capneia (ETCO2; 5.0-5.5%), during 60 minutes after the administration. In propofol (Pp) study we estimated the difference 30min after continuous infusion at two rates of Pp (0.25 and 0.75 mg/kg/min iv) on HGA and PNA.

We measured the following parameters on the integrated neurogram; the peak amplitude (AMP) and the root mean square (RMS) in both HGA and PNA, and the neural respiratory time (Tc; defined as the period between the start of PNA and that of the next PNA). Other parameters including end-tidal CO_2 ($ETCO_2$), arterial blood pressure (ABP), heart rate (HR) and rectal temperature were also continuously monitored.
The changes in AMP and RMS were expressed as a percent of these pre-Dz values.

Results: Figure 1 shows the following results; Dz-induced HGA inhibition was reduced under oxygen-rich moderate hyper-capnic ventilation. In contrast, there was no remarkable changes in Dz-induced PNA inhibitions between normo- and moderate hyper-capneic conditions. About 20% reduction in Dz-induced HGA inhibition with shortening Tc is occurred in the hyoer-capnic, not in the normo-capneic ventilation.
In the results from Propofol Group there is no remarkable difference both normo- and moderate hyper-capneic ventilation.

Conclusions: These results suggested that pharmacological respiratory drive, e.g. inhalation of low doses of CO_2, might be an interesting approach for prophylaxis and/or treatment of diazepam-induced upper airway obstruction.

Fig.-1


Influence of ETCO2 on Dz-I HGA and PNA
% of pre-Dz Values
150
100
50
0
pre-Dz 1min 5min 10min 20min 40min 60min
PNA; 5.0-5.5 %
PNA; 4.0-4.5 %
HGA; 5.0-5.5 %
HGA; 4.0-4.5 %
Mean ± SD
++; p< 0.01 v.s Each pre-Dz Value
*; p<0.05 **; p< 0.01 v.s Each Corresponding HGA Value

Post-Approval Study of the aerFree™ System for Maintaining Upper Airway Patency During Mild to Moderate Sedation

Presenting Author: A. Puleo, Sommetrics, Inc., Vista, CA
Co-Authors: G. Winston, W. Flicker and R. Rose, Sommetrics, Inc., Vista, CA

Background: Drugs producing sedation in the acute care setting can induce upper airway narrowing and collapse. The aerFree™ system delivers continuous negative external pressure (cNEP) over the upper airway, and is FDA cleared as an airway support device to assist in the management of patients undergoing mild to moderate sedation. Use of this device can reduce the frequency and duration of sedation related airway collapse (Endoscopy 2016; 48:544-7). We undertook a small post-approval, observational study of the aerFree™ system to better characterize its utility in various acute care settings.

Methods: The aerFree™ system consists of a single-use soft silicone collar placed over the anterior surface of the neck and is connected to regulated wall suction at a nominal pressure range of -40 to -45 cm. The system was distributed free of charge to 9 acute care sites in California. Personnel (largely nurses and respiratory therapists) at each site received in-service training in the use of aerFree™. After each patient experience with aerFree™, medical staff were asked to subjectively rate whether the system was successful in maintaining airway patency based on lack of observed alterations in breathing (stridor), need for chin lift, and fall in oxygen saturation.

Results: aerFree™ was employed in 30 patients in various clinical settings: Cardiac Cath lab (9); PACU (9); OR (4); and out-patient procedures (8). Overall success rate was 80%. 3 patients receiving MAC required chin lift and in 3 patients the collar could not be maintained in the proper position. No adverse events attributable to aerFree™ were reported. Overall, medical staff found aerFree™ to be easy to use and a benefit to their care of sedated patients.

Conclusion: Use of aerFree™ in this small post-approval study was safe, appeared to be effective in maintaining upper airway patency, and was well received by medical staff.

Comparison Between Novel Mobile Phone App-Based Pulse Oximetry System with Proprietary Level 4 Home Sleep Testing Device (Konica Minolta Pulsox-300i) – Prospective Observational Study of Patients Suspected of Obstructive Sleep Apnea

Presenting Author: Edwin Seet, Head, Department of Anaesthesia, Khoo Teck Puat Hospital
Co-Authors: Cheryl Saw, Ministry of Health Holdings, Singapore; Leong Kwong-Ming, Ministry of Health Holdings, Singapore; Daniel Chia, Director Innovation, Khoo Teck Puat Hospital

Introduction: Substantial number of elective surgical patients have unrecognized obstructive sleep apnea (OSA). Level 4 home sleep testing devices are increasingly used, however proprietary hardware and software is required and calculation of sleep parameters are inflexible and cumbersome. Smart phones are ubiquitous and may be used for data management and processing. Severe desaturation during sleep has been recently found to predict postoperative cardiovascular events.[1] This study seeks to determine the utility of a novel smart phone app for OSA detection and cumulative time of oxyhaemoglobin desaturation.

Methods: After ethics approval (DSRB2017/00891), a smart phone loaded with a novel app (patent filed E201502060504V), coupled with a commercially available oximetry finger probe (Masimo, $iSpO_2$) was created. Patients suspected of OSA (STOP-Bang screening score ≥ 3) were voluntarily consented and recruited. Preoperative sleep studies using the Pulsox-300i and the novel smart phone app were done concurrently. Data was compared between the two devices to determine the correlation and agreement.

Results: Eight patients participated in this study – 7 males and 1 female. Mean age was 60±10 year. The novel smart phone finger probe was dislodged for 1 patient and Pulsox-300i finger probe dislodged for 1 patient. Two patients had no OSA, 4 mild OSA and 2 moderate OSA. Cumulative time <90% (in percentage of sleep time) was 1.1±0.9% for the smart phone group and 1.7±1.8% for the Pulsox-300i group. Spearman's correlation coefficient for this parameter was 0.87 and intraclass correlation coefficient was 0.59.

Discussion: Finger probe dislodgement during sleep studies is a common occurrence (12.5%). Similar to published studies[1], ¾ of this cohort had unrecognised OSA. Intraclass correlation between the devices showed moderate agreement. This novel smart phone app may play a role in perioperative OSA screening and detection.

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Patient S/N Date	Parameter	Novel Smart Phone	Pulsox-300i
1.52yo, M (26/12/18) Mild OSA	Heart rate Lowest SpO2 CT90% CT80% ODI4%	67-99 /min 74% 2min 29s (0.7%) 26s (0.1%) 1.74/hr	67-99 /min 62% 7min 56s (2.1%) 1min 42s (0.5%) 6.3/hr
2. 56yo, M (28/1/19) Mild OSA	Heart rate Lowest SpO2 CT90% CT80% ODI4%	64-109 /min 92% 0s 0s 0.25/hr	41-108 /min 79% 1min 16s (0.6%) 0s (0%) 14.5/hr
3. 59yo, F (18/2/19) No OSA	Heart rate Lowest SpO2 CT90% CT80% ODI4%	73-92 /min 94% 0s (0%) 0s (0%) 0.25/hr	73-101 /min 83% 12s (0%) 0s (0%) 0.4/hr
4. 72yo, M (28/3/19) Moderate OSA	Heart rate Lowest SpO2 CT90% CT80% ODI4%	Probe off after 3min	55-132 /min 64% 7min 34s (1.7%) 1min 6s (0.2%) 26.9/hr
5. 40yo, M (15/4/19) Moderate OSA	Heart rate Lowest SpO2 CT90% CT80% ODI4%	53-112 /min 84% 7min 26s (1.86%) 1min 0s (0.25%) 4.5/hr	70-112 /min 79% 17min 20s (4.3%) 10s (0%) 16.1/hr
6. 72yo, M (1/5/19) Mild OSA	Heart rate Lowest SpO2 CT90% CT80% ODI4%	49-98 /min 66% 9min 42s (2.4%) 1min 19s (0.3%) 0.45/hr	45-101 /min 64% 17min 48s (4.4%) 2min 54s (0.7%) 13.2/hr
7. 64yo, M (14/5/19) No OSA	Heart rate Lowest SpO2 CT90% CT80% ODI4%	44-85 /min 98% 0s (0%) 0s (0%) 0/hr	Probe off after 34 min
8. 66yo, M (6/6/19) Mild OSA	Heart rate Lowest SpO2 CT90% CT80% ODI4%	46-70 /min 79% 5min 41s (1.6%) 5s (0%) 4.8/hr	43-86 /min 80% 2min 6s (0.6%) 0s (0%) 11.4/hr

Cannabidiol As Part of Multimodal Pain Management? A Survey of Surgeons' Attitudes and Knowledge

Presenting Author: Alexandra Sideris, PhD[1]
Co-Authors: Valeria Rotundo, BA[1], Kethy M Jules-Elysee, MD[1,2], Jawad Saleh, PharmD[3], Stavros G. Memtsoudis, MD, PhD, MBA[1,2,4]

[1]Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY
[2]Department of Anesthesiology, Weill Cornell Medicine, New York, NY
[3]Pharmacy Department, Hospital for Special Surgery, New York, NY
[4]Department of Anesthesiology, Perioperative Medicine and Intensive Care Medicine, Paracelsus Medical University, Salzburg, Austria

Background: Treating pain after surgery has traditionally relied on the administration of opioids. Accelerated by the opioid epidemic, an increasing focus has been placed on the employment of multimodal approaches to reduce opioid consumption. Evidence suggests that patients and particularly those suffering from sleep apnea suffer fewer complications when non-opioid analgesics are employed, but drugs beyond non-steroidal anti-inflammatory medications and cyclooxygenase inhibitors have limited value in a multimodal pathway.[1,2] Cannabidiol (CBD), a non-intoxicating cannabinoid, has been increasingly used by the general public to manage pain, sleep and mood disorders. Although its anti-inflammatory properties are well-supported by preclinical evidence, clinical studies are lacking. It remains unknown to what degree clinicians, and especially surgeons are familiar and/or comfortable with the use of CBD in the recovery period.

General Aim: To elucidate this topic, we designed a questionnaire and distributed it to surgeons. We hypothesized that surgeons would have limited knowledge but would generally have positive attitudes towards perioperative CBD use.

Methods: After IRB approval, an anonymous, 11-item questionnaire was designed with the purpose of collecting basic demographics and information on familiarity with, attitudes towards and concerns regarding the use of CBD in postoperative patients (Table 1). Questionnaires were distributed electronically or in paper form to all 126 surgeons at an orthopedic specialty hospital. At the time of abstract submission, data collection was ongoing and preliminary results are presented here. The full results are expected to be available at the time of potential presentation.

Results: Out of 126 questionnaires, 52 were returned and evaluated. Most respondents were joint arthroplasty orthopedists or specialized in sports medicine. Surgeons' years in practice spanned from less than 5 to more than 25 years. Most surgeons (86%) were familiar with CBD, but only 6% claimed to be very familiar. None thought that CBD might harm the recovery process, while 25% thought it to be a useful adjunct and 71% said they did not know. Of those reporting CBD to be useful, 85% thought it was either moderately to very useful. 75% of surgeons agreed with the use of CBD if a patient or another provider suggested its inclusion in the care process. Most surgeons expressed interest in learning more (83%), studying CBD further (90%) or recommending it if it was shown to be opioid and/or NSAID sparing (86%). No surgeons were categorically opposed to using CBD as part of multimodal pain management if shown to be beneficial with minimal side effects. 21% of surgeons listed concerns with CBD including safety and lack of clinical data.

Conclusion: Surveyed orthopedic surgeons expressed generally positive attitudes towards the perioperative use of CBD in their patients, expressing a desire for further study to address efficacy and safety. This environment suggests that CBD will possibly be studied more in the clinical setting and -if successful- represent a standard alternative to traditional pain modulating agents. Due to its non-opioid and non-intoxicating nature it holds promise especially for the use in OSA patients who may be at particularly high risk when exposed to opioids.

Table 1. Questionnaire distributed to orthopedic surgeons

- **What is your primary service?**
- **How many years are you in practice?**
- **How familiar are you with CBD?**
- **Do you believe CBD is a useful adjunct during a patient's recovery from surgery?**
  If yes, how useful do you believe CBD is as an adjunct during a patient's recovery from surgery?
- **Do you believe CBD is harmful to a patient as his/her recovery process?**
  If yes, how harmful do you believe CBD is to a patient and his/her recovery process?
- **If a patient of another provider requests inclusion of CBD in a postoperative multimodal regimen and if side effects are minimal, would you agree to its use?**
- **Would you be interested in learning more about CBD?**
- **Would you be interested in seeing CBD studied in the perioperative and recuperative setting?**
- **If CBD would be shown to be opioid or NSAID sparing, would you be in favor of recommending it to patients?**
- **Assuming potential benefit and minimal side effects, would you direct a patient to take CBD postoperatively as part of a multimodal pain regimen?**
- **Do you have any concerns regarding CBD?**
  If yes, what is your biggest concern?

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Describing the Trends in Neck, Leg and Total Fluid Volumes in Patients Undergoing Non-Cardiac Surgery in the Perioperative Period – A Prospective Cohort Study

Presenting Author: Gincy Lukachan MD
Co-Authors: Azadeh Yadollahi PhD, Nayeemur Rehman MBBS, Stuart McCluskey MD, Douglas Bradley MD, Frances Chung MBBS, Mandeep Singh MD

University Health Network, University of Toronto, Toronto, Canada

Funding: This study team is funded by the grants from the Society of Anesthesia and Sleep Medicine (SASM), Ontario Thoracic Society and the University Health Network Foundation.

Background: The severity of OSA has been shown to increase postoperatively.[1] In the general population, IV administration of crystalloids has been shown to increase neck fluid volume, especially in older men, by the process of rostral fluid shift [2,3]. The changes in segmental fluid volume especially the neck fluid volume may be related to increasing airway collapsibility and thus worsening of OSA in the postoperative period. In this analysis of ongoing prospective cohort study, we hypothesized that in patients receiving general anesthesia (GA) and IV fluids after non-cardiac surgery trends in segmental fluid volumes will be different between males and females.

Methods: Following REB approval, adult patients ($\geq$18 yrs), ASA I-IV, undergoing elective inpatient surgery, were consented for this prospective cohort study in two major academic tertiary level hospitals. Patients underwent home sleep studies using a type 3 monitor to obtain the preoperative apnea-hypopnea index (AHI). On the day of surgery, the preoperative and postoperative fluid measurements for neck fluid volume (NFV), leg fluid volume (LFV) and total fluid volume (TFV) were recorded using bioelectrical impedance analysis (BIA).[3] Patients underwent GA and surgery as per the standard of care. All measurements were conducted with the patient in supine position in the pre-operative period (PreOp) before surgery, within 30 minutes of arrival to the post-anesthesia care unit (PACU), in the evening of the surgery (Night 1), and the next morning (Day 2). Primary outcome was NFV in the PACU and Day 2. Fluid changes across various time points were analyzed using the repeated measures ANOVA, and stratified based on sex. Multivariable linear regression analyses were performed for patients with or without moderate -severe OSA (AHI > 15) for covariates: age, sex, body position, preoperative apnea-hypopnea index (AHI) and total IV fluids received.

Results: Sixty-two of 345 screened patients consented for the study. Thirty-three patients undergoing laparoscopic general surgical, urological and gynecological surgeries with complete data were included in this analysis (Table 1). In the cohort, males were older with a lower BMI compared to females. There was no significant difference in the amount of fluids received or the fluid balance, preoperative AHI, or duration of surgery across sex.

Compared to preoperative values, NFV, LFV and TFV increased significantly in the PACU, and Day 2. (Figure 1) Compared to preoperative value (360 $\pm$ 162 ml, mean $\pm$ SD), NFV increase in the PACU (460 $\pm$ 171 ml, $p<0.05$) and Day 2(455$\pm$132 ml, $p<0.05$) in males. Also, in females, there was increase in the volume from Preop (289$\pm$77 ml) to

PACU (355±95 ml, p<0.05) and Day 2(340±98, p<0.05). In males, LFV significantly increased from Preop (3302 ± 611ml) to PACU (3385±670ml, p<0.05) and Day 2 (3672±720ml, p<0.05). In females, LFV significantly increased from Preop (3087 ± 831ml) to PACU (3189±901ml, p<0.05) and Day 2 (3423±951, p<0.05). TFV increased consistently from preoperative values to PACU and Day2 consistently for both groups. Multivariable linear regression analysis indicated significant predictors for NFV in PACU and Day 2 to be preoperative AHI and sex, respectively.

Conclusion: This is the first study to demonstrate variability of segmental fluid volumes in the perioperative period with differences across sex. It remains to be seen if the changes in NFV translate into worsening of upper airway collapsibility, increased OSA severity and worse cardiorespiratory complications in the perioperative period.

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Table 1. Demographic information of included patients.

Variable	Males (n = 15)	Females (n = 18)	P-Value
Age (yrs, mean ± SD)	58.33±12.11	53.94±11.54	0.2982
BMI (kg/m2, mean ± SD)	28.42±4.94	34.87±7.67	0.0068
Preoperative AHI (events/hr, mean ± SD)	11.45±11.80	15.05±11.91	0.391
Fluids Input at PACU (ml)	2287.67±968.56	1812.78 ±1061.84	0.1894
Fluids Input at Night 1 (ml)	881.87±390.67	798.17±320.13	0.59
Fluids Input at Day 2 (ml)	827.27±513.18	1086.74±355.04	0.08
Duration of Surgery (min, median [range])	253.47±111.12	235.71±111.36	0.640
OSA grading (AHI score)			
No OSA (0-5 events/Hr)	5	4	
Mild OSA (5-15 events/Hr)	7	7	
Moderate OSA (15-30 events/Hr)	1	3	
Severe OSA (>30 events/Hr)	2	4	
Type of Surgery			
Bariatric Surgery(number, percentages)	0	5(15.15%)	
General Surgery	4(12.12%)	5(15.15%)	
Urology	11(33.33%)	3(9.09%)	
Gynecology	0	5(15.15%)	

Legend: AHI: apnea-hypopnea index.

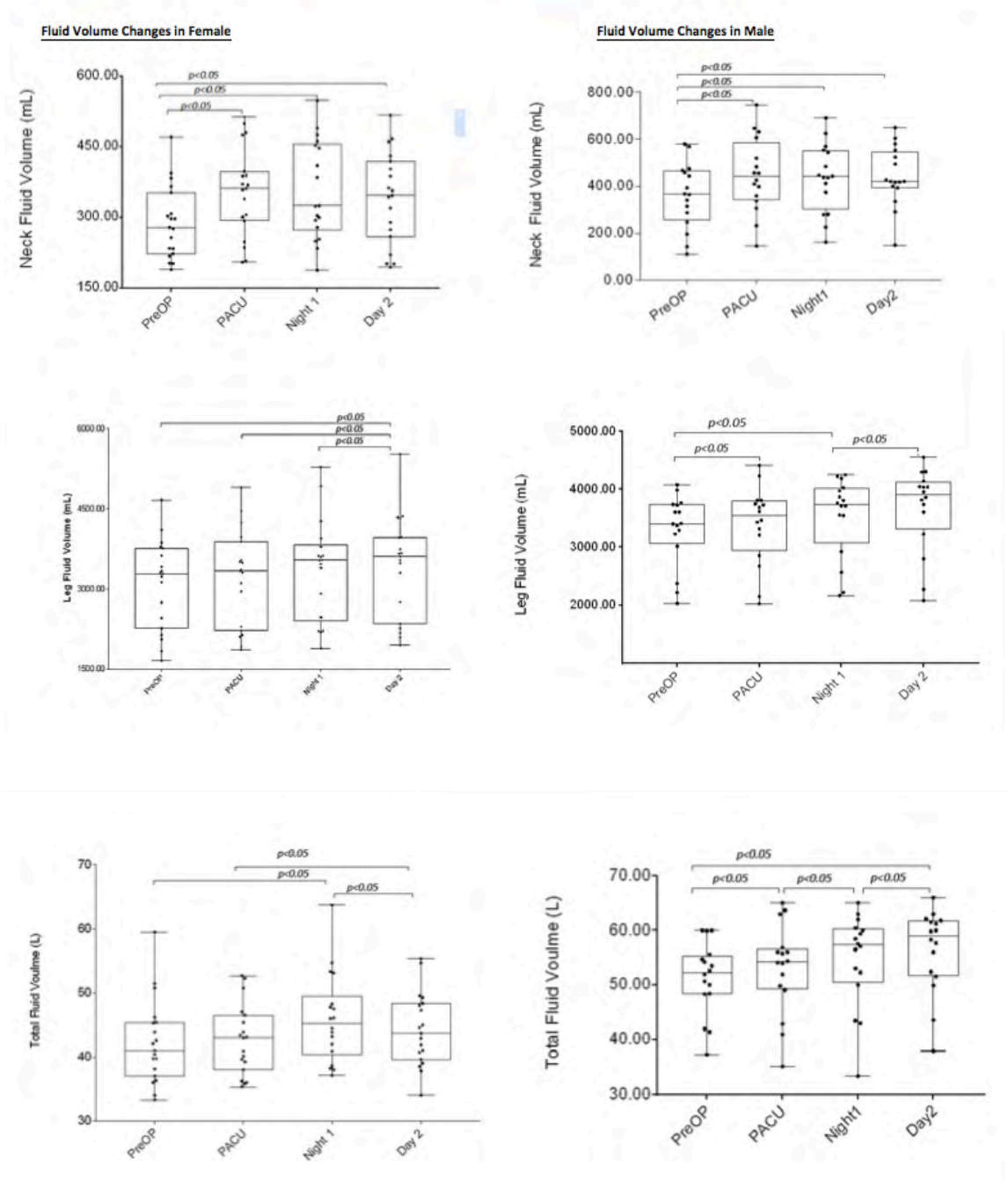


Figure 1. Postoperative changes in the neck fluid, leg fluid volume and total body water following general anesthesia - Group effects of time and gender using repeated measures ANOVA.

POCU: pre-operative care unit: PACU: Post-anesthesia care unit

A Simple Modified Infant Facemask Provided Nasal CPAP to Maintain Spontaneous Ventilation and Oxygenation in a High-Risk Elderly Obese Patient with OSA During Insertion of a Wireless Pacemaker Under MAC

Presenting Author: Heather Stoddard, MD, MPH Anesthesiology and Perioperative Medicine, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ
Co-Authors: Jessica L. Varga, DO, Anesthesiology, Hackensack University Medical Center, Hackensack, NJ; Antonio Chiricolo, MD, Anesthesiology and Perioperative Medicine, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ; James Tse, PhD, MD, Anesthesiology and Perioperative Medicine, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ

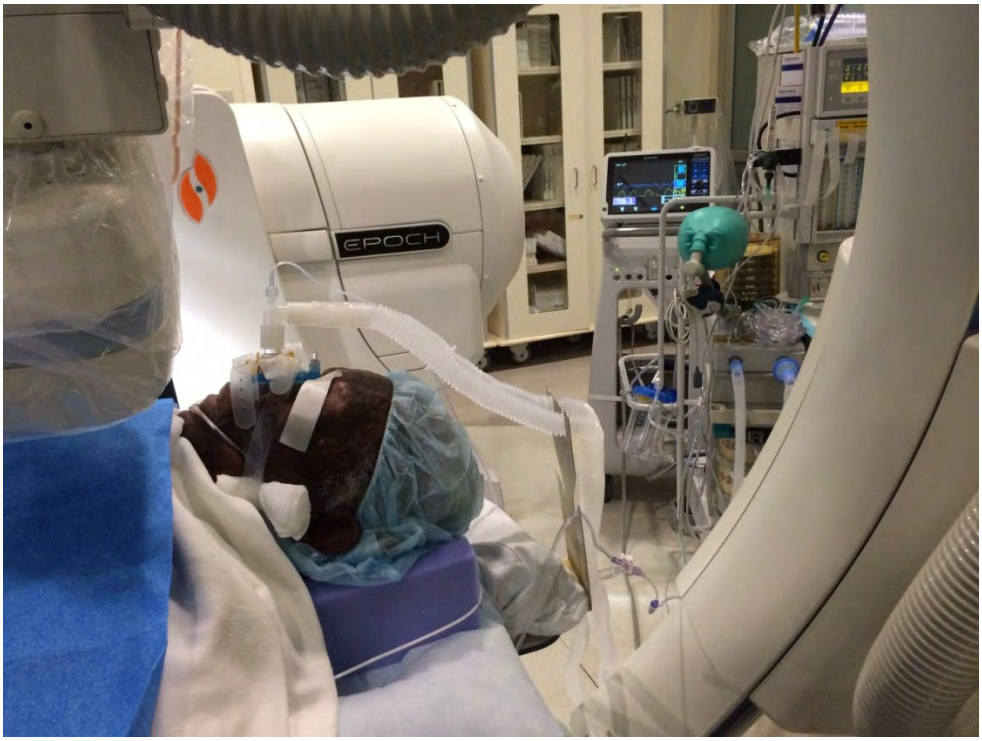
Background: Patients under monitored anesthesia care (MAC) often receive intravenous sedation and supplemental oxygen via nasal cannula. Over-sedation and/or airway obstruction is common and can cause decreased ventilation and oxygen desaturation requiring airway manipulation or other rescue interventions, especially in obese patients with obstructive sleep apnea (OSA). [1-8]

Aim: To discuss a case when a simple nasal positive airway pressure (PAP) mask assembly using a pediatric facemask and the existing anesthesia circuit and machine can maintain spontaneous ventilation and improve oxygenation in a sedated and obese patient with OSA and severe cardiopulmonary disease during insertion of a wireless pacemaker under MAC.

Case Description: A 88 year-old female, 5'2", 194 lb., (BMI 35.5 kg/m^2) with hypertension, coronary artery disease s/p coronary artery bypass grafting, non-insulin dependent diabetes mellitus, end-stage renal disease, anemia, chronic obstructive pulmonary disease, OSA (noncompliant with at home continuous positive airway pressure (CPAP)), bradycardia and sick sinus syndrome presented for insertion of a wireless pacemaker. Her nose was fitted with an infant facemask with a fully inflated air cushion. Squeezing the mask into an appropriate shape further modified the infant mask. The modified infant mask was then secured over her nose with elastic head-straps and connected to the anesthesia machine via a long anesthesia breathing circuit. The adjustable pressure-limiting (APL) valve was adjusted to deliver 3-4 cm H_2O CPAP with 4 L/min fresh oxygen flow. Following nasal mask pre-oxygenation, her SpO_2 increased from 96% on room air to 100%. Sedation was then titrated slowly with 2 mg Midazolam, 25mcg Fentanyl, 40mg Lidocaine and 30mg Propofol. During insertion of femoral catheters, she required additional fentanyl (3 x 25 mcg) for pain control. The CPAP was easily increased to 8 cm H_2O for increased oxygenation.

Results: The patient maintained spontaneous ventilation and 100% SpO_2 throughout the entire procedure. She tolerated the procedure well without any complication and did not require any airway manipulation or other rescue intervention. During the post-procedure visit she was relieved that the procedure went well.

Discussion: This simple modified infant mask provided nasal CPAP and maintained spontaneous ventilation in a high-risk elderly obese patient with OSA during insertion of a wireless pacemaker under MAC. It successfully supported a patent airway and improved oxygenation without manipulation of the airway. This low cost and easily accessible method utilized the existing anesthesia circuit and machine and took less than 2 minutes to prepare. Case reports are IRB-exempted at our institute. This patient gave her consent for photography and case report.



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Systematic Review of Pediatric Preoperative Screening of Obstructive Sleep Apnea and Anesthesia Outcomes

Presenting Author: Denis H Jablonka[1]
Co-Authors: Mohamed A Mahmoud, [2] Frances F T Chung, [3] Heather A McClung, [1], Rajeev Subramanyam[1]

[1]Children's Hospital of Philadelphia, University of Pennsylvania, Pennsylvania
[2]Cincinnati Children's Hospital, University of Cincinnati, Ohio
[3]Toronto Western Hospital, University Health Network, University of Toronto, Canada

Background: Obstructive Sleep Apnea (OSA) has a prevalence of up to 5% in the general pediatric population. Overnight polysomnography (PSG) is the gold standard for diagnosing OSA, but it carries the burden of high cost, limited access, and scheduling constraints for parents of young children. It is then critical to understand the value of available screening methods for children with OSA in the perioperative arena. We set out to perform a systematic review of screening questionnaires and other simple tools for the detection of pediatric OSA and their role in predicting anesthesia related adverse events.

Methods: A search on PubMed, SCOPUS, and Web of Science Core Collection was conducted for relevant literature using the terms "obstructive sleep apnea" and "diagnosis." The PICOS criteria included (P) population: 0-18 years, (I) Intervention: screening or diagnosis of OSA, (C) Comparator: PSG or overnight sleep study, (O) Outcomes: presence or absence of OSA, and (S) Studies: prospective or retrospective. Results were limited within each database to include published studies from 2008 to 2018. We imported the results into a citation management software de-duplicated yielding 1,789 citations for the initial screening. We also added grey literature search and cross-reference checks.

Results: The initial screening generated 115 abstracts for full-text review, and 46 manuscripts described screening methods for OSA (Figure 1). After excluding duplicates, there were a total of 17 different screening modalities for pediatric OSA, where 75% were questionnaires. We reported the sensitivity, specificity, and predictive values of each modality in Table 1. From these 17 different screening modalities, the Pediatric Sleep Questionnaire (PSQ) had sensitivity and specificity rates of more than 80% in the general pediatric population. Only 3 out of 17 screening modalities explored the relationship between OSA and anesthesia adverse events (Table 2). We observed positive associations between these events and OSA diagnosis using all three screening modalities.

Conclusions: There are 17 different screening modalities available for pediatric OSA with wide variability in predictive performance. Very few studies have explored the relationship between diagnosis using OSA screening tools and anesthesia adverse events. The available data indicate that several existing screening tools can identify OSA in the general population, but with limited use in the perioperative period.

TABLE 1: OBSTRUCTIVE SLEEP APNEA SCREENING TOOLS									
No.	Author/Year	Type	Age (Yr.)	Questions	Positive for OSA	Sens. %	Spec %	PPV %	NPV %
1	Brouillette/1984	Brouillette Score	1-10 (3.8)	3	Score > 3.5	-	-	65.3	45.7
2	Brouillette/2000	Nocturnal Pulse Ox	0-18 (4.5)	3	≥ 3 desat. Clusters and ≥ 3 desat. < 90%	-	-	97	-
3	**Chervin/2000**	**PSQ**	2-18	22	≥ 8	**81**	**87**	97	45
4	Franco/2000	OSA-18	1-12 (4)	18	Score >60	-	-	-	-
5	Li/2006	HK-CSQ	5-15 (10)	3	Score ≥ 7	76	80	61	89
6	Chau/2007	Videotape	(5.9)	N/A	-	65	81	65	81
7	Gasparini/ 2012	Obstructed Airway Test	1-16 (7.3)	12	Score ≥ 31	-	-	-	-
8	Goldstein/2012	15-items	2-12	15	Score > 32	77	61	82	53
9	Lesser/2012	ApneaLink Plus	9-18(13.6)	N/A	80-100% ↓ in airflow + resp. Effort > 10 s	100	46.2	63	100
10	Spruyt/ 2012	6-item	5-9	6	Score >2.72	59.03	82.85	35.4	92.7
11	Tait/2013	STBUR	(6.58)	5	≥ 3	26.4	91.4	77.8	52
12	Villa/2013	Sleep Record	(6.1)	3	Score ≥ 6.25	96.05	67	-	-
13	ASA/2014	ASA Checklist	≥ 1	19	≥ 2 categories	-	-	-	-
14	Bhushan/2014	14 item	(5.7)	14	Score ≥ 4	73.7	70	-	-
15	Kadmon/2014	I'M SLEEPY	3-18	8	Score ≥ 3	82	50	44	85
16	Ho/2016	Neck/Height ratio	5-18	N/A	NHR≥0.25	-	-	76	52
17	Raman/2016	6-item	6-18(11.4)	6	Score ≥ 2	89	41	-	-

TABLE 2: OBSTRUCTIVE SLEEP APNEA SCREENING AND ANESTHESIA OUTCOMES								
No.	Author/ Year	Screening Tool	Screening Assessment	Surgery	Age Years	Patients (n)	PSG + n (%)	Outcomes
1	Tait/ 2013	STBUR – 5 questions	STBUR vs. SRBD (a subset of PSQ Questionnaire) and PSG	Elective surgery in ASA 1 and 2	2-14	302	32 (9.5%)	3 of 5 positive→ 3 times ↑ PRAE 5 of 5 positive → 10 times ↑ PRAE
2	Tait/ 2016	STBUR – 5 questions	STBUR	Inpatient/outpatient surgery in ASA 1-3	2-17	678	198 (29%)	≥ 3 of 5 positive → increased risk of desaturation
3	Kako/ 2017	6-item questionnaire	6-item questionnaire vs. PSG	ENT and Non-ENT ASA 1-3	3-18	185	45 (24%)	≥ 2/6 score or OSA + on PSG → more common supplemental oxygen use in PACU
4	Horwood/ 2014	Nocturnal pulse Oximetry studies	Nocturnal Pulse Oximetry scored with McGill Oximetry Score	T&A	2-17	362	14 (4%)	Time from oximetry to surgery, postop. length of stay, readmissions and ER visits 1 month after surgery and major surgical complications.
5	Lee/ 2013	Nocturnal Pulse Oximetry	Pre-operative home oximetry with MOS 1	T&A	5.63±2.88	231	-	Major postop respiratory complication (intubation or ICU).
6	Raghavendran 2010	McGill Oximetry Scoring (MOS)	McGill Oximetry Score	T&A MOS 4	2.1-4.3	97	-	Major respiratory medical intervention.

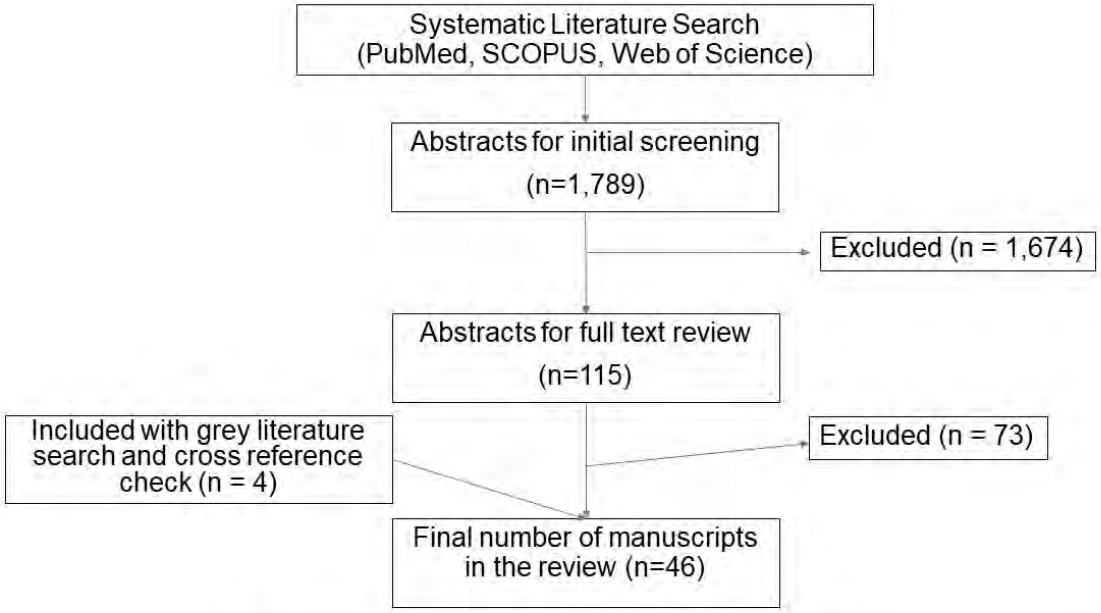

Figure 1: CONSORT diagram for the systematic review

Prevalence of Obstructive Sleep Apnea and Associated In-Hospital Outcomes of Cardiac Inpatients: A Scoping Review

Presenting Author: Colin Suen
Co-Authors: Rabail Chaudhry, Clodagh Ryan, Samuel Goh, Tiffany Got, Jean Wong, Frances Chung

Background: Obstructive sleep apnea (OSA) is a syndrome of sleep-disordered breathing associated with long-term cardiovascular morbidity. OSA is highly prevalent in patients with cardiovascular disease (CVD) and is estimated to be between 46-85%. Individuals with unrecognized, and therefore untreated OSA are at the highest risk of adverse cardiovascular events. Although the impact of OSA on the long-term co-morbid conditions is well established, the acute complications in non-surgical hospitalized inpatients are uncertain. The objective of this scoping review was to systematically examine literature to determine the prevalence of OSA and to map the range of outcomes associated with OSA among inpatients hospitalized for CVD.

Methods: We included studies involving adults with OSA or at high risk of OSA who were hospitalized for CVD. We searched Ovid MEDLINE(R), Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, Embase and Cochrane Databases. In-hospital outcomes were collected from admission up to 30 days post-discharge from hospital. Other sleep-disordered breathing syndromes such as central sleep apnea were excluded from analysis. Surgical patients were excluded due to extensive literature already available from the cardiac surgery population.

Results: In total, 4,641 studies were identified using our electronic search strategy. After screening, 28studies were selected for inclusion in the review for qualitative synthesis. Eligible studies included patients presenting with acute coronary syndromes (n=20), and congestive heart failure (n=4), or any cardiovascular disease (n=2). The prevalence of OSA in cardiac inpatients varied depending on the method of diagnosis, ranging from 48% [43, 52, 95% CI] using polysomnography and/or cardiorespiratory monitoring compared to 1.3% in one study using administrative coding. Among studies with sleep study data, an apnea-hypopnea index 5 (n=8), 10 (n=1) or 15 (n=10) was used as the threshold for OSA diagnosis. In-hospital outcomes reported were mortality (n=4), length of stay (n=7), left ventricular ejection fraction (n=5), peak troponin (n=5), peak B-type natriuretic peptide (n=3), and cardiovascular complications (n=2) which are summarized in Table 1. There was limited data on the effect of OSA treatments such as positive airway pressure on in-hospital outcomes.

Conclusions: OSA is highly prevalent in the cardiac inpatient population. The outcomes reported encompass the clinical domains of mortality, cardiac function, cardiac biomarkers, and resource utilization. There are significant knowledge gaps regarding the proportion of positive airway pressure users, the overall effect of treatment during hospitalization, and the effect of OSA severity on these outcomes. The findings from this review serve to inform further areas of research on the management of OSA among patients with cardiovascular disease, who are potentially at risk for acute decompensation and worsening of cardiac status.

Table 1- In-hospital outcomes of cardiac inpatients with OSA

Reference	n, OSA	n, Non-OSA	Method of OSA Dx	Cardiac Dx	Outcome OSA	Outcome Non-OSA/Control	Comments
In-Hospital Mortality							
Mohananey 2017	24623(1.3%)	1826002(98.6%)	ICD-9-CM 327.23	ACS	3.7%	7.4%	aOR, 0.83 [95% CI, 0.81–0.84]; p<0.001
Barbe 2015	213(49.4%)	218	Type 3	ACS	0.70%	0%	p=0.29, ns
Szymanski 2013	54(34%)	104(66%)	BQ + ESS	ACS	7.40%	1%	p=0.03. High vs low suspicion of OSA
Marin 1998	55(21.9%)	196	Clinical + oximetry	ACS	12.7%	10.2%	ns
Length of Stay (days)							
Mohananey 2017	24623 (1.3%)	1826002 (98.6%)	ICD-9-CM 327.23	ACS	5±4.68	4.85±5.96	p<0.001
Leao 2016	46(63%)	27	Type 3	ACS	5.5 (IQR 5-9)	7 (IQR 3.8-7.5)	p=0.292, ns
Khayat 2015	525(47%)	592	Type 3	HF	9±11.4	7.2±8	P<0.05
Barbe 2015	21(49.4%)	218	BQ + ESS	ACS	6.8±3.8 CCU: 2.6±1.3	6.5±3.7 CCU: 2.3±1.0	ns p<0.05
Szymanski 2013	54(30.4%)	104	Type 3	ACS	10.4±5.2	8.7±4	p=0.016. High vs low suspicion of OSA
Jia 2018	373(70%)	156(30%)	Type 2	ACS	8±5.6	6.7±4.2	p=0.007
Sommerfeld 2017	99(22.8%)	245	Chart Review	HF	6.2±5.9	5.5±4.8	p=0.235
Left Ventricular Ejection Fraction (LVEF)							
Gessner 2017	91(41%)	132(59%)	Type 2	ACS	50±12%	57±7%	p=n/a
Khayat 2015	525(47%)	248(22%)	Type 3	HF	26.3±10.5%	29.5±10.4%	p<0.05
Barbe 2015	213(49.5%)	218(50.5%)	Type 3	ACS	54.8±11.6%	57±9.5%	ns
Leao 2016	46(63%)	27	Type 3	ACS	49.4±9.2%	51.2±8.7	p=0.462, ns
Loo 2014	24(35%)	44(65%)	Type 3	ACS	52±13.9	52±11.4	0.989
Cardiovascular Complications During Hospitalization							
Barbe 2015	213(49.5%)	218(50.5%)	Type 3	ACS	8.1%	9.8%	Ns
Marin 1998	55 (22%)	196 (78%)	Clinical + oximetry	ACS	38.2%	34.2%	Ns. Rate of ventricular arrhythmias higher in non-OSA vs OSA
Peak Troponin							
Gessner 2017	91(41%)	132(59%)	Type 2	ACS	37791±52652 ng/L	5368±4357 ng/L	p=n/a
Leao 2016	46(63%)	27(37%)	Type 3	ACS	27.7±36.3 ng/mL	28±34.8 ng/mL	p=0.974, ns
Loo 2014	24(35%)	44(65%)	Type 3	ACS:	54 (IQR 7.8-80.0)ug/L	80.0 (IQR 0.3-80.0) ug/L	0.345, ns
Jia 2018	373(70%)	156(30%)	Type 2	ACS	9.7±9.7 ng/mL	8.3±8.3 ng/mL	p=0.534
Sanchez-de-la-Torre 2018	89(70%)	38(30%)	Type 3	ACS	3.79 (IQR 0.37-243) ng/mL	10.70 (1.78-40.1) ng/mL	p=0.04. Higher # stents placed in OSA vs non-OSA

Peak BNP							
Gessner 2017	91(41%)	132(59%)	Type 2	ACS	241±308 pg/ml	177±261 pg/ml	p=n/a
Szymanski 2013	54(30.4%)	104	BQ + ESS	ACS	153.2 ±153.2 pg/mL	22.2±22.2 pg/mL	p = 0.0001. High vs low suspicion of OSA
Jia 2018	373(70%)	156(30%)	Type 2	ACS	90.8±240.1 pg/mL	60.3±139 pg/mL	p=0.068

Abbreviations: OSA – obstructive sleep apnea, ACS – acute coronary syndromes, HF – heart failure, aOR – adjusted odds ratio, ns – non-significant, ICD-9CM – International Classification of Diseases, Ninth Edition, Clinical Modification, BQ = Berlin Questionnaire, ESS = Epworth Sleepiness scale

The Association of CPAP Compliance and Nocturnal Hypoxemia in the Perioperative Period

Presenting Author: Kahiye Warsame[1,2]
Co-Authors: Colin Suen[1,3], Rida Waseem[1], Jean Wong[1,3], Rabail Chaudhary[1,3], Frances Chung[1,3]

[1]Department of Anesthesia, Toronto Western Hospital, University Health Network, Toronto, ON, Canada
[2]Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada
[3]Department of Anesthesia, University of Toronto, ON, Canada

Background: Obstructive sleep apnea (OSA) is highly prevalent in the surgical patient population. Continuous positive airway pressure (CPAP) is the first line treatment for OSA patients. However, evidence supporting the efficacy of CPAP and compliance rates in the perioperative period is largely lacking. The objective of this study was to determine the perioperative compliance rate of patients with OSA with a CPAP prescription. As well, we investigated the effect of compliance to CPAP on perioperative oxygen saturation.

Methods: This prospective cohort study included adult surgical patients with a diagnosis of OSA with or without a CPAP prescription undergoing non-cardiac surgery. Preoperative CPAP compliance was defined as average use ≥ 4 h/night for > 70% of nights based on self-reporting. Postoperative CPAP compliance was determined each night and defined as use ≥ 4 h/night. Overnight oximetry was performed preoperatively and on postoperative night 1, 2 and 3 using a wristwatch oximeter. The primary outcomes were rate of CPAP compliance and nocturnal oxygen saturation. The parameters included were mean SpO_2, lowest SpO_2, oxygen desaturation index (ODI) and cumulative time percentage with SpO_2 < 90% (CT90).

Results: We enrolled 129 patients with OSA with a preexisting CPAP prescription in the preoperative clinic. 84 were compliant with CPAP, and 55 were non-compliant. Preoperative compliance was 60.5%; whereas compliance on postoperative night 1 was 57.8%; night 2: 66.2%, and night 3: 38.5%. One hundred twenty four patients completed preoperative overnight oximetry (75 compliant, 49 non-compliant). The non-compliant group had significantly lower preoperative lowest SpO_2 (79 vs 83%) and higher ODI (10.8 vs 4.3 events/h) and CT90 (3.4 vs 0.5) compared to the compliant group (Table 1). On postoperative night 1, lowest SpO_2 (79 vs 83%) were significantly decreased in the CPAP non-compliant vs compliant groups. No significant differences were observed in other parameters such as ODI, CT90 or for any oximetry parameter on postoperative night 2. Supplemental oxygen use was slightly higher in the non-compliant group on postoperative night 1 (55 vs 44%) and night 2 (12 vs 5%), although these differences were not statistically significant.

Discussion: Among patients with a preoperative CPAP prescription, compliance was 60.5% preoperatively, and on postoperative night 1: 57.8%; night 2: 66.2%, decreasing on night 3 to 38.5%. CPAP non-compliance was associated with a greater degree of oxygen desaturation (lowest SpO2, ODI, CT90) during the preoperative period, while only modest differences were detected on postoperative night 1. However, the higher rate of supplemental oxygen use in the non-compliant group may mask potential differences in oxygen saturation.

Table 1: Oxygen desaturation of OSA patients compliant vs non-compliant with CPAP in the perioperative period

	Preoperative			Postoperative Night 1			Postoperative Night 2		
	Compliant	Non-compliant	P Value	Compliant	Non-compliant	P Value	Compliant	Non-compliant	P Valu
N	75	49	-	59	43	-	49	25	-
Mean SpO_2 (%) ǂǂ	94 ± 2	93.1 ± 2.2	0.086	93.4± 2.0	94.1± 2.3	0.110	93.1 ± 2.1	93.1 ± 2.3	0.94
Lowest SpO_2 (%) ǂ	83.0 (78.0, 86.0)	79.0 (72.0, 83.5)	0.021*	83.0 (78.0, 86.0)	79.0 (72.0, 84.0)	0.015*	80.0 (71.0, 84.0)	77.0 (72.5, 84.5)	0.83
ODI (events/h) ǂ	4.3 (2.5, 9.9)	10.8 (8.0, 18.2)	<0.001*	5.1 (2.3, 12.0)	7.3 (3.0, 12.3)	0.494	6.3 (3.3, 10.3)	6.1 (3.0, 14.4)	0.76
CT90 (%) ǂ	0.5 (0.1, 4.4)	3.4 (0.8, 12.7)	<0.001*	3.3 (0.7, 13.7)	2.0 (0.8, 6.8)	0.377	2.9 (0.7, 9.6)	4.5 (0.3, 22.7)	0.78
Supplemental O_2 use at night	n/a	n/a	n/a	44%	55 %	0.316	5%	12%	0.25

CPAP = continuous positive airway pressure; CT90 = cumulative time percentage with SpO_2 <90%; ODI = oxygen desaturation index. Compliance is defined as an average CPAP use ≥ 4hrs per night at least 70% of nights. Independent sample t-test or Wilcoxon rank-sum (Mann-Whitney) and Chi-square tests were conducted to examine differences between CPAP compliant and non-compliant OSA surgical patients

* $p < 0.05$ level

ǂ ǂ Data expressed as mean ± SD

ǂ Data expressed as median (25^{th}, 75^{th} percentile)

Use of a Simple Modified Infant Face Mask to Provide Immediate Pressure-Control Nasal Ventilation/Oxygenation and Prevent Oxygen Desaturation in a Super-Obese Patient with Severe OSA During Outpatient EGD Under MAC

Presenting Author: Justin Chacko, MD, Department of Anesthesiology and Perioperative Medicine, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ;

Co-Authors: James Tse, PhD, MD, Christina Brooks, MD, Scott Mellender, MD, Department of Anesthesiology and Perioperative Medicine, Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ

Background: Patients routinely receive IV sedation and O_2 via a nasal cannula (NC) during esophagogastroduodenoscopy (EGD). The NC O_2 reservoir is lost when the mouth is kept open by a bite block. Over-sedation and/or airway obstruction may cause severe desaturation, especially in obese patients with obstructive sleep apnea (OSA). These patients may require nocturnal CPAP or bi-level PAP. While under sedation, they may require frequent chin-lift, jaw-thrust or a nasal trumpet to maintain a patent airway. A simple nasal CPAP mask assembly using a pediatric face mask has been shown to maintain spontaneous nasal ventilation and improve oxygenation in deeply sedated OSA patients.[1-4]

We used a modified pediatric face mask to provide nasal pressure-control ventilation (PCV) in a super-obese patient with OSA during EGD.

Case Description: A 46-year-old male, 5'11", 400 lb, BMI 55.8 kg/m^2, with h/o hypertension and severe OSA requiring nocturnal CPAP presented for outpatient screening EGD prior to bariatric surgery.

The patient was fitted with an infant face mask (size #2) which was modified by squeezing the mask for 1-2 mins.

The modified infant mask was secured over his nose with elastic head straps to obtain a tight seal. It was connected via an adult breathing circuit to the anesthesia machine (Fig). The patient breathed comfortably with the APL valve adjusted to deliver CPAP (6-8 cm H_2O) and 4 L/min fresh O_2 flow.

After nasal CPAP pre-oxygenation, his SpO_2 increased from 97% to 100%. Deep sedation was then titrated with 100 mg of lidocaine and propofol boluses (50 mg x 3) and propofol infusion (150 mcg/kg/min). He maintained spontaneous ventilation and 100% SpO_2. However, he reacted to somewhat difficult insertion of the endoscopic probe. Following an additional 50 mg of propofol was given, his airway was obstructed and his SpO_2 decreased to 95%. He was immediately supported with nasal PCV (PIP 40 cm H_2O, PEEP 12 cm H_2O and RR 12/min) and he maintained 97% SpO_2. The procedure was accomplished without interruption.

After removing the bite block, his nasal PCV settings were reduced (PIP 20 cm H_2O, PEEP 5 cm H_2O, RR 12/min) for a few mins. He was supported with CPAP (6-8 cm H_2O) until fully awake and maintained his 97-99% SpO_2 with NC O_2 (4 L/min) with a simple face tent.[1] He was elated that the procedure was over so quickly and without complication. He was discharged home without delay.

Discussion: This simple modified infant face mask provided nasal CPAP/PCV and maintained oxygenation in a super-obese patient with severe OSA during EGD. It takes 1-2 mins to modify

a tear-drop shaped infant face mask into a rounded triangular nasal mask that fits most adult noses. It prevents severe desaturation and procedure interruption in obese patients with OSA and may improve patient safety and increase efficiency at a low cost.

Case reports are IRB-exempted at our institute. This patient gave his consent for photography and case report.

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Sleep Apnea and Opioids After Total Joint Arthroplasty: Are Patients Prescribed Higher Quantities of Opioids at Increased Risk Of Readmission?

Presenting Author: Lauren A. Wilson MPH, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY
Co-Authors: Jashvant Poeran MD PhD, Institute for Healthcare Delivery Science, Department of Population Health Science & Policy, Icahn School of Medicine at Mount Sinai, New York, NY

Megan Fiasconaro MS, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY

Janis Bekeris MD, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY; Department of Anesthesiology, Perioperative Medicine and Intensive Care Medicine, Paracelsus Medical University, Salzburg, Austria

Jiabin Liu MD PhD, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY

Stavros G. Memtsoudis MD PhD MBA FCCP, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY; Department of Anesthesiology, Perioperative Medicine and Intensive Care Medicine, Paracelsus Medical University, Salzburg, Austria; Department of Health Policy and Research, Weill Cornell Medical College, New York, NY

Background: There has been a well-established relationship between opioids and adverse perioperative outcomes in patients with obstructive sleep apnea as they can exacerbate respiratory depression.[1,2] Most research has focused on opioid utilization during hospitalization while few have evaluated effects of opioids prescribed at discharge.

Aim: We hypothesized that patients prescribed higher quantities of opioids at discharge were at increased risk for readmission due to opioid-related complications in this vulnerable patient population.

Materials and Methods: Approval for this retrospective cohort study was obtained from the Institutional Review Board of Hospital for Special Surgery (IRB # 2017-0169). Patients who underwent total hip (THA) or knee (TKA) arthroplasties from 2011 to 2017 and were identified from the Truven Health MarketScan database. The cohort was restricted to patients who were continuously enrolled for at least six months before and after surgery (in order to obtain sufficient pre-operative comorbidity information) and filled a prescription for an analgesic within two days of hospital discharge. Total oral morphine equivalents prescribed on discharge were calculated and categorized as (none, <50 oral morphine equivalents, 50-105, and >150). The primary outcome of interest was 30-day readmission. A multivariable logistic regression model was run including an interaction between sleep apnea and opioid quantity prescribed (categorized). Odds ratios (OR) and 95% confidence intervals (CI) are reported.

Results: Of the 137,674 unique total joint arthroplasty patients identified from 2011-2017, 2,896 (2.87%) patients had a preoperative diagnosis of sleep apnea. The median quantity of opioids prescribed at discharge was 84 [interquartile range (IQR) 56, 113] and 80 [IQR 50, 105] oral morphine equivalents for those with and without sleep apnea ($p<0.001$). Overall, 30-day readmission was seen in 1.93% (n=2,237) of patients while this was 2.87% (n=632) among patients diagnosed with sleep apnea. When evaluating the modifying effect of opioid quantity

prescribed on readmission risk in sleep apnea patients, we found a universally increased risk of readmission which was independent of opioid quantity prescribed (Table 1: interaction term p<0.9042).

Discussion: We observed no significant interaction between sleep apnea and discharge opioid dose when considering odds of 30-day readmission. Though patients with sleep apnea are typically prescribed fewer opioids, they were prescribed a greater quantity of oral morphine equivalents relative to patients without sleep apnea.

Conclusion: Regardless of the strength of opioids dispensed, patients with sleep apnea experienced significantly greater odds of being readmitted within 30 days of discharge. This will become increasingly important given the growing sleep apnea patient population and current financial penalties imposed on US hospitals for readmitted patients.

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Table 1. Results of interaction between sleep apnea and oral morphine equivalent prescribed at discharge from the multivariable model evaluating 30 day readmission

	30 Day Readmission	
	OR [95% CI]	**p-value**
Sleep Apnea*Discharge Oral Morphine Equivalents		0.9042
Sleep Apnea + <50 OME	1.36 [1.09, 1.68]	
Sleep Apnea + 50-105 OME	1.25 [1.10, 1.68]	
Sleep Apnea + >105 OME	1.28 [1.08, 1.52]	

*Adjusted for age at surgery, preoperative opioid use, sex, whether or not the procedure was bilateral, peripheral nerve block use, year of procedure, length of stay, region of patient residence, insurance plan type, discharge status, insurance plan type, and Charlson-Deyo comorbidity index

Opioid Use and Complication Risk in Obstructive Sleep Apnea: Does Sex Matter?

Presenting Author: Lauren A. Wilson MPH, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY
Co-Authors: Jashvant Poeran MD PhD, Institute for Healthcare Delivery Science, Department of Population Health Science & Policy, Icahn School of Medicine at Mount Sinai, New York, NY

Megan Fiasconaro MS, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY

Janis Bekeris MD, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY; Department of Anesthesiology, Perioperative Medicine and Intensive Care Medicine, Paracelsus Medical University, Salzburg, Austria

Jiabin Liu MD PhD, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY

Stavros G. Memtsoudis MD PhD MBA FCCP, Department of Anesthesiology, Critical Care & Pain Management, Hospital for Special Surgery, New York, NY; Department of Anesthesiology, Perioperative Medicine and Intensive Care Medicine, Paracelsus Medical University, Salzburg, Austria; Department of Health Policy and Research, Weill Cornell Medical College, New York, NY

Background: Perioperative opioid use has been associated with complications in sleep apnea patients.[1] Sex differences in both sleep apnea diagnoses and patterns of opioid use have been observed. Males experience a greater prevalence of sleep apnea (though this is largely driven by underdiagnoses in females)[2] and women typically have higher opioid use than men.[3] However, few studies have evaluated the modifying role of sex in the pathway from opioid use to complications in sleep apnea patients.

General Aim: We hypothesized that there would be sex-specific differences in the relationship between opioid use and postoperative complications among patients with sleep apnea.

Materials and Methods: Approval for this retrospective cohort study was obtained from the Institutional Review Board of Hospital for Special Surgery (IRB #2012-050). Patients who underwent elective, inpatient total joint arthroplasties from 2006 to 2015 were identified from the Premier Healthcare database. The patient cohort was restricted to those with a diagnosis of sleep apnea that was present on admission. The three outcomes of interest were any complication (acute renal failure, delirium, sepsis, inpatient falls, hematoma, cardiopulmonary, renal cerebral, and wound complications), cardiopulmonary complications (myocardial infarction, cardiac or pulmonary complications/infections), and ICU admission. The main effect of interest was the interaction between patient sex and opioid use, defined as total oral morphine equivalents dispensed throughout hospitalization and categorized as low (<185 oral morphine equivalents), medium (185-460), and high (>460) based on quartiles of oral morphine equivalents. Multivariable logistic regression models were run for each outcome, including an interaction term between sex and opioid use, odds ratios (OR) and 95% confidence intervals (CI) are reported.

Results: Overall, 102,202 (54.4%) and 89,251 (46.6%) of patients were male and female, respectively while 23.7%, 48% and 23.9% of patients were categorized in the low, medium and high opioid utilization groups. After adjustment for relevant covariates, men had significantly greater odds of experiencing any complication compared to women (Table 1). While there appears to be signal towards stronger sex-specific effects on complications with increasing use

of opioids, the applied interaction term did not reach statistical significance (p=0.086). A similar pattern was observed for cardiopulmonary complications and ICU admission.

Discussion: In these preliminary analyses, patient sex does not appear to be a modifier of the association between opioid use and perioperative complications after total joint arthroplasty among patients with obstructive sleep apnea. However, given the observed signal towards more pronounced sex-specific effects in patients with higher opioid use, further analyses are warranted while also assessing alternative clinically informed thresholds for opioid utilization categories.

Conclusion: Sex was not a significant modifier of the relationship between opioid use and perioperative complications among total joint arthroplasty patients with sleep apnea in this sample.

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Table 1. Interaction between sex and opioid use from multivariable logistic regression models evaluating the outcomes of any complication, cardiopulmonary complication, and ICU admission

	Any Complication		Cardiopulmonary Complication		ICU Admission	
	OR [95% CI]	**p-value**	**OR [95% CI]**	**p-value**	**OR [95% CI]**	**p-value**
Sex*Opioid Use		0.086		0.087		0.586
Male vs Female w/ Low Opioid Use (<185 OME)	1.09 [1.01, 1.17]		0.89 [0.81, 0.98]		0.97 [0.86, 1.09]	
Male vs Female w/ Medium Opioid Use (185-460 OME)	1.14 [1.09, 1.20]		0.98 [0.92, 1.05]		0.97 [0.90, 1.05]	
Male vs Female w/ High Opioid Use (>460 OME)	1.22 [1.14, 1.30]		1.04 [0.96, 1.14]		1.05 [0.96, 1.14]	

*Adjusted for age, race insurance type, hospital size, location, and teaching status, procedure year, type of anesthesia, Deyo index, obesity, procedure type, and length of stay

Two Cases of Postoperative New Onset Atrial Fibrillation in the Setting of Opioid Induced Respiratory Depression as Detected by Continuous Capnography Monitoring

Presenting Author: Juan Fiorda-Diaz, M.D.[3]
Co-Authors: Toby N Weingarten, M.D.[1]; Hiroshi Morimatsu, M.D.[2]; Sergio D. Bergese, M.D.[3,4]; Makiko Ariyoshi, R.N, M.P.H.[2]; Juraj Sprung, M.D., Ph.D.[1]; Albert Dahan, M.D.[5]; Frank J Overdyk, M.S.E.E., M.D.[6]

1. Department of Anesthesiology and Perioperative Medicine, Mayo Clinic, Rochester MN, USA
2. Department of Anesthesiology and Resuscitology, Okayama University, Okayama, Japan
3. Department of Anesthesiology, The Ohio State University Wexner Medical Center, Columbus OH, USA
4. Department of Neurological Surgery, The Ohio State University Wexner Medical Center, Columbus OH, USA
5. Department of Anesthesiology, Leiden University Medical Center, RC Leiden, The Netherlands
6. Department of Anesthesiology, Roper St Francis Medical Center, Charleston, SC, USA

Corresponding Author: Toby N Weingarten, M.D., Department of Anesthesiology College of Medicine, Mayo Clinic, 200 First Street SW, Rochester, MN 55905; Phone: (507) 255-1612 / Fax: (507) 255-6463; E-mail: weingarten.toby@mayo.edu

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Background: Patients with obstructive sleep apnea (OSA) experience intermittent episodes of nocturnal hypoxemia secondary to obstructive apneic events leading to increased sympathetic activation that contributes to the development of atrial fibrillation. Surgical patients with underlying OSA have been found to be at increased risk of postoperative atrial fibrillation (POAF). POAF complicating noncardiac surgery is associated with increased morbidity, mortality, and hospital cost.

General Aim: The PRODIGY trial (ClinicalTrials.gov Identifier: NCT02811302) was a multicenter prospective study designed to develop a risk prediction score for postoperative respiratory depression on the ward.[1]

Materials and Methods: After ethical review board approval, surgical patients admitted to standard postoperative wards and received parenteral opioids underwent continuous, electronic cardiorespiratory monitoring to detect episodes of opioid induced respiratory depression (OIRD). Monitoring was performed with the Capnostream™ 20p or 35 portable bedside monitor (Medtronic, Dublin, Ireland) which provided continuous assessment of respiratory patterns by measurement of end-tidal carbon dioxide and respiration rate using Microstream™ capnography technology. Heart rate (HR) and oxyhemoglobin saturation were also monitored. Signals consistent with OIRD were reviewed. Two cases were identified who had signal patterns consistent with OIRD and an abrupt change in HR consistent with POAF.

Results:

Case I
The first patient was a 75 year-old male with a normal preoperative electrocardiogram and no dysrhythmia history. He underwent laparoscopic colorectal surgery. Postoperatively the Capnostream™ monitor was applied. On postoperative day two, multiple apneic events were detected. During this time the HR abruptly increased from 80 – 90 bpm range to a variable rate of 100 – 150 bpm. This pattern continued for approximately 5 hours and then spontaneously resolved (Image 1). This episode was undetected by routine clinical monitoring.

Case II
The patient was a 72 year-old Caucasian male with a normal preoperative electrocardiogram and no dysrhythmia history. He underwent partial hepatic resection under general anesthesia. Postoperatively the Capnostream™ monitor was applied. Ten hours after surgery, multiple apneic events were detected. During this time the HR increased from 60 to 90 bpm for 5 minutes, and then to a variable rate between 120 – 180 bpm (Image 2). This episode was undetected by routine clinical monitoring.

Discussion and Conclusion: We describe two cases where patients developed probable POAF during obstructive breathing patterns, detected retrospectively from bedside capnography. Both cases were asymptomatic and not detected by routine clinical monitoring or electrocardiogram. Undetected postoperative OIRD can lead to respiratory arrest. Intermittent vital sign assessments have low-to-moderate sensitivity and specificity when detecting OIRD, and advocacy groups have called for continuous multimodal monitoring of respiratory status in hospitalized patients. These cases illustrate the limitation of intermittent vital signs monitoring in detecting other pathophysiologic abnormalities, such as POAF, which may result in hemodynamic instability and other serious outcomes. As more centers adopt continuous monitoring, the detection of these events will undoubtedly increase.

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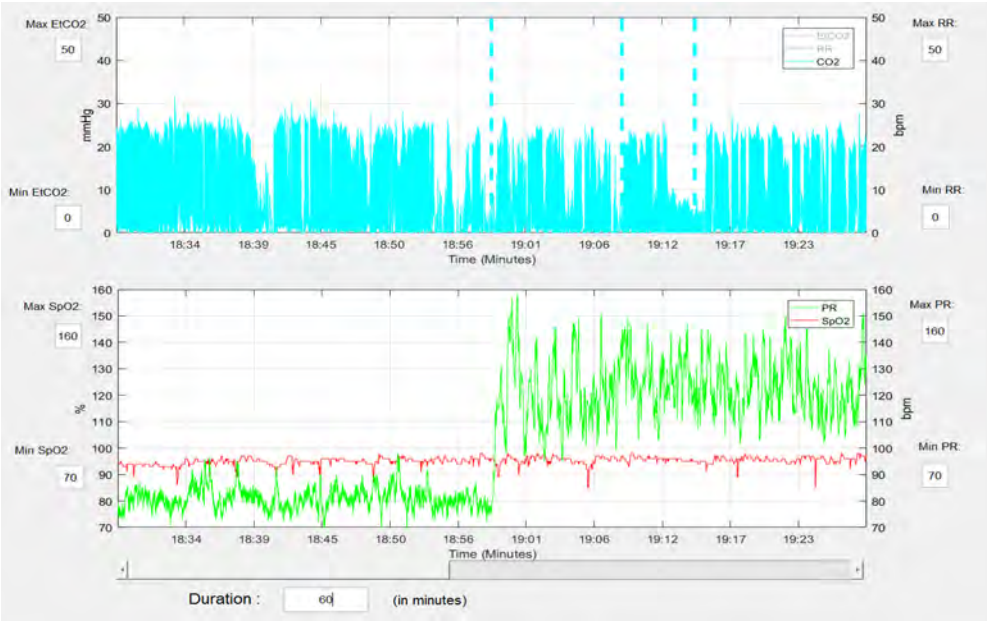
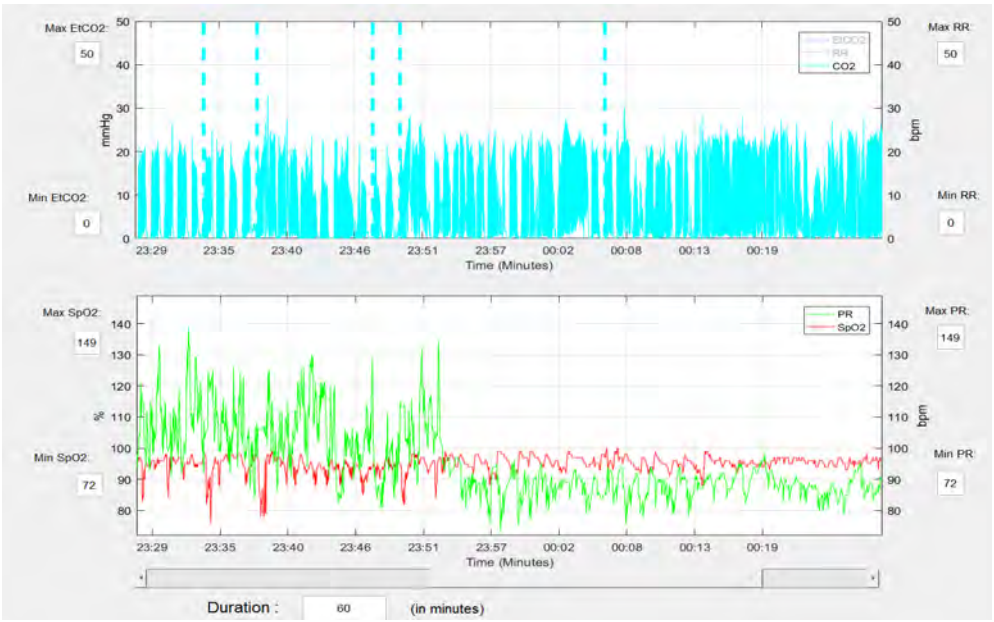
Image 1. Postoperative abrupt change in heart rate consistent with atrial fibrillation in a 75 year-old male

1A)



1B)



The top panel presents exhaled end-tidal carbon dioxide (etCO2, represented by blue lines) measured with the Microstream™ capnography monitor. The blue dash lines are alerts generated by apneic episodes (no breath detected for > 30 second). The bottom panel presents oxyhemoglobin saturation (SpO2 red line) and heart rate (green line) measured with Nellcor™ pulse oximetry. In image1A, there is an abrupt change in heart rate from approximately 80 – 90 beats per minute (bpm) to a highly variable rate of 100 – 150 bpm. This change coincides with an apneic episode. In Image 1B, after 5 hours there is another abrupt change in the heart rate returning to 80 – 90 bpm range. Also note the intermittent hypoxemic episodes that coincide with apneic episodes.

Image 2. Postoperative changes in heart rate consistent with atrial fibrillation in a 72 year-old male

The top panel presents a highly abnormal breathing pattern marked by numerous apneic episodes (blue dashes). The bottom panel shows the heart rate (green) increase from the 60 bpm range to 90 bpm range for 5 minutes, and then increased to a variable rate between 120 – 180 bpm. There are some associated changes in SpO2 (red) consistent with hypoxemia secondary to apneic spells.

Clinical Outcomes of Esophagogastroduodenoscopy Using a Modified Laryngeal Mask Airway in Children and Adolescents

Presenting Author: Mohammed Hakim MBBS
Co-Authors: Shabana Z. Shafy M.B.B.S, Renata M. Miketic MD, Jason Bryant MD, Joseph D. Tobias, MD.

Introduction: Esophagogastroduodenoscopy (EGD) is frequently performed in children under general anesthesia (GA). A laryngeal mask airway (LMA) may be used to control the airway with the EGD probe inserted around the cuff of the LMA and into the esophagus. Due to the probe size, the intracuff pressure of the LMA may increase. Additionally, navigating the EGD scope around the cuff of the LMA may prove challenging. We evaluated a newly designed LMA (LMA Gastro™ Airway, Teleflex) which is designed with an internal channel exiting from the middle of the distal end to facilitate EGD probe insertion. Our primary goal was to compare intracuff pressure with this newly designed LMA and a standard LMA (AuraOnce™, Ambu).

Methods: Following IRB approval, children ≤18 years of age and weighing more than 30 kg, were enrolled in the study to undergo EGD under GA with planned use of an LMA. The study cohort was randomized to the new vs. old LMA. After the induction and LMA placement, the intracuff pressure was monitored using a transducer attached to the pilot balloon of the LMA cuff, and recorded every minute for the first 5 minutes after induction. The EGD probe was then inserted by the gastroenterologist and the intracuff pressure was recorded every 2 minutes during the procedure. Intracuff pressures >40 cmH2O were considered excessive. The changes in intracuff pressure compared to baseline were compared between groups using an independent t-test. Secondary outcomes included throat soreness, ease of EGD procedure, blood found on the LMA, difficulty ventilating. These measures were compared using rank-sum, Chi-square, or Fisher's exact tests, as applicable.

Results: To date, 86 patients have been enrolled (31/55 male/female, mean age 14 ± 3 years, mean weight 59 ± 17 kg), 43 of whom were in the new LMA group. LMAs were successfully placed on the first attempt in 82 (95%) cases. Average intracuff pressure was 40 ± 18 cmH2O over the first 5 minutes after anesthetic induction (before EGD probe insertion), and did not differ between study groups (**Table 1**). After EGD probe insertion, maximal intracuff pressure was 50 ± 20 cmH2O with the new LMA and 51 ± 23 cmH2O with the old LMA (95% confidence interval of difference: -8, +11 cmH2O; p=NS). The change in intracuff pressure was 9 ± 8 cmH2O with the new LMA and 12 ± 9 cmH2O with the old LMA (95% confidence interval of difference: -1, 7 cmH2O; p=0.126) No secondary outcomes differed between groups.

Discussion: Use of a new LMA did not prevent high intracuff pressures during EGD as compared to an older model. Despite high intracuff pressures observed in both groups, throat soreness was generally low and complications were infrequent (median of 3 on a 1-10 scale) and intraoperative complications were infrequent.

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Table 1. Outcomes of esophagogastroduodenoscopy scope insertion according to type of laryngeal mask airway used (N=86)

Outcome	*LMA Gastro™ Airway, Teleflex (N=43)*	*AuraOnce™ LMA, Ambu (N=43)*	*P value*
IP following anesthetic induction, prior to EGD probe insertion	41 ± 16	40 ± 20	0.759
Maximum IP after EGD probe insertion	50 ± 20	51 ± 23	0.707
Increase in IP from baseline following EGD probe insertion	9 ± 8	12 ± 9	0.126
Ease of EGD procedure	9 (8, 10)	9 (8, 10)	0.288
Throat soreness prior to discharge (VAS)	3 (2, 4)	3 (2, 3)	0.349
Throat soreness first postoperative day (VAS)	2 (2, 3)	2 (2, 3)	0.680
Blood found on LMA or in oropharynx	5 (12%)	1 (2%)	0.202
Difficulty with ventilation	0	1 (2%)	>0.999

Data are presented as the mean ± SD or median with the IQR. The IP is listed in cmH2O.
IP = intracuff pressure; EGD = esophagogastroduodenoscopy; IQR = interquartile range; LMA = laryngeal mask airway; SD = standard deviation; VAS = visual analog scale.

Hypoid Position with the Application of cNEP: A Case Report

Presenting Author: Kingman P. Strohl MD, Department of Pulmonary, Critical Care and Sleep Medicine, University, Hospitals Cleveland Medical Center, Cleveland OH

Background: Continuous submental negative external pressure (cNEP) will decrease critical closing pressure in the retro-palatal and retroglossal upper airway in thin but not obese anesthetized humans (1), and in patients (BMI 34 and AHI ~44/hr) with OSA (2) cNEP resulted in 13 of 15 being “responders” (AHI fall by 50% and an AHI <20/h) with 9 of 15 having an AHI < 5/h. The hypothesis is that to have this type of response cNEP might open the upper airway at multiple sites and advance the hyoid as does hypoglossal nerve stimulation (HNS) (3). In a demonstration of feasibility, in one awake, seated OSA patient, changes in upper airway Methods: volume and the sizes of the retro-palatal and retroglossal were assessed using CBCT, comparing cNEP to +10 cmH2O and -2 cmH2O and the ability of cNEP to change upper airway volumes with the application of -2 cmH2O.

Results: Results confirmed the dilating and narrowing effects of +10 (~32%) and -2 cmH2O (-21%), respectively, with the additional observation that cNEP (-40 cmH2) opened the retro-palatal and retroglossal regions at rest by 21% and 15%, respectively. The narrowing of both with -2cmH2O was largely reversed by cNEP. However, the position of the hyoid relative to the mandible appeared not move, unlike the forward and upward effects seen in HNS (3). Conclusions: This study supports a mechanism for cNEP to produce a dilating force that is transmitted to the airway behind the palate and tongue, but without altering hyoid position.

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Atypical Presentation of OSA in an Adult with Retinal Nerve Fiber Layer Thinning

Authors: Joshua Sill, MD, Phillip A. Nye, MD

Affiliations: [1]Eastern Virginia Medical School, Norfolk, VA; [2]Sentara Norfolk General Hospital, Norfolk, VA

Introduction: Retinal nerve fiber layer thickness (RNFL) is evaluated for thinning in conditions such as macular degeneration, glaucoma and secondary retinopathy. RNFL thinning in the absence of other ocular signs may also suggest periods of hypoxia as seen in obstructive sleep apnea (OSA). Undiagnosed OSA can lead to cardiovascular disease, diabetes, stroke and death.

Case Presentation: We report the case of an 80-year-old, non-obese woman who presented to her ophthalmologist for routine eye exam and was diagnosed with RNFL thinning. She denied snoring, day-time sleepiness, or other sleep complaints. She was referred to a sleep specialist because of this abnormal finding on eye exam. A home apnea test revealed severe OSA, with an apnea hypopnea index of 63/hr. and an oxygen saturation nadir of 75%. She was started on continuous positive airway pressure therapy.

Discussion: In severe OSA, patients typically present with excessive day time sleepiness, nonrestorative sleep and insomnia. OSA is more common in men and associated with obesity. Inherited ventilatory responses may also affect the respiratory drive and predispose patients to obstructive and central sleep apnea. Many factors contribute to OSA, resulting in commonly seen symptoms. This patient reported none of the classic symptoms associated with an AHI $\geq$ 30.

Conclusions: Ophthalmologists evaluate RNFL thickness to help diagnose glaucoma and retinopathy related to vascular disease. Chronic ischemia secondary to the intermittent hypoxia seen in OSA will also cause RNFL thinning. These patients are rarely referred for a sleep evaluation. This case demonstrates the benefits of screening for OSA in patients that present with RNFL thinning.

Effects of Audiovisual Distraction Versus Standard Sedation on Desaturation and Airway Intervention in OSA-Patients Undergoing Total Knee Arthroplasty Under Neuraxial Anesthesia

Presenting Author: Danya DeMeo, BS[1]
Co-Authors: Megan Fiasconaro, MS[1]; Crispiana Cozowicz, MD[12]; Valeria Rotundo[1], Ellen Soffin, MD, PhD[1]; Alejandro Gonzalez Della Valle, MD[3]; Michael Cross, MD[3]; Friedrich Boettner, MD[3]; Stavros G. Memtsoudis, MD, PhD, FCCP[1]

[1] Hospital for Special Surgery, Department of Anesthesiology, Critical Care and Pain Management, New York, NY
[2] Paracelsus Medical University, Department of Anesthesiology, Perioperative Medicine and Intensive Care Medicine, Salzburg, Austria
[3]Hospital for Special Surgery, Adult Reconstruction and Joint Replacement Service, New York, NY

Introduction: Obstructive sleep apnea (OSA) is associated with increased risk for adverse events in a peri-operative setting such as airway complications and desaturations, which may be caused or exacerbated by sedation. Theoretically, non-pharmaceutical alternatives, including audiovisual distraction, may represent viable options to reduce stress and anxiety, and avoid adverse events during surgery for OSA patients secondary to drug induced apneas. To test this hypothesis, we conducted a randomized control feasibility study to determine the effects of audiovisual distraction on desaturation and airway interventions for patients with OSA compared to standard IV sedation.

Methods: After IRB approval, nineteen patients with OSA or a STOP BANG of ≥ 5 undergoing primary total knee arthroplasty under neuraxial anesthesia were randomized to receive either continuous IV sedation (group A) or audiovisual distraction (AVD) with minimal sedation (group B). Patients in the AVD group chose content from a preexisting video library and were fitted with the devices (HappyMed Video Glasses, Vienna, Austria and Cinema ProMed by Zeiss, Oberkochen, Germany) prior to being transferred to the operating room.

The number of desaturations, airway interventions, and requests for additional sedatives were recorded throughout the duration of the procedure. Level of alertness was monitored at baseline and in the recovery room. Patient satisfaction scores were collected using the Heidelberg Peri-anaesthetic questionnaire.

Results: A total of 19 patients (n= 9 group A and n= 10 group B) were enrolled. Imbalances in demographic baseline variables between groups, with standardized differences of over 20% were observed for gender, ethnicity, race, age, and BMI were seen. Unexpectedly, a large number of patients did not agree to participate in the study, suggesting discomfort with the idea of being awake during surgery.

From Group A, 6 participants (66.7%) experienced a desaturation event, and there were 2 (20.0%) participants from Group B. The primary outcome was number of desaturations, and the median number of desaturations experienced for Groups A and B were 1 and 0, respectively. The p-value resulting from our Wilcoxon test was 0.07, and we did not identify a significant difference between groups. However, we found a significant difference between groups for those that experienced an airway intervention. With 7 (77.8%) from Group A, and 2 (20.0%) from Group B, a p-value of 0.02 was observed. Additionally, we found all 9 participants (100%) from Group A either experienced an airway intervention or desaturation event, in comparison to Group B's 2 participants (20.0%). A significant p-value of 0.001 resulted for this combined outcome.

Secondary outcomes of the need for additional sedation, patient satisfaction, and change in alertness levels from intra op to in holding, in holding to PACU admission, and PACU admission to 30 minutes after, did not show to differ significantly between groups.

Discussion: Patients with OSA or high risk for OSA undergoing total knee arthroplasty under neuraxial anesthesia and standard IV sedation required more airway interventions compared to the group receiving audiovisual distraction. In the context of high satisfaction, this approach may represent a viable alternative to prevent airway compromise. Further studies are needed to evaluate the extent of this effect as our feasibility study was not adequately powered to unequivocally support our hypothesis.

Patient Outcomes

Outcome	Group A	Group B	P-Value
# Desaturations*	1 (0,2)	0 (0,0)	0.07
Airway Intervention	7 (77.8%)	2 (20.0%)	0.02
Additional Sedation	1 (11.1%)	2 (20.0%)	1.00
Satisfaction*	53 (50, 56)	52.8 (49, 56)	0.23
Change in Alertness (intra op - in holding)*	0 (0,0)	0 (-1,0)	0.5
Change in Alertness (in holding - PACU admission)*	0 (0,0)	0 (0,0)	0.62
Change in Alertness (PACU admission - 30 min after)*	0 (0,0)	0 (0,0)	0.31
Airway Intervention or desaturation event	9 (100.0%)	2 (20.0%)	0.001

** Continuous variable, median and IQR reported*

A Molecular Basis for Membrane-Mediated Inhaled Anesthesia

Presenting Author: Scott B. Hansen, PhD, Scripps Research
Co-Authors: Mahmud Arif Pavel, PhD, Scripps Research
E. Nicholas Petersen, PhD, Scripps Research
Richard A Lerner, MD, Scripps Research

Background: Inhaled anesthetics are a diverse collection of hydrophobic molecules that activate twik-related potassium subtype 1 (TREK-1) channels and reversibly induce loss of consciousness[1]. Lipid based mechanisms of inhaled anesthesia have been proposed, but they have failed to fully explained how the proposed perturbation in the lipid bilayer would then result in a dysfunctional membrane protein[2]. Absent a membrane-mediated mechanism, anesthetics are thought to bind channels directly, including TREK-1. We recently showed disruption by mechanical force and anesthetics of lipids can activate the enzyme phospholipase D2 (PLD2) through substrate presentation[3–5]. The enzyme translocated out of saturated lipids where it encounters its substrate phosphatidylcholine[6,7].

General Aim: We aim to show the lipid membrane is a target of inhaled anesthetics and demonstrate an indirect molecular mechanism for anesthetic activation of TREK-1 independent of direct binding to the channel.

Methods: Ion channels were purified into detergent and reconstituted into lipid vesicles. Direct anesthetic binding, or the absence thereof, was detected in a fluorescent ion flux assay. Anesthetic activation of TREK-1 channel was measured by whole cell patch clamp in HEK293 cells overexpressing the channel with and without the catalytically dead enzyme phospholipase D2 (xPLD2). The current-voltage relationships (I-V curves) were elicited by 1-s depolarizing pulses from -100 to 100 mV in +20 mV increments. Membrane disruption by anesthetics and translocation of PLD2 away from saturated lipids were measured by super resolution imaging of lipids and enzyme labeled with fluorescent cholera toxin B and antibody respectively. *In vivo* resistance of *Drosophila* (fruit fly) to inhaled anesthetics was tested in wild type and PLD^{null} flies using volatiles and aerosols with positional recording (VAAPR)[8].

Results: Here we show anesthetics indirectly activate TREK-1 through perturbations to the lipid membrane. We show the cell harnesses lipid membrane heterogeneity to inactivate TREK-1 by sequestering it away from its signaling-lipid phosphatidic acid (PA) into regions of saturated fatty acid. Inhaled anesthetics then disrupt lipid localization to activate the channel by facilitating the release of the enzyme and production of PA near the channel. The catalytically dead xPLD blocked all detectable current from TREK-1 (Fig. a-b). A non-anesthetic channel, TWIK-related arachidonic acid-activated potassium channel (TRAAK), was made robustly anesthetic sensitive by transferring a PA localization signal to the channel (TRAAK/CtTREK) (Fig. c). Genetic deletion of the PLD renders flies resistant to inhaled anesthetics.

Conclusion: We conclude the membrane is a target of inhaled anesthetics. The lipid PA is a chemical transducer, and TREK-1 is a downstream effector of membrane-mediated anesthesia (Fig. d). Anesthetic sensitivity is modular and can be transferred to non-anesthetic channels that are activated by PA. Hence, the question “do anesthetics target the membrane” is now better stated “to what extent do anesthetics target the lipid membrane to exert their effect?”

Figure:

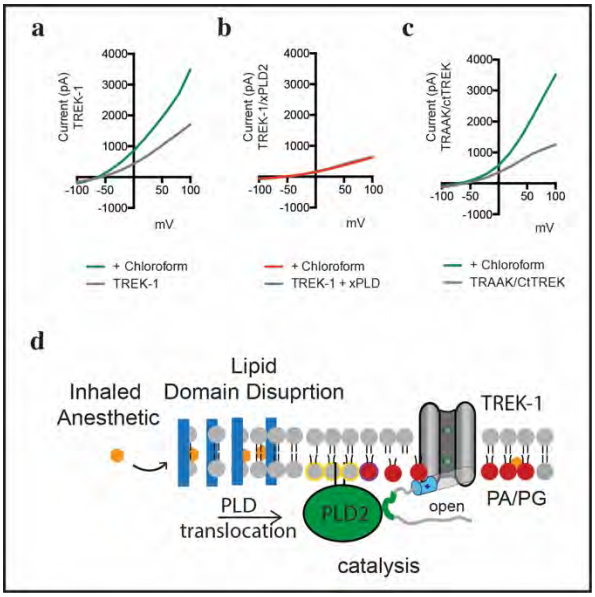

Figure Membrane-mediated anesthesia. (**a**) Representative TREK-1 whole-cell currents activated by chloroform (1 mM) in physiological K^+ gradients and (**b**) in the presence of a catalytically inactive mutant K758R of PLD2 (xPLD2). (**c**) Representative TRAAK/ctTREK currents activate by chloroform. (**d**) Cartoon of membrane mediated (two-step) activation of TREK-1 by inhaled anesthetic. Anesthetic (orange hexagon) is shown with disrupted saturated lipids (blue rectangles). A translocated PLD2/TREK-1 complex activated by phosphatidic acid (PA, red lipid) and substrate (yellow lipid, phosphatidylcholine) presentation.

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