SASM
Society of Anesthesia and Sleep Medicine

4th Annual Meeting Syllabus
October 9-10, 2014

Hotel Monteleone
New Orleans, LA

Safety in Surgical Patients with Sleep Disordered Breathing

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Denise Wedel, MD
Mayo Clinic

Lisa Wolfe, MD
*Northwestern University
Feinberg School of
Medicine*

Tucker Woodson, MD
*Medical College of
Wisconsin*

Learning Objectives

After attending this program, participants should be able to:

1. Discuss the issues surrounding 'Safety Concerns of the Perioperative Patient With Sleep Disordered Breathing' and its relationship between anesthesia and sleep medicine

2. Recognize factors and the mechanisms for postoperative respiratory complications resulting from pain, disrupted sleep and breathing, as well as the perioperative impact of sedatives and opioids in both adults and children

3. Enhance interpretation and appropriate application of several modalities used to assess ventilatory behavior and become comfortable with newer modes of non-invasive ventilation (NIV) used to treat sleep disordered breathing

4. Discuss various risk assessment tools and reveal several clinical situations resulting in special challenges to caregivers in terms of outcome and management in the perioperative period

Scope of Practice

Participants with all levels of experise are invited to participate in any of the program's sessions.

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:

1. Explore the mechanisms whereby anesthetic agents and opioids may affect respiratory function and the safety benefit that alternative or additive medications might offer

2. Examine various methodologies to measure respiratory rate, minute ventilation, or carbon dioxide elimination and their possible impact on avoiding adverse postoperative outcomes

3. Better understand the use of more sophisticated modes used to deliver positive airway pressure therapy in patients requiring NIV to treat ventilatory insufficiency

4. Discuss several methods of predicting safety hazards/risk factors and what has been and could be learned from the application of these assessments

5. Note some special challenges encountered in those treating premature infants, children, and when performing surgery for sleep apnea as an outpatient procedure

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.

Accreditation Statement

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education through the joint sponsorship of the Institute for the Advancement of Human Behavior (IAHB) and the Society of Anesthesia and Sleep Medicine (SASM). The IAHB is accredited by the ACCME to provide continuing medical education for physicians.

Credit Designation Statement

The IAHB designates this live activity for a maximum of *11.5 AMA PRA Category 1 Credits™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

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.

Program Committee Disclosures

Peter Gay, MD
2014 Annual Meeting
Program Chair

Girish P. Joshi, MBBS
2014 Annual Meeting
Program Co-Chair

Speaker Disclosures

The following faculty indicated with an asterisk (*) stated they had no such relevant financial relationships to disclosure. Their financial relationship is nothing to disclose (NTD) and resolution is not applicable (N/A).

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Schedule of Events

Thursday, October 9, 2014

Time	Topic	Moderator
1:00 - 1:05 pm	Welcome	*Peter Gay, MD*
1:05 - 3:00 pm	Anesthesia Safety	
	• **Pain and Disrupted Sleep - A Bidirectional Relationship** *David Hillman, MD* • **Can Dexmedetomidine Replace Opioids?** *Mervyn Maze, MB, ChB* • **Carotid Body Chemoreceptor Function and Relationship to Anesthetic Agents** *Malin Fagerlund, MD, PhD* • **Is There An Ideal Anesthetic Regime for OSA?** *Matthias Eikermann, MD, PhD* • **The Mechanisms Underlying Long-term Memory Deficits After Anesthesia** *Beverley Orser, MD, PhD* • **Discussion/Q&A**	*Bhargavi Gali, MD*
3:00 - 3:25 pm	Break	
3:25 - 5:00 pm	Workshop: Postoperative Monitoring & Non-Invasive Ventilation	
	Respiratory Rate, Acoustic Monitor, Minute Ventilation, Expired CO2 • **Respiratory Rate: Plethysmography vs. Acoustic Monitor** *Scott Kelley, MD vs. Michael Ramsay, MD* • **Minute Ventilation vs. Expired CO2 Monitoring** *Evan Pivalizza, MBChB, MD vs. Satya Krishna Ramachandran, MD* • **Discussion/Q&A**	*Stavros Memtsoudis, MD, PhD*
5:00 - 6:00 pm	**How to Do PAP Therapy:** • **AVAPS, Trilogy -** *Lisa Wolfe, MD* • **ASV, VPAP Adapt –** *Peter Gay, MD* • **Discussion/Q&A**	*Michael Pilla, MD*
6:00 - 6:30 pm	Welcome Reception	
6:30 - 8:30 pm	Dinner	
6:30 - 6:35 pm 6:35 - 6:45 pm 6:45 - 7:30 pm 7:30 - 8:00 pm 8:00 - 8:30 pm	Welcome and Introductions IARS President Address – *Denise Wedel, MD* Dinner Followed by Additional Speakers **Propofol: Murder, Mayhem and Mercy -** *Steven Shafer, MD* **Zero by 2020: Time to Co-Operate -** *Michael Ramsay, MD*	*Frances Chung, MB BS*

Friday, October 10, 2014

Time	Topic	Moderator
7:00 - 7:55 am	Registration and Continental Breakfast	
7:15 - 7:55 am	Annual General Meeting	
7:55 - 8:00 am	Welcome	*Frances Chung, MB BS*
	Moderator: *Peter Gay, MD*	
8:00 - 8:50 am	*Keynote:* **How New Technologies Will Impact Patient Safety**	*Mark Warner, MD*
8:50 - 9:30 am	*Keynote:* **Predicting Safety Hazards - MEWS, PEWS, SCHMEWS**	*Tim Morgenthaler, MD*
9:30 - 10:00 am	**Life Threatening Respiratory Events**	*Lorri Lee, MD*
10:00 - 10:15 am	**Q & A**	
10:15 – 10:45 am	Refreshment Break and Moderated Poster Viewing	

Friday, October 10, 2014 (continued)		
	Moderator: *Babak Mokhlesi, MD, MSc*	
10:45 - 11:10 am	**The Obstructive Sleep Apnea Phenotype**	*Atul Malhotra, MD*
11:10 - 11:35 am	**Preoperative Red Flags and Preparation of Patients with OSA**	*Amy Guralnick, MD*
11:35 am - 12:00 pm	**Rational Pain Management in the Patient with Sleep Disordered Breathing**	*Girish P. Joshi, MBBS, MD*
12:00 - 12:15 pm	**Q & A**	
12:15 - 1:15 pm	Lunch Break and Poster Viewing	
1:15 - 1:45 pm	Awards to Research Grant and Scientific Abstracts Winners Presentations from Best of Clinical and Pre-Clinical/Basic Research Abstract Winners	*Frances Chung, MB BS* *Anthony Doufas, MD, PhD*
	Moderator: *Roop Kaw, MD*	
1:45 - 2:10 pm	**Should Upper Airway Surgery be Done as an Outpatient Surgery?**	*Tucker Woodson, MD*
2:10 - 2:35 pm	**Predicting Cardiac Arrest on the Wards: Past, Present and Future**	*Matthew Churpek, MD, PhD*
2:35 - 2:45 pm	**Q & A**	
2:45 - 3:15 pm	Refreshment Break and Moderated Poster Viewing	
	Moderator: *Dennis Auckley, MD*	
3:15 - 3:40 pm	**Pregnancy and Obstructive Sleep Apnea**	*Ellen Lockhart, MD*
3:40 - 4:05 pm	**Adenotonsillectomy Outcomes in Treatment of Obstructive Sleep Apnea in Children**	*Rakesh Bhattacha-rjee, MD*
4:05 - 4:25 pm	**Guidelines for Perioperative Management of Patients with OSA**	*Tracey Stierer, MD*
4:25 - 4:45 pm	**Perioperative CPAP: Is It Efficacious?**	*Frances Chung, MB BS*
4:45 - 5:00 pm	**Q & A**	
5:00 pm	i-Pad Giveaway and Closing Remarks	*Peter Gay, MD*

Continuing Medical Education (CME) Certificate

IMPORTANT!

The online certificate site will be available starting at the end of the day, October 10, 2014 through November 10, 2014. After November 10, 2014, the site will be removed and certificates will no longer be available. If you need a CME/CE certificate, you must complete the evaluation and certificate process prior to that date; otherwise you will forfeit your credit for the course.

To get your certificate, just go to SASM.CmeCertificateOnline.com and click on the "4th Annual Meeting" event. On the site, you will be asked to enter a password, which is **SASM14AM**, and evaluate various aspects of the meeting. You may then print your certificate immediately, which is encouraged.

Please address any questions about the process to: help.cmecertificateonline.com.

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Research Grant Award

Congratulations to Principal Investigator, Dr. Sapna Kudchadkar with John Hopkins School of Medicine for winning the Society of Anesthesia and Sleep Medicine (SASM) Research Grant! Dr. Kudchadkar will be awarded following the 4th Annual Meeting Luncheon on Friday, October 10, 2014.

Project Title: The Role of Sleep Disturbances on Neuroinflammation in the Developing Brain
Principal Investigator: Sapna R. Kudchadkar, MD

Abstract Awards

Best Pre-Clinical and Basic Research Awards

First Place Award

Abstract: Sedation with Dexmedetomidine or Propofol Impairs Control of Breathing in Healthy Male Volunteers: A Randomized Cross-Over Study

Co-Authors: [1]Ase Danielson, MD, PhD-Student, DESA, [1]A. Ebberyd, BMA, [1]A. Hardemark Cedborg, MD, PhD, [1]S. Mkrtchian, MD, PhD & [1]E. Christensson, MD, PhD-Student, DESA

[1]Karolinska University Hospital and Karolinska Instituet Stockholm, Sweden

Second Place Award

Abstract: Obstructive Sleep Apnea Mice with Insulin Resistance Are Susceptible to Postoperative Cognitive Decline

Co-Authors: [1]Susana Vacas, MD, PhD, [1]Martin Contreras, PhD, [1]Suneil Koliwad, MD, PhD & [1]Mervyn Maze, MB, ChB

[1]University of California, San Francisco, San Francisco, CA USA

Third Place Award

Abstract: Circadian Protein Period 2 Modulation of Innate Immune Function

Co-Authors: [1]Philips Kurien, MD, [1]Ying-Hui Fu, PhD & [1]Louis Ptacek, MD

[1]University of California, San Francisco, San Francisco, CA USA

Best Clinical Research Awards

First Place Award

Abstract: Identifying the Non-Sleep Apnea Patients Who May Develop Postoperative Sleep Disordered Breathing

Co-Authors: [1]Pu Liao, MD, [1]Yiliang Yang, MD, [1]Weimin Kang, MD, [1]Maged Andrewes, MD, [1]Colin Shapiro, PhD, [1]Frances Chung, MB BS & [2]Babak Mokhlesi, MD, MSc

[1]University Health Network, Toronto, ON, Canada
[2]University of Chicago, Chicago, IL USA

Second Place Award

Abstract: Submental Negative Pressure Application Improves Collapsibility of the Passive Pharyngeal Airway

Co-Authors: [1]Shinichiro Kato, MD, [2]Shiroh Isono, MD, [2]Megumi Okuyama, MD, [2]Shin Sato, MD, [2]Aya Yamamura, MD, [2]Junko Okazaki, MD, [2]Yumi Sato, MD & [2]Teruhiko Ishikawa, MD

[1]Kimitsu Chuo Hospital, Chiba, Japan
[2]Chiba University Hospital, Chiba, Japan

Third Place Award

Abstract: Residual Neuromuscular Block with Rocuronium Reduces Hypoxic Ventilatory Response in Patients with Untreated Obstructive Sleep Apnea

Co-Authors: [1]Eva Christensson, MD, PhD-Student, DESA, [1]A. Ebberyd, BMA, [1]A. Hardemark Cedborg, MD, PhD, [1]A. Danielson, MD, PhD-Student, DESA & [2]KA Franklin, MD, PhD

[1]Karolinska University Hospital and Karolinska Instituet, Stockholm, Sweden

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Abstract Table of Contents

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

Morning Abstracts

Chronic Opioid Use and Central Sleep Apnea – A Review of the Prevalence, Mechanisms, Risk factors and Perioperative Considerations

Presenting Author: Denis Correa, MD, Department of Anesthesiology, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada

Co-Authors: Robert Farney, MD, University of Utah Health Sciences Center, Salt Lake City, Utah, USA

Frances Chung, MBBS, FRCPC, Department of Anesthesiology, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada

Arun Prasad, MBBS, FRCA, FRCPC, Department of Anesthesiology, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada

Jean Wong, MD, FRCPC, Department of Anesthesiology, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada

Abstract

Background: Chronic opioid use has recently been associated with the development of sleep disordered breathing such as central sleep apnea (CSA).[1,2,3] A large number of patients on chronic opioids may suffer from unrecognized sleep apnea that contributes to unexplained morbidity and mortality.[4,5] Currently, information regarding the perioperative management of patients with chronic opioid associated CSA is limited. The objectives of this review are to define the clinical manifestations of sleep disordered breathing associated with chronic opioid therapy, especially CSA, the prevalence, mechanisms, risk factors, and the perioperative management.

Methods: We searched Medline (January 1946 - November 2013), Medline in process and other non-indexed citations (November 2013), EMBASE (1947 – November 2013), Cochrane Database of Systematic Reviews (January 2005 - October 2013), and the Cochrane Central Registry of Controlled Trials (October 2013), PubMed basic search for new materials (1946 - November 2013), Anesthesia and Sleep Medicine meeting abstracts (2002 - 2013) were also searched for relevant articles. We included all prospective, retrospective studies and case reports with CSA and chronic opioids confirmed by polysomnography. CSA was defined as the absence of airflow for ≥10 seconds with the absence of breathing efforts. A Central Apnea Index ≥5 events/hr was considered significant.

Results: The search strategy yielded 8 studies. The total numbers of patients were 560. The overall prevalence of CSA in patients with chronic opioid use was high (24%). The morphine equivalent daily dose was strongly associated with the severity of the sleep disordered breathing, predominantly CSA. More than 200 mg morphine equivalent daily dose was associated with CSA. Concurrent use of benzodiazepines or hypnotics was associated with the severity of CSA in one study. Body mass index (BMI) was inversely related to the severity of sleep disordered breathing. There were inconsistent results for the best positive airway pressure therapy for the treatment of opioid-associated CSA. Continuous positive airway pressure (CPAP) may be ineffective in eliminating or may even increase CSA. Adaptive servo ventilation and bilevel positive airway pressure ventilation was effective in some reports.

Conclusion: The overall prevalence of CSA in patients taking chronic opioids was 24%. The most important risk factors for severity of CSA were a morphine equivalent daily dose greater than 200mg, and low or normal BMI. CPAP is often ineffective for treatment of CSA. Limited data are available on the peri-operative management of patients with CSA associated with chronic opioid use. There is a need for further prospective studies on the perioperative risks and management of these patients.

References:

1. Walker, J. M. (2007). "Chronic opioid use is a risk factor for the development of central sleep apnea and ataxic breathing." Journal of Clinical Sleep Medicine 3(5): 455-461
2. Mogri, M, (2009). "Hypoxemia in patients on chronic opiate therapy with and without sleep apnea." Sleep & Breathing 13(1): 49-57
3. Farney RJ, McDonald AM, Boyle KM, et al. Sleep disordered breathing in patients receiving therapy with buprenorphine/naloxone. Eur Respir J 2013; 42: 394–403.
4. Porucznik C, Johnson EM, Crook J, Wrathall J, Anderson JW, Rolfs RT. Adult Use of Prescription Opioid Pain Medications--Utah, 2008.MMWR.2010.Porucznik.pdf>. MMWR 2010: 59(6): 153-157
5. Young T, Finn L, Peppard PE, Szklo –Coxe M, Austin D, Nieto FJ, Stubbs R, Hila KM, Sleep disordered breathing and mortality: Eighteen year follow up of the Wisconish sleep cohort. Sleep 31: 1071-1078, 2008.

Table 1: Study Design, Demographics and Prevalence of Sleep Disordered Breathing

Author (Year)	Study Design	Population Studied	N	Female %	Age	BMI	SDB	CSA%
Teichtahl[1] (2001)	Prospective	Addiction	10	40	33 ± 6	27 ± 6	70	60
Wang[2] (2005)	Prospective	Addiction	50	50	35 ± 9	27 ± 6	NR	30
Walker[3] (2007)	Retrospective	Sleep Apnea	60	67	53 ± 13	32 ± 8	NR	NR

Webster[4] (2008)	Retrospective	Chronic Pain	140	60	51 (22-84)	30 ± NR	75	24
Mogri[5] (2009)	Retrospective	Chronic Pain	98	42	48* (22-80)	30* (21-47)	85	24
Sharkey[6] (2010)	Prospective	Addiction	71	59	38 ± 8	28 ± 6	42	14
Jungquist[7] (2012)	Combined	Chronic Pain	61	49	50 ± 11	33 ± 7	77	18
Farney[8] (2013)	Prospective	Addiction	70	60	32 ± 12	25 ± 7	63	30[¶]

Legend Table 1:

Combined: Prospective and Retrospective data combined
Addiction: Methadone or Buprenorphine for chronic addiction or detoxification
Sleep Apnea: Patients using opioids presented for evaluation of possible obstructive sleep apnea syndrome
Chronic Pain: Patients treated with opioids for chronic pain
Age: Mean (years)±SD or (Range)
Body Mass Index (BMI): Mean kg/m^2
Apnea/Hypopnea Index (AHI): Mean Apneas plus Hypopneas/Total Sleep Time (hrs)± (SD)
Sleep Disordered Breathing (SDB): Prevalence of Apnea/Hypopnea Index ≥ 5/hr in the total cohort of patients
NR: Not Reported or insufficient information from the study to report or calculate
*: Value is reported as Median.
¶: Unpublished Data

Postanesthesia Respiratory Depression Following Total Joint Arthroplasty with Spinal Anesthesia: A Retrospective Analysis

Presenting Author: Catherine W. Njathi MD, Mayo Clinic Rochester MN

Co-Authors: *Toby Weingarten MD, *Adam K. Jacob MD, *Juraj Sprung MD/PhD

* Mayo Clinic, Rochester MN

Background. Respiratory depression during Phase I postanesthesia recovery is a common cause for delayed discharge from our postanesthesia recovery unit. Multimodal analgesia protocol has been adopted to shorten hospitalization following arthroplasty. It is not known whether individual components of this protocol affect immediate postoperative respiratory depression. The purpose of this study is to test the hypothesis that the sedating medication components of the multimodal protocol are associated with increased rate of postanesthesia respiratory depression.

Methods. We reviewed the anesthetic electronic records of patients undergoing total arthroplasty under spinal anesthesia from January 1, 2008 and December 31, 2012. Episodes of respiratory depression as well as potential causative factors were abstracted and analyzed for potential associations. Respiratory depression was defined as apnea, hypopnea, oxyhemoglobin desaturations, or pain/sedation mismatch (episodes of severe pain despite moderate to profound sedation).

Results. Of 5,333 patients reviewed 766 (14.4%) had an episode of respiratory depression [144 *per* 1,000 cases (95% CI 135 – 153)]. There was an increased association with respiratory

depression in patients administered ≥ 300 mg gabapentin [odds ratio, OR 1.45 (1.13, 1.86)], ≥ 10 mg of sustained release oxycodone [OR 1.37 (1.04, 1.82)], increasing doses of midazolam [OR 1.04 (1.010, 1.078) *per* 1 mg increase], and intravenous opioids [OR 1.15 (1.01, 1.32)] *per* 10 mg intravenous morphine equivalent). In addition male sex was associated with respiratory depression [OR 1.88 (1.60, 2.22)] while increase age [OR 1.05 (0.96, 1.16) *per* decade], ASA physical status [OR 0.848 (0.69, 1.05) ASA III – IV vs. ASA I – II], and obstructive sleep apnea (OR 1.11 (0.86, 1.43)] were not. Increasing body mass index had an inverse association with respiratory depression [OR 0.72 (0.62, 0.84) *per* 10 kg/m^2 increase]. *Post hoc* analysis of gabapentin and sustained release oxycodone administration practices found these medications were more likely to be withheld or prescribed at lower doses in patients considered higher risk for postoperative respiratory depression (older age, higher ASA status, obstructive sleep apnea, and higher body mass index). The exception was male patients who received higher doses of these medications.

Discussion. Sedating perioperative medications at higher doses were associated with increased risk of early respiratory depression. The more conservative practice with gabapentin and sustained release oxycodone in higher risk patients may explain the lack of association between traditional clinical risk factors and respiratory depression. If increased scrutiny and elimination or reduction of protocol components would translate into less postoperative respiratory depression merits further study.

Effects of Rapid Recovery Anesthetic Protocol on Early Postanesthesia Respiratory Depression

Presenting Author: Catherine W. Njathi MD, Mayo Clinic, Rochester MN

Co-Authors: *Toby Weingarten MD, * Juraj Sprung MD/PhD

*Mayo Clinic, Rochester MN

Background. Our anesthetic practice was hindered by inadequate postanesthesia care unit (PACU) space resulting in delays in patient transfers from the operating room to the PACU. To improve efficiency we introduced an anesthetic protocol that substituted isoflurane to desflurane, eliminated routine use of midazolam, and prescribed aggressive prophylaxis antiemetics. This protocol was associated with a decreased recovery time from median 72 [50, 102] to 62 [44, 90] minutes, (adjusted) P <0.001. Early postanesthesia respiratory depression (RD) was identified as a common cause for prolonged anesthesia recovery. The purpose of this study is to determine if the institution of the anesthesia protocol was associated with decreased rates of RD. Secondary aims were to determine if volatile anesthetic and midazolam were associated with RD.

Methods. The anesthesia protocol was implemented August 1st 2010. The records of patient undergoing general endotracheal anesthesia were reviewed from two 6-month epochs (Epoch I-preceding practice implementation, between October 1, 2009, and March 31, 2010, and Epoch II— following practice implementation, between October 1, 2010, and March 31, 2011). RD was defined as a single episode of hypoventilation (3 episodes of < 8 respirations/minute); apnea (episode of apnea ≥ 10 seconds); hypoxemia (3 episodes of

oxyhemoglobin desaturations <90% with or without nasal cannula); or "pain/sedation mismatch" (Richmond Agitation Sedation Score = -3 – -5 and numeric pain score > 5). Episodes of RD as well as potential causative factors were abstracted and analyzed for potential associations.

Results. During Epoch I 2,936 and Epoch II 3,137 patients underwent general endotracheal anesthesia. Midazolam use decreased from 57.4% to 24.0% cases, isoflurane from 50.8% to 5.7%, while desflurane use increased from 25.6% to 77.0%. The rate of RD declined from Epoch I (N=229, 78, 95% CI 69 – 88 *per* 1,000 cases) to Epoch II (N=161, 51, 95% CI 44 – 60 *per* 1,000 cases), P<0.001, with a reduction in the adjusted odds ratio of RD (odds ratio 0.63, 95% CI 0.51 – 0.77), P <0.001. A secondary analysis substituting study epoch for anesthetic agent and midazolam found that compared to isoflurane, desflurane reduced odds of RD (0.67, 95% CI 0.52 – 0.87, P =0.002) but no association was found between RD and elimination of midazolam (0.84, 95% CI 0.67 – 1.07, P = 0.16).

Discussion. Introduction of an anesthetic protocol designed to facilitate Phase I recovery was associated with a reduction of RD. Subanalysis of the protocol components identified that desflurane was independently associated with a reduction of RD.

Effects of CPAP on Postoperative Outcomes in OSA Patients Undergoing Surgery: A Systematic Review and Meta-analysis

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Abstract

Background: Obstructive sleep apnea (OSA) is a commonly encountered co-morbid condition in patients undergoing surgery and is associated with a higher risk of postoperative adverse events. The objective of this meta-analysis was to investigate the effectiveness of CPAP in reducing perioperative Apnea Hypopnea Index (AHI), length of hospital stay (LOS) and the risk of postoperative adverse events in OSA patients undergoing surgery.

Methods: A systematic search of the literature databases was carried out. We reviewed the studies that included: 1) adult surgical patients (> 18 yrs old) with information available on OSA; 2) patients using either perioperative CPAP or no-CPAP; 3) available reports on preoperative and postoperative AHI, LOS and postoperative adverse events; 4) all published studies in English including case series.

Results: Six studies including 904 patients were eligible for the meta-analysis. The preoperative baseline AHI without CPAP was reduced significantly with postoperative CPAP use (preoperative AHI vs. postoperative AHI 37±19 vs 12±16 events/h P<0.001). LOS was significantly shorter for CPAP group versus no-CPAP group (5.5±2 vs. 9.7±10 days P=0.05). The meta-analysis for postoperative adverse events was carried out in 904 patients (CPAP n=471, events=134; no-CPAP n=433, events=133 P=0.19). There was no significant difference in the postoperative adverse events between the two groups, with a trend towards CPAP treatment reducing the risk.

Conclusion: Our meta-analysis suggests that patients using CPAP had significantly lower postoperative AHI and LOS. There was no significant difference in the postoperative adverse events between CPAP and no-CPAP treatment. There may be potential benefits in the use of CPAP during the perioperative period.

References

1.   Anesth Analg 2014;118:251–3.

2.   Chest 1995;107:367–74.

3.   Mayo Clin Proc 2001;76:897–905.

4.   Surg Obes Relat Dis 2008;4:512–4.

5.   Anesthesiology 2013;119:837–47.

6.   Can J Anaesth 2009;56:819–28.

7.   Chest 2013;144:72–8.

Study or Subgroup	CPAP Events	CPAP Total	No CPAP Events	No CPAP Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Gupta 2001	9	33	30	68	14.6%	0.62 [0.33, 1.15]
Jensen 2008	1	144	3	140	2.3%	0.32 [0.03, 3.08]
Liao 2009	61	150	42	90	39.0%	0.87 [0.65, 1.17]
Liao 2013	47	87	47	90	34.3%	1.03 [0.78, 1.36]
O'Gorman 2013	10	43	9	43	6.7%	1.11 [0.50, 2.46]
Rennotte 1995	6	14	2	2	3.1%	0.52 [0.24, 1.12]
Total (95% CI)		471		433	100.0%	0.88 [0.73, 1.06]
Total events	134		133			

Heterogeneity: Chi² = 5.45, df = 5 (P = 0.36); I² = 8%
Test for overall effect: Z = 1.32 (P = 0.19)

Favours [CPAP]   Favours [no CPAP]

Figure 1: Forrest plot, Association of Postoperative Outcomes in Patients with CPAP vs no CPAP Treatment.

Respiratory Impairment is Common During Routine Colonoscopy

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Study objectives The use of sedatives and opiate analgesics during endoscopy is associated with increased collapsibility of the upper airway and suppression of ventilatory drive, which may lead to respiratory impairment. In this observational study, we characterized the frequency and nature of apneas and impaired oxygenation during a commonly performed outpatient procedure.

Methods Consecutive patients undergoing routine colonoscopy were enrolled if they were between the ages of 18 and 72, had no active cardiopulmonary disease and provided informed consent.   All patients received standard care as routinely provided at the study site, which includes the administration of intravenous sedative and analgesic agents by endoscopy staff, and administration of oxygen at 2L/min by nasal cannula. Patients were monitored and assessed according to published guidelines based on recommendations from the American Society of Anesthesiologists. Although capnography is now routinely employed at the study site, it was not used at the time the study was conducted. Moderate sedation was achieved by an initial bolus of 2-3 mg midazolam plus either 25-50 mg meperidine or 25-50 mcg fentanyl. Additional doses were administered every two minutes as required to maintain the patient in a state of moderate sedation characterized by exhibiting purposeful responses to verbal or tactile stimuli.   The predetermined threshold for increasing administered oxygen was an oxygen saturation (SpO_2) < 92%. All patients underwent comprehensive respiratory monitoring (Nox T3, CareFusion, San Diego, CA) which continuously measures SpO_2 by pulse oximetry and determines the frequency and classification of apneas (obstructive, central, or mixed) by measuring nasal airflow and respiratory effort. Data were analyzed by the T3 monitor using internal algorithms. All study participants completed the STOP-Bang questionnaire prior to the procedure.

Findings The study population consisted of 9 females and 15 males. Demographic characteristics expressed as mean values ± S.D. were: age 60 ± 12.2 yrs; BMI 25.9 ± 4.6 kg/m^2; STOP-Bang score 2.8 ± 1.5. Apneas of at least 20 sec duration occurred in 74% of patients. Of the 41 apneas observed, 21 were obstructive, 17 were central and 3 were mixed. The mean duration of each episode was 45.6 ± 5.72 sec (range 20 – 68 sec).   Sixteen patients exhibited a decline in SpO_2 of > 4% for at least 10 sec; in 10 patients supplemental oxygen was increased. 60% of apneas and 64% of episodes of declining SpO_2 occurred within the first 10 min of the procedure. Review of the procedure records did not identify any airway support interventions such as jaw thrust, or reduction of sedative dosage in response to respiratory impairment.   There was no correlation between STOP-Bang score and the frequency of apneas, and no adverse consequences of apnea or oxygen desaturation were identified.

Interpretation   In this common clinical setting, sedation-related respiratory impairment occurs frequently, particularly during the initial portion of the procedure, and may not be recognized by medical personnel. These observations emphasize the need for close ventilatory monitoring, and indicate that interventions aimed at preventing respiratory impairment could improve patient safety in this setting.

Re-Modeling The STOP-Bang Score: Can The Sensitivity and Specificity Be Improved? An Explorative Study.

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Introduction:

The STOP-Bang (SB) questionnaire is a simple effective diagnostic screening tool for obstructive sleep apnea (OSA) that uses 8 parameter scoring for a possible total of 8 points. We hypothesized that re-modeling the point values to emphasize certain OSA characteristics – SB-modified (SBmod) – could improve the SB's sensitivity and specificity. Recent evidence suggesting a link between OSA and metabolic syndrome (MetS) prompted a third model - SBMetS – to be developed and tested.

Methods:

Following written informed consent, we prospectively enrolled patients presenting for an overnight polysomnography (PSG) at a tertiary care medical center. Data collection included demographics, medical history, PSG results and neck and waist circumferences. The presence of MetS was determined by using NCEP/ATPIII criteria[1]. The original, modified and MetS SB scores are shown in table 1. OSA severity was adjudicated as follows: AHI 5 – 15 mild, 16 – 30 moderate, >30 severe. The area under the ROC curve (AUC) for none vs any, mild vs moderate/severe, and mild/moderate vs severe OSA, and sensitivity/specificity analyses for cut-off values were performed. A $p < 0.05$ was significant.

Results:

258 patients (44% ♀) were enrolled with an age of 51 ± 15 years, a body mass index of 32.2 ± 8.1 kg/m^2, a neck circumference of 40.4 ± 7.6 cm and a 30 % prevalence of MetS.
Mild, moderate and severe OSA was found in 31.6 %, 18.6 % and 25.6 % respectively.
For none vs any OSA the AUC was best for SBMetS (0.80) followed by SBmod (0.79) and the SB original (0.77). The AUC of the SBmod was significantly different from the SB original ($p = 0.02$).

There was no significant difference for all other AUC comparisons. A sensitivity and specificity analysis identified best cut-off values for different OSA severities which were very similar between scoring systems.

Conclusion:

Although the SB modified had a significantly better AUC for none vs any OSA, the degree of this difference may not be clinically relevant, to warrant its implementation. SB original, modified and MetS were very similar in discriminating OSA severity in this study. Compared to the original SB questionnaire, the new models tested in this study were all suited to identify patients at risk for OSA but not consistently better. The prevalence of MetS was 30 % in this prospective cohort.

Refs:
1. Alberti KG et al. Circulation. 2009;120:1640-5

Table 1. STOP-Bang scoring methods

Parameters	STOP-Bang Original	STOP-Bang Modified	STOP-Bang MetS
Snoring	1	1	1
Tired	1	0.5	0.5
Observed gasping	1	1	1
Pressure (HTN)	1	1.5	1.5
BMI > 40	1	0.5	0.5
Age > 50 (+ > 65)	1 (+ 0)	0.5 + 0.5	0.5 + 0.5
Neck circumference (F=40, M=43)	1	1.5	1.5
Gender – ♂ (postmenopausal ♀)	1 0	1 0.5	1 0.5
MetS present	0	0	2
Total max points	8	8	10

MetS = metabolic syndrome

Does a Semi-Upright Position During Sleep Prevent Postoperative Worsening of Apnea Hypopnea Index in Patients with Obstructive Sleep Apnea (OSA)?

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Background

There is increasing evidence that the severity of obstructive sleep apnea (OSA) increases in the postoperative period. Currently no efficacy data on the post-operative use of positional therapy is available for patients with OSA   Our objective was to determine whether a semi-upright patient position in the postoperative period would prevent the worsening of postoperative apnea-hypopnea index (AHI).

Methods

Following REB approval, patients visiting preoperative clinics with consents underwent preoperative portable polysomnography (PSG). Patients with OSA (AHI $\geq$5 events/h), were randomized into the treatment group, semi-sitting position (45 degrees incline, Group P), or control group (supine position, Group C). The bed angle was measured by using either an in-built bed-angle monitor or a goniometer, at the beginning and end of night. All patients were monitored for three postoperative nights using oximetry and underwent a PSG on postoperative night 2 (N2) or night 3 (N3). The primary outcome measurement was postoperative AHI. ANCOVA analysis was used to compare change of AHI as a continuous variable from baseline between two groups.

Results

Eighty-three OSA patients undergoing mainly orthopedic and general surgeries were enrolled after randomization (Group P: 41 and Group C: 42). There was no difference between the two groups in baseline demographics and comorbidities. Forty-six patients (Group P: 25 and Group C: 21) completed PSG on postoperative N2/N3. The AHI and oxygen desaturation index (ODI) increased postoperatively within the groups, indicating worsening of severity of OSA (Table). Based on intention-to-treat analysis, no significant difference was observed in AHI or ODI on postoperative N2 and N3 between two groups (p >0.05) (Table).

Conclusion. This proof-of-concept trial demonstrated feasibility of use of semi-sitting position amongst OSA patients postoperatively. Semi-sitting position did not prevent postoperative worsening of severity of OSA compared to the supine group. Future trials with sufficient power may be needed to detect clinically significant change in AHI and explore this further.

Table. Effect of semi-sitting position on various sleep related parameters compared to the supine position (Control).

Variable	Supine (n=25)			Semi sitting (n=21)			Between group (P-value)
	Pre-Surgery	Post-Surgery	Within group (P-value)	Pre-Surgery	Post-Surgery	Within group (P-value)	
AHI	20.2±14	25.0±26	0.001	22.0±11	22.9±27	<0.001	0.741
ODI	21.8±13	25.0±23	0.001	22.0±13	24.5±26	<0.001	0.281

AHI: Apnea-hypopnea Index, RDI: Respiratory disturbance Index, ODI: Oxygen desaturation index.

Development and Validation of a Morphological Preoperative Obstructive Sleep Apnea Prediction Score: the DES-OSA Score

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Background: Obstructive Sleep Apnea (OSA) significantly increases the perioperative risk. American Society of Anesthesiologists' guidelines insist on the necessity of identifying OSA patients during the preoperative period[1,2]. We planned to develop a preoperative prediction score based on the morphological characteristics of the OSA patients. We call it the DES-OSA Score.

Methods: Following informed consent, patients and IRB approvals, we included 149 patients scheduled for an overnight polysomnography (OPS) in our sleep study center. Before the OPS, we measured several morphological metrics of their body, face, and neck. According to their value, each of them received a 1, 2 or 3 point(s) score, as indicated in the table below. After the OPS, the AHI (Apnea Hypopnea Index, which is defined by the number of apnea and hypopnea per hour) was calculated for each patient. Different combinations of morphological metric scores were then summed and tested for their ability to predict a severe OSA (AHI > 30)[3]. This ability was calculated using ROC curve analysis and prediction probability (PK). A two-tailed P value lower than 0.05 was considered significant.

Results: 10 patients were excluded for technical reasons. Among all tested prediction scores, the best one took account of four parameters: the *Mallampati* score, the distance between the thyroid and the chin (DTC), the body mass index (BMI) and the neck circumference (NC). Our score is illustrated in Table 1. The PK for an AHI > 30 was 0.868 (95% CI: 0.81-0.92). The area under the curve was 0.83 (95% CI: 0.735-0.926). Sensitivity (Se) and Specificity (Sp), expressed in %, were 100 (Se) and 28.1 (Sp) for a summed score > 3, 73.1 (Se) and 78.9 (Sp) for a summed score > 5, and 53.8 (Se) and 94.7 (Sp) for a summed score > 6, respectively.

Discussion: Our study defines a simple, morphological and predictive score, aimed at detecting OSA patients preoperatively. The results of our score vary between 2 and 12. A score > 3 presents a sensitivity of 100% and a score > 6 presents a specificity of 94.7% to identify an OSA patient with an AHI > 30. The best valuable threshold is certainly a score higher to 5 points.

TABLE 1 (Illustration of the DES-OSA Score):

	1 pt	2 pts	3 pts	
Mallampati	I	II	III-IV	
DTC (cm)	> 6	5 - 6	< 5	
NC (cm)	> 37	> 42	> 48	
BMI (kg/m^2)	> 28	> 39	> 41	
			TOTAL :	

References:

[1] Gross JB, *et al.*, Anesthesiology 2006;104:1081-93
[2] Gali B. *et al.*, *J Clin Sleep Med* 2007;3:582-588
[3] Adesanya AO. *et al.*, Chest;2010:138:1489-1498

Adherence to Continuous Positive Airway Pressure (CPAP) Therapy

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Background: Obstructive Sleep Apnea (OSA) represents a perioperative risk. Continuous positive airway pressure (CPAP) therapy has demonstrated its ability to reduce this risk. However, many patients don't adhere to this treatment. Our study was designed to identify patients with poor adherence to CPAP therapy.

Methods: After IRP approval and informed consent, we include 90 consecutive patients who were treated by CPAP for over a year. According to a CPAP use of more or less than 4 hours per night, they were split into two groups: adherent or non-adherent. 62 potential causes of non-adherence were listed and presented to patients. The questions were divided into five categories: demographic and socioeconomic, CPAP-related problem, upper airway-related problem, physiopathology and beliefs about health. A multivariate logistic regression was used to identify significant causes of non-adherence to CPAP therapy. A two-tailed P value lower than 0.05 was considered significant.

Results: 75 patients (83.3%) were considered to be adherent and 15 (16.7%) as non-adherent. Three criteria were significant for adherence to CPAP (OR ; CI 95%) : 1) being aware of the risk of complications if not using CPAP (2.54 ; 1.36-4.75) ; 2) being aware that CPAP treatment is effective (3.19 ; 1.2-8.46) ; 3) feeling of being less sleepy during the day after starting CPAP therapy (1.74 ; 1.2-2.52). One criteria was significant for non-adherence to CPAP: feeling of breathlessness with the CPAP mask (0.42 ; 0.25-0.72). Figure 1.

Conclusions: Our study corroborates already published data but highlights previously unidentified factors of compliance. Although our two groups are not fully matched, our results clearly isolate 4 criteria that every anesthesiologist should seek during the preoperative visit. Our results must be confirmed by a study on a larger scale.

Clinical Implications: Our study would allow detecting more efficiently non-adherent patient to

CPAP therapy. Isolating insufficiently treated OSA patients with increased postoperative risk would allow better orienting toward in- or outpatient surgery management.

FIGURE 1:
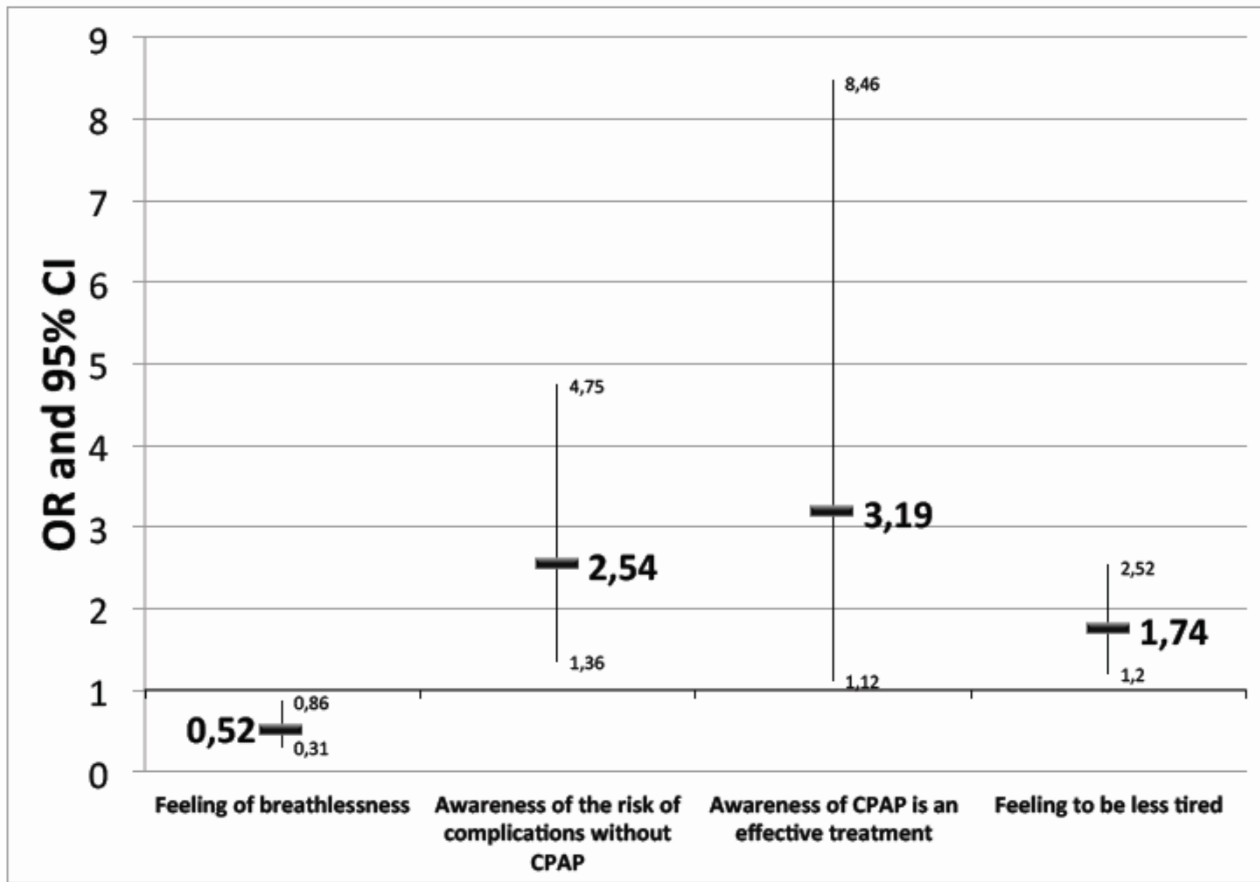
Identifying the Non-Sleep Apnea Patients Who May Develop Postoperative Sleep Disordered Breathing

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Background: Recently published data show that postoperative apnea hypopnea index (AHI) was significantly increased in a proportion of patients without preoperative sleep apnea (non-sleep apnea).[1] The objective of this study was to explore the identification of the preoperatively non-sleep apnea patients who may develop postoperative moderate-to-severe sleep disordered breathing (SDB).

Methods: This is a prospective observational study. Following approval from Institution Research Ethics Board, consented preoperative patients were invited to undergo sleep studies with a portable device (Embletta x100) preoperatively (preop) at home, first (N1), and third (N3) postoperative night in the hospital or at home. The sleep study recordings were scored by a certified sleep technologist. The patients (n=120) without preoperative sleep apnea were selected. Patients with AHI >15 events/h on either postoperative N1 or N3 was defined as postoperative moderate-to-severe SDB (postop SDB). Patients with AHI ≤15 events/h on both postoperative night 1 and 3 were defined as postop non-SDB group. Logistic regression was used to evaluate predictors of the occurrence of postoperative moderate-to-severe SDB.

Results: Of 120 non-OSA patients who completed postoperative N1 and/or N3 polysomnography, 31 (26%) patients had postop SDB. To explore the factors that may be associated with the occurrence of postoperative SDB, the variables with significant difference between the two groups from clinical characteristics and preoperative polysomnography were first evaluated against the occurrence of postoperative moderate-to- severe SDB by univariate logistic regression. Age, preoperative AHI, preoperative respiratory disturbance index, total arousal index, respiratory arousal index, respiratory effort related arousals index, awake average SpO_2, sleep average SpO_2 were found to be significant. Since the correlation coefficient between preoperative RDI and AHI, total arousal index, respiratory arousal index

and total combined cumulative apnea and hypopnea duration as a percentage of sleep time (TAHD %) was greater than 0.5, preoperative RDI was chosen to represent the above variables in multivariate logistic analysis. Based on the same reasoning, preoperative average SpO_2 and age were also selected for multivariate logistic regression analysis. The multivariate logistic regression analysis showed that age and preoperative RDI were significantly associated with the occurrence of postop moderate-to-severe SDB (Table 1).

The area under the receiver operating characteristic (ROC) curve for preoperative RDI to predict postoperative SDB was 0.68, which was close to 0.73 from multivariate logistic regression analysis including age, preoperative RDI and average SpO_2. To keep it simple and practical, we further explored the predictive performance of preoperative RDI. The optimal RDI cut-off with maximal predictive accuracy was ≥7.4 events/h. The sensitivity privilege RDI cut-off with sensitivity ≥90% was ≥4.5 events/h. The specificity privilege RDI cut-off RDI with specificity ≥90% was ≥ 13.6 events/h. The predictive performance of three cut-offs for postop SDB was shown in Table 2.

Conclusions: Twenty-six percent of preoperatively non-sleep apnea patients developed moderate-to-severe SDB after surgery. Preoperative RDI and age were significantly associated with the occurrence of postoperative moderate-to-severe SDB. Preoperative RDI ≥4.5 events/h detected 90% patients developing moderate-to-severe postoperative SDB.

Reference: 1. Chung F, et al, Anesthesiology 2014; 120: 287-98.

Table 1 Predictors for the occurrence of postoperative SDB (multivariate logistic regression)

Dependent variable	Independent variable	unit	Estimate	Odds Ratio (95% CI)	p
Postoperative SDB	Age	1	0.047±0.020	1.048(1.008-1.089)	
		5		1.264 (1.041-1.534)	0.018
		10		1.597 (1.084-2.352)	
	Preop RDI	1	0.103±0.037	1.108 (1.030-1.192)	
		5		1.670 (1.158-2.409)	0.006
		10		2.789 (1.341-5.803)	
	Average SpO$_2$	1	-0.145±0.148	0.865(0.648-1.156)	0.327

Note: SDB=sleep-disordered breathing, Preop=preoperative, RDI=respiratory disturbance index,

Table 2 Predictive performance of different cut-offs of preoperative respiratory disturbance index for the occurrence of postoperative moderate-severe SDB

Cut-offs	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
RDI ≥ 4.5 events/h	0.903(0.799-1.00)	0.348(0.249-0.447)	0.326(0.247-0.425)	0.912(0.816-1.00)
RDI ≥ 7.4 events/h	0.581(0.407-0.754)	0.618(0.517-0.719)	0.346(0.216-0.476)	0.809(0.715-0.902)
RDI ≥ 13.6 events/h	0.258(0.104-0.412)	0.910(0.851-0.970)	0.500(0.255-0.745)	0.779(0.699-0.859)

Note: RDI = respiratory disturbance index. SDB=sleep-disordered breathing

Perioperative Utilization of CPAP, Oximetry Monitoring and Supplemental Oxygen in Patients with Obstructive Sleep Apnea

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Introduction:

Obstructive sleep apnea (OSA) has been associated with adverse postoperative outcomes such as respiratory failure, cardiac events and higher perioperative resource utilization. Still, guidelines on the perioperative management of patients with sleep apnea are largely based on expert opinion and conclusive data on national practice are lacking. We therefore aimed to analyze the rates of perioperative utilization of CPAP, oximetry monitoring and supplemental oxygen application using a large claims based database.

Methods:

We analyzed 142,650 patients with OSA undergoing either elective primary total hip or knee arthroplasty or anterior cervical or posterior lumbar vertebral fusion between January 2006 and December 2013 from the Premier Perspective database. Perioperative utilization of CPAP therapy and oximetry monitoring, as well as supplemental oxygen on day of surgery (D_0) and on postoperative day 1 (D_1) was determined using billing data and ICD-9 CM codes. Patient and hospital related characteristics, length of stay (LOS) and cost of hospitalization (COH) were compared between patients with and without these interventions.

Results:

In our sample, 16.2% received perioperative CPAP, 37.0% were monitored with oximetry and 47.8% of all patients reportedly received supplemental oxygen on D_0. We saw a minimal increase of 0.6% in CPAP utilization between 2006 and 2013. A decrease of 11.1% and 5.4% was noted for monitoring and supplemental oxygen, respectively. Of those monitored by oximetry 58.2% were still monitored on D_1 vs. 10.3% that were not initially monitored. White patients were more commonly monitored and received more supplemental oxygen but received less CPAP therapy compared to other racial groups. While teaching hospitals were slightly more likely to use CPAP therapy, oximetry monitoring and supplemental oxygen application on D_0 were less frequently utilized (16.6%, 28.8% and 41.7%, respectively). Mean COH was increased by 2,743 USD for patients with CPAP therapy. For patients receiving oximetry monitoring and supplemental oxygen the average cost decreased by 452 USD (P=0.016) and 776 USD, respectively. Patients with either variable had a tendency to stay

longer in hospital, the maximum being + 0.6 days for patients for CPAP therapy. All differences are considered to be statistically significant (P<0.001), if not otherwise stated.

Conclusion:
This analysis shows a steady perioperative use of CPAP therapy over the last 7 years in patients with OSA undergoing elective orthopedic surgery. Patients monitored with oximetry on the day of surgery were more commonly monitored the following day, and only 10% of initially not monitored patients required monitoring the next day. Still, there is some variability on the decision to monitor patients based on patient and hospital related characteristics. The fact that patient care for patients receiving CPAP therapy was more costly might be based on the use of CPAP itself but may reflect the overall care of a sicker patient group. The reasons for a tendency to lower COH within the same LOS for oximetry monitoring and supplemental oxygen requires further investigation in order to elucidate possible causality.

Effect of CPAP, Oximetry Monitoring and Supplemental Oxygen on Postoperative Outcome in Obstructive Sleep Apnea

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Introduction:

Previous studies have shown the detrimental effect of obstructive sleep apnea (OSA) on postoperative outcome and noted an increase in complications as well as in resource utilization.[1] While published perioperative treatment guidelines are based mainly on expert opinion, evidence on the effect of basic perioperative management strategies is largely missing. With this analysis we aimed to elucidate the effect of perioperative CPAP utilization and oximetry monitoring as well as the use of supplemental oxygen delivery on postoperative outcomes.

Methods:

142,650 patient records of elective primary total hip or knee arthroplasty, as well as anterior cervical and posterior lumbar vertebral fusion from January 2006 to December 2013 from the Premier Perspective database were analyzed. We compared demographics and postoperative complications of OSA patients with or without perioperative CPAP therapy use, oximetry monitoring as well as supplemental oxygen delivery on the day of surgery. These variables were determined using billing data and ICD-9 CM codes.

Results:

OSA patients receiving CPAP were on average of similar age, more commonly obese and had a higher Deyo comorbidity index compared to those not receiving interventions. Patients with CPAP use developed cardiac (7.7% vs. 2.1%) and pulmonary complications (1.6% vs. 0.8%) more frequently. While those receiving oximetry monitoring had a tendency for lower rates of cardiac complications (0.9% vs. 1.0%; P=0.014) and higher occurrences of pulmonary complications (3.2% vs. 2.9%; P=0.001), no significant effect could be shown between the groups for supplemental oxygen use. CPAP use was associated with more frequent ICU admission (18.2% vs. 12.6%), while oximetry monitoring was associated with lower rates of ICU service utilization (11.8% vs. 14.5%). Supplemental oxygen delivery did not seem to affect these rates differentially. Mechanical ventilation was less frequently recorded in patients with monitoring or supplemental oxygen (0.6% vs. 1.6% and 0.4% vs. 2.1%; respectively), while CPAP use was associated with higher rates of mechanical ventilation (2.7% vs. 1.0%). All mentioned differences are statistically significant (P<0.001) unless otherwise specified.

Conclusion:

In this study, CPAP therapy seemed to be initiated more frequently in OSA patients that were on average more obese and had a higher comorbidity burden. Because no direct causal relationships can be established from our data, the finding of increased rates of postoperative complications and resource utilization may be associated with worse disease or comorbidity burden. The reduced rates of ICU admissions associated with oximetry monitoring, and a beneficial effect of both monitoring and supplemental oxygen on the requirement for mechanical ventilation may reflect truly protective effects. However, it is entirely possible again that lower OSA disease burden and ICU care as a preventive rather than being reflective of complication response may be a factor in choice of the monitoring environment. As the increased rate of complications might be explainable by multiple effects, accounting for possible confounders by multilevel logistic regression modeling is the next step in our analysis of these data.

References:

1. Memtsoudis SG, Stundner O, Rasul R, Chiu YL, Sun X, Ramachandran SK, Kaw R, Fleischut P, Mazumdar M: The impact of sleep apnea on postoperative utilization of resources and adverse outcomes. Anesth. Analg. 2014; 118:407–18

A Simple and No-Cost TSE-Alloteh Nasal CPAP Mask/Circuit Assembly to Maintain Spontaneous Respiration and to Improve Oxygenation in Morbidly Obese OSA Patients During Intra-Operative Sedation and Awake Intubation: Four Challenging Cases

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Introduction: Patients under monitored anesthesia care (MAC) routinely receive IV sedation and supplemental O_2. 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 BiPAP at home during sleep. Under sedation, they may require frequent chin-lift, jaw-thrust or insertion of a nasal trumpet. To avoid the risk of epistaxis with inserting a nasal trumpet, a pediatric face mask has been used to provide nasal CPAP for the OSA patients under intra-operative sedation (TSE-Alloteh nasal CPAP assembly)[1-4]. A pediatric mask with fully inflated air cushion is placed over the nose, secured with head straps and connected to an anesthesia breathing circuit and machine (Photo 1-4). It has been shown to improve oxygenation in sedated OSA patients[1-4]. We report here four challenging cases using this simple technique to maintain spontaneous respiration and to improve oxygenation in obese OSA patients under intraoperative sedation or during awake intubation.

Case 1: A 61 y/o morbidly obese female (BMI 56 kg/m^2) presented for gynecological examination under anesthesia, hysteroscopy and D&C for postmenopausal bleeding. She had multiple comorbidities including anemia, atrial fibrillation, COPD, CAD, CHF, HTN, Renal insufficiency, respiratory failure (required supplemental O_2 at nursing home), ambulatory difficulty (secondary to hip pain), lower extremity edema, gastroesophageal reflux, scoliosis, kyphosis, limited neck extension, a difficult airway and OSA requiring nocturnal CPAP. Because of her multiple comorbidities, it was decided to proceed with spinal anesthesia and minimal IV sedation. After spinal anesthesia was performed, the patient assumed supine position, with her back elevated (15 degree incline), this nasal CPAP assembly using an infant mask (#2) was used and the APL valve was adjusted to deliver CPAP (6 cm H_2O) with a mixture (0.7 FiO$_2$) of O_2 (4 L/min) and air (1 L/min). She maintained spontaneous respiration with tidal volume of 167-200 ml, RR of 24-27 breaths/min and peak expiratory pressure of 12-14 cm H_2O. Her O_2 saturation (Sat) was 100% throughout the procedure. She tolerated the procedure well and recovered without complication.

Case 2: A 79 y/o obese male (BMI 35 kg/m^2) with HTN, NIDDM, OSA and non-compliance with home CPAP, presented for atrial flutter ablation under sedation. A toddler face mask (#3) was used to provide CPAP from the beginning (Photo 2). Sedation was initiated with 2 mg of midazolam and 50 mg of propofol. Remifentanyl, starting at 0.03 mcg/kg/min and increasing to 0.05 mcg/kg/min was used for improved procedure tolerance. Shortly after bolusing

propofol, a one minute apneic episode was managed with assisted nasal ventilation. Once spontaneous respiration resumed, the APL valve was adjusted to provide CPAP of 5-8 cm H_2O. Because the $ETCO_2$ waveforms were not adequately shown in an old capnography monitor and chest excursion was difficult to assess under the drapes, the reservoir breathing bag was inverted in order to exaggerate its movement and augment patient monitoring. The patient tolerated the procedure well without further episodes of apnea and maintained 99-100% O_2 Sat with 0.7-0.8 FiO_2 throughout.

Case 3: A 48 y/o morbidly obese male (BMI 45 kg/m^2) presented for irrigation and debridement of left ankle ulcer. He had prior extremely difficult endotracheal intubation, status post tracheostomy several year prior, severe peripheral neuropathy, CAD, IDDM, spina bifida and OSA requiring home BiPAP (16/7 cm H_2O). Because of his multiple comorbidities and severe peripheral neuropathy, it was decided to proceed without local anesthesia or sedation. He was on nasal cannula (NC) O_2 (2 L/min) and his O_2 Sat was 95% while sitting upright. His oropharynx was pretreated with 5% lidocaine cream for possible awake fiber optic intubation if need arose. He complained of dyspnea while lying down with a foam wedge (30 degree incline). His O_2 Sat decreased to 92% even with NC O_2 (5L/min). He requested a BiPAP mask and was fit with an adult facial mask to provide CPAP using an adult anesthesia breathing circuit, but felt more comfortable when an infant mask (#2) to provide CPAP (5 cm H_2O) with a mixture (0.75 FiO_2) of O_2 (5 L/min) and air (2 L/min). He maintained spontaneous respiration and 100% O_2 Sat throughout the procedure. He tolerated the procedure well without complication. The patient was happy with this nasal CPAP mask and gave consent for showing the photography without covering his eyes (Photo 3). Subsequently, the patient required BKA under femoral/sciatica block and requested the same nasal CPAP mask assembly.

Case 4: A 62 y/o obese female (BMI 48 kg/m^2) with HTN, asthma, sarcoidosis, possible cor pulmonale, steroid-induced DM, GERD, anemia and OSA presented for emergency incision and debridement of perirectal abscess and necrotizing fasciitis. An awake endotracheal intubation was planned because of she had an obviously difficult airway (a Class III airway, small mouth and short thick neck), a full stomach and morbid obesity. After the patient received albuterol nebulizer treatment in a beach chair position, an infant mask (#2) was used to provide nasal CPAP (Photo 4). The patient breathed comfortably with CPAP (5-6 cm H_2O) provided by adjusting the APL valve. She then received IV midazolam (2 mg x 2), fentanyl (50 mcg) and propofol (50 mg) during administration of topical anesthesia with Cetacaine sprays and 2% lidocaine gel "lollipop". However, she could not tolerate lidocaine "lollipop". Her O_2 Sat decreased from 100% to 80% due to gagging on lidocaine "lollipop" which was immediately removed. Her mouth was quickly closed and 4 small breaths were delivered through the nasal mask with closed APL valve. Her O_2 Sat quickly increased to 96% and to 100% after she resumed spontaneous respiration with CPAP. After additional topical

anesthesia was provided with 5cc of 3% viscous lidocaine, a quick awake videolaryngoscope (VL) look revealed full view of the vocal cords. Her mouth was closed and made sure she was fully oxygenated. Endotracheal intubation was easily performed with VL. Simultaneously, she was given IV propofol (140 mg) and rocuronium (40 mg). She tolerated the procedure well under general anesthesia and was kept intubated overnight. She was extubated next day and had no anesthetic complication.

Discussion: This nasal CPAP assembly maintained spontaneous respiration and improved oxygenation in all 4 obese OSA patients during intraoperative sedation or awake intubation. It proactively prevented severe desaturation by allowing immediate assisted nasal mask ventilation. It takes only 2-3 minutes to assemble this nasal mask/circuit using existing anesthesia equipment/machine. It may improve patient safety at no extra cost.

Ref: 1. www.TSEMask.com; 2.SAMBA 28th Annual Meeting, April 11-14, 2013; 3.SASM 3rd Annual Meeting:P27, 35 & 43, Oct 10-11, 2013

Photo 1. Nasal CPAP Assembly

Photo 2. Nasal CPAP for AF Ablation

Photo 3. Nasal CPAP without Sedation

Photo 4. Nasal CPAP for Awake Intubation

Afternoon Abstracts

Monitoring for Opioid-Induced Advancing Sedation and Respiratory Depression in the Hospital Setting

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Abstract
Adverse events related to opioid-induced unintended advancing sedation and respiratory depression in hospitalized patients are occurring with increased frequency, and these adverse events can have a negative impact on quality and cost outcomes This poster will present current statistics on monitoring practices and an evidenced-based systematic approach for organizations to use in implementing strategies to reduce adverse events secondary to opioid induced advancing sedation and respiratory depression in the hospitalized adult patient. Its goal is to inform the healthcare team on best practices for preventing opioid induced advancing sedation and respiratory depression and inform nurse leaders on implementation strategies to guide change in policies and practice.

Published evidence-based and consensus guidelines emphasize that nurses should assess patients by direct observation, and use of sedation scales, with the addition of continuous monitoring of oxygen saturation and/or ETCO2 for high-risk patients. In a 2013 survey of the Association for Pain Management Nursing membership, serious gaps in best practices were identified: 1) many institutions maintain pain management practices that do not integrate sedation assessments and respiratory parameters as recommended, 2) only 58% of respondents considered patients receiving PCA to be at risk for adverse sedation and respiratory events, 3) 60% of institutions are not using continuous pulse oximetry, and 4) 50% of institutions were using sedation scales inappropriately or not using sedation scales at all.

Framework
An action-oriented framework was developed based on the authors' experiences, strategies recommended by the Institute for Healthcare Improvement (IHI), the National Association of Healthcare Quality (NAHQ) and expert consensus-based best monitoring practices published by the ASPMN, APSF, SAMBA, and ASA. This framework incorporates the systematic

identification of individual, iatrogenic, and pharmacologic risk factors known to be associated with near-miss and adverse events secondary to opioid administration, and suggests structures and processes to promote safe patient care. A step-by-step approach is configured to integrate recommendations by professional societies and organizations, literature-based findings, and interprofessional collaboration to achieve an organization-wide program for reducing opioid-related adverse events.

(Figure 1)
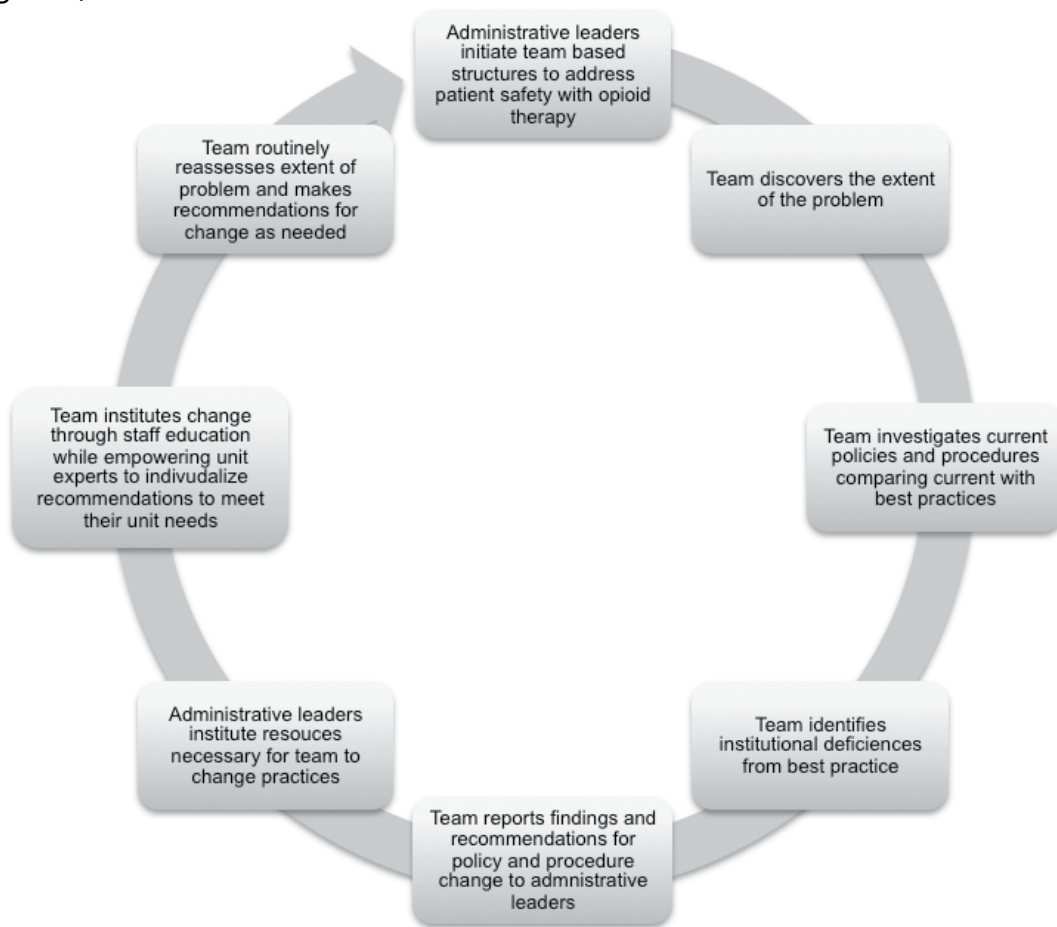
References

1. Joint Commission. (2012). Safe use of opioids in hospitals. *The Joint Commission Sentinel Event Alert*, *49*, 1-5.
2. Kessler et al. (2013). Cost and Quality Implications of Opioid Based Postsurgical Pain Control Using Administrative Claims Data from a Large Health System: Opioid Related Adverse Events and Their Impact on Clinical and Economic Outcomes. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*, *33*(4), 383-391.
3. MacIntyre et al. (2011). Opioids, ventilation and acute pain management. *Anaesth Intensive Care*, *39*(4), 545-58.

4. Chung et al. (2013). Predictive Performance of the STOP-Bang Score for Identifying Obstructive Sleep Apnea in Obese Patients. *Obesity Surgery*, 1-8.
5. Horlocker et al. (2009). American Society of Anesthesiologists Task Force on Neuraxial Opioids. Practice guidelines for the prevention, detection, and management of respiratory depression associated with neuraxial opioid administration. *Anesthesiology*, *110*(2), 218-230.
6. Jarzyna et al. (2011). American Society for Pain Management Nursing guidelines on monitoring for opioid-induced sedation and respiratory depression. *Pain Management Nursing*, *12*(3), 118-145.
7. Joshi et al. (2012). Society for Ambulatory Anesthesia consensus statement on preoperative selection of adult patients with obstructive sleep apnea scheduled for ambulatory surgery. *Anesthesia & Analgesia*, *115*(5), 1060-1068.
8. Jungquist, C.R., Willens, J.S., Dunwoody, D.R., Klingman, K.J., Polomano, R.C. (2013) Monitoring for Opioid Induced Advancing Sedation and Respiratory Depression: ASPMN membership survey of current practice. *Pain Management Nursing*.
9. Luther et al. (2013). Tapping front-line knowledge: identifying problems as they occur helps enhance patient safety. *Healthcare executive*, *28*(1), 84.
10. Proehl et al. (2011). Emergency Nursing Resource: The use of capnography during procedural sedation/analgesia in the emergency department. *Journal of Emergency Nursing*, *37*(6), 533-536.
11. Weinger et al. (2011). No patient shall be harmed by opioid-induced respiratory depression. *APSF Newsletter*, *26*, 21-26.
12. Willens et al. (2013). ASPMN Survey—Nurses' Practice Patterns Related to Monitoring and Preventing Respiratory Depression. *Pain Management Nursing*, *14*(1), 60-65.

Minute Ventilation Formulas in Obese Surgical Patients: Evaluation of the Accuracy of Standard Formulas

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Introduction: Recently, a non-invasive respiratory volume monitor (RVM, ExSpiron, Respiratory Motion, Inc., Waltham, MA) was introduced that provides accurate minute ventilation (MV), tidal volume and respiratory rate measurements in spontaneously breathing patients. Post-operative MV changes have not been systematically studied in the obese population who are considered to have an increased risk of post-operative complications. Current MV reference values based on ideal body weight (IBW) or body surface area (BSA) may not be accurate in this population. The aims of this study are: 1) to describe perioperative

MV changes in in an obese surgical population, and 2) to compare traditional nomogram-based MV references against an intra-operative MV standard and RVM measurements.

Methods: Following IRB approval and written informed consent, continuous respiratory traces were collected using an impedance-based RVM in obese surgical patients receiving general anesthesia (GA). Ventilator settings during GA were assumed to be adjusted to maintain an appropriate end-tidal CO_2 and this intra-operative MV was defined as the standard reference. MV-based respiratory performance was measured at seven time-points perioperatively and compared the individuals MV_{PRED} values based on BSA, IBW a new MV reference model (MVRM) which derived predicted MV values based on a combination of IBW and BSA formulas. Two-sample F-tests for equal variance were used to compare distributions of MV at various time points.

Results: Data from 65 patients (age 45 ± 13 years, BMI 44 ± 8 kg/m^2, were obtained. The preoperative and spirometer MV variances were not significantly different from the intra-operative average-during-surgery MV variance ($p > 0.05$ for each comparison). In contrast, the MV variance at each of the three PACU time-points was significantly greater than the average MV variance during surgery ($p<0.0001$, Figure 1 bottom). Intra-operative MV was 24.5% above the MV_{PRED} by the IBW-based MV prediction, and 15.5% below the BSA-based MV prediction (Figure 1 A&B). MV_{PRED} using the new MVRM formula was most closely associated with intra-operative MV values (4.5% higher, Figure 1C). Within 30 minutes of PACU arrival 9% of patients demonstrated <80% MV_{PRED} and 2% declined to <40%. In the last 30 mins prior to PACU discharge, 17% of patients spent more than 1/3 of the time with less than 40% MV_{PRED}.

At 15 mins prior to PACU discharge, 13% of patients were on average below 80% MV$_{PRED}$ and

2% remained at <40% (Figure 1, bottom).

Conclusions: A wide variability in post-operative MV exists and may reflect individual

responses to surgery, anesthesia and analgesia. A subset of patients was identified with less

than 40% predicted MV possibly indicating an increased risk for respiratory complications.

Our data suggest that traditional MV nomograms appear to be sub-optimal in the obese

population and that a new MVRM formula may provide the best estimate of respiratory

requirement, but further work is required to validate the accuracy and clinical utility of this

formula. Real-time RVM enables respiratory status assessment of non-intubated obese

patients, providing a better understanding of changes in respiratory physiology and a

framework to develop individualized protocols to improve patient safety and satisfaction.
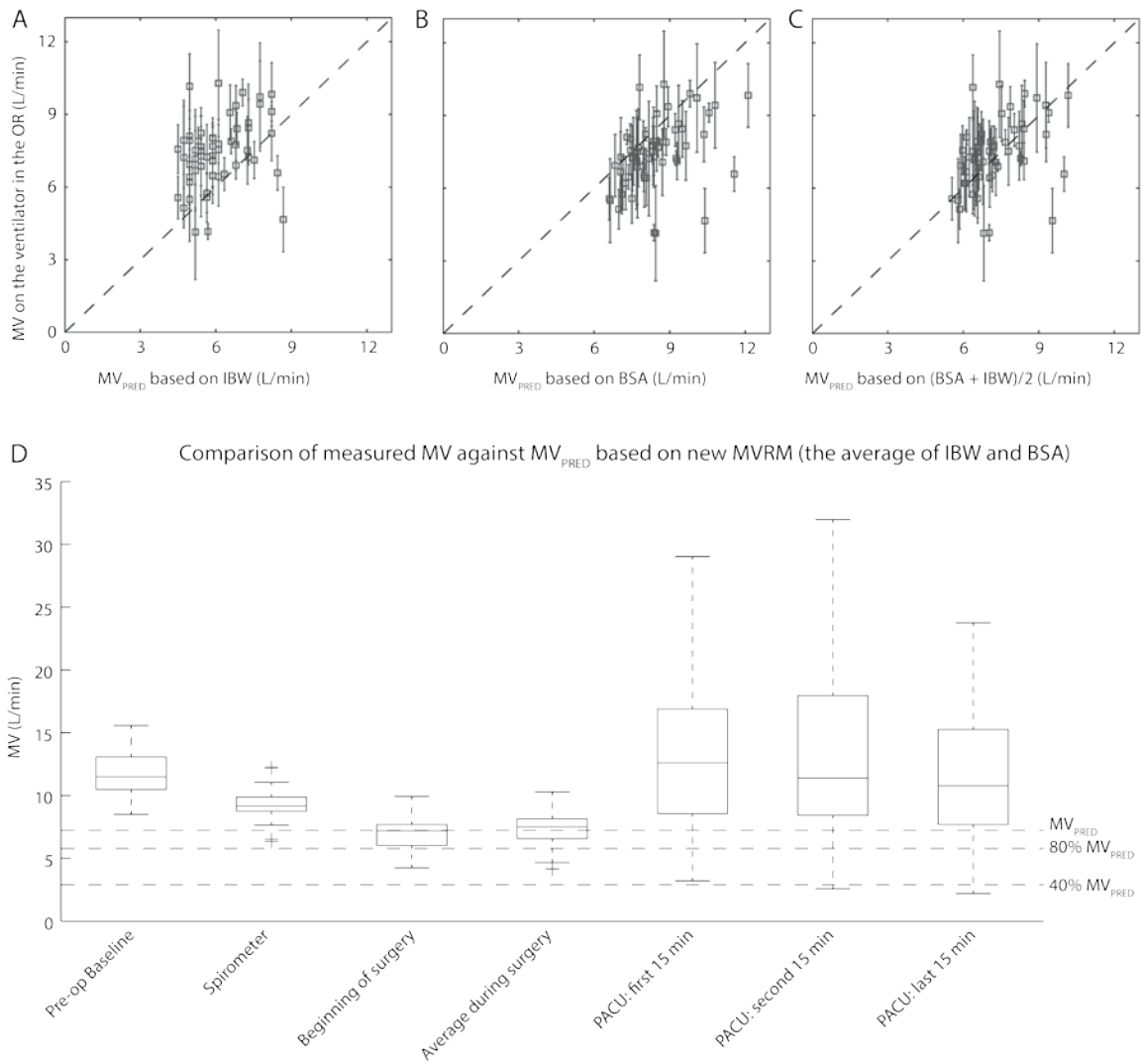
Figure 1: (A-C) Minute ventilation (MV) settings on the ventilator during surgery for the cohort compared to predicted MV (MVPRED) based on standard formulas A) ideal body weight (IBW), B) body surface area (BSA) and C) the new MVRM. The x-axis value represents the average MVPRED from the IBW and BSA formulas. (Bottom) MV measurements at various time-points during the case compared to the average MVPRED. Each box-plot shows the median MV (red line), the box extends from the 25th to 75th percentile, whiskers extend to the most extreme non-outlier data points, and red "plus" sign reflect statistical outliers. Spirometer = minute-long spirometer trial.

Submental Negative Pressure Application Improves Collapsibility of the Passive Pharyngeal Airway

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Background: Upper airway obstruction is a major cause of postoperative respiratory complications. Although the literatures suggest possible clinical usefulness of the postoperative nasal CPAP (continuous positive airway pressure), patients do not always accept the treatment and alternative approaches are to be tested and developed. Pharyngeal airway patency is determined by transmural pressure (the pressure difference between intraluminal and extraluminal pressures) and nasal CPAP dilates the airway by increasing the intraluminal airway pressure. Therefore, one possible alternative is to decrease the extraluminal pressure for increasing the transmural pressure. Despite the possibility, we lack knowledge of influences of the extraluminal soft tissue pressure on the pharyngeal airway patency in humans. We tested a hypothesis that application of negative external pressure (NEP) to the submental region improves collapsibility of the passive pharynx, and obese persons respond to the intervention less than non-obese persons.

Methods: With IRB approval (Graduate School of Medicine, Chiba University: 1579), we recruited 10 obese and10 non-obese adult females undergoing elective surgeries under general anesthesia and obtained written informed consent from each. Static mechanical properties of the passive pharynx were assessed before and during submental NEP

application (-25 and -50 cmH2O) under general anesthesia and paralysis. NEP was applied with using a silicone collar covering the whole submental region and a vacuum pump (cNEP, 5i Science Inc., Carlsbad, CA). Static pressure/area relationships of the retropalatal and retroglossal airways were obtained by step changes of airway pressure during recording of the endoscopic cross-sectional area of each segment. Exponential curve fitting to the measured pressure/are data yields three mechanical parameters such as Amax (measured maximum cross-sectional area), Pclose (closing pressure) and constant K (an index of pharyngeal airway stiffness).

Results: Results are shown in the table. In non-obese subjects, submental NEP application (-25 and -50 cmH2O) significantly decreased the Pclose at both the retropalatal and retroglossal airways and stiffened the retroglossal airway wall as evidenced by significant reduction of the K value. No significant mechanical changes were observed during the submental NEP application in obese subjects.

Discussions: This is the first study demonstrating improvement of airway closing pressures and airway wall stiffness of the passive pharynx particularly at the retroglossal airway region in response to the submental NEP application in human subjects. Obese persons responded to the intervention less than non-obese persons possibly due to differences of the amount of the soft tissue and fat distribution surrounding the pharyngeal airway. The results clearly support involvement of the extraluminal tissue pressure in the pathophysiology of pharyngeal obstruction and indicate submental NEP application as a promising alternative approach for treatment of postoperative upper airway obstruction particularly in non-obese persons.

Conclusion: We conclude that application of submental negative pressure improves collapsibility of the passive pharyngeal airway in non-obese subjects.

	non-obese group (n=10)		obese group (n=10)	
	retropalatal	retroglossal	retropalatal	retroglossal
ΔA_{max}-NEP$_{25}$(cm^2)	0.01±0.17	0.14±0.20	0.03±0.31	0.19±0.32
ΔA_{max}-NEP$_{50}$(cm^2)	0.12±0.27	0.29±0.37£	0.14±0.24	0.31±0.32
ΔK-NEP$_{25}$	0.06±0.10	0.06±0.05*££	0.02±0.06	0.01±0.02
ΔK-NEP$_{50}$	0.08±0.09	0.06±0.04*££	0.03±0.04	0.01±0.04
ΔP_{close}-NEP$_{25}$(cmH$_2$O)	2.3±3.2£	2.9±2.7££	0.7±0.8	1.4±1.7
ΔP_{close}-NEP$_{50}$(cmH$_2$O)	2.0±3.0£	3.7±2.6*££	1.1±1.2	1.0±1.9

*:P<0.05 versus obese group.
£,££:P<0.05, 0.01 versus no NEP application.

SUMMARY: This is the first study testing and demonstrating that application of negative external pressure to the submental region improves collapsibility of the passive pharynx in anesthetized adult persons. The positive responses were only observed in non-obese persons, not in obese persons.

Moderate To Severe Obstructive Sleep Apnea: A Predictor of Difficult Airway

Authors: Eleanor Chew, Edwin Seet, Chew-Yin Wang, Carolyn Yim, Stanley Tam, Frances Chung, Matthew Chan, for the POSA Study Investigators

Background: The risks of difficult mask ventilation, laryngoscopy and tracheal intubation are important considerations in the perioperative management of patients with obstructive sleep apnea. Previously published studies were retrospective or yielded conflicting results.[1-3] As a secondary aim of the international Postoperative Vascular Events in Unrecognized Obstructive Sleep Apnea (POSA) trial, we determined the association between unrecognized OSA and difficult airway in moderate-to-high risk patients undergoing major noncardiac surgery.

Methods: The study was approved by local research ethics committee (ClinicalTrials.gov Identifier: NCT01494181). All patients gave written informed consents. Patients above 45 years, with a history of atherosclerotic disease received preoperative portable sleep monitoring (ApneaLink, Resmed, San Diego, CA) to determine the presence and severity of unrecognized OSA before surgery. We compared the incidence of difficult mask ventilation (defined as inability to maintain oxygen saturation >90% with 100% oxygen and positive pressure ventilation in unassisted anesthesiologist), difficult laryngoscopy [Cormack and Lehane classification 3 and 4] and difficult tracheal intubation [defined as multiple (> 3 or > 10 min) or failed tracheal intubation attempts using conventional laryngoscope] among patients with different severity of OSA based on apnea-hypopnea index (AHI), using χ^2 test.

Results: Among 729 patients in the POSA Study, 491 patients (67.5%) received general anesthesia and 484 patients (66.4%) had tracheal intubation. OSA was found in 302 patients – mild OSA (AHI 5-15) - 33.5%, moderate OSA (AHI 15-30) - 16.7% and severe OSA - 12.2%. Table 1 shows the distribution of laryngeal view and the incidence of difficult tracheal intubation. Patients with moderate-to-severe OSA (AHI ≥ 15) had a higher risk for difficult mask ventilation, difficult laryngoscopy and difficult tracheal intubation, odds ratio (95%CI): 2.91 (1.13-7.54), p = 0.017, -2.57 (1.32-4.98), p = 0.0031 and 2.83 (1.36-5.90), p = 0.0035, respectively.

Conclusions: Unrecognized OSA is common in moderate-to-high risk patients undergoing major surgery. Difficult mask ventilation, difficult laryngoscopy and difficult tracheal intubation are more common in patients with moderate-to-severe OSA.

	Non-OSA	Mild OSA	Moderate OSA	Severe OSA	*p* value
Difficult mask ventilation	5 (2.8%)	3 (1.9%)	2 (2.2%)	8 (12.7%)	0.006
No. of patient	181	158	89	63	
Laryngeal view					0.005
1	105 (59.0%)	99 (62.7%)	38 (48.1%)	27 (47.4%)	
2	63 (35.4%)	49 (31.0%)	32 (40.5%)	20 (35.1%)	
3	10 (5.6%)	9 (5.7%)	8 (10.1%)	10 (17.5%)	
4	0 (0.0%)	1 (0.6%)	1 (1.3%)	0 (0.0%)	
No. of patient	178	158	79	57	
Difficult intubation	8 (4.6%)	7 (4.8%)	9 (12.9%)	7 (14.9%)	0.011
No. of patient	182	162	81	59	

References:
1. Siyam et al. Difficult endotracheal intubation in patients with sleep apnea syndrome. Anesth Analg 2002;95:1098.
2. Kim et al. Preoperative predictors of difficult intubation in patients with obstructive sleep apnea syndrome. Can J Anaesth 2006;53:393.
3. Neligan et al. Obstructive sleep apnea is not a risk factor for difficult intubation in morbidly obese patients. Anesth Analg 2009;109:1182.

Mechanisms of Expiratory Upper Airway Obstruction During Positive Pressure Ventilation Through a Nasal Mask

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Background:

Adequate mask ventilation is an important task for anesthesiologists to ensure patient safety during general anesthesia induction. Observation of partial expiratory airway obstruction, possibly caused by valve-like behavior of the soft palate, during positive pressure ventilation through the nose made Safar recommend mouth-to-mouth breathing for resuscitation (Anesthesiology, 1959). Just recently, Buffington et al. reported that the expiratory obstruction more frequently occurred in anesthetized persons with narrower retropalatal airway (RP) and presence of obstructive sleep apnea (OSA) was its independent risk factor (Open journal of Anesthesiology 2012;2:38-43). None has confirmed the Safar's speculation and clarified mechanisms of the expiratory upper airway obstruction during nasal mask ventilation. We tested a hypothesis that dynamic RP obstruction during nasal mask ventilation causes the expiratory flow limitation, and more frequently occurred in OSA patients.

Methods:

Anesthetized and paralyzed adult persons with or without OSA was ventilated through a nasal mask with the mouth closed and taped for eliminating air leak through the mouth. Nasal airflow, mask and intra-oral pressures were measured while endoscopically detecting occurrence of the expiratory RP obstruction during stepwise increases of the level of PEEP every two to three ventilation cycles from 2 cmH2O to 18 cmH2O and then decreases to 2 cmH2O.

Results:

Dynamic RP closure during expiration occurred in 4 of 6 OSA patients but none of 5 non-OSA persons. As demonstrated in the Figure, the expiratory flow limitation occurred in accordance with the dynamic RP closure and eliminated by increasing the PEEP level. Occurrence of the RP closure and expiratory flow limitation is possibly explained by larger pressure gradient between the intra-oral and mask pressures reflecting transmural pressure across the soft palate.
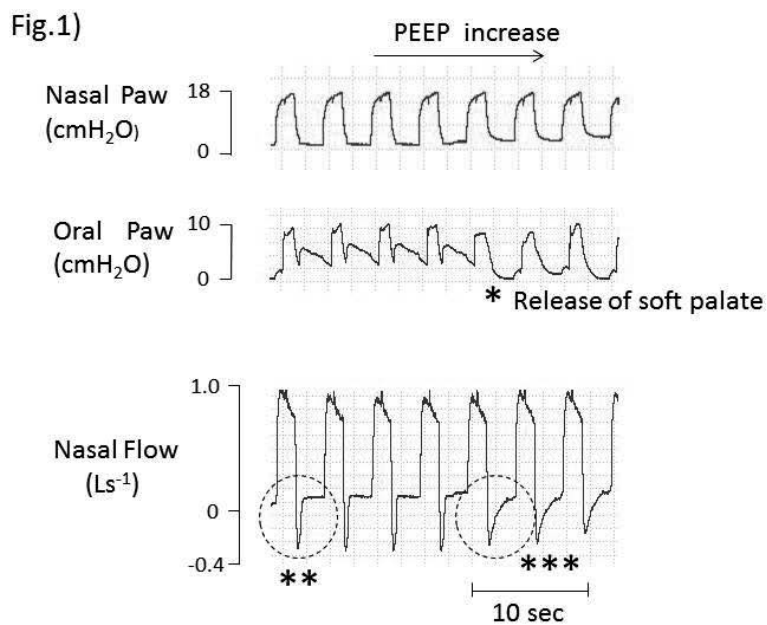
Conclusion:

Expiratory valve-like mechanism of the soft palate may contribute to dynamic expiratory RP airway obstruction and airflow limitation during nasal pressure ventilation.

*: reduction of pressure gradient across the soft palate
**: expiratory flow limitation
***: no expiratory flow limitation

Fig.1)

A Comparison of Two Different Doses of Intrathecal Fentanyl: BIS and Clinical Study

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Introduction: Adding fentanyl into cocktails of local anesthetics is a common practice to enhance and prolong the spinal sensory block. Sedation could be induced even without use of systemic sedatives[1-3]. Usage of local anesthetics alone for neuraxial block could reduce the patients' requirements of inhalation and sedative anesthetic agents.

Objective: This study evaluates and compares the possible sedative effect of different doses of intrathecal fentanyl in unpremeditated patients undergoing lower limbs orthopedic surgery by using the Ramsay sedation score and Bispectral Index (BIS) monitoring.

Material and Methods: We have randomly assigned 90 patients undergoing lower extremities orthopedic surgery into three equal groups. Each group has received a total volume of 3 ml of subarachnoid anesthesia in the form of hyperbaric bupivacaine 12.5 mg with either normal saline (G1), fentanyl 12.5 mcg (G2), or fentanyl 25 mcg (G3). The primary end point was the level of the consciousness and the level of sedation. Bispectral index (BIS) values, Ramsay sedation score and standard physiological monitoring were recorded before and for 120 minutes after subarachnoid block at 10-minute intervals. The sensory block level was assessed every 5 minutes up to 30 minutes after injection. The patient satisfaction was evaluated postoperatively using surveys analyzed by Likert scale and narrative descriptors.

Results: Mean BIS values dropped at 20 minutes after subarachnoid injection, to be significantly lower in G3 and G2 than G1; 88.96 ± 3.02 versus 92.39 ± 2.66 versus 95.02 ± 1.23, ($P = 0.001$) consecutively up to the end of our study. Over the initial 30 minutes BIS values did not show any significant difference between G2 and G3. However the BIS values were significantly different between G2 and G3 over the next 50 min versus 70 min consecutively. Ramsay sedation scores in both G2 and G3 were 2.03 ± 0.38 versus 2.09 ± 0.35 consecutively; higher than their corresponding baseline. Meanwhile, the respiratory and heart rates were lower during all assessment time points in the G2 and G3 groups. The sedation score, respiratory and heart rate showed no significant differences in the G1 group in relation to their baseline values.

Conclusion: Adding fentanyl to bupivacaine for spinal anesthesia gives more sedative effect than using bupivacaine alone, and this effect was more by adding 25 mcg fentanyl to bupivacaine for spinal anesthesia as indicated by BIS index.

References:

1. Vaghadia H, McLeod DH, et al. Small-dose hypobaric lidocaine-fentanyl spinal anesthesia for short duration outpatient laparoscopy. I. Anesthesia and Analgesia 1997; 84: 59–64.

2. Bano F, et al. Intrathecal fentanyl as adjunct to hyperbaric bupivacaine in spinal anesthesia for caesarean section. Journal of the College of Physicians and Surgeons Pakistan 2006; 16: 87–90.

3. Inagaki Y, et al. Epidural lidocaine delays arousal from isoflurane anesthesia. Anaesth Analg 1994; 79: 368-72.

Residual Neuromuscular Block with Rocuronium Reduces Hypoxic Ventilatory Response in Patients with Untreated Obstructive Sleep Apnea

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Background:
Obstructive sleep apnea (OSA) has been identified as a leading risk factor behind serious complications in the postoperative period. Among postoperative adverse events, respiratory depression with subsequent hypoxia has been associated with residual effects of drugs used in anesthesia. In this context, residual neuromuscular block may markedly reduce the acute hypoxic ventilatory response (HVR), as shown in healthy volunteers (1). This is primarily due an interaction between muscle relaxants and nicotinic acetylcholine receptors present on peripheral chemoreceptors of the carotid body (2, 3). While untreated OSA patients has an increased HVR and animals exposed to intermittent hypoxia have an increased chemosensitivity in the carotid body (4), it is not known to what extent neuromuscular blocking agents interact with hypoxic control of breathing in OSA patients.

Materials and Methods:
After informed consent, 11 newly diagnosed and untreated OSA patients entered the study. They were studied supine with a 30 degree head-up tilt and a mask fitted to their face while standard circulatory and respiratory monitoring as well as thoracic and abdominal impedance bands was applied. Neuromuscular function was assessed by recording of the mechanical adductor pollicis train-of-four (TOF) response after supramaximal ulnar nerve stimulation. After a resting period, the individual baseline isocapnic HVR and normoxic hypercarbic ventilatory response (HCVR) were measured. Thereafter, CPAP was applied at 6-7 cm of H2O via the same face mask and was followed by three series of HVR and HCVR tests with resting periods in-between: i.e. control, during rocuronium-induced residual neuromuscular block aiming at a TOF ratio of 0.70 and finally after recovery to a TOF ratio >0.90. At each occasion, isocapnic HVR was studied at an inspiratory FiO2 of 0.08-0.12 targeting a SpO2 of 80% while normoxic HCVR was performed by addition of 5% CO2 to the inspired air (FiO2 21 %). The protocol was repeated in each patient after three month of nightly CPAP-treatment at home.

Results:
HVR and HCVR tests before three months of CPAP-treatment in eight of the 11 OSA patients have been analysed (age 49 ± 5 years, BMI of 30.3 ± 0.9 and AHI of 23 ± 1). Residual neuromuscular block caused a reduction in HVR while the HCVR was unaffected

(Figure 1). The breathing tests after 3 month of nightly CPAP treatment is currently under analysis.
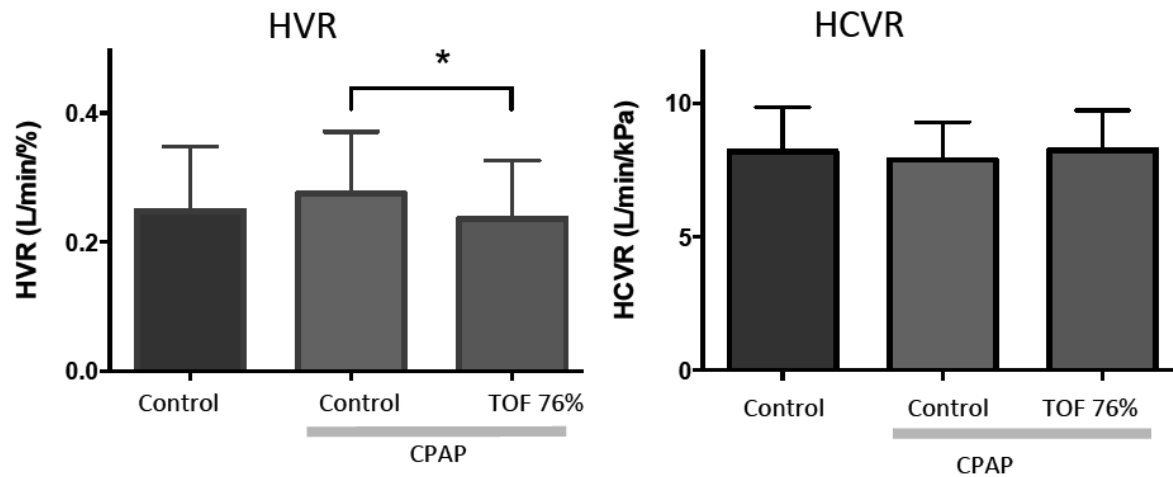
Figure 1: Residual paralysis by rocuronium reduced HVR but not HCVR in untreated OSA patients. Data are presented as mean ± SEM, n=8. * P<0.05.

A total of 33.2 ± 6.8 mg rocuronium was infused i.v. for 49 ± 9 min to acheive a steady-state adductor pollicis TOF ratio of 0.76 ± 0.03 during HVR and HCVR tests.

Conclusions:
Based on the preliminary data from this study, residual neuromuscular block by rocuronium attenuates the acute HVR in untreated OSA patients. Notably, this is not due to muscle paralysis since the HCVR is unaffected, but rather a depression of the peripheral chemosensitivity. The reduction in HVR by rocuronium in OSA patients was smaller compared to previous studies using other neuromuscular blocking agents in healthy volun teers. We speculate that this difference can be attributed to an increased baseline HVR in untreated OSA patients.

References:
1. Eriksson LI, et al. Anesthesiology. 1993;78(4):693-9.
2. Jonsson M, et al. Anesthesiology. 2006;105:521-33.
3. Jonsson M, et al. Eur J Pharm. 2004;497(2):173-80.
4. Spicuzza L, et al. Chest. 2006;130(3):774-9.

Efficacy of Ventilation through a Novel Cuffed Airway Exchange Catheter: An Animal Model Study

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Background: Airway exchange catheters (AECs) are commonly used in difficult airways management as a guide for re-intubation or ventilation when attached to a jet ventilator. However, barotrauma has been a major concern when using jet ventilation with AECs. We propose alternative methods of ventilation via AECs with a customized novel functional cuff (Cuffed AEC) (Figure). The aims of this study were to determine the efficacy of ventilation using Cuffed AEC with ICU ventilator (ICU vent) and manual ventilation bag (Bag) on adult human sized animals.

Methods: Five Yorkshire swine, weighting 45 to 50 kg, were studied under general anesthesia. 14 or 19 Fr AEC was used to create Cuffed AEC. A 5 cm long latex cuff was placed over the distal side ports of AEC and a 1 cm long internal resistor was inserted into the tip of the AEC to create a resistor. The proximal end was connected to an ICU vent set to pressure control with peak pressure 25, 50, or 70 cmH$_2$O (Vent 25, 50, and 70, respectively) or Bag with peak driving pressure 80 to 100 cmH$_2$O. Tidal volume was calculated using plethysmograph; each animal had its own calibration curve to determine tidal volume.

Results: With the cuffed AEC, ICU ventilator and Bag were able to generate tidal volumes of 363 ml with 14 Fr (Vent 25: 207 ml, Vent 50: 303 ml, Vent 70: 361 ml, Bag: 434 ml) and 470 ml with 19 Fr (Vent 25: 285 ml, Vent 50: 471 ml, Vent 70: 566 ml, Bag: 554 ml). Air

trapping was not observed.

Conclusions: Cuffed AEC may enable practitioners to use ICU vent or Bag to establish adequate ventilation without using jet ventilator. Because an AEC requires much lower driving pressure than that with the jet ventilation, we expect the incidence and/or severity of complications associated with jet ventilation to be minimized. Further safety studies in large animal and human are needed.
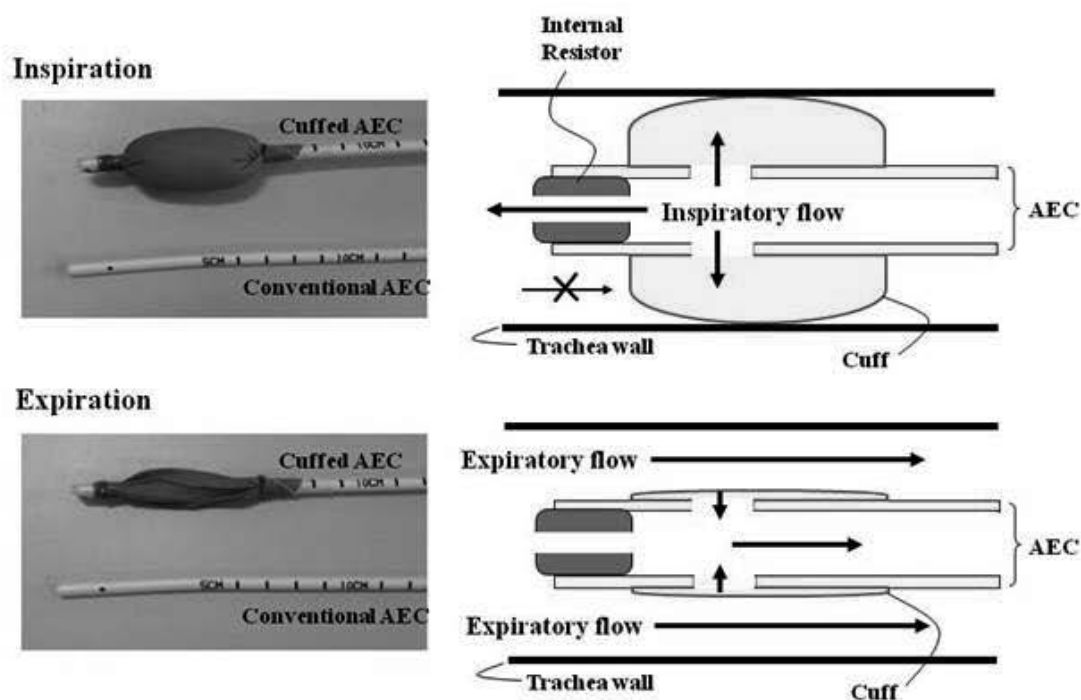

Figure 1. Illustration of Cuffed AEC. The cuff inflated during inspiration due to pressure generated by the resistor during inspiratory flow through the AEC. During expiration, the intra-lumen pressure of the AEC returns to baseline creating a pressure gradient leading to cuff deflation. The novel cuff ensures inflow through AEC lumen and outflow through trachea around the AEC.

Relationship of White Blood Cell and Its Subtypes in Obstructive Sleep Apnea

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ABSTRACT:

Background: Obstructive Sleep Apnea (OSA) is associated with ischemic heart disease and metabolic syndrome[1]. Raised White Blood Cell (WBC) were shown to predict increased morbidity and mortality in patients with metabolic syndrome[2]. The association of OSA and WBC is unclear. We examined the relationship of WBC and its subtypes with OSA and components of polysomnography in a pre-operative setting.

Methods: 4,077 patients were screened for inclusion. 413 patients had pre-operative complete blood count and polysomnography performed were included in the study. Association between WBC, subtypes of neutrophil, lymphocyte, monocyte, eosinophil and basophil were analyzed according to the severity of OSA. Correlation analysis of WBC and polysomnography and a linear regression analysis of the association of WBC and OSA were also performed.

Results: White blood cells counts were significantly raised in patients with severe OSA (7.56 ± 2.42 x 109 cells per liter) compared to patients with no OSA (6.72 ± 1.87 x 109 cells per liter; p = 0.011). Similar increase were seen with monocytes and basophils (p< 0.001).

Using Spearman correlation analysis, White Blood Cell were significantly correlated with higher Apnea-Hypopnea Index, lower Average SpO2, higher Cumulative Time below SpO2 90% and Lowest SpO2 (Table 1). Similar relationship were observed with monocytes. Basophil were not statistically correlated with the polysomnography results.

WBC were significantly associated with severity of OSA (p = 0.021, adjusted r^2 = 0.04), independent of age, gender, smoking, asthma, COPD and average SpO2 in a linear regression analysis. There was a significant association between monocytes with gender, smoking status and average SpO2 but not with the severity of OSA.

Conclusion: White Blood Cell were increased with patients with severe OSA and were correlated with clinical components of polysomnography and apnea-hypopnea index. This association may point to altered immune function with hypoxic induced inflammatory changes in OSA.

	AHI			Average SpO2			CT90			Lowest SpO2		
	r_s	p	n	r_s	p	n	r_s	P	n	r_s	p	n
WBC	0.154	0.002	413	-0.198	<.001	399	0.196	0.000	346	-0.168	0.001	399
Neutrophil	0.094	0.062	398	-0.180	0.000	385	0.183	0.001	341	-0.155	0.002	385
Lymphocyte	0.088	0.079	398	-0.053	0.297	385	0.049	0.367	341	-0.039	0.448	385
Monocyte	0.213	<.001	398	-0.289	<.001	385	0.210	<.001	341	-0.198	<.001	385
Eosinophil	0.130	0.009	398	-0.144	0.005	385	0.113	0.038	341	-0.096	0.059	385
Basophil	0.141	0.005	397	-0.096	0.060	384	0.066	0.226	340	-0.078	0.126	384

Table 1   Spearman correlation coefficients of White Blood Cells and

Polysomnography parameters

AHI- Apnea Hypopnea Index, SpO2- Oxygen saturation, CT90- cumulative time of oxygen saturation under 90%, r_s – Spearman correlation, $p < 0.05$ were significant.

References

1)   Vgontzas AN, Bixler EO, Chrousos GP. Sleep apnea is a manifestation of the metabolic syndrome. Sleep Med Rev 2005; 9: 211-24.

2)   Madjid M, Awan I, Willerson JT, Casscells SW. Leukocyte count and coronary heart disease: implications for risk assessment. J Am Col Cardiol 2004; 44: 1945-56.

Sleep patterns in the Ontario Health Study: Ethnic variations in sleep duration

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Background: Previous epidemiologic data indicates that age- and sex-related differences exist in the Canadian general population.(1,2) However, it is unclear whether ethnic differences exist in this population. We hypothesized that ethnic differences in sleep duration exist amongst the general population of adult residents of Ontario.

Methods: After Institutional review ethics board approval; we performed a cross-sectional study using data from the Ontario Health Study (OHS), a longitudinal cohort of self-reported health questionnaire data collected online from a sample of residents of Ontario, Canada. Adults (18 years or older), proficient in English or French provided medical history, socio-demographic characteristics and sleep duration. Participants reported self-reported sleep duration in hours and minutes by answering the question: "*On average, how many hours per day do you usually sleep, including naps?*" Using a multiple linear regression model, differences in sleep duration between ethnic groups were examined after stratifying based on gender and controlling for age, body mass index, general health perception, amount of light entering the bedroom and self-reported physician diagnosis of sleep apnea.

Results: The study cohort consisted of 167,518 respondents with complete data, the mean age was 46.33 years (SD 14.9) and there were more women (60%) than men. Participants of White ethnicity formed the majority of the cohort (136 753(82%), n(%)). Participants of Chinese (6448(4%)), South-Asian (5829(3.5%)), Black (2314(1.4%)), and Mixed (>1 ethnicity) (8437(5%)) ethnicities were the other large groups. The remainder of the ethnicity groups (Latin American Hispanic, East Asian, Filipino, Aboriginal, South East Asian, West Asian, Korean and Japanese) formed less than 1% of the cohort. The mean sleep duration of the entire cohort was 7.39 hours (minimum (min)1.17, maximum (max) 22.98). The mean sleep duration for females (7.4 hours; min 1.18. max 20.5) was longer than males (mean7.28; max 22.98,min 1.17) (P<0.01). In the multivariate model for males, compared to the White group as reference (mean=7.53 hours), mean sleep duration was shorter in the Filipino, Japanese, Black, Arab, Chinese, groups by 28.8, 23.4, 21, 7.2 and 6, minutes, respectively (p<0.05). In the multivariate model for females, compared to the White group as reference (mean=7.53 hours), mean sleep duration was shorter in the Filipino, Black, Japanese, Korean, Chinese, South-East Asian,

South-Asian, and Mixed, and groups by 28.2, 26.4, 16.8, 14.4, 10.2, 10.2, 6 and 4.2, minutes, respectively (p<0.05).

Conclusion: In this large cohort of the Canadian adult general population, ethnic and gender differences exist in self-reported sleep duration. Future research is indicated to target efforts in optimizing this important health indicator.

References:
1. Hurst M. Can. Soc. Trends, Stat. Canada. 2008;(11-008-X):39–45.
2. Williams, C. (2001). Canadian Social Trends, 60(Spring), 10-14. Statistics Canada, Catalogue no. 11-008-XIE.

Obstructive Sleep Apnea Mice With Insulin Resistance Are Susceptible to Postoperative Cognitive Decline

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Introduction:

Postoperative cognitive decline (POCD) can produce serious long-term consequences including loss of independence and increased mortality rate. Amongst the possible risk factors for the development of POCD include obstructive sleep apnea (OSA) and the metabolic syndrome[1,2]. In order to ascertain the possible reasons for the enhanced risk in these groups of patients we used an animal model involving New Zealand Obese (NZO) mice, a putative model for OSA, in which the male species also has insulin resistance.

Methods:

In the first experiment cohorts of 12-14 week old mice (n=12) were trained in a trace-fear conditioning (TFC) paradigm and then underwent tibial surgery under general anesthesia. On postoperative day 3 mice were tested for contextual memory in the TFC paradigm. In a second experiment, mice underwent surgery and were sacrificed 24h later to assess the systemic inflammatory response to surgery (n=6). Because of the positive influence of dexmedetomidine (DEX) on outcome in patients with OSA[3], in a third set of experiments we sought to establish the effect of DEX on the development of postoperative cognitive decline and inflammation.

Results:

A postoperative decrement in freezing behavior in the TFC paradigm was noted in the male but not the female NZO mice; perioperative administration of DEX attenuated this effect (fig. 1). A postoperative increase in the pro-inflammatory cytokine, IL-6, was noted in the male NZO mice; this inflammatory response was blocked by DEX.

Discussion:

The increased susceptibility for the development of postoperative memory decline in male NZO mice may be due to insulin resistance. It is notable that rats with insulin resistance (as part of the constellation of abnormalities present in the metabolic syndrome) exhibited an exaggerated and longer-lasting postoperative cognitive decline. DEX, an alpha-2 adrenergic agonist, may protect susceptible organisms from postoperative, inflammation-based, complications, such as cognitive decline, through its action on the autonomic nervous system promoting parasympathetic dominance.

1   Hudetz, J. A., Patterson, K. M., Amole, O., Riley, A. V. & Pagel, P. S. *J Anesth* (2011).
2   Flink, B. J. *et al*. *Anesthesiology* **116**, 788-796 (2012).
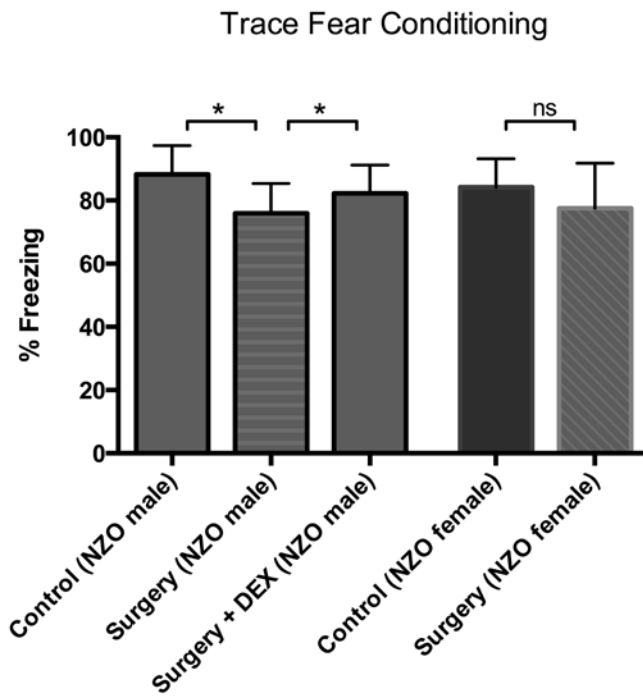3   Ankichetty, S., J, W. & Chung, F. *J Anaesthesiol Clin Pharmacol* **27**.

fig.1

Sedation with Dexmedetomidine or Propofol Impairs Control of Breathing in Healthy Male Volunteers. A Randomized Cross-Over Study

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Background:
The intravenous alpha2-agonist dexmedetomidine (DEX) is being increasingly used for sedation worldwide. It has been suggested that DEX causes alteration in blood pressure and may induce bradycardia while resting ventilation is maintained unchanged. However, it was previously demonstrated that clonidine (a more long-acting alpha2-agonist) reduces the hypoxic ventilatory response (HVR) (1). Moreover, DEX seems to reduce the hypercarbic ventilatory response (HCVR) in volunteers (2). Propofol is a well known respiratory depressant and reduces both HVR and HCVR.
The primary aim of this study was to compare the effect of sedation with DEX or propofol on HVR. The effect of sedation with DEX or propofol on HCVR and different sedation scales, BIS and plasma concentrations of both drugs were also investigated.

Materials and Methods:
After informed consent, 11 healthy male volunteers were included and randomized to receive DEX or propofol infusions in a cross-over design. Volunteers were studied supine with 30 degrees head-up tilt and a mask fitted to their face. Standard circulatory and respiratory monitoring as well as thoracic and abdominal impedance bands were applied and the sedative effect was measured by OAA/S, RASS and BIS recordings. Blood samples for plasma concentrations of DEX and propofol were taken after each hypoxic challenge. The protocol was as follows: HVR and HCVR were measured on three occasions; at rest, during sedation with DEX or propofol to OAA/S 2-4 and finally after recovery (OAA/S 5). This protocol was repeated for both drugs in each volunteer on separate days. We applied an isocapnic HVR by reducing the inspiratory FiO_2 to 0.08-0.12 targeting a SpO_2 of 80%. HCVR was performed by addition of 5% CO_2 to the inspired air.

Results:
Ten of the 11 volunteers (age 28 ± 6 years and a BMI of 24 ± 2) completed the study protocol. DEX was given as a bolus of 0.59 ± 0.25 µg/kg for 10 min followed by an infusion of 0.53 ± 0.22 µg/kg/h for a total time of 75.3 ± 12.7 min. Propofol was given as a 10 min bolus of 74.48 ± 1.64 µg/kg/min followed by 48.62 ± 10.04 µg/kg/min as an infusion for a total time of 75.5 ± 10.5 min. The OAA/S at the sedation goal was 3 (3-4) (median(min-max)) for both DEX and propofol. BIS was 82 ± 8 and 75 ± 3 for DEX and propofol, respectively. The plasma concentrations at the sedation target were 0.66 ± 0.14 ng/ml and 1.21 ± 0.38 µg/ml for DEX and propofol, respectively. Sedation with DEX or propofol reduced HVR and HCVR (Figure 1).
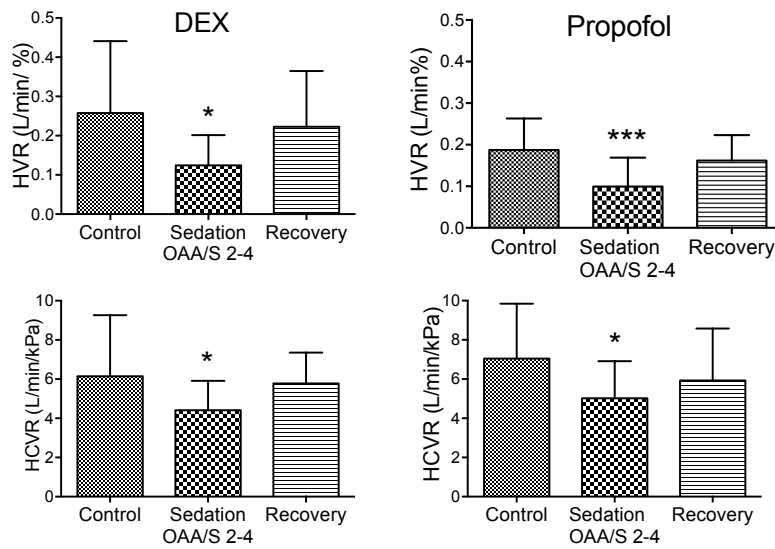
Figure 1: Sedation with DEX or propofol reduces HVR and HCVR in healthy male volunteers. Data are presented as mean ± SD, n=10. * P<0.05, **P<0.001.

Conclusion:

We demonstrate that DEX reduces both HVR and HCVR to a similar extent as propofol during light-moderate sedation. Although sedation with DEX preserves resting ventilation, DEX seems to interact with both peripheral and central control of breathing during hypoxia and hypercarbia.

References:

1. Foo IT, et al. Br J Anaesth. 1996;76(2):214-20.
2. Belleville JP, et al. Anesthesiology. 1992;77(6):1125-33.

Circadian Protein Period 2 Modulation of Innate Immune Function

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Circadian rhythm is maintained by molecular clocks at the cellular level and provides context for the coordination of various tissue intrinsic and extrinsic processes. Immune cells express clock proteins and cytokines in a rhythmic pattern, outlining circadian rhythm[1,2]. Given the distinct functions of different immune cell types in response to an inflammatory stimulus, it is likely that circadian proteins play an important role in coordinating inflammation. Previous experiments have linked circadian rhythm disruption to innate immune susceptibility in the setting of simulated chronic jet lag[3,4] and, by ablating core clock proteins[5–7]. Collectively, data from these experiments intimate causality through the modulation of core clock machinery, specifically the transcription factor BMAL. To investigate the effect of altered BMAL levels on immune function we employ the model of Familial Advanced Sleep Phase (FASP). FASP transgenic mice harbor mutations in the *Period2* (*PER2*) gene and confer reduction in PER2 protein phosphorylation resulting in an advanced phase phenotype and altered *BMAL* cycling[8]. Here we show that FASP transgenic mice rapidly recover after simulated chronic jet lag as evidenced by actigraphic measurements. After recovery from simulated jet lag, peritoneal macrophages from FASP mice demonstrate persistent changes in cytokine and clock gene expression after inflammatory stimulation compared to wild-type controls *ex vivo*. Under normal conditions, bone marrow derived macrophages from FASP mice generate less cytokine after LPS stimulation compared to controls suggesting an immunoprotective phenotype. Examination of clock genes in these cells points toward an alternative mechanism whereby PER2 may modulate immune function independent of BMAL.

Citations

1. Silver, A. C., Arjona, A., Hughes, M. E., Nitabach, M. N. & Fikrig, E. Circadian expression of clock genes in mouse macrophages, dendritic cells, and B cells. *Brain. Behav. Immun.* **26,** 407–13 (2012).
2. Bollinger, T. *et al.* Circadian clocks in mouse and human CD4+ T cells. *PLoS One* **6,** e29801 (2011).
3. Castanon-cervantes, O. *et al.* DISREGULATION OF INFLAMMATORY RESPONSES BY CHRONIC CIRCADIAN DISRUPTION. *J. Immunol.* **185,** 5796–5805 (2011).
4. Logan, R. W. *et al.* Chronic shift-lag alters the circadian clock of NK cells and promotes lung cancer growth in rats. *J. Immunol.* **188,** 2583–91 (2012).
5. Nguyen, K. D. *et al.* Circadian gene Bmal1 regulates diurnal oscillations of Ly6C(hi) inflammatory monocytes. *Science* **341,** 1483–8 (2013).
6. Gibbs, J. E. *et al.* The nuclear receptor REV-ERBα mediates circadian regulation of innate immunity through selective regulation of inflammatory cytokines. *Proc. Natl. Acad. Sci. U. S. A.* 2–7 (2012). doi:10.1073/pnas.1106750109/ /DCSupplemental.www.pnas.org/cgi/doi/10.1073/pnas.1106750109
7. Narasimamurthy, R. *et al.* Circadian clock protein cryptochrome regulates the expression of proinflammatory cytokines. *Proc. Natl. Acad. Sci. U. S. A.* **109,** 12662–12667 (2012).
8. Xu, Y. *et al.* Modeling of a human circadian mutation yields insights into clock regulation by PER2. *Cell* **128,** 59–70 (2007).

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