

# PARRC 2017 Abstracts

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## Original Research Abstracts for Oral Presentations:

## Alterations in Brain Mitochondrial Dynamics after Successful Resuscitation from Cardiac Arrest in a Pediatric Porcine Model

**Kumaran Senthil**, Michael Karlsson, Ross Plyler, Ryan Morgan, Robert A Berg, Robert Sutton, Frank McGowan, Todd J Kilbaugh

University of Pennsylvania; Department of Anesthesiology and Critical Care Medicine

**Introduction:** Pediatric in-hospital cardiac arrests affect thousands of children each year, more than half of who do not live to hospital discharge, with brain injury being common among survivors.<sup>1,2</sup> A critical convergence point for neurologic injury is cerebral mitochondrial function, which is closely linked to mitochondrial dynamics (fission and fusion) in response to injury. Fission is necessary to separate damaged mitochondria for mitophagy, but can also increase ROS-production that may propagate oxidative damage and signal apoptosis. Fusion increases complementation between damaged mitochondria and can improve oxidative phosphorylation capacity and bioenergetic output. We performed an analysis of cerebral mitochondrial dynamics following asphyxia-associated ventricular fibrillation in a pediatric porcine model of cardiac arrest with two distinct CPR strategies.

**Hypothesis:** We hypothesized that 24h after return to spontaneous circulation (ROSC), cortical tissue from a blood pressure guided CPR strategy would have increased mitochondrial fusion protein expression and decreased mitochondrial fission expression compared to a standard of care depth guided CPR strategy.

**Methods:** Four week old piglets (8-10 kg), neurodevelopmentally comparable to a human toddler, were designated into two cohorts: 1) n=5, American Heart Association (AHA) standard Depth-Guided CPR (DG- CPR) (systolic BP achieved 70 mmHg), 2) n=5, Blood pressure guided CPR (BP-CPR) (goal systolic BP 90- 110 mmHg). CA protocol: 7 minutes of hypoxia, induction of ventricular fibrillation, 10 minutes of CPR, and post-ROSC standardization of blood pressure, oxygenation and ventilation. The primary outcome was western blot quantification of porcine cortex proteins for fission (DRP-1, phosphorylated DRP-1(p- DRP-1) Ser616, p-DRP-1 Ser637, ratio of p-DRP-1 Ser 616 to 637) and fusion (Opa-1, MFN-2). Cohorts were compared using Mann-Whitney U tests.

**Results:** With regard to fusion proteins, BP-CPR demonstrated a significant increase in Opa-1 (p=0.016) and no change in MFN-2 compared to DG-CPR. The BP-CPR strategy had increased p-DRP-1 Ser616 (p=0.032), but no difference in DRP-1, p-DRP-1 Ser637 or the ratio of p-DRP-1 616 to 637.

**Discussion:** Animals resuscitated with BP-CPR displayed a significant increase in cerebral mitochondrial fusion measured by Opa-1, potentially favoring mitochondrial complementation and increasing oxidative phosphorylation efficiency and energy production 24 hours post-CA. BP-CPR also exhibited a significant increase in phos-DRP-1 Ser616, indicating an increase in a subtype of fission through the CDK- 1 pathway. However, no change was noted between groups in phos-DRP-1 Ser637, which has been shown to be most associated with ischemia reperfusion injury in adult models.

**Conclusions:** Based on our published data that has shown BP-CPR significantly increases cerebral blood flow (CBF), brain oxygenation (PbtO<sub>2</sub>), and survival compared to DG-CPR, we conclude that improved CBF and PbtO<sub>2</sub> during BP-CPR increases mitochondrial fusion and potentially fission at 24 hours compared to AHA standard DG-CPR which may improve mitochondrial bioenergetics following CA. Further research will delineate the time course of mitochondrial dynamics in this model, both through protein expression and immunohistochemistry of mitochondrial networks. Better understanding of the progression of mitochondrial dynamics after cardiac arrest will offer therapeutic windows for intervention by either

potentiating fusion or diminishing mitochondrial fission.

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## Intranasal Medication Administration Using a Squeeze Bottle Atomizer Results in Overdosing if Deployed in Supine Patients

Jordan E. Goldhammer, M.D.<sup>1</sup>, Mark A. Dobish, M.D.<sup>1</sup>, Joshua McAnulty, M.D.<sup>2</sup>, Todd J. Smaka, M.D.<sup>3</sup>, Richard H. Epstein, M.D.<sup>3</sup>

<sup>1</sup>Department of Anesthesiology, Thomas Jefferson University, Philadelphia, PA, USA, <sup>2</sup>Thomas Jefferson University, Philadelphia, PA, USA, <sup>3</sup>Department of Anesthesiology, Perioperative Medicine and Pain Management, University of Miami, Miami, FL, USA.

**Background:** Vasoconstrictors and local anesthetics are commonly administered using a squeeze bottle atomizer to the nasal mucosa to reduce edema, limit bleeding, and provide analgesia. Despite widespread use, there are few clinical guidelines that address technical details related to safe administration. The purpose of this study was to quantify, via simulation, the amount of liquid delivered to the nasal mucosa when patients are in the supine and upright position; and administration parameters that would reliably provide the desired amount of medication per spray.

**Methods:** A convenience sample of ten anesthesia providers was studied. Providers were instructed to use a 25 ml dip and tube nasal squeeze bottle to administer the test solution (sterile water) to a mannequin in the upright (90° elevation) and supine (0° elevation) position (Figure 1). Following mannequin testing, additional testing was completed with the spray bottles at 0°, 15°, 30°, 45°, and 90° (Figure 2) to determine the effect of the angle of administration on amount of liquid dispensed.

**Results:** The mean volume delivered per spray was substantially greater when administered in the supine position (0.56 ml) compared to the upright position (0.041 ml, difference = 0.52 ml, 95% CI 0.37 to 0.67 ml, P<0.001).

Converting the administered volume to the dose of phenylephrine that would be administered using our standard 0.25% solution, an additional 1300 mcg is delivered per spray in the supine position compared to the upright position (95% CI 925 to 1675 mcg, P<0.001). Administration with a delivery angle ≤ 30° resulted in significantly more volume than when the bottle was oriented at a 90° angle. The volume dispensed at 45° was equivalent to the volume delivered at 90° (0.032 ml vs 0.030 ml, P= 0.34, Figure 3).

**Conclusions:** We found a 14-fold increase in the volume (i.e. dose) delivered per spray when a nasal squeeze bottle was used with a mannequin in the supine position. Given the reported toxicity from the use of intranasal medication and the inadvertent overdosing that occurs when squeeze bottle atomizers are used in clinical practice, our data suggest that all intranasal drugs should be administered with a precise, metered

dose device. If a metered dose device is unavailable, the medication should be delivered at an angle  $\geq 45^\circ$ ; however, we recommend administering the drug with the patient in the sitting position and the bottle at  $90^\circ$ , as only a small change in angle below  $45^\circ$  will result in a substantial increase in medication delivered.

Figure 1.

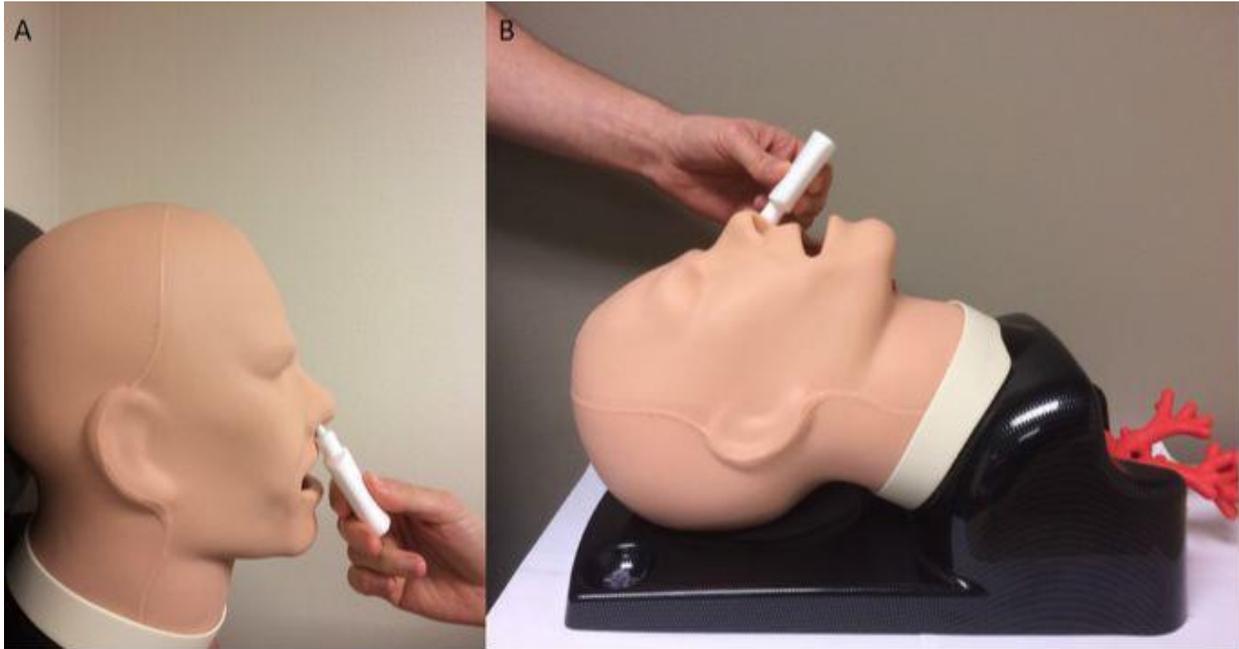
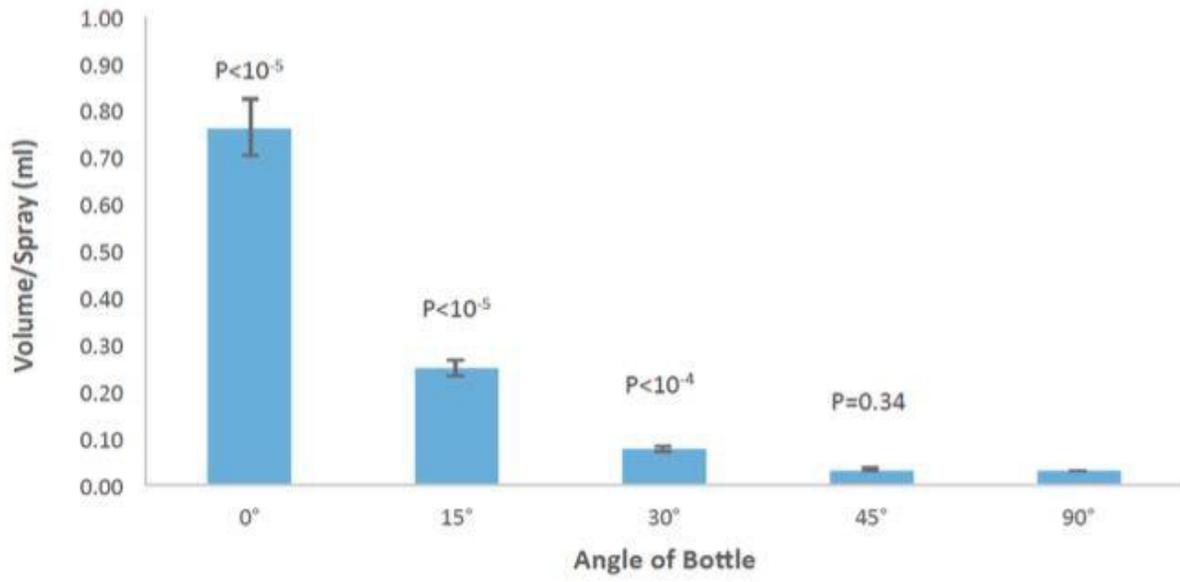


Figure 2.



Figure 3.



# Preoperative continuation of angiotensin converting enzyme inhibitors does not cause hypotension upon induction of general anesthesia

Uzung Yoon, MD, MPH<sup>2</sup>, Adam Setren, MD<sup>2</sup>, Alexander Chen, BS<sup>1</sup>, Tara Kennedy, MD<sup>1</sup>, Mark Torjman, PhD<sup>1</sup>

<sup>1</sup>Sidney Kimmel Medical College, Philadelphia, PA

<sup>2</sup>Thomas Jefferson University Hospital, Philadelphia, PA Department of Anesthesiology

## Introduction

Angiotensin-converting enzyme inhibitors (ACE-I) and angiotensin II receptor blockers (ARB) are commonly prescribed for the treatment of hypertension, cardiac, vascular, and renal-protective properties in chronic heart failure. These medications have been reported to result in intraoperative hypotension in patients undergoing general anesthesia [<sup>1,2</sup>]. Nevertheless, preoperative discontinuation of ACE-I treatment remains controversial [<sup>3,4</sup>].

## Objective

The aim of this study is to find out whether the preoperative continuation of long term ACE-I or ARB treatment is associated with intraoperative hypotension during induction of general anesthesia.

## Methods

A retrospective review of elective non-cardiac surgeries performed under general anesthesia, among patients who were receiving an ACE-I or ARB was performed. Patient demographics, comorbidities, other antihypertensive medications use, type and doses of anesthetic induction agents, intraoperative blood pressure and heart rate measurements, and vasopressor administration during the first fifteen minutes of anesthesia was collected. Hypotension was defined as either: systolic BP <90 mm Hg or systolic BP decrease of >20%.

## Results

166 patients were included for final analysis. The mean admission ASA status was  $2.7 \pm 0.4$ , age  $64 \pm 11$  years, and BMI  $30 \pm 6.7$  kg/m<sup>2</sup>. Medications taken at the day of surgery is listed in table1, table 2. There was no statistical difference in induction medication and pressor use for hypotension ( $p=0.757$ ) between the ACE-I/ARB group and no ACE- I/ARB group. SBP at 12 min time point was statistically significantly lower (103 mmHg

vs. 109 mmHg) in the ACE-I/ARB group, figures 1 and 2. There was no statistically significant difference in DBP and HR between the two groups over the 7 time points, with a p value of  $p=0.554$ ,  $p=0.113$  respectively, figure 3.

### Conclusion

ACE-I or ARB continuation at the day of surgery was not associated with intraoperative hypotension upon induction of general anesthesia. However, the decision to continue or hold ACE-I or ARBs preoperatively should be made based on individual perioperative risk factors [5].

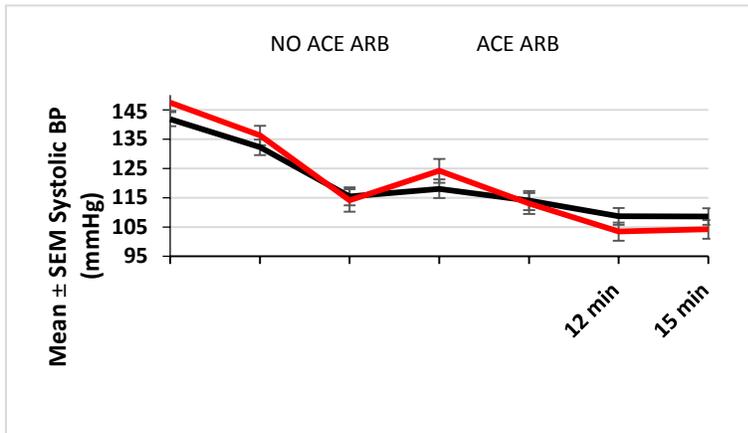
**Table 1. Pre-operative medication use.**

Pre-operative medication use	N	%
ACE-I	103	62 %
ARB	63	40 %
ACE-I and ARB	2	1.2 %
Additionally on Ca antagonist	8	4.8 %
Additionally on diuretic	20	12 %

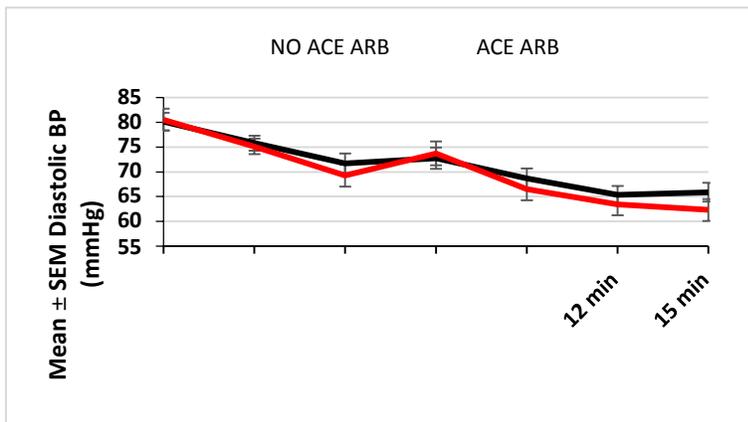
**Table 2. Medications taken in the morning of surgery.**

Morning medication	N	%
ACE-I or ARB	74	46 %
ACE-I	46	28 %
ARB	28	17 %
Other antihypertensive medications	20	12 %

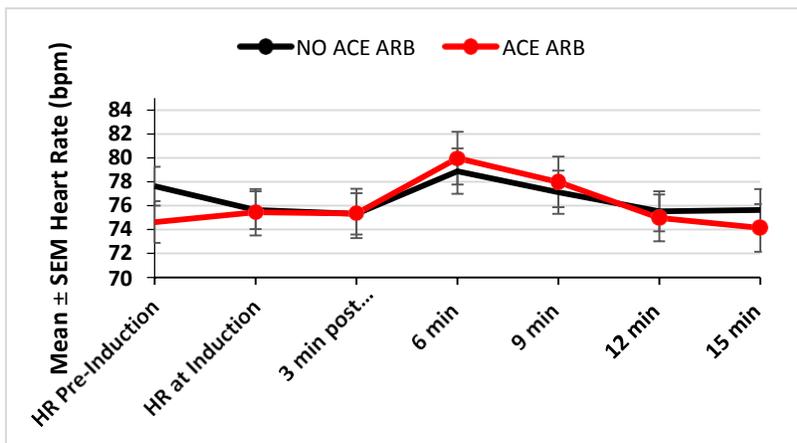
**Figure 1.** Mean  $\pm$  SEM systolic blood pressure measured pre-induction and at six additional time points for 15 minutes post induction.



**Figure 2.** Mean  $\pm$  SEM diastolic blood pressure measured pre-induction and at six additional time points for 15 minutes post induction.



**Figure 3.** Mean  $\pm$  SEM heart rate measured pre-induction and at six additional time points for 15 minutes post induction.



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Evaluation of Perioperative and Postoperative Risks: Using Risk Calculators to Identify Gaps in Patient Care as Compared to Current Preoperative Evaluations at one University Medical Center

**James Light, MD, MS;** Ellen Hauck DO, PhD; Morewood, Gordon, MD, MBA Department of Anesthesiology, Lewis Katz School of Medicine at Temple University

#### Objective/Hypothesis

The purpose of this study is to determine how well Pre-Admission Testing (PAT) and the surgeons PAT serves identify patients at risk of perioperative events as compared to use of validated risk calculators.

#### Introduction/Background

Perioperative cardiac events are a leading cause of morbidity after surgery, so risk stratification for perioperative cardiac events has become an integral part of the preoperative workup. While less common, postoperative respiratory failure can impart significant morbidity to the patient.

Both perioperative cardiac and respiratory events increase patient hospital stays at significant costs to health systems. Temple University Hospital (TUH) relies on the Pre-admission Testing (PAT) department to identify patients at increased risk for perioperative complications. Evidence-based advice from organizations like the American College of Cardiology/American Heart Association and the American Society of Anesthesiologists help providers evaluate these perioperative risks. Regular use of risk calculators, such as the Revised Cardiac Risk Index and the NSQIP risk calculators, is recommended as part of the preoperative evaluation. Dr. PK Gupta and his colleagues have also developed and validated perioperative risk calculators, including a predictor of postoperative respiratory failure. These risk calculators provide established, objective scores for meaningful stratification.

#### Methods

The following information was collected from ASA 3 and 4 patients seen in PAT over a four-week period. The patient's age, pre-op creatinine, ASA class, preoperative functional status, and procedure site were collected from each patient record. Gupta risk calculators for cardiac events during surgery and postop respiratory failure (chosen due to their presence on all hospital work phones) were used to compute estimated risk probabilities. In addition, any specialty consults or testing requested by the patient's surgeon, primary care physician or the anesthesiologist in PAT was noted.

#### Results

Data from 394 patients were collected. Using the Gupta calculators, 11% of this cohort had a cardiac risk of > 1%, 66.7% had a post-op respiratory failure risk > 1%, and 9% had a post-op respiratory failure risk > 5%. Of these patients, 55.5% with a cardiac risk > 1% had *no* prior specialist workup, request for specialist or cardiac studies on file. 91.4% of patients with a respiratory failure risk > 5% had *no* workup. Additionally, 15% of patients with a cardiac risk < 1% still had requests for specialists and/or recent cardiac studies despite their low risk.

#### Conclusion/Discussion

The use of validated risk calculators in the preoperative period is recommended by the ACC/AHA and the American College of Surgeons. Our analysis of a cohort of ASA 3 and 4 patients visiting PAT as part of their surgical pathway shows that the added use of risk calculators can provide important information.

We identified several patients whose cardiac risk warranted further workup, some who received

unnecessary cardiac evaluation and a large group whose respiratory function put them a significant risk for postoperative morbidity. Using this information, steps are underway to 1) integrate the use of risk calculators into every patient's preoperative evaluation and 2) develop a plan to help decrease perioperative pulmonary morbidity for our patients who are at elevated risk.

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## Creating a model of anesthetic sensitivity using zebrafish

**Victoria M Bedell**, Michael A Pack, Max B Kelz, Roderic Eckenhoff

Department of Anesthesiology & Critical Care, University of Pennsylvania Perelman School of Medicine

### Introduction:

There are a variety of medications that can be used to induce and maintain the state of general anesthesia. These drugs have both overlapping and unique mechanisms that are just beginning to be elucidated. Due to their small size, they bind to many different proteins. The pharmacodynamics of these medications may mean that there are no large transcriptional changes to determine the genes and proteins important in their function. Also, little is known about the effect anesthetic medications have on neural patterning during development and how the drugs affect the epigenome. The zebrafish is an ideal model organism to study these medications in an intact organism with complex behavior. The embryos develop externally and are transparent, allowing visualization of development. Within five days of egg fertilization, the larvae have a developed brain and neural system. Additionally, technology to efficiently modify the genome allows for targeted experimental approaches. Finally, drug uptake is mostly diffusional, eliminating the complexities of pharmacokinetics in larger, mammalian models.

### Objective:

To create an *in vivo* model of response to various anesthetics and to use that model to define the genes and epigenetics required for response to anesthetic medication.

### Methods:

We used 5 day-old zebrafish larvae. The larvae were placed in increasing concentrations of propofol in their water. We allowed 30 min for equilibration. To assess the induction and emergence of the larvae from the anesthesia we used multiple different behavioral changes including response to light touch, electrical stimuli and loss of spontaneous movement. After 60 minutes, they were placed back in fresh embryo water and observed for recovery and for toxicity at 24 hours.

### Results:

We created a response curve defining the time and concentration needed for induction and emergence of the zebrafish larvae as defined by withdrawal from physical manipulation and movement in response to electrical stimuli (as a surrogate for a pain stimulus). The concentration required to have all larvae anesthetized is 15 $\mu$ M. The EC50 (effective concentration 50) for the larvae is approximately 3 $\mu$ M. There is more than 50% recovery 30 minutes following drug washout. Finally, we defined the LD50 (lethal dose 50) of the zebrafish larvae, approximately 80  $\mu$ M and created a lethal dose curve. The LD50 curve fits the line:  $y=196.07e^{-0.881x}$ ,  $R^2=0.9971$ .

### Conclusions:

These data are required to define the anesthetic concentrations required for wild type larvae. In addition to propofol, we will be performing the same dose curves on other IV and inhaled anesthetics, since it is now clear that different general anesthetics may use different pathways to the anesthetic state. We will compare various knockout zebrafish larvae for changes in sensitivity to determine which genes are

important for the anesthetic response. The transparent nature of the larvae allows us to follow neural development and any changes seen in response to these medications. Finally, the zebrafish is an ideal model to study epigenetic changes induced by exposure to anesthetic drugs.

Characterization of Anesthetic Distribution in Brain Sections Using a Bifunctional Propofol Derivative  
**E. Railey White**, Kellie A. Woll, Roderick G. Eckenohoff

Department of Anesthesiology and Critical Care, University of Pennsylvania

**Introduction:** The application of photoaffinity labeling has provided critical insight into the molecular mechanisms of general anesthetics (GA).<sup>1-4</sup> The technique modifies the GA structure by the substitution of a small photo-active diazirine moiety that irreversibly binds, and therefore 'labels', protein targets for downstream identification.<sup>5</sup> The bifunctional propofol derivative called AziPm-click, in addition to the photoactive group, incorporates an alkyne group that participates in a specific bioorthogonal 1,3-dipolar cycloaddition reactions with azide-containing compounds, known as 'click chemistry'.<sup>6</sup> Previously AziPm-click has been successfully employed to identify propofol specific protein targets within synaptosomes derived from whole brain tissue.<sup>7</sup> However these findings do not determine whether alkylphenol-based anesthetics demonstrate selective tissue distribution and/or cellular localization.

**Hypothesis/Objective:** Here we propose that the AziPm-click can be used to characterize alkylphenol-based anesthetic distribution within the brain and cellular localization. The objective of this project was to optimize the conditions of this bifunctional chemical activity within *ex vivo* tissue and observe distribution of the anesthetic by confocal microscopy.

**Methods:** In brief, mouse brain tissue was harvested and immediately sectioned into 200 $\mu$ m thick slices using a vibratome. Fresh brain slices were then incubated with a buffered solution of AziPm-click. After a variable incubation time, the samples were exposed to UV irradiation to label macromolecular anesthetic targets. After fixation, multiple conditions for 'click chemistry' were investigated to associate an azide-fluorophore to AziPm-click labeled regions. The distribution of AziPm-click within brain sections was determined by fluorescence confocal microscopy.

**Results:** The efficiency of UV photoaffinity labeling was readily achieved in a variety of reaction conditions. Multiple acceptable 'click chemistry' reaction conditions were achieved. There was variability in the efficiency of 'click chemistry' conditions as well as in some cases the formation of insoluble precipitate during the reaction.

**Discussion:** A variety of conditions were found to be adequate for the bifunctional activity of AziPm-click. Quantification using fluorescence could not be obtained, however qualitative preliminary images suggest preferential distribution of AziPm-click within brain regions. Further method optimization is needed to minimize damage to the *ex vivo* tissue by UV irradiation and improve 'click chemistry' conditions, particularly to allow for cellular localization.

**Conclusion:** Preliminary data serves as proof of concept for the application of the bifunctional propofol derivative AziPm-click to determine the distribution of alkylphenol-based anesthetics within *ex vivo* brain tissue. Further optimization is underway at the level of cell culture before revisiting these reactions on brain tissue.

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**Title:** Treatment patterns for respiratory distress syndrome in low-resource settings: A report from Bangladesh.

**Authors:** Richard Hubbard, MD<sup>1</sup>; Grace Lim<sup>1</sup>, MD, MS; David Seng<sup>1</sup>, DO; Kamal Choudhury, MBBS<sup>2</sup>

1. Department of Anesthesiology, University of Pittsburgh Medical Center;
2. Department of Pediatric Surgery, BIRDEM-II Hospital

**Introduction:** Respiratory Distress Syndrome (RDS) is a disease of inadequate endogenous surfactant production and immature lung anatomy, typically affecting premature neonates.<sup>1-3</sup> Advances in neonatal critical care have led to an 85% mortality reduction in wealthy nations.<sup>4</sup> However, RDS remains the leading cause of neonatal death in low-income countries, where resources for respiratory support (continuous positive airway pressure and/or mechanical ventilation) and surfactant replacement may be limited, or non-existent.<sup>2-4</sup> Even if available, the cost of care may limit access for the sickest children.<sup>5</sup>

**Objectives:** The objective was to identify practice patterns in the care of RDS-afflicted neonates in the developing world, and to isolate risk factors for mortality prior to discharge in this population.

**Methods:** This retrospective, observational study included all neonates diagnosed with RDS at a tertiary care facility in Bangladesh between July 2015, and June 2016. The primary endpoint was death prior to discharge. The presence/absence of the following hypothesized risk factors for mortality were recorded: gestational age less than 32 weeks, birth weight less than 1500g, vaginal delivery, birth outside the study location (a tertiary care facility), diagnosis of sepsis, and requirement for intubation/mechanical ventilation. Univariate analysis of each factor on the primary endpoint was completed utilizing the Fischer's Exact Test. Adjusted Odds Ratios for mortality were completed utilizing a multivariate regression analysis.

**Results:** 104 neonates were included in the study, of whom 38 died (mortality 36.5%). Of all babies who died, 97% were mechanically ventilated prior to death. Of those who were mechanically ventilated, 22% received surfactant. Univariate analysis found a significant link between the following risk factors and mortality: mechanical ventilation, birth outside the study facility, vaginal delivery, gestational age less than 32 weeks, and birth weight less than 1500g (Table 1). However, adjusted odds ratios based on the multivariate analysis suggested only mechanical ventilation and birth weight less than 1500g as independent risk factors for mortality. Univariate and Multivariate subgroup analysis on invasively ventilated patients demonstrated a trend towards mortality benefit with surfactant administration, but was not statistically significant (Table 2).

**Discussion:** As low-income countries develop economically, attempts have been made to modernize neonatal care. The results of this study demonstrate an adequate availability of mechanical ventilator support at the study site, while simultaneously showing a very low utilization of surfactant replacement therapy.

**Conclusion:** In relation to neonatal mortality, multivariate analysis demonstrated a significant relationship only to low birth weight, and mechanical ventilation. Though not statistically significant, a clear trend towards survival benefit in surfactant replacement in mechanically ventilated patients was demonstrated.

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## Tables

Table 1: Univariate and multivariate analysis of suggested risk factors for mortality

Risk Factor	Survived	Died	Unadjusted OR (95% CI)*	Adjusted OR (95% CI)	Unadjusted p-value	Adjusted p-value
<u>Respiratory Support</u>						
Invasive	21	37	79.3 (12.3-823.8)	101.5 (7.1- >999.9)	<0.001	<0.001
Non-Invasive	45	1				
<u>Born at study site</u>						
Yes	13	17	3.3 (1.4-7.7)	3.19 (0.7-15.6)	0.013	0.153
No	53	21				
<u>Mode of Delivery</u>						
Vaginal	12	19	4.5 (1.8-10.9)	1.1 (0.2-4.9)	0.001	9.939
Cesarean	54	19				
<u>Sex</u>						
Female	25	19	1.6 (0.7-3.6)	2.3 (0.6-9.3)	0.303	0.219
Male	41	19				
<u>Sepsis</u>						
Yes	22	20	2.2 (0.9-5.5)	3.0 (0.7-12.3)	0.064	0.134
No	44	18				
<u>Gestational Age</u>						
≥ 32 weeks	49	9	9.3 (3.7-22.3)	1.0 (0.1-7.9)	<0.001	0.991
< 32 weeks	17	29				
<u>Birth Weight</u>						
≥ 1500g	51	5	22.4 (7.1-58.1)	9.0 (1.2-69.3)	<0.001	0.034
< 1500g	15	33				

\*OR = Odds Ratio, CI = Confidence Interval

Table 2: Subgroup analysis of mechanically ventilated patients

Mechanically Ventilated Patients							
Surfactant use	Survived	Died	Mortality	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted p-value	Adjusted p-value
Yes	8	5	0.385	0.30 (0.09-1.03)	0.24 (0.04-1.35)	0.105	0.104
No	15	31	0.675				

# **Dexamethasone and hyperglycemia in diabetic patients undergoing functional endoscopic sinus surgery**

**Adam Setren, MD<sup>1</sup>**, Alexander Grant, MD<sup>1</sup>, Marc Torjman, PhD<sup>2</sup>, Tara Kennedy, MD<sup>2</sup>

<sup>1</sup>Thomas Jefferson University Hospital, Philadelphia, PA. <sup>2</sup>Sidney Kimmel Medical College, Philadelphia, PA.

## **INTRODUCTION**

Dexamethasone is routinely administered during otolaryngological surgery at our institution. Benefits include reduction of postoperative vomiting and decreased operative times for sinus surgery via anti-inflammatory effects. Controversy exists regarding the routine use of dexamethasone; hyperglycemia may lead to poorer perioperative outcomes such as delayed wound healing and infection. Diabetes mellitus is also a risk factor for these complications.

## **OBJECTIVE**

We sought to determine if hyperglycemia was observed in the immediate postoperative period in patients with diabetes mellitus who received dexamethasone during elective functional endoscopic sinus surgery (FESS).

## **METHODS**

We conducted a retrospective review of patients who underwent elective outpatient FESS at Thomas Jefferson University from 2011-2015. Reviewed databases included outpatient medical records from otolaryngology clinics and preoperative, intraoperative and post-operative care unit records.

Perioperative and outpatient records were reviewed for age, sex, body mass index, preoperative hemoglobin A1C levels, perioperative blood glucose measurements, and diagnosis coding indicating the presence of diabetes mellitus. Intraoperative records were reviewed for the presence or absence of dexamethasone, time of administration, and length of surgery. Exclusion criteria were: patients under 18 years old; presence of diabetes mellitus not requiring pharmacologic therapy; ASA physical status greater than 3 or a designation of emergent status; preoperative corticosteroid use; absence of a blood glucose measurement in the PACU; use of dextrose-containing intravenous fluid during surgery; and use of antibiotics as an outpatient, implying active infection.

## RESULTS

The initial cohort included 14,307 patients, 777 of whom had an outpatient diagnosis code for diabetes mellitus. Dexamethasone was administered in 11,912 out of 19,006 surgeries (63%). We limited our search to FESS and identified 3,945 surgeries involving 3,419 patients, 205 of whom had a diagnosis of diabetes. Dexamethasone was given in 3,026 of these cases (77%). After applying exclusion criteria, we identified 46 cases for 43 diabetic patients who underwent FESS and had recorded postoperative blood glucose measurements. In 24 cases, dexamethasone was given intraoperatively, and in 22 cases it was not administered (Table 1).

Diabetic patients who received dexamethasone had a significant increase in blood glucose from preoperative to postoperative measurements (Figure 1,  $p < 0.001$ ). We did not find a significant difference between preoperative and postoperative measurements in comparing patients with insulin dependent versus non-insulin dependent diabetes mellitus ( $p = 0.151$ ), and did not find an association between changes in blood glucose versus age ( $p = 0.837$ ), BMI ( $p = 0.435$ ), time from preoperative to PACU BG ( $p = 0.887$ ), or length of surgery ( $p = 0.793$ ).

## DISCUSSION

As surgical patients present with increasingly severe comorbidities, it is important to identify

perioperative risk factors to help improve surgical outcomes. Surgery is known to cause an intense pro-inflammatory state, and these inflammatory mediators are associated with significant morbidity. Glucocorticoids such as dexamethasone may be able to modulate this inflammatory response. However, concern regarding the consequences of dexamethasone-induced hyperglycemia has precluded its routine use by some anesthesiologists and surgeons.

A few studies to date have examined the relationship between intraoperative dexamethasone and hyperglycemia, with varying results. Hans et al. showed a clinically significant increase in blood glucose concentration after administration of dexamethasone to obese patients with impaired glucose tolerance.<sup>1</sup> Lukins et al. found significant hyperglycemia in nondiabetic patients who received dexamethasone during craniotomy.<sup>2</sup> Intriguingly, Abdelmalak et al. demonstrated that non-diabetics exhibited a greater increase in blood glucose compared to diabetics after 8mg of dexamethasone.<sup>3</sup>

To reduce the contribution of surgical stress on blood glucose concentration in this study, we limited our review to functional endoscopic sinus surgery performed on an elective, outpatient basis. FESS is a minimally invasive procedure that utilizes a small endoscope and CT image guidance. This technique ensures that only necessary excess tissue and bone is shaved down, and is perhaps less physiologically stressful than more invasive surgery.

The main finding of this retrospective review is that there was a significant ( $p < 0.001$ ) increase in the blood glucose concentration in diabetic patients who received dexamethasone compared to those who did not receive dexamethasone.

We did not find a significant difference between preoperative and postoperative blood glucose in patients who did not receive dexamethasone. Additionally, the magnitude of the increased blood glucose was not related to the length of surgery. These findings may be explained by the low physiologic stress of the FESS procedure.

Limitations of this study include the length of time that blood glucose was measured after dexamethasone. As these are relatively short procedures performed in the outpatient setting, blood

glucose concentrations were generally measured only in the PACU. Additional blood glucose measurements may have been beneficial to better track the pharmacodynamic effect of dexamethasone on glucose metabolism. Lukins et al.<sup>2</sup> and Eberhart et al.<sup>4</sup> found a maximum increase in blood glucose 8-10 hours after dexamethasone administration. In addition, it is not known why dexamethasone was not administered to the 22 patients we reviewed. There may have been a concern that these patients were poorly controlled diabetics, and perhaps greater concern for perioperative hyperglycemia. Our retrospective analysis has further limitations in that many patients did not have recorded preoperative and postoperative blood glucose measurements, which led to their exclusion from our analysis.

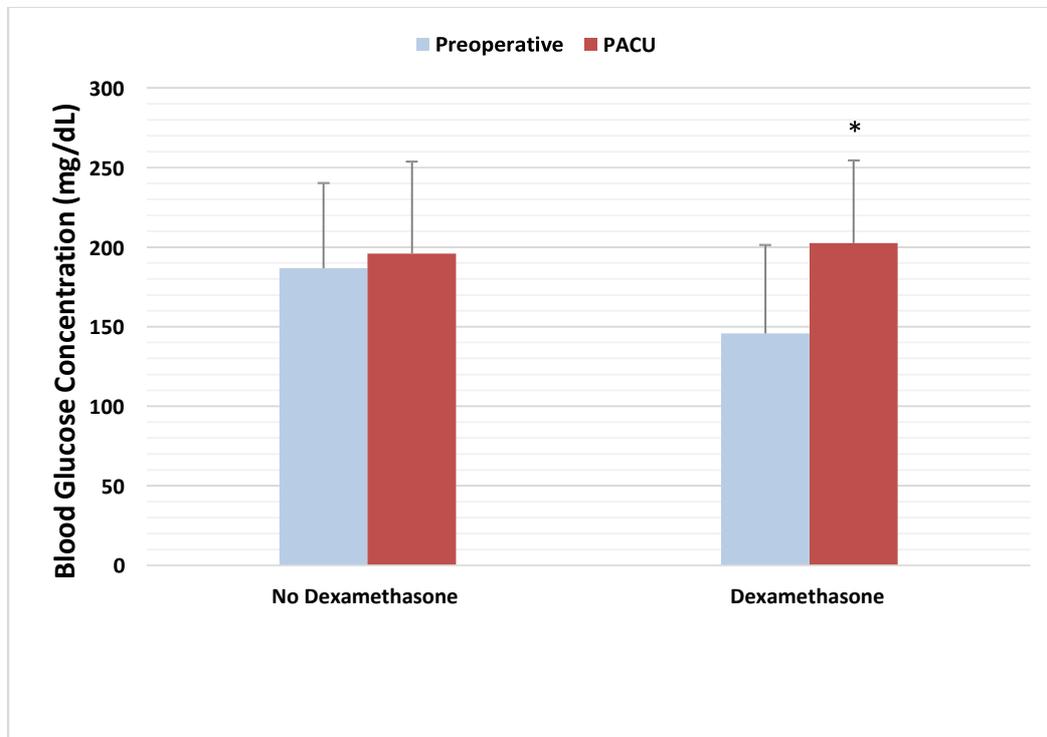
## CONCLUSION

Dexamethasone administration was associated with postoperative hyperglycemia in diabetic patients undergoing outpatient FESS. This may identify a preventable cause of increased perioperative morbidity and mortality which could impact quality measures and cost of care.

**Table 1.** Demographics and descriptive statistics for groups receiving vs. not receiving dexamethasone.

	Dexamethasone administered	Dexamethasone not administered	Overall
<b>n</b>	24	22	46
<b>Age</b>	20-71 (median 60.5)	21-71 (median 60)	20-71 (median 60.5)
<b>Sex</b>			
Male	11 (46%)	10 (45%)	21 (46%)
Female	13 (54%)	12 (55%)	25 (54%)
<b>ASA Physical Status</b>			
2	10 (42%)	5 (23%)	15 (32%)
3	14 (58%)	17 (77%)	31 (68%)
<b>BMI</b>	21-56 (median 31. mean 33)	26-56 (median 36. mean 36)	21-56 (median 32. mean 34)
<b>Diabetes</b>			
Insulin-dependent	9 (37%)	14 (64%)	23 (50%)
Non-insulin dependent	15 (63%)	8 (36%)	23 (50%)
<b>Surgery duration</b>	40-191 minutes (median 116, mean	35-201 minutes (median 117, mean	35-201 minutes (median 117, mean
<b>Dexamethasone dose</b>			
4mg	n=1	n/a	n/a
6mg	n=1		
8mg	n=9		
10mg	n=13		

**Figure 1.** Blood glucose concentration changes in patients who received or did not receive dexamethasone. \* $p < 0.001$  comparing preoperative and postoperative measurements in diabetic patients who received intraoperative dexamethasone.



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# Improved quality of recovery from ambulatory shoulder surgery after implementation of a multimodal perioperative pain management protocol

Anthony T. Wang<sup>1</sup>, Andrew F. Kuntz<sup>2</sup>, Jiabin Liu<sup>1</sup>, Matthew Mattera<sup>1</sup>, Nabil M. Elkassabany<sup>1</sup>

<sup>1</sup>Department of Anesthesiology and Critical Care, Hospital of the University of Pennsylvania

<sup>2</sup>Department of Orthopaedic Surgery, Hospital of the University of Pennsylvania

## Introduction

Shoulder surgery has been described as one of the most painful ambulatory procedures. Establishing pain control following this and other surgeries continues to pose a major challenge<sup>1</sup>. Despite the growing use of regional anesthesia, opioids play a significant role in postoperative pain management, often resulting in adverse side effects<sup>2</sup>. Multimodal pain management, or the use of multiple drugs to synergistically enhance analgesia via a variety of mechanisms, has been shown to facilitate patient recovery with fewer side effects<sup>3</sup>. To investigate these benefits in the context of recovery from ambulatory shoulder surgery, we studied the quality of postoperative analgesia and the quality of recovery before and after implementation of a multimodal perioperative pain protocol (MP3).

## Hypothesis/Objective

A multimodal analgesia protocol can improve pain management and quality of recovery after ambulatory shoulder surgery.

## Methods

As per IRB approval, all patients undergoing outpatient shoulder surgery at Penn Presbyterian Medical Center from July 2013 to April 2016 were enrolled in this study. The MP3 was adopted in September 2015, enabling comparison to postoperative outcomes prior to its implementation. Pain management prior to the MP3 mainly consisted of oxycodone/paracetamol taken as needed. The MP3 features preoperative acetaminophen and gabapentin, intraoperative ketorolac, and postoperative scheduled acetaminophen, gabapentin, and ketorolac with oxycodone as needed for breakthrough. All patients received a brachial plexus nerve block (unless contraindicated) and general anesthesia for surgery. Patients were surveyed using the revised American Pain Society Patient Outcome Questionnaire (APS-POQ-R) postoperatively at 24 and 48 hours and the Patient-Related Quality of Recovery Questionnaire (QoR-Score) postoperatively at 24 and 48 hours and 1 week. In addition, patients recorded their pain levels and medications in a pain diary for a 72-hour period following the procedure.

## Results

A total of 252 patients were enrolled in the study (120 in the MP3 group). Relative to patients in the pre-intervention control group, MP3 patients had significantly greater QoR scores at 24 hours, 48 hours, and 1 week after surgery (Figure 1). Total oxycodone requirements 72 hours after surgery were also significantly decreased (23.1 mg for MP3 vs. 48.3 mg for control,  $p=0.004$ ). As summarized in Tables 1 and 2, pain severity, in addition to pain interfering with activity, sleep and mood, were decreased in the MP3 group relative to the control group. However, pruritus was the only side effect of treatment found to be improved in the MP3 group (Table 3). PACU duration was shorter in the MP3 group (114.2 vs 134.1 minutes,  $p=0.002$ ).

## Discussion/Conclusion

Implementation of our multimodal pain protocol was effective in increasing the patient reported quality of recovery, while decreasing the need for opioid consumption after ambulatory shoulder surgery. These improvements were observed across a variety of measures and at time scales outlasting the effects of a single shot brachial plexus block.

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Table 1. Mean APS scores (and standard deviation). Bolded items are significant. All items rated on 10-point scale.

	24 hours			48 hours		
	Control	MP3	P value	Control	MP3	P value
Least pain	4.4 (3.3)	1.8 (2.3)	<0.001	4.2 (2.9)	3.0 (2.5)	0.001
Worst pain	7.3 (3.0)	6.5 (2.9)	0.004	<b>7.2 (3.0)</b>	<b>6.7 (2.6)</b>	<b>0.068</b>
% of time in severe pain	44.3 (34.9)	21.4 (26.0)	<0.001	45.5 (34.3)	23.1 (25.9)	<0.001
% of pain relief	59.3 (31.2)	72.6 (23.0)	<0.001	57.5 (30.5)	69.4 (24.8)	0.005
Pain treatment satisfaction	<b>8.6 (2.4)</b>	<b>9.1 (1.8)</b>	<b>0.050</b>	8.4 (2.6)	9.1 (2.0)	0.026
Pain interfered with activities in bed	6.6 (3.5)	4.7 (3.9)	<0.001	6.1 (3.5)	5.1 (3.5)	0.021
Pain interfered with activities out of bed	4.8 (3.6)	3.2 (3.4)	<0.001	4.3 (3.4)	3.2 (3.1)	0.013
Pain interfered with falling asleep	5.6 (3.7)	3.8 (3.9)	<0.001	5.3 (3.6)	3.8 (3.4)	0.001
Pain interfered with staying asleep	6.2 (3.3)	4.1 (3.9)	<0.001	5.9 (3.5)	4.4 (3.6)	0.002
Pain caused you to feel anxious	3.7 (3.6)	2.3 (3.1)	0.003	<b>2.9 (3.5)</b>	<b>2.3 (3.2)</b>	<b>0.194</b>
Pain caused you to feel depressed	2.6 (3.4)	1.2 (2.6)	<0.001	2.1 (3.2)	1.2 (2.5)	0.039
Pain caused you to feel frightened	2.3 (3.3)	0.8 (1.9)	<0.001	1.9 (3.0)	0.8 (2.0)	0.002
Pain caused you to feel helpless	4.0 (3.8)	2.5 (3.2)	0.003	3.3 (3.7)	2.2 (3.1)	0.044
Nausea	<b>2.4 (3.3)</b>	<b>1.6 (2.6)</b>	<b>0.059</b>	<b>2.0 (3.1)</b>	<b>1.2 (2.2)</b>	<b>0.078</b>
Drowsiness	<b>4.9 (3.3)</b>	<b>5.1 (3.2)</b>	<b>0.677</b>	<b>4.2 (3.4)</b>	<b>4.1 (3.1)</b>	<b>0.743</b>
Itching	2.5 (3.2)	1.3 (2.6)	<0.001	3.0 (3.4)	1.4 (2.6)	<0.001
Dizziness	<b>3.0 (3.2)</b>	<b>2.2 (2.7)</b>	<b>0.108</b>	<b>2.3 (2.8)</b>	<b>2.1 (2.7)</b>	<b>0.469</b>

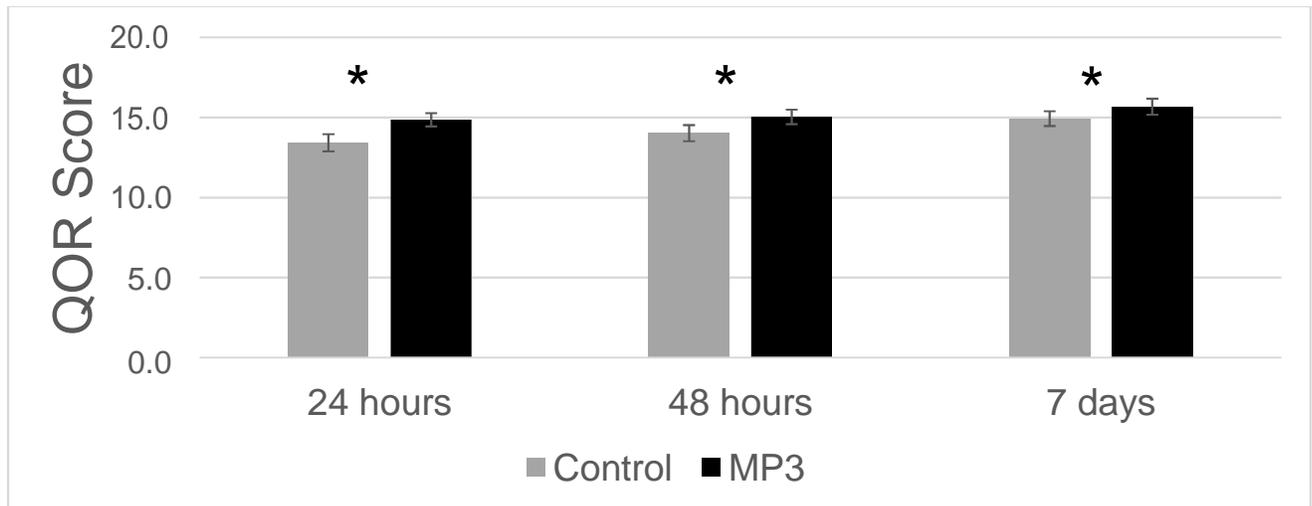


Figure 1. QOR scores 24 hours, 48 hours, and 7 days after surgery. Significant differences between control (grey) and MP3 (black) groups are marked with an asterisk. Error bars represent 95% CI.

## PERIOPERATIVE THROMBOTIC COMPLICATIONS ASSOCIATED WITH PEDIATRIC LIVER TRANSPLANTATION: A UNOS DATABASE EVALUATION.

**Authors:** Molly Deacutis, MD, Priti G. Dalal, MD, Robert P. Moore, MD, Piotr K. Janicki, MD, PhD, Dmitri Bezinover, MD, PhD

Department of Anesthesiology and Perioperative Medicine, Penn State Health Milton S. Hershey Medical Center, Hershey, PA

**Background:** Portal vein thrombosis (PVT) is a known complication of liver transplantation (LT) and associated with increased morbidity in transplant patients, leading to graft failure, repeat interventions, re-transplantation, and increased mortality. Pediatric patients are at greater risk for this type of complication compared to adults due to differing physiology, specifics of liver disease, and level of difficulty of surgical procedure.

**Objective:** This evaluation focuses on the factors contributing to perioperative thrombotic complication in pediatric patients undergoing LT. Specifically, we investigated what factors correlate to developing preoperative PVT, as well as to possible correlations of preoperative PVT and postoperative vascular thrombosis leading to graft failure. Identifying factors related to development of perioperative thromboses, and thus identifying high risk patients, can change perioperative management, such as recommended antithrombotic therapy for patients at risk, and potentially improve patient outcome.

**Methods:** This retrospective study evaluated the incidence of PVT at the time of transplantation as well as postoperative thromboses leading to graft failure from data provided by the UNOS database from 2000-2015, which included 8133 pediatric LT cases. We divided the data into three age groups based on initial evaluation of trend of thromboses, Group I (0-5 years old), Group II (6-11 years old), and Group III (12-18 years old), and conducted multivariate regression analysis of factors associated with perioperative thrombotic complications across these groups. The variables in this evaluation were chosen based on expert opinion, scientific publications and availability in the UNOS database. Variables included age, BMI, ethnicity, donor type, cause of ESLD, PELD score, serum albumin, ascites, and dialysis. Additional regression analysis of postoperative vascular complications leading to graft failure evaluated for association between such complications and the above variables as well as association with PVT at the time of transplantation.

**Results:** Of the 8133 pediatric liver transplant cases between 2000 and 2015 listed in the UNOS database, 361 patients had preoperative PVT and 382 patients had postoperative thromboses (4.4% and 4.7%, respectively). Group III had a lower incidence of both preoperative and postoperative thromboses than that of Group I and II combined (3.10% vs 4.79% preoperative,  $p=0.003$  and 1.87% vs. 5.45% postoperative,  $p=0.0001$  respectively). Group I had a higher incidence of postoperative thromboses than that in Group II and III combined (5.80% vs. 2.75%,  $p=0.0001$ ). Group I was more likely to have postoperative thromboses leading to graft failure than in Group III (OR=3.1,  $p<0.001$ ). Lastly, preoperative PVT was independently associated with postoperative thromboses leading to graft failure across all groups (OR=2.1,  $p=0.005$ ).

**Conclusion:** This study indicates that perioperative thromboses are significantly associated with postoperative thromboses leading to graft failure in pediatric liver transplants. The postoperative complications were more likely in small children. Preoperative PVT was predictive of postoperative thrombotic complications. With these findings in mind, perioperative antithrombotic therapy, therefore, should be considered in this group of patients.

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## **Case Report Poster Presentations:**

Severe Myocardial Depression in a Crush Injury Patient with Streptococcal Septic Shock  
Syndrome: Recovery After VA---ECMO

Mikaela Jayashekaramurthy, M.D., Dilipkumar Patel, M.D., Jeffrey J. Derham, M.D., and Joseph M. Lopez, Jr., M.D.

Departments of Anesthesiology and Surgery, Temple University Hospital

Introduction:

Necrotizing fasciitis (NF) is a fulminant, rapidly spreading bacterial infection with a high morbidity and mortality rate. Type II necrotizing soft tissue infections (NSTIs) are the only group associated with toxic shock syndrome, which is caused by either group A streptococcus alone or combined with staphylococcus aureus. Type II NSTIs are prominent in healthy young hosts with a recent surgical history or trauma. Delayed or incomplete surgical debridement has a direct relationship with increasing mortality; it is crucial to remove infarcted tissue and toxins to help improve antibiotic penetration. Early surgical debridements, antibiotic therapy, invasive hemodynamic monitoring, early resuscitation and treatment of shock, including immunotherapy, are often needed. We report a successful case involving use of veno---arterial extracorporeal membrane oxygenation (VA---ECMO) used to support severe LV dysfunction caused by severe septic myocardial dysfunction when conventional resuscitation failed.

Case Presentation:

A healthy 30---year---old man suffered a crush injury from a generator falling on his leg. He was emergently brought to the operating room for right leg exploration. He was hypotensive, on high dose norepinephrine, and hypoxic on a non---rebreather when he arrived. He was experiencing increasing leg pain with discoloration and new hemorrhagic bullae with a non---palpable, but dopplerable pulse. The patient desaturated quickly with minimal sedative on board. Induction consisted of propofol, ketamine and rocuronium. The intraoperative course consisted of two episodes of pulseless electrical activity that responded well to aggressive resuscitation efforts. The ACLS protocol was initiated and return of spontaneous circulation was achieved with epinephrine both times. Norepinephrine, epinephrine, and vasopressin infusions were required to maintain adequate blood pressures thereafter. Despite aggressive resuscitation and ventilatory support, profound hypoxia and hypotension persisted in conjunction with cardiac failure, pulmonary edema, and severe metabolic and respiratory acidosis.

Intraoperative TEE indicated a severely depressed left ventricular function with an EF of 5---10%. Later that day, the patient required another right leg debridement and emergent VA---ECMO, both performed at the bedside due to his cardiovascular instability. Confirmation of necrotizing fasciitis was made by intraoperative pathology. Wound cultures indicated Group A streptococcus, and intravenous immunoglobulin (IVIG) therapy was administered. Antibiotics, serial surgical debridement, hemodialysis, management of ARDS, and VA---ECMO were the mainstay of treatment. On the sixth day, biventricular function was preserved, and the patient was weaned off ECMO. Two months later, he was discharged home after full recovery.

#### Discussion:

The Third International Consensus on Sepsis defines septic shock as a subset of sepsis where particularly profound circulatory, cellular, and metabolic abnormalities substantially increase mortality. Under these guidelines, the Sequential Organ Failure Assessment (SOFA) can expedite recognition and early treatment of sepsis by clinicians. In septic patients, avoiding the use of etomidate for induction is prudent given the potential worsening of adrenal insufficiency with even a single dose. Fluid resuscitation, invasive monitoring, echocardiography, steroid administration, and vasopressors are all part of the ongoing resuscitative strategy for septic shock.

Cardiac dysfunction presents in up to 60% of septic patients and is associated with a poor prognosis. TEE can facilitate hemodynamic evaluation and identification of sepsis-induced cardiac depression. GAS exotoxins and other myocardial depressants can directly injure and kill cardiomyocytes. Major inflammatory markers of sepsis, such as cytokines and nitric oxide, can attenuate the adrenergic response by downregulating  $\beta$ -adrenergic receptors. Myocardial dysfunction typically reaches its maximum at 48 hours after the onset of sepsis with subsequent gradual normalization of left ventricular function in survivors. However, when conventional resuscitative methods fail, ECMO can be a valuable form of life support in an otherwise healthy patient with a reversible cause.

Conclusion: During the perioperative period, a number of hemodynamic challenges are encountered and need to be identified to care for a patient with streptococcal septic shock syndrome. If conventional resuscitative measures are failing, it needs to be recognized without delay and access to life-saving but costly resources, such as VA-ECMO become paramount. Effective communication among the anesthesiologist, surgeon and critical care team is vital as the patient's status changes and unfolds.

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**Darsi N. Pitchon** M.D., Meera N. Gonzalez M.D. Department of  
Anesthesiology. Temple University Hospital.

## Management of Postdural Puncture Headache in a Patient on Anticoagulation

### Introduction:

The differential diagnosis for headache is extensive and often requires lumbar puncture (LP) to rule out meningitis when other concerning symptoms are present. Unfortunately, LP can lead to aggravation of the headache by causing a postdural puncture headache (PDPH). Standard therapy for PDPH is an epidural blood patch (EBP), with a success rate of up to 75-93%. However, contraindications such as recent anticoagulation may prevent some patients from receiving treatment. Performing a sphenopalatine block has demonstrated success for the treatment of PDPH with little side effects and few contraindications.

### Case Report:

A 31-year-old female with no significant PMH presented to the emergency department (ED) complaining of headache for 2 weeks. The headache was bilateral, parietal, and throbbing in nature. She had a traumatic LP with a 20G needle in the ED which ruled out meningitis. She had one episode of fever to 101.7°F which resolved and she was sent home. The following day she returned to the ED with a headache that was worse with standing, nausea, vomiting, photophobia, and persistent fevers. She had no other signs of infection. The headache was so severe (10/10) that she was severely debilitated and could not sit up. The acute pain service was consulted for evaluation and management of presumed postdural puncture headache from the LP. Because of the suggestive signs of PDPH, an EBP was discussed. However, the patient had

received Lovenox for DVT prophylaxis 3 hours earlier. Rather than wait 9 hours (per ASRA guidelines) in severe pain, she was offered a topical bilateral sphenopalatine ganglion block for temporary relief until the EBP could safely be performed. The patient had 2 squirts of oxymetazoline spray to each nostril. Two long cotton-tipped applicators with 5% lidocaine jelly were applied to each nostril and advanced posteriorly until resistance was met. The applicators remained in place for 10 minutes and then two more applicators with 5% lidocaine jelly were applied to the posterior nasopharynx via both nares for 8 minutes. These applicators were then removed and two more applicators with 5% lidocaine were applied to the posterior nasopharynx and removed after 12 minutes. The patient sat up and reported the headache was now down to 7/10 and much improved. However, the headache persisted the following day. The last Lovenox dose had been given 24 hours prior so an EBP was performed at L4-L5 with 20mL of autologous blood. Although she did not notice immediate improvement, a few hours later she had no headache while supine, and the next day she reported complete resolution of her headache even while ambulating. She was discharged home later that day.

### Discussion:

EBP is the standard treatment for PDPH, but some reports cite the use of non-invasive sphenopalatine ganglion block to successfully treat PDPH. While this patient reported only mild and temporary relief from the block, it was an appropriate and temporizing option for her at the time due to recent anticoagulation. Hence, topical sphenopalatine ganglion block may be a less invasive option for cases in which EBP is contraindicated to relieve PDPH.

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**Darsi N. Pitchon M.D., Meera N. Gonzalez M.D., Ellen Hauck D.O. PhD.**

Department of Anesthesiology. Temple University Hospital.

Using Modern Technology to Coach Performance of a Nerve Block Remotely

## Introduction

Our institution has a Geriatric Hip Fracture Program which recommends a fascia iliaca nerve block for preoperative pain as soon as possible after admission. Unfortunately, only 7 of our 43 attending anesthesiologists (the Acute Pain Service) are formally trained to perform nerve blocks. On evenings and weekends, only 2 attending anesthesiologists are present, so unless an Acute Pain attending is present, patients who arrive during these times cannot get a nerve block until the next business day, potentially causing poorly-controlled pain and increased narcotic use. We used modern technology to assist a non-nerve block trained anesthesiologist to perform a nerve block for a patient with severe pain from a hip fracture.

## Case Description

A 73-year-old man with a past medical history of heart failure, atrial fibrillation, hypertension, dementia, and alcohol abuse presented on a Sunday afternoon to the emergency department with a right hip fracture, and was scheduled for operative repair the next afternoon. Neither on call anesthesiologist was trained to perform a nerve block. A member of the Acute Pain service offered to watch the procedure via FaceTime® on an iPhone® from home and coach the on call attending. With full view via FaceTime of the Sonosite S Turbo ultrasound screen, the needle was moved through the fascia iliaca and local anesthetic infiltrated below the fascia iliaca and above the iliacus muscle. The patient reported a significant decrease in pain from a Visual Assessment Score (VAS) of 9 to 0. He did not experience any pain throughout the night. He did not require any doses of narcotic for 14 hours after the block was performed.

## Discussion

Fascia iliaca block has been found to provide pain relief for patients with hip fractures<sup>1</sup> and is part of the American Association of Orthopaedic Surgeons Hip Fracture Guidelines (2014)<sup>2</sup>. Because not every anesthesiologist is trained to do these blocks, some patients do not receive care recommended by best-practice guidelines depending on who is on-call. We used technology to attempt to provide best care and were successful. Although video instruction of procedures is common for training purposes, there is very little literature on instruction for direct patient care by direct video observation. Prescher et al (2015) found that intubation success for medical students was similar with physically present vs. remote video supervision from attending physicians.<sup>3</sup> Al Jundi et al (2016) found no difference in feedback given for surgical residents observed suturing via direct and remote video observation by surgical attendings.<sup>4</sup> More studies should be done to see if remote video coaching is as effective as direct. This can reduce costs and improve patient care. This case demonstrates a patient receiving an intervention that significantly reduced pain by a non-trained physician via remote video coaching. This method may allow patients to receive standard of care treatment during off-hours without being limited by staff training.

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**Darsi N. Pitchon M.D., Meera N. Gonzalez M.D., Jon Livelsberger D.O.**

Department of Anesthesiology, Temple University Hospital.

Postdural Puncture Headache after Thoracic Dural Tear from Epidural Attempt: Is a Blood Patch Effective in the Lumbar Region?

Intro:

Thoracic epidurals are effective for postoperative pain control. Complications include transient paresthesia, nonfunctioning catheter, dural puncture causing post dural puncture headache (PDPH), hematoma, infection, and permanent neurological injury. The incidence of dural tear in large single- institution studies ranges from 0.6% to 1.2% [2,3,4], but there are no reports of any patients with PDPH in these studies. Standard treatment of PDPH is an epidural blood patch (EBP). While much of the literature recommends injection one level below the suspected dural tear, this case demonstrates complete resolution of headache from a thoracic dural puncture with an EBP in the low lumbar region.

Case Report:

A 37-year-old 116 kg female with Stage IV breast cancer with liver metastases had an exploratory laparotomy for lysis of adhesions and liver microwave ablation. She had no other significant medical history. Her medications included Oxycodone PRN, Anastrozole, Neurontin, Zofran, Colace, and Aspirin. CBC, BMP, INR were within normal limits, but ALT and AST were elevated to 136 and 116, respectively. Preoperatively, thoracic epidural was attempted at T8-T9 for postoperative pain control. An 18G 3.5 inch Hustead needle was inserted midline using loss of resistance technique with saline. After four unsuccessful attempts, a paramedian approach was attempted at T9-10 but free-flowing CSF was encountered. The procedure was aborted and intrathecal morphine was injected easily at L4-L5 with a 25G, 3.5 inch Pencan needle. The surgical procedure proceeded uneventfully the patient was extubated at the end.

On POD#1 the patient complained of a severe, postural, frontal/occipital headache. The Acute Pain Service encouraged conservative treatment measures which had not improved the headache on POD#2. The patient agreed to an EBP. She received an EBP at L4-L5 with 10mL of autologous blood, which improved the headache from a 10/10 to a 3/10. Because of the immediate and significant improvement after the EBP, the lumbar EBP was deemed successful in treating the patient's thoracic dural tear.

Conclusion:

Thoracic epidurals are a commonly employed technique for postoperative pain control after large abdominal and thoracic procedures. A potential complication of thoracic epidural catheter placement is PDPH. However, it is rarely reported in the literature. Therefore, optimum location for injection of autologous blood during EBP treatment of thoracic PDPH has not been elucidated. While much of the literature pertaining to EBP recommends injection one level below the supposed dural tear, this case demonstrates near-complete resolution of headache from a thoracic dural tear with a low lumbar EBP. With the rare but potentially serious

complications associated with thoracic epidurals, it may be safer and more efficacious to perform the EBP at the lumbar level, especially for less experienced practitioners.

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## Anesthetic Management in a Patient with Stevens Johnson Syndrome and Toxic Epidermal Necrolysis Syndrome for Emergency Surgery

Muhammad Fayyaz Ahmed MD, Meera N Gonzalez MD Department

of Anesthesiology, Temple University Hospital

### **Introduction**

Toxic epidermal necrolysis (TENS) and Stevens Johnson Syndrome(SJS) are acute, life-threatening syndromes characterized by extensive erythema and exfoliation of necrotic tissue. Mucosal involvement can lead to airway compromise. [1][2].There are multiple etiologies, but antibiotics are the most common cause of SJS. [3][4]. Anesthetic considerations include airway involvement, application of monitors, and maneuvers involving the skin. We present a case of a patient undergoing emergency eye surgery with SJS/TENS affecting the airway.

### **Case Description**

44-year-old male presented with bilateral eye swelling with purulent discharge, mucosal lesions, and rash. He had a history of glioblastoma multiforme and was on decadron, Keppra, and Bactrim.He was diagnosed with SJS/TEN likely due to Bactrim. He had significant involvement of the bulbar and palpebral conjunctiva. His eyelids were so edematous that he could not open them. He was scheduled for emergent conjunctivoplasty to prevent visual loss.

On exam, the patient had limited mouth opening due to severe pain. There was significant ulceration of his oral cavity and diffuse sloughing of mucosa. Due to pain he had limited neck range of motion from involvement of the anterior neck and was unable to swallow his copious, thick, secretions.

Otolaryngology (ENT) was consulted to evaluate the airway. A nasal fiberoptic laryngoscopy showed significant sloughing of mucosa in the oropharynx, tongue, and an erythematous and friable epiglottis with multiple secretions pooling in the hypopharynx. Vocal cords appeared normal.

A multidisciplinary discussion with ENT, ophthalmology, and anesthesiology occurred. ENT recommended to postpone for a few days before attempting intubation to avoid catastrophic airway obstruction from trauma. Sedation was not ideal because the patient could not manage secretions. The options were awake fiberoptic intubation, local with minimal sedation to avoid airway manipulation, or postpone the surgery. Ophthalmology felt he was at risk of losing his vision if the operation were postponed. The patient decided to attempt the procedure with local anesthetic, after being educated that it would likely be uncomfortable, but would avoid airway trauma.

Monitors were placed very carefully and with difficulty due to skin sloughing. The patient was positioned with head elevated to 45 degrees. Oxygen was supplied via nasal cannula at three liters per minute. Midazolam 1mg was given. The patient was extremely uncomfortable when the local anesthetic was given in the severely edematous eyelid. A total of midazolam 5mg and fentanyl 150mcg was titrated to discomfort for the 74 minute case. The patient was responding to commands and spontaneously ventilating the entire time. The patient was intermittently suctioned with a soft suction catheter to clear secretions. The patient was transferred to the burn unit after the surgery.

### **Discussion**

In patients with SJS/TENS the airway should be secured during early signs of oral mucosa and airway involvement. If emergency surgery is required, a multidisciplinary discussion can facilitate a plan for best

patient care. Regional or local anesthesia should be considered to avoid airway manipulation.

## **Conclusion**

Apart from few case reports currently there are no guidelines regarding airway management in patients with SJS/TEN requiring surgery.

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- Title

## Intraoperative Cardiac Arrest in a Patient Undergoing Wound Debridement

- Authors (first name, middle name, last name: presenting author should be first, name bolded)

**Connie Bruno**, M.D., Mario H. Farias-Kovac, M.D., Vanessa Starks, M.D., Nnenna Okereke, M.D., Amanda G. Hargrove, M.D., Jessica M. Reardon, M.D., Abiona Berkeley, M.D., J.D.

- Department and Institution

Anesthesiology, Temple

University Hospital ○

### Introduction

The reported incidence of cardiac arrest in non-cardiac surgery patients has declined over time. However, major adverse cardiovascular events (MACE) remain a significant cause of intraoperative and 30-day postoperative mortality. Surgical patient population has also increased in age and complexity. Therefore, as anesthesiologists, we need to understand the pathophysiology of perioperative myocardial infarction (PMI), signs and symptoms of PMI in the OR setting, and strategies for perioperative management of CV events.

- Case Presentation

A fifty-five-year-old ASA 4 male with a history of coronary artery disease s/p CABG, chronic heart failure, hypertension, end stage renal disease on hemodialysis, severe pulmonary hypertension, diabetes mellitus type II, severe peripheral vascular disease s/p right toe amp was admitted for gangrene in his feet. The patient underwent a popliteal to posterior tibial bypass, and on post-op day 8, he was taken to OR for debridement of foot wounds. 65 minutes into the debridement an ST elevation on lead V was noted with subsequent asystole. Chest compressions were started and 1 amp of epinephrine was given. After 5 minutes of compression, the patient returned to sinus rhythm. A twelve lead ECG was performed showing depression on lead V. CTA chest showed pulmonary embolism associated with pulmonary infarction.

- Discussion

In this case, a frail patient with known history of non-occlusive DVT in his left common femoral vein was brought to the OR for debridement of wounds. The patient had cardiac arrest which occurred as wound vacuums and dressings were being placed, suggesting temporally that mobilization of blood clot to the lungs caused rapid cardiovascular decompensation and PMI. PE was confirmed on post-op imaging. Additionally, the patient returned to baseline vital signs approximately 5 minutes after CPR was initiated, and it is conceivable that the mechanical component from chest compressions may have further displaced the pulmonary embolism to an area of smaller physiologic burden aiding his rapid restoration of hemodynamics.

- Conclusion(s)

Unstable coronary artery plaque rupture is not the only pathophysiologic mechanism of PMI. Preoperative evaluation and risk stratification for MACE using ACC/AHA clinical practice guidelines are of utmost importance for identifying alternatives, maximizing patient and surgical variables, and creating

specific management plans. Intraoperative, anesthetized patients will be unable to complain of CP or SOB to signify a PMI, and identifiers of intra-op PE may be transient and nonspecific.

Therefore, aggressive management of modest hemodynamic changes is important for patients with low physiologic reserve. Postoperative management must be catered individually because antithrombotic therapy may cause detrimental bleeding. EKG and serial troponins are recommended if there is suspicion of PMI.

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- Title

## Anesthetic Management of Extended Hepatectomy with Veno-Veno Bypass

- Authors (first name, middle name, last name: presenting author should be first, name bolded)

**Connie Bruno**, M.D., Jessica Lumsden, D.O., Wesley Simons, D.O.

- Department and Institution

Anesthesiology, Temple

University Hospital ○

### Introduction

Hepatic resection is a procedure historically associated with a high mortality, yet improvements in patient optimization, as well as in surgical and anesthetic techniques have drastically reduced the perioperative mortality. The procedure is performed for resection of hepatocellular carcinoma tumors as well as for solitary colonic metastases.

- Case Presentation

A 35 year old male with no significant past medical history presented with a chief complaint of abdominal pain of several months duration. The patient was hospitalized for GI bleeding and after an extensive workup, an MRI of the abdomen revealed a 19.8 x 12.2 x 13.4 cm left liver mass. The mass was biopsied and shown to be hepatocellular carcinoma. The patient presented for surgical resection of this mass. The surgical plan, after discussion with the surgeon, was for an extended left hepatectomy with the utilization of veno veno bypass.

On the day of surgery the patient was premedicated with midazolam 2mg i.v. Once in the operating room, general anesthesia was induced with ketamine and sufentanil and endotracheal intubation was performed successfully. A right brachial arterial line was placed, as well as a right internal jugular central venous catheter and introducer for veno veno bypass. A TEE probe was placed and revealed normal LV and RV function. The patient remained hemodynamically stable throughout the six-hour procedure, including during reperfusion of the liver remnant. The patient remained intubated immediately postoperatively and was transferred directly to the surgical ICU. He remained in the ICU for several days and he was eventually transferred to a regular floor and then discharged home.

- Discussion

Hepatectomy procedures present unique challenges in terms of intravascular volume shifts, potentially profound effects on cardiac output, and electrolyte aberrations. Hepatectomy is often performed for solitary lesions of the liver. Veno- veno bypass is infrequently used for resections, and often reserved for liver transplantation.

- Conclusion(s)

In this case, we elected to use veno-veno bypass in order to prevent hemodynamic instability during tumor resection. When resecting the tumor, a pringle maneuver was performed. Such a maneuver can frequently lead to ischemia of hepatocytes and potential instability. Extreme diligence by the anesthetic team, accompanied by the utilization of veno- veno bypass allowed the patient to remain hemodynamically stable throughout the operation.

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## Iatrogenic Type B Aortic Dissection Caused By Cannulation of the Ascending Aorta For Cardiopulmonary Bypass During Lung Transplantation

Nguyen, A MD<sup>1</sup>; Courtright, P MD<sup>1</sup>; Salamanca, Y MD<sup>2</sup> and Shao, Y MD<sup>2</sup>

<sup>1</sup>Temple University Hospital

<sup>2</sup> Lewis Katz School of Medicine at Temple University

A 55 year old man suffering from endstage idiopathic pulmonary fibrosis was admitted for hypoxemia. However, ventilator support failed to maintain adequate oxygenation so he was placed on VVECMO.

Three days later, he underwent lung transplantation with CPB. After initiating CPB, the intraoperative TEE revealed an iatrogenic Type B dissection (ITBD) with the tip of the aortic cannula located at the distal aortic arch. Given the urgency of the lung transplant and no evidence of ascending aortic dissection, the patient was treated medically with blood pressure control intraoperatively and in the ICU. The postoperative TEE and CT angiography showed resolving of ITBD.

## Perioperative Cardiac Arrest after Transcatheter Aortic Valve Replacement

**Anish Sethi, D.O.**, Jeffrey Derham, M.D., Edo Ginsburg, M.D. Department of Anesthesiology, Temple University Hospital, Philadelphia, PA

### Introduction

Aortic stenosis (AS) is the most common valvular heart disease in the developed world, affecting 2% of people over age 65. For patients with symptomatic AS, aortic valve replacement is the mainstay of treatment, offering significant improvements in symptomatology and life expectancy. Surgical aortic valve repair entails substantial perioperative risks for significant morbidity and mortality; as such, surgery may not be appropriate for some patients.

Transcatheter aortic valve replacement, or TAVR, remains an option for certain patients with severe symptomatic AS who have extremely high surgical risk, or for those who meet certain clinical criteria. Patients who are considering TAVR should be assessed by a multidisciplinary team, including cardiologists, surgeons, and anesthesiologists for appropriateness; inclusion and exclusion criteria for TAVR should be considered pre-operatively.

### Case Presentation

An 82 year old male with past medical history of severe aortic stenosis, cerebral infarcts, COPD, hypertension, and H presented for scheduled TAVR. In the months prior to this procedure, he had become progressively short of breath, worsened with heavy exertion. He underwent cardiac testing, which revealed severe aortic stenosis with an estimated valve area of  $0.83 \text{ cm}^2$  and mean gradient of 24 mmHg, mild aortic regurgitation, left atrial dilation, left ventricular diastolic dysfunction, and LVEF of 35-40%.

Intraoperatively, the patient received sedation and supplemental oxygen via nasal cannula. Blood pressure monitoring was performed via radial artery catheter. Cardiology obtained femoral arterial and venous access for catheter/valve insertion. In addition, an 8.5 French introducer was placed in the right internal jugular vein. Under fluoroscopic guidance, a 29 mm Core valve was successfully placed with no gradient and no AR post insertion. At the end of the procedure, the decision was made by cardiology to exchange the right IJ catheter for a 7 Fr sheath to prepare the patient for eventual transfer to the medical floor. As the catheter was replaced, the patient became markedly hypotensive and hypocapnic, with eventual hemodynamic collapse. CPR/ACLS was immediately initiated, and the patient was emergently intubated. Echocardiography was immediately performed, revealing a marked amount of microbubbles from the right and left pulmonary veins into the left atrium and the left ventricle, indicative of air embolism that occurred during the catheter exchange. The patient was transferred to the cardiac intensive care unit, and was weaned from vasopressors and extubated six hours later with no residual complications.

### Discussion/Conclusion

Perioperative complications of TAVR include stroke, vascular injury, myocardial injury, heart block, paravalvular aortic regurgitation, ventricular arrhythmias/perforation, and aortic arch dissection/rupture. Venous air embolism is a serious and under-recognized complication occurring with the insertion and removal of central venous catheters. Inspiration during the removal of the catheter increases negative intrathoracic pressure, causing passage of air into the circulation. Small amounts of entrained air can be removed by the pulmonary vascular bed; however, large amounts can obstruct the pulmonary outflow tract resulting in hemodynamic compromise, RV overload, and myocardial ischemia. Intraoperatively, the combination of end-

tidal CO<sub>2</sub> monitoring and echocardiography have high sensitivity for diagnosing VAE.

Patients with suspected air embolism should be managed with supportive therapy including high- flow oxygen, tracheal intubation with mechanical ventilation, ACLS, vasopressors, and optimal positioning.

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### Figures



**Figure 1:** Echocardiographic image obtained post-hemodynamic collapse displaying LA and LV air bubbles.

Poster for PAARC 2017

Title: Double Lung Retransplantation after Acute rejection of previously transplanted Single Lung

Authors: **Akshat Gargya** MBBS, Kathleen Tyson MD

Department and Institution: Department of Anesthesiology, The Lewis Katz School of Medicine at Temple University

Introduction: Current indications for Lung retransplantation includes lung transplant recipients with severe lung allograft dysfunction not amenable to medical or other surgical therapies and the selection criteria for lung retransplantation are similar to those for initial lung transplantation (1). Very rarely early postop period mortality is contributed to acute rejection and most deaths occur due to technical difficulties, ischaemia related complications and infection(2).

Case presentation: 58 yo Caucasian female with progressive respiratory insufficiency due to IPF, MCTD and pulmonary hypertension was taken to the OR for an off pump left single lung transplant. CMV D-R+, EBV D+R+. She had no intra-op complications but post op period was complicated with hypoxia, hypotension and she was started on Epi/Vaso/Milrinone. POD 1 she was febrile with WBC count 30.4 and Tmax 38.7, Xray showing complete white out of L lung. She remained intubated on AC with FiO2 100%, PEEP 15, INO 20ppm. Bronchoscopy done on POD2 had an unsuccessful removal of thick mucus secretions and fibrinous tissue at anastomosis & showed 30% stenosis beyond the anastomotic area. Rigid Bronchoscopy was done on POD 4, showed complete collapse of LUL, LLB. Diagnosis of acute graft failure (Fibrotic phase hypersensitivity pneumonitis & acute humoral rejection) was made. She never got weaned off of ventilator and was relisted for transplantation. Double lung transplant on pump was done, CMV D+ R-, EBV D- R+ on POD 30. Patient had no intraop complications, was continued immunosuppression and got discharged on vent to LTAC. She had multiple readmissions in next couple of months for hypoxic respiratory failure, worsening hypoxemia and inability to wean from the vent likely due to BOOP related changes in transplanted lung with restrictive allograft dysfunction. She required VV ECMO & remained vent dependent. She was treated with broad antibiotics, high dose steroids to treat the underlying BOOP changes before finally developing multi system organ failure, PNA, septic shock & alveolar hemorrhage and expired after 9 months of DLT.

Discussion: As per recent OPTN/SRTR annual transplant report, infection followed by CV abnormalities and graft failure are the most common causes of transplant failure within the 1<sup>st</sup> year of lung transplant (3). Although the early survival rate after lung transplant continues to improve (current national one-year adult expected survival rate being 87.47%)(3), the mortality is still high with retransplantations with an estimated mortality at one and five years being 38% and 55% respectively(4). The key factors that affect outcomes after retransplantation include the primary indication for retransplant & requirement for mechanical ventilation(4). In patients with sudden & severe graft function deterioration the option of retransplantation remains a controversy in addition to the ethical justification in the setting of scarce organ supply.

Conclusion: Appropriate risk factors for acute failure should be identified in patients and early diagnosis with bronchoscopy is mandated. More research is required in understanding the mechanisms of increased risk of acute graft failure, selection of candidates for reimplantation & optimizing their functional status to guide better outcomes.

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Critical Scare-Way: Obstetric Management of a Treacher-Collins Patient Starks, VS,

Bhambhani S, Bruno, C.

Treacher-Collins Syndrome (TCS) is a genetic syndrome of craniofacial abnormalities characterized by mandibular micrognathia, hearing loss, malar deficiency, down-slanting eyes, euryblepharon, and cleft palate. They may also have hypoplastic dental anomalies, and mild to severe obstructive sleep apnea<sup>1,2</sup>. These patients are conventionally very difficult to intubate and ventilate<sup>1</sup>, and the degree of difficulty of intubation increases with increasing age<sup>3</sup>. We present here a case of an 18 year old female with TCS, previously known to the OB/GYN and Anesthesiology teams, who presented for induction of labor at 41 weeks gestation for post datism.

Her pre anesthetic evaluation at 36 weeks revealed a past medical history of mild asthma, bipolar and anxiety disorders, and a history of difficult intubation and ventilation. She had significant midfacial hypoplasia and left ear hearing loss. Her height was 4 feet 11 inches, weight 50.8Kg. Airway exam revealed a Mallampatti score of IV, <4cm thyromental distance, micrognathia, small mouth opening with a large tongue, and limited ability to prognath. At that time, a plan was formulated for early epidural placement.

On admission her Hb was 10.9gm%, platelet count 349/c.mm, and fetal presentation was cephalic. A lumbar epidural was placed easily before induction of labor. Analgesia was maintained with an infusion of 0.2% ropivacaine with a T10 sensory level. As her labor progressed she experienced a lot of pressure in the midline vaginal area, but denied pain. After several hours, in view of Category II non-reassuring fetal heart tracings, the decision to deliver the baby via c-section was made. Lidocaine 2% with 1:200,000 epinephrine was administered via the epidural in small incremental doses until a T6 level was achieved.

The baby was delivered with Apgar scores of 8 and 9 at 1 and 5 minutes respectively. The mother remained hemodynamically stable, the epidural catheter was removed at the end of the procedure and she was taken to the recovery room. The rest of her hospital stay was uneventful and she was discharged home on post op day 3.

Patients with craniofacial abnormalities pose a challenge to the Anesthesiology team and efforts should be made to prepare for difficult intubation, or to avoid intubation altogether. In our case, we were able to avoid intubation and respiratory compromise by early epidural placement and titration of the epidural to sensory level.

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# Acute Retrograde Type A Aortic Dissection Developed after A Thoracic Endovascular Repair of Type B Aortic Dissection

Jessica Varga, Darsi Pitchon, Yanfu Shao

Department of Anesthesiology, Temple University Hospital

## Introduction

Acute retrograde type A aortic dissection (AD) following a thoracic endovascular aortic repair (TEVAR) for a type B AD is a rare complication but has high mortality.<sup>1</sup> However, a literature review yields only few case reports and limited retrospective cohort studies; also, there are no published guidelines for anesthetic management for this lethal disease. Further knowledge and experience in the management of this condition is needed. Here we present a case of acute retrograde type A AD occurred on the 3<sup>rd</sup> day after TEVAR for chronic type B AD.

## Case Presentation

A 63 year old gentleman with past medical history of hypertension presented with chest pain and subsequent workup revealed a chronic type B AD. For 3 months, his type B AD was medically managed by controlling hypertension. However follow-up CT scans showed a progression of AD to 5cm. Accordingly, the patient underwent TEVAR under general anesthesia. In figure 1, the transesophageal echocardiographic (TEE) descending aortic short-axis view showed the descending AD and the endograft (arrow). On postoperative day #3, he developed sudden chest pain and a CT scan revealed acute retrograde type A AD. Consequently, he underwent an emergency ascending aorta and hemi-arch replacement with deep hypothermia circulatory arrest. The intraoperative TEE study revealed the aortic insufficiency (AI, Figure 2) and the aortic root morphology. In figure 2, TEE mid esophageal ascending aortic long-axis view revealed the ascending AD flap impinging on aortic valve (**A**) and caused AI (**B**) during diastole (LA = left atrium; Ao = aorta). The TEE information was critical in formulating the surgical plan, and as such the surgery went well. The patient recovered from this unfortunate event and was eventually discharged to a nursing facility.

## Discussion

Type B AD are initially treated medically; however close observation is mandatory to monitor for AD progression. Acute retrograde type A AD is rare but most feared complication of TEVAR due to its high mortality.<sup>1</sup> Emergency surgical intervention is necessary for treatment, and the surgical plan is greatly aided by the use of intraoperative TEE. TEE is recommended for examination of aortic dissection.<sup>2</sup> However, TEE may be underutilized in AD. In a multinational study, intraoperative TEE was used to assess AD in 72% of academic center and 52% of nonacademic center.<sup>3</sup>

## Conclusion

TEE has a highly sensitivity (100%) in diagnosing type A dissection.<sup>3</sup> A recent study showed that TEE confirmed AD flap, revealed AI and mitral regurgitation, defined size of pericardial effusion, and examined left and right ventricular functions. The findings led directly to a change in planned surgery in 39% of patients.<sup>3</sup>

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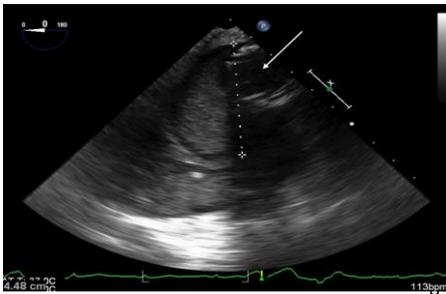


Figure 1. Dissection of the descending thoracic aorta and the endograft (arrow) are shown in TEE descending aortic short-axis view.

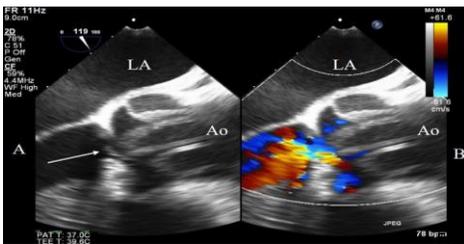


Figure 2. Dissection of the ascending aorta is shown in TEE mid esophageal ascending aortic long-axis view. (A) The dissection flap (arrow) impinges on the aortic valve and causes aortic regurgitation (B) during diastole. LA = left atrium; Ao = aorta

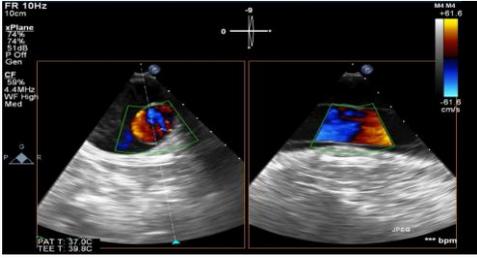


Figure 3. Dissection of the descending aorta is shown in TEE descending aortic short- axis (left) and long-axis (right) views. The color Doppler images demonstrate the true lumen.

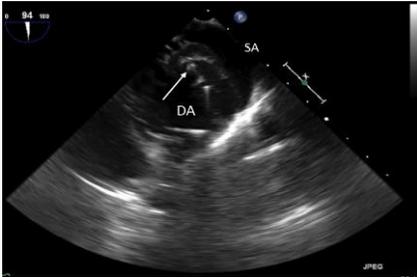


Figure 4. The upper esophageal aortic arch short-axis view reveals a piece of endograft in the distal aortic arch (arrow). SA = Subclavian artery; DA = distal arch.

## **Combined Heart and Liver Transplantation in a Patient With Latent Tuberculosis, Difficult Access and Right Ventricular Dysfunction Post Heart Transplant but Pre Liver Transplant**

Christian Balabanoff Acosta MD; Darsi Pitchon MD; Mario Farias Kovac MD; Yoshiya Toyoda MD; Jeffrey Derham MD,

Department of Anesthesiology, Temple University Hospital, Philadelphia, PA

### Introduction

Combined heart and liver transplant surgeries are uncommon. In the United States there have been a total of 184 combined heart and liver transplants since 1988 (1). The most common indication for transplanting is amyloidosis (2). Only specialized centers around the world perform them. Survival rates at one and three years are 84.8% and 79.5 % respectively. Another single center study has survival rates at one month, one year and five years that were 93%, 93% and 82 % (2). There is currently no report about the anesthetic management of a combined heart and liver transplant.

### Case

A forty-two year-old male with none ischemic cardiomyopathy, cirrhosis, systemic hypertension, atrial fibrillation, diabetes, chronic kidney disease disease and latent tuberculosis on treatment presented for a combined heart and liver transplant. The patients left heart ejection fraction was 15 %. Upon arrival to the OR monitors were placed and a preinduction arterial catheter was placed in the left brachial artery. He was induced with midazolam, fentanyl, rocuronium and Etomidate. A dual lumen venovenous bypass catheter was placed in the right IJ but was subsequently removed to facilitate passage of a pulmonary artery catheter because the latter could not be passed in the left IJ, or subclavians. Induction of immunosuppression was performed. The heart transplant was performed and prior to beginning the liver transplant TEE evaluation of the heart showed severe RV dysfunction that could potentially complicate the liver transplant, this initiated the debate on whether to proceed with the liver transplant. Surgery proceeded and VVBP cannulas were placed in the left femoral vein and right atrium. During the liver transplant portion the patient was continued on pressors and inotropic support.

### Discussion

Although a rare combination of transplants, the anesthetic management is quite unique in the sense that you have to maintain adequate function of a newly transplanted heart while providing care for a liver transplant where intense physiologic alterations may present themselves. The use of intraoperative echocardiography is essential in both evaluating cardiac function and volume status. The management should be performed by a multiple team.

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# CARBON DIOXIDE INDUCED NARCOSIS IN FOUR PATIENTS HAVING RETROPERITONIAL ROBOTIC SURGERY

Christian Balabanoff Acosta MD; Robin Schiller MD; John Ferrari MD; Eric Gewirtz MD; Ellen Hauck DO,  
PhD

Department of Anesthesiology, Temple University Hospital, Philadelphia, PA

## Introduction

Insufflation of the peritoneum and retroperitoneum leads to increases in arterial CO<sub>2</sub> content which can be followed using end tidal CO<sub>2</sub> monitor or arterial blood gas monitoring. During these procedures, the formation of subcutaneous emphysema is possible, as is the accumulation of CO<sub>2</sub> in between anatomical structures forming CO<sub>2</sub> pockets that could still exist after surgery. We present four cases of acute postoperative respiratory failure following robotic retroperitoneal surgery believed to have been due to CO<sub>2</sub> narcosis.

## Case

Patient A: A 45 y.o. male with a past medical history (PMH) of right lung pneumonia and right lung lobectomy secondary to abscess. He had a right robotic nephrectomy that was performed over a period of 2 hours. At the end of the case, the patient was reversed with neostigmine and glycopyrrolate. He was conscious and following commands prior to extubation. In route to the post anesthesia care unit (PACU), the patient was coherent and talkative but on the way he became unresponsive and apneic, requiring bag mask ventilation for 10 minutes before regaining consciousness.

Patient B: A 46 y.o. male patient with a PMH of coronary artery disease, hypertension, MI, arrhythmia, diabetes mellitus, tobacco and alcohol use. He required a robotic ureterostomy with buccal graft urethroplasty and omental wrapping. Surgery lasted 6 hours. He was reversed with neostigmine and glycopyrrolate. The patient was extubated once he was spontaneously breathing, awake and appropriately responsive. Forty minutes after extubation, while in PACU, he became apneic and required resuscitation with reintubation. He was extubated 22 hours after the event.

Patient C: A 62 y.o. female patient with a PMH of asthma, anxiety and depression who presented with a right ureteral obstruction that required a robotic pyeloplasty; the surgery lasted 4 hours. The patient's paralysis was reversed with the maximum dose of neostigmine and glycopyrrolate. The patient was extubated without complication. 42 minutes after arrival in PACU, she became apneic and required bag mask ventilation until recovery of consciousness and was placed on bipap and discharged from the PACU on 2L nasal cannula.

Patient D: 89 y.o. male patient with a history of COPD, hypertension, hyperlipidemia, basal cell carcinoma, daily alcohol use and a right kidney mass who presented to the hospital for a total right robotic nephrectomy. The surgery lasted 6 hours. The patients paralysis was reversed with the maximum dose of neostigmine and glycopyrolate when a ToF was 4/4. After extubation he was able to answer adequate questions and able to do simple tasks. After 10 minutes he became somnolent and was started on BIPAP for 2 hours due to elevated CO2 values.

#### Discussion

There are many reasons for postoperative respiratory failure, including narcotic overdose, residual weakness from incomplete reversal of paralysis and pulmonary disease of the patient, such as those with COPD. Narcotic overdose and incomplete reversal of paralysis are less likely for their respiratory failure. We believe that all four patients experienced CO2 narcosis as a result of increased bodily CO2 that occurred once spontaneous respirations began.

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## **ACUTE PNEUMOPERITONEUM CAUSING PATIENT INSTABILITY DURING PERORAL ENDOSCOPIC MYOMECTOMY (POEM)**

Christian Balabanoff Acosta MD; Mario Farias Kovac MD; Daniel Donohue CRNA; Donald Koers MD; Abiona Berkeley M.D., J.D.

Department of Anesthesiology, Temple University Hospital, Philadelphia, PA

### Introduction

Per-oral endoscopic myotomy (POEM) was developed in (2005) for the treatment of dysphagia caused by achalasia and is now used for gastric outlet obstruction (G-POEM) (1). It provides an alternative treatment to surgery for these conditions and is also effective as a rescue procedure should surgery fail (2). Long term and acute complications are rare. Known complications are esophageal perforations and continued achalasia on follow ups. Secondary to CO2 insufflation pneumothorax and pneumomediastinum, pneumoperitoneum and subcutaneous emphysema may present themselves but usually do not have any clinical significance(3). These cases are performed under general anesthesia and in many cases require a rapid sequence intubation (RSI) to prevent aspiration, which is one of the challenges with the anesthetic management in POEM procedures. In this poster we present a patient who during her POEM presented hemodynamic instability secondary to an unsuspected pneumoperitoneum

### Case

This is a 76 yo female patient with a history of bilateral kidney cancer, chronic kidney disease on dialysis, hypertension, hypothyroidism, gastroesophageal reflux with a 25 year history of achalasia. Upon admission to the preanesthetic area NPO status was determined to be 8.5 hr. In the operating room, general anesthesia was attained with rapid sequence induction (RSI) using propofol, fentanyl, and succinylcholine without complications. Anesthesia was maintained with sevoflurane and rocuronium.

Approximately halfway through the procedure, the patient became hemodynamically unstable. The patient developed acute onset hypotension, bradycardia, decreased etCO2, and high peak pressures in the 40's (baseline 20-30's). Breath sounds were reduced bilaterally. Fluids and norepinephrine were initiated with minimal success in achieving a normal BP and evaluation of the airway and circuit did not show signs of malfunction. Within a few minutes the abdomen was seen to increase in girth. After a discussion with the surgical team a percutaneous needle was used to decompress the abdomen with complete resolution of symptoms. Norepinephrine was discontinued and the procedure ended without further events. The patient was extubated successfully after surgery.

### Discussion

POEM is an effective procedure and with no straight forward anesthetic management. The risk of aspiration is the most common risk associated with the anesthetic. Even though the formation of a clinically insignificant pneumoperitoneum is common, a high suspicion should always be maintained with regard to unexpected hemodynamic instability.

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**UNDIAGNOSED RIGHT TENSION PNEUMOTHORAX WITH HEMODYNAMIC  
INSTABILITY WITH CONCOMITANT HIBERNATING MYOCARDIUM  
PRIOR TO DOUBLE LUNG TRANSPLANT**

**Christian Balabanoff Acosta MD; Mario Farias Kovac MD; Yoshiya Toyoda MD; Edo Ginsberg MD,**

**Department of Anesthesiology, Temple University Hospital, Philadelphia, PA**

**Introduction:**

Lung transplant surgery is a common procedure in today's medical era. In the United States alone last year 2057 lungs and 15 heart lung transplants were performed( 1). The most common reason for needing a lung transplant is interstitial pulmonary fibrosis (IPF), emphysema or COPD and cystic fibrosis(2). These patients usually are ASA classification of 4. This procedure has many complications. We present a case of a patient who on the day of his lung transplant presented to the OR unstable due to an acute pneumothorax (PTX) and left temporary ventricular dysfunction otherwise known as a hibernating myocardium.

**Case**

A 65 yo. male patient with a past medical history of arterial hypertension, right heart failure with cor-pulmonale, ex-smoker (80 pack year) with COPD and emphysema on 4-8 Lts of home O2 who was admitted to the hospital with a COPD exacerbation and pneumonia that was treated adequately. On the day of surgery the patient had a preoperative evaluation and was seen to be on bipap secondary to increased shortness of breath and CO2 retention. The chest x ray performed that day did not show signs of pulmonary edema or signs of pneumonia and was identical to prior days. A transthoracic echocardiogram performed 3 months before surgery showed a severely dilated RV with a normal left ventricle, a cardiac cath performed one week prior showed normal coronary vessels. Upon transfer to the OR 3 hours after the preoperative evaluation the patient was found to have increased shortness of breath. In the OR he was hypotensive, had arterial and peripheral lines place and intubated quickly. A transesophageal echocardiogram was performed showing a severely depressed left ventricle depression with an EF of 15 % and an epinephrine drip was started. A right internal jugular vein pulmonary artery catheter was inserted. Upon insertion of the needle one cm into the skin air could be aspirated.

Discussion with the surgeons where held about the possibility of starting ECMO therapy. The surgeon indicated he would start surgery and place the patient on cardiopulmonary bypass. On opening the chest a gush of air was expelled and the vital signs got slightly better but the heart continued to show a low EF. Epinephrine was continued and the case proceed without any further complications. Two days later, while the patient was in the ICU a new echocardiogram was performed showing a normal EF with reduced pulmonary artery pressures.

## Discussion:

Surprises may present itself at any moment like in this patient. Acknowledging that there is a pneumothorax is of utmost importance. Once patients spiral down and start to have hemodynamic changes treatment can be difficult and can result in bad outcomes. In this case the patient had both undiagnosed pneumothorax and left ventricular dysfunction, but after the pneumothorax was liberated with the thoracotomy hemodynamic instability continued and LV dysfunction was diagnosed.

Anesthesiologist should be able to recognize and manage both of these states adequately, one never knows when something a like may present itself.

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# Scleroderma and Severe Restrictive Lung Disease Complicating an Obstetric Delivery Plan

Felipe Edghill, MD; Matthew Troum, DO; Bradley Hammond, DO; Ihab Kamel, MD Department of

Anesthesiology, Lewis Katz School of Medicine at Temple University **Introduction**

Scleroderma is a chronic autoimmune condition characterized by hardening of the skin and in the most severe forms can affect internal organs. Scleroderma can be limited to cutaneous manifestations or can be diffuse which is a rapidly progressing form that affects the lungs, esophagus, liver, kidneys and other vital organs. The prognosis is good for people with limited cutaneous Scleroderma, however those with the diffuse type have a poor prognosis.

## **Case Presentation**

A 40-year-old female presenting for a scheduled cesarean section with a past medical history of scleroderma, gastro esophageal reflux disease, chronic anemia, and 2 previous cesarean sections under general anesthesia. Her baseline requirement was 7-10 liters of oxygen at home. Echocardiography revealed a normal ejection fraction, with mild tricuspid regurgitation and mildly elevated pulmonary artery pressures. Pulmonary Function Tests showed a moderately decreased FEV1 and FVC with a normal ratio. She received 2 units of PRBCs the day before surgery to optimize oxygen carrying capacity and intravascular volume. On the day of surgery, the decision was made to perform the case in the main operating room to have appropriate resources and a dedicated anesthesiology team. Standard ASA monitors were applied and a lumbar epidural catheter was placed using 2% lidocaine solution titrated to achieve a T4 sensory level while monitoring the patient respiratory status. The obstetrician proceeded with the head of the bed elevated to 20 degrees. The C-section was completed and a life female infant was delivered. The patient had an uneventful postoperative course and was discharged home.

## **Discussion**

Scleroderma in pregnancy increases the risk to both the mother and the fetus. Overall scleroderma is associated with reduced fetal weight for gestational age. In the United States the prevalence of Scleroderma is estimated at 240 per million and the annual incidence is estimated at 19 per million people. The 5-year survival for patients with diffuse cutaneous scleroderma is approximately 55% with the majority of deaths occurring due to pulmonary fibrosis, pulmonary hypertension and Scleroderma Renal Crisis. There is no definitive cure for Scleroderma as most people are just treated for the symptomatology. Patients with scleroderma pose a challenge to the anesthesiologist. Poor neck mobility can lead to difficult tracheal intubation especially in the term parturient. Restrictive lung disease can make it a challenge to adequately oxygenate the patient and renal disease can affect the metabolism and excretion of medications commonly delivered. In this case the head of the bed was elevated during cesarean delivery. This was done because the patient experienced shortness of breath and a drop in the hemoglobin saturation in the supine position. Esophageal dysmotility can increase the risk of aspiration.

Elevating the head of the bed was maintained throughout the case to minimize the risk of pulmonary aspiration. When preparing for any anesthetic in patients with Scleroderma it often requires a multidisciplinary approach.

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## Pulmonary Embolism During a Sickle Cell Crisis

**Jessica Varga**, Jeongae Yoon, Edo Ginsburg

Department of Anesthesiology, Temple University Hospital Introduction

Sickle cell disease (SCD) is the most common hemoglobinopathy where abnormal clumping of deoxygenated hemoglobin S distorts RBC into rigid, sickle cell shape and causes microvascular thrombosis.<sup>1</sup> SCD is a systemic disease, but pulmonary complication, i.e. acute chest syndrome (ACS), is especially associated with high morbidity and mortality.<sup>2</sup> Recently SCD is increasingly recognized as hypercoagulable state and associated with elevated risks for venous thromboembolism and pulmonary embolism (PE).<sup>3</sup> Here we present a case of a young patient with SCD who developed PE during a sickle cell crisis.

### Case Presentation

A 29-year-old male with PMH of SCD (hemoglobin SS) and non-Hodgkin's lymphoma in remission was admitted to an outside hospital with fever, shortness of breath, and hypoxia. Chest x-ray showed bilateral pulmonary infiltrates. The patient was promptly transferred to a second institution for ACS with possible pneumonia. Upon admission, he became acutely hypoxic, acidotic, and hemodynamically unstable, with altered mental status. The patient was transferred to ICU, intubated, and started on empiric antibiotics, vasopressors, and exchange transfusion. TTE revealed severe RV dilation and dysfunction with McConnell's sign concerning for PE. He received t-plasminogen activator without resolution of the symptoms, hence was taken to the OR for a pulmonary thromboendarterectomy. He couldn't be weaned off cardiopulmonary bypass in surgery, thus was placed on a central VA-ECMO and transferred to our institution. On admission, the patient was in grave condition requiring multiple vasopressors, CVVHD, and massive transfusions because of high chest tube output. Patient was weaned off ECMO and his chest closed when RV recovered. Although his RV recovered from PE and ACS, the patient suffered anoxic brain injury, acute respiratory distress syndrome (ARDS) requiring tracheostomy, and acute kidney disease requiring hemodialysis from the sickle cell crisis and currently is in palliative care.

### Discussion

Patients with SCD have an increased incidence of venous thromboembolism due to aberrant red blood cell shape and adhesion, platelet dysfunction, chronic inflammation, intravascular hemolysis, and altered fibrinolysis.<sup>3</sup> PE has been noted to occur approximately 3.5 times more frequently in younger SCD patients, with a mean age of 28 years.<sup>2</sup> Chronic pulmonary complications in SCD are pulmonary hypertension (PH), venous thromboembolic disease, asthma, and pulmonary function abnormalities.<sup>1</sup> Acute complications of SCD are ACS, PH, and PE, which has been shown to be one of the leading causes of death in SCD patients.<sup>2</sup>

### Conclusion

Our case illustrates acute PE in the setting of ACS leading to multiple morbidities including RV failure, anoxic brain injury, ARDS, and kidney injury requiring hemodialysis. A high suspicion for PE in SCD patients should be maintained, particularly in those hospitalized with ACS.

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# Emergent Reoperation on Patient with Combined Heart Liver Transplant: the Anesthetic Implications

Roshawnda Brown M.D., Darsi Pitchon M.D., Wesley Simons D.O.

Department of Anesthesiology, Lewis Katz School of Medicine, Temple University, Philadelphia, PA

## Introduction

Heart and liver transplant patients present unique challenges for the anesthesiologist during non-transplant surgery. Considerations regarding altered physiology, medication interactions, increased risk of infection, and organ rejection must be taken into account.

## Case Presentation

A 43 year old male with a history of atrial fibrillation, diabetes, hepatitis C, multiple DVTs, and a remote history of heroine abuse was admitted POD#56 status post combined heart liver transplant for volume overload of unclear etiology. His hospital course was complicated by enterococcal bacteremia, *C. difficile* infection and sepsis. On POD#73, CT of the abdomen ordered due to bright red blood per rectum and tenesmus showed pneumatosis and portal venous air. He returned to the OR emergently for an exploratory laparotomy requiring a total colectomy and end ileostomy. The patient returned to the ICU on mechanical ventilation, but expired POD#85

## Discussion

Anesthetic concerns in non-cardiac surgeries arise due to the altered physiology of the transplanted heart, immunosuppression, and drug interactions. Due to the denervation of the heart, it lacks the chronotropic response to hypotension, hypoxia, hypercarbia and laryngoscopy that is normally exhibited as a result of sympathetic stimulation. The transplanted heart will not respond to indirect acting agents such as glycopyrrolate, neostigmine, or maneuvers such as Valsalva, and carotid massage<sup>1</sup>. However, it will respond to direct acting agents. Reports on whether ephedrine works in transplanted hearts varies by source<sup>1,3</sup>. In order to maintain cardiac output the transplanted heart is “preload dependent” relying on increases in stroke volume that occurs due to catecholamine circulation. Avoiding acute decreases in preload is paramount in these cases. Transplant patients are on various medications, including immunosuppressives which mask typical signs of infection. Considerations must be taken to maintain aseptic technique when required, to avoid medication interactions, and drugs that may worsen an already deteriorating system, such as the kidneys. Finally, it appears safe to give NMB reversal to patients, with minimal effect to the CV system<sup>2</sup>.

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## A CASE REPORT: Employment Of ECMO For Tracheobronchial Anastomosis Repair After Carinal Resection with Re-anastomosis and Left Pneumonectomy for Adenoid Cystic Carcinoma.

Steyn, PP, MB ChB; Hauck, ES, DO PhD; Gargya, A, MBBS; William Runcie, MD; Keresztury, M, MD; Dorotan, J, MD; Ginsberg, E, MD; Lee, M, MD; Berkeley, A, MD JD.

### Temple University Hospital, Department of Anesthesiology

Despite technical refinements in tracheal surgery, tumors with involvement of the carina still remain a challenge for both thoracic surgeons and anesthesiologists. Prior to 1970, tools available to the anesthesiologist and surgery team included a variety of ventilation methods including one lung ventilation and jet ventilation. Over the decades, ECMO has found more uses and is slowly becoming a more common treatment for patients with respiratory and cardiac failure.

We present a patient who required both veno-venous and veno-arterial ECMO in the course of treatment for lung cancer; A 48 year old female with past medical history of diabetes, cervical cancer and hypertension, presented with chest pain, persistent cough and significant weight loss. Bronchoscopy with biopsy revealed an adenoid cystic carcinoma of the left mainstem bronchus, encroaching into the midline above the carina.

Her planned surgery was for carinal resection with primary reanastomosis and left pneumonectomy. The anesthetic plan for this patient included postoperative pain control with intrathecal morphine, placement of a bronchial blocker for one lung ventilation as well as veno-venous lines for extracorporeal membrane oxygenation as back up.

After the pneumonectomy, full oxygenation of the patient became difficult and veno-venous ECMO (VV ECMO) was initiated. A tracheostomy was placed.

On postoperative day 6, the patient developed a tension pneumothorax that required placement of a left chest tube. Dishecence of anastomosis was suspected. She was brought back to the operating room for placement of a bronchial stent, then returned to the ICU. On postoperative day 9, the patient acutely desaturated, became hemodynamically unstable and was taken to the operating room for emergent surgery. She had a revision of her tracheostomy with recannulation and reanastomosis of her trachea using an omental flap. During this surgery, the patient twice developed pulseless electrical activity from which she was resuscitated. She became severely hypercarbic at this point and veno-arterial ECMO (VA ECMO) was instituted. She was then returned to the ICU on VA ECMO.

Ventilation and oxygenation during tracheobronchial resection is one of the most challenging moments for the anesthesiologist. Adequate ventilation perioperatively is a major predictor of outcomes after tracheal resection surgery. ECMO was a critical component of this patient's care. Two modes of ECMO were employed during her surgeries and care in the ICU.

The CESAR trial showed improved 6 month survival rates in ARDS. In contrast, a systematic review after the H1N1 pandemic showed insufficient evidence of benefit to justify use of VA ECMO

## Transesophageal Echocardiography Findings and Intraoperative Management of Uncommon Robotic Assisted Anterior Mitral Valve Mass Resection

Wilkens, Eric, MD, MPH, CSH-1V. Troum, Matthew, DO

### **Introduction**

Primary tumors of the heart are relatively uncommon and among them myxomas are the most common. Most myxomas occur in the right or left atrium with 86% of them occurring in the left atrium. The treatment for myxomas is surgical excision due to the high likelihood embolization. Most atrial myxomas are found incidentally on echocardiography while screening for other abnormalities. Myxomas originating from the actual mitral valve leaflet itself is extremely rare and only a few cases have been identified. Here we will discuss a case of a myxoma originating from the ventricular side of the anterior mitral valve leaflet with tremendous Transesophageal Echocardiography findings and pictures.

### **Case Presentation**

This case involves a 54 year old female with a past medical history of anxiety who presented to her primary care physician for generalized fatigue and mild dyspnea on exertion. A transthoracic echocardiogram (TTE) was done which showed an 8mm x 8mm mass which seemed to originate from the ventricular side of the anterior mitral valve leaflet. On that TTE she had no mitral regurgitation, stenosis, or any other valvulopathy elsewhere. Her pre-operative review of systems was positive only for generalized fatigue and mild shortness of breath with exertion and physical exam was relatively unremarkable. Prior to the induction of anesthesia bilateral ultrasound guided brachial arterial lines were placed due to the surgeon's use of an endo-balloon as an aortic cross clamp. Anesthesia was induced with Etomidate, Fentanyl, Versed and Rocuronium. Patient was intubated easily and anesthesia was maintained with Isoflurane and Fentanyl. A Right Internal Jugular single lumen cordis later be used by the cardiac surgeon for cannulation. Also with the use of fluoroscopy and TEE in concert a pulmonary artery vent was placed as well as a percutaneous coronary sinus cardioplegia catheter for retrograde cardioplegia. A bronchial blocker was placed in the right mainstem bronchus and placement was confirmed using a fiberoptic bronchoscope. The surgeon made the laparoscopic ports and the daVinci robot was brought in from the left side of the patient.

The patient was then heparinized with 25,000 units and cannulated for cardiopulmonary bypass. The patient went onto bypass uneventfully. During the operation a 8mm x 8mm mass was noted on TEE and visualized surgically. The mass appeared white, soft and attached to the underside of the anterior mitral valve leaflet by a very small, 1 mm, stalk. Frozen sections were sent to pathology intraoperative which revealed mass with myxoid composition which permanent biopsies later confirmed. After complete resection of the mass, the mitral valve was repaired robotically with patch closure of the anterior mitral valve leaflet. Post-operative TEE showed a competent mitral valve with no leaks and no remnants of the mass. The patient had an uneventful postoperative course, was extubated later that afternoon and discharged from the hospital Day 6.

### **Discussion**

Cardiac Myxoma is a rare tumor with an overall incidence of 0.02% with the majority of tumors occurring in the left atrium. A myxoma on the anterior mitral valve leaflet is so rare that the actual incidence is not known. They can occur in any age group however tend to be more common between the third and sixth decades. The clinical signs and symptoms of myxomas are variable but are largely dependent upon the location, size, friability and mobility. Because most myxomas are left sided in nature they frequently cause systemic

embolization involving the cerebral arteries and to a lesser degree the renal, splanchnic and coronary circulation. Therefore the primary treatment for any myxoma is surgical excision. The exact incidence of embolization of myxomas in the atrium compared to the actual mitral valve itself is unknown likely due to the very few cases involving the mitral valve. Surgical excision is the primary treatment of choice for atrial and valvular myxomas. Post-operative complications are fairly common with arrhythmias leading the way leading to the potential use of long term anti- arrhythmic agents however this case had no complications.

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# Chronic Inflammatory Demyelinating Polyneuritis in Pregnancy, a Case of Patient-Controlled Epidural Analgesia

Jespersen K, M.D., Mele M, M.D., Huffnagle HJ, D.O., Huffnagle SL, D.O., Wenzel J, M.D.

Introduction: Chronic inflammatory demyelinating polyneuritis (CIDP) is an acquired inflammatory disorder affecting peripheral nerves (1). CIDP is characterized by impaired sensation, symmetrical limb weakness, absent or diminished deep-tendon reflexes, and demyelination on nerve-conduction studies. We discuss a case of patient-controlled epidural analgesia (PCEA) in a 30-year-old, primigravida undergoing treatment with IV immunoglobulin (IVIG) for active CIDP symptoms.

Case: Our patient's initial symptoms consisted of difficulty going up and down stairs, generalized muscle cramps, and b/l lower extremity paresthesias. At 22-weeks gestation she began experiencing unprovoked falls and increased pain and cramping in her arms and hands. She was admitted at 24-weeks and received IVIG 2g/kg over 5 days; some neurologic improvement was noted at discharge. Our patient was admitted at 5 week intervals for additional IVIG. She reported no more falls after therapy.

At 39 weeks, labor was induced for thrombocytopenia, platelet count  $79 \times 10^9/L$ . Two units of pooled platelets were transfused with a repeat count of  $122 \times 10^9/L$ . At 5-cm dilation, an epidural catheter was placed at the L3-L4 interspace. PCEA was initiated with an infusion of 0.125% bupivacaine + 1.5-mcg/mL fentanyl at a rate of 8-mL/hr, a patient initiated bolus of 5- mL, and lockout of 10 minutes. Twelve hours after initial placement, she complained of inadequate pain relief and the epidural was replaced at L4-L5. Nine hours later she had an uncomplicated vaginal delivery and was discharged on POD #5. Follow-up at 2 months revealed no new or progressive symptoms.

Discussion: CIDP is an acquired condition affecting the peripheral nervous system, with a prevalence of about 1-2 per 100,000 adults. Symptoms include impaired sensation, absent or diminished deep tendon reflexes, paresthesias in the hands and/or feet, and symmetrical limb weakness. Diagnosis is based on these symptoms, demyelination on EMG, and greater than 2 month duration of illness. Pathogenesis is thought to be autoimmune related. Effective therapies include IVIG, plasma exchange, and corticosteroids. 60 to 80% of patients show improvement with these treatments.

There is little experience with administration of neuraxial anesthesia in patients with CIDP. What concentration of local anesthetic and duration of exposure is safe? One case report describes PCEA analgesia in a laboring parturient (2). Her epidural was in place for only five hours and the analgesic mixture was different than ours (0.1% ropivacaine + fentanyl 2mcg/mL). Despite a much longer exposure to epidural local anesthetic (21 hrs), our patient did not develop an exacerbation of CIDP symptoms after delivery or 2 months later. This case suggests that prolonged contact with a dilute solution of epidural local anesthetic may be safe as well

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Title: Sepsis and Cardiopulmonary Bypass, Rare Complications of a Retained Guidewire

Authors: Jillian Dashiell, MD; Elizabeth Wolo, MD; Jordan Goldhammer, MD Institution:

Department of Anesthesiology, Thomas Jefferson University Hospital

#### Introduction:

Central venous catheterization is often necessary peri-operatively and it is associated with complications.<sup>1</sup> Although intravascular retention of a guidewire is rare, this complication needs to be recognized as it can cause increased morbidity.<sup>2,3,4</sup> This case report describes central venous catheter (CVC) retained guidewire induced sepsis and its extraction requiring cardiopulmonary bypass (CPB).

#### Case Report:

A 60 y/o M with a history of diabetes, hypothyroid, and pancreatitis presented to the emergency room after 3 weeks of fevers and pleuritic chest pain. A chest x-ray was performed, which showed a guidewire overlaying the SVC, right atrium (RA), and IVC extending inferiorly out of view. Upon questioning, the last procedure he underwent was in 2008 where a right sided CVC was placed. To further evaluate, a CT chest/abdomen/pelvis was performed. CT depicted the wire extending superiorly out of the left innominate vein into the soft tissue and a piece of the wire in the IVC/RA junction.

Inferiorly the wire extended to the R common femoral vein. The CT also depicted several pulmonary nodules suspicious for septic emboli.

Blood culture results were positive and the patient was started on broad spectrum antibiotics. Interventional radiology (IR) and cardiothoracic surgery were consulted for removal of the wire. Due to the right atrial involvement and extravasation, IR deferred to cardiac surgery for removal.

Upon opening the chest, the wire was seen sticking out of the innominate vein but only a piece of the wire could be extracted. CPB was initiated in order to extract the wire. The right atrium was opened and the wire, which was adherent to the lateral wall, was removed (Figure 1). In addition, a separate piece of wire with a vegetation in the IVC was easily extracted. CPB time was 17 minutes. Post-operatively, blood cultures grew *Streptococcus mitis* and the patient was discharged home on post-operative day 4 on ceftriaxone.

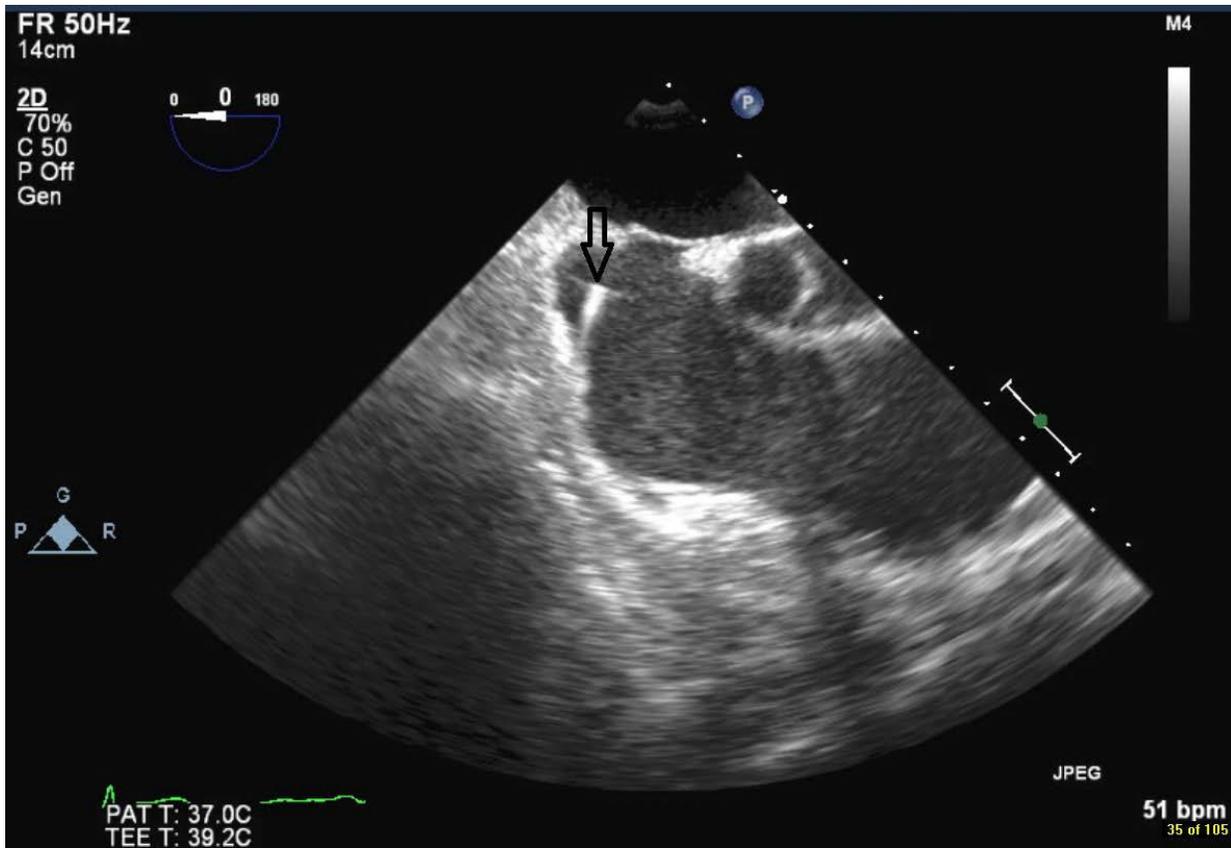


Figure 1: Retained Guidewire (arrow) depicted in RA on Intraoperative Transesophageal Echocardiography

Discussion:

CVCs are placed peri-operatively at a rate of 5 million per year.<sup>1</sup> The anesthesia closed claim database reports several cases of retained wire/embolus from CVC placement.<sup>2</sup> Risk factors for this complication include inadequate supervision, opening of more than one CVC kit, double stick technique and hemodynamically unstable patients.<sup>2,3,5</sup> A majority of the wires were discovered post-operatively on routine chest or abdominal X-ray in asymptomatic patients, although radiologic detection can be missed.

<sup>2,3,4,5,6,7</sup> All but one wire was extracted percutaneously.<sup>2,3,4,5,6,7</sup>

This case is unique, due to; the resultant sepsis, the presence of septic emboli and a vegetation, the fragmentation of the wire, the time to discovery, and the need for cardiopulmonary bypass for its extraction. In our literature search, only one other case report demonstrated the need for CPB for wire extraction and one separate case report described a retained guidewire causing bacteremia.<sup>8,9</sup> Neither described the presence of septic emboli or vegetations.

This case suggests the need for future quality improvement studies or protocols to prevent retained guidewires. Quality improvement in this area could focus on the supervision of CVC placement, CVC documentation and routine chest x-rays after placement. Creating protocols for preventing retained guidewires would be of high value considering the cost and morbidity associated with failure to detect

this complication.

Conclusions:

Although guidewire retention is a rare complication of CVC placement it is associated with high morbidity and may even require cardiopulmonary bypass for extraction. Institutions should have clinical verification and written documentation of the guidewire's removal.

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# Delayed Hypercarbia and Subcutaneous Emphysema After Laparoscopic Surgery

Uzung Yoon MD, MPH, Nirmal Shah DO, Elaine Kilmartin MD

Department of Anesthesiology, Thomas Jefferson University Hospital, Philadelphia, PA, USA

## Introduction

Delayed hypercarbia, occurring after the end of surgery, and subcutaneous emphysema is an uncommon presentation in laparoscopic surgery. Abdominal insufflation can cause CO<sub>2</sub> to diffuse into subcutaneous tissue, causing subcutaneous emphysema and hypercarbia [1]. However, the hypercarbia usually occurs within 30 minutes of insufflation and resolves after the end of surgery with hyperventilation or without further treatment due to the high solubility of the gas in the body. The incidence of delayed hypercarbia is 5.5% [1] and subcutaneous emphysema is 0.3 to 3% during laparoscopic surgery. High insufflation pressure and prolonged surgical duration are the strongest risk factors [2]. It is critical to rule out other causes when faced with delayed and prolonged hypercarbia.

## Case Presentation

A 33-year-old female with a BMI of 24 presented with uterine fibroids and excessive bleeding. The patient was scheduled for a laparoscopic hysterectomy. She had a PMH of pulmonary embolism during pregnancy, asthma, anxiety, C-sections, gastric surgery, cholecystectomy and hernia repair. She reported to be allergic to latex, morphine, meperidine, pecans, walnuts and shellfish. Anesthesia induction was uneventful and anesthesia was maintained with sevoflurane along with 50% air and 50% O<sub>2</sub>. Minute ventilation (MV) was 5-6 L, 450 ml tidal volume and a respiratory rate of 12. Following peritoneal insufflation, the patient was hemodynamically stable with an ETCO<sub>2</sub> of 35 mmHg. Upon skin closure, three hours after surgery start; she had an unexpected rise in ETCO<sub>2</sub> up to 60 mmHg. Immediate hyperventilation was initiated with increasing MV to control hypercarbia. Other causes of hypercarbia were entertained, including malignant hyperthermia, fever, and thyroid storm. Patient was afebrile. Physical examination revealed significant subcutaneous emphysema on the abdominal wall and lower chest cavity. Since the patient's hypercarbia could not be normalized in the operating room for 1 hour, the patient remained intubated and was mechanically ventilated in the PACU. The subcutaneous emphysema resolved after a 1 hour PACU stay, and patient was extubated without complications.

## Discussion

Hypercarbia and subcutaneous emphysema during laparoscopic surgery is mostly due to extraperitoneal insufflation and diffusion of CO<sub>2</sub> into tissue. The most common causes are extraperitoneal port placement or port migration. Risk factors include: longer operative times, higher insufflation pressures, greater number of surgical ports, older patient age, and extraperitoneal laparoscopic procedures [1]. There is also a strong

correlation between CO<sub>2</sub> absorption and development of subcutaneous emphysema. Gas absorption from a cavity depends on its diffusibility and perfusion of walls of that cavity [4].

In delayed hypercarbia or subcutaneous emphysema, a differential diagnosis is important and a physical exam should be performed to rule out other causes such as intestinal perforation, esophageal perforation, tracheal perforation, pneumothorax, CO<sub>2</sub> embolus, asthma, allergic reaction and malignant hyperthermia [5,6]. Initial intraoperative management involves communication with the surgeon, hyperventilation, decreasing insufflation pressure and avoidance of nitrous oxide. In severe cases, converting to open surgery or abruption of surgery should be considered. Arterial blood gas, close monitoring and possible postoperative mechanical ventilation may be helpful for diagnosis and treatment.

## **Conclusion**

Delayed hypercarbia in laparoscopic surgery is less common and early differential diagnosis is important. In this case we could not identify other causes and believe it was due to port migration and/or CO<sub>2</sub> absorption.

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# CASE REPORT

**TITLE: Severe Lactic Acidosis in a Liver Transplant Patient**

**AUTHORS: Shweta R. Yemul Golhar, MD**

**Michael S. Green, DO**

**Department of Anesthesiology**

**Drexel/Hahnemann University Hospital, Philadelphia**

Introduction:

Lactic acidosis is a universally accepted marker for inadequacy of perfusion. Lactic acidosis in a liver transplant patient is an indicator of early organ dysfunction, failure or rejection.<sup>1</sup> However there are other significant causes of lactic acidosis. We discuss a case of severe lactic acidosis in a liver transplant patient with an unusual cause and an ambiguous presentation.

Case Presentation:

A 68 yo liver transplant patient on immunosuppression presented with vague abdominal pain and rising lactic acidosis. Liver function tests and liver perfusion was normal except diffuse bowel edema on CT scan (fig 1). The patient was urgently explored without finding any obvious cause. Intraop the patient became hypotensive and severely lactic acidotic (LA 13, pH 6.90). Vasopressors were started. Post procedure CVVHD and bicarbonate infusion was started but the patient continued to deteriorate. A repeat CT scan a few days later showed mesenteric stranding and peritoneal thickening (fig 2). Biopsy taken during repeat laparotomy showed post-transplant lymphoproliferative disease (PTLD). Immediately immunotherapy was stopped and chemotherapy initiated. The patient showed clinical improvement and was soon extubated however succumbed to sepsis and pulmonary embolism.

Discussion:

Lactic acidosis in a liver transplant patient holds immense significance. It is an early indicator of liver failure, rejection or ischemia. PTLD, especially peritoneal, is very rare and extranodal lymphoma has a poor prognosis. Vague symptoms at presentation cause delay in diagnosis. There is a 6.8-24 times more association between EBV infection and lymphoproliferative disease.<sup>2</sup> However, EBV negative PTLD, (like our patient) is more aggressive, has later presentation and has poor prognosis. PTLD is rare however fatal and lactic acidosis as a marker for diagnosis can help early detection and initiation of treatment which can potentially bring about remission.<sup>3</sup> Decrease in the in lactic acid levels is a good indicator of remission.

Conclusion:

Post-transplant lymphoproliferative disease should be high on the differentials in post-transplant patients with severe non-responsive lactic acidosis. Early diagnosis and discontinuation of immunosuppression with initiation of chemotherapy is potentially curable.

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Figure 1: Diffuse nonspecific bowel edema



Figure: 2 Mesenteric stranding and peritoneal thickening diagnostic for peritoneal lymphoma



Figure 4: Lactic Acid Level timeline

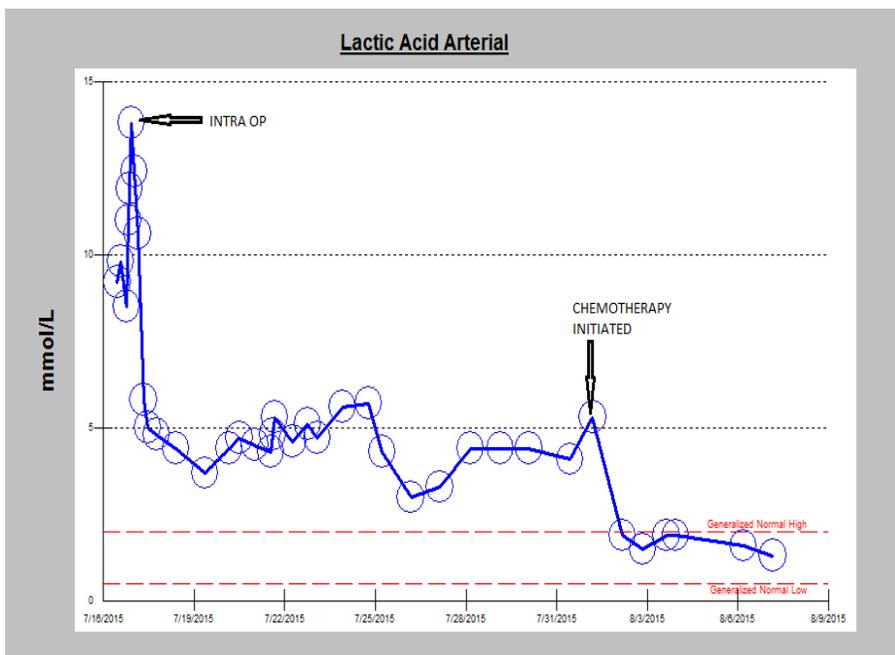


Figure 5: Resolution of the mesenteric and the peritoneal thickening after initiation of chemotherapy



**Title: Novel Application of Interventional Pain Procedures for Peripheral Nerve Hyperexcitability Syndromes**

**Author: Farshad Rashidian, DO; Anita Gupta, DO, PharmD; Celeste Swain; Lucas First**

**Department of Anesthesia and Perioperative Medicine  
Drexel University College of Medicine/Hahnemann University Hospital**

**Abstract:**

Peripheral nerve hyperexcitability (PNH) syndromes are a rare set of neuromuscular disorders that include Cramp-fasciculation syndrome (CFS) and Isaacs syndrome (IS). Successful treatment of these diseases has been achieved with antiepileptic medications, however, chronic pain symptoms can persist. We provide a case report of a 25-year-old female who has suffered from painful severe muscle spasms and fasciculations since childhood. With CFS as our working diagnosis, a treatment regimen using interventional pain techniques including sympathetic chain blocks, ketamine infusions, and trigger point injections resulted in a significant decrease in the patient's chronic pain symptoms. This case offers a novel application of interventional pain procedures and may help further our understanding of PNH syndromes.

## **TAVR and PCI: A high risk procedure and its complications**

**Adrian Alexis Ruiz, Warren R. Spitz, John G. Augoustides, Prakash A. Patel**

Department of Anesthesiology and Critical Care, University of Pennsylvania, Philadelphia, PA

**Introduction:** Transcatheter aortic valve replacement (TAVR) has grown rapidly since its introduction in the United States over a decade ago. TAVR is now a Class I recommendation for patients at increased risk for surgical valve replacement.<sup>1</sup> While it may seem that TAVR is becoming more of a 'routine' case as expansion has occurred to include inoperable, high-risk, intermediate-risk, and now low-risk patients, we must keep in mind that it still remains a high risk procedure. The following case highlights some of the challenges and complications that can still occur.

**Case Presentation:** An 89 y.o female (62in, 54kg) with a past medical history of coronary artery disease, two drug-eluting stents, resting angina, aortic stenosis, diastolic heart failure with preserved EF, peripheral vascular disease, femoral artery stents, hypertension, and left bundle branch block presented for a combined percutaneous coronary intervention (PCI) and TAVR. After standard ASA monitors were placed, a radial arterial line was obtained, followed by uneventful induction of general anesthesia and central line placement. With an 80% left main coronary lesion (in addition to 95% circumflex and 90% RCA), mechanical circulatory support was needed for the high-risk PCI. With the assistance of an Impella device, 5 drug-eluting stents were placed. Afterwards, a balloon-expandable TAVR was placed via a transfemoral approach. Satisfactory position was confirmed by angiography and transesophageal echocardiography; however, mild paravalvular aortic regurgitation remained. After all femoral sheaths were removed, an aortogram of the iliacs demonstrated impaired distal flow with possible thrombus in her prior femoral stent. She required vascular surgery intervention with bilateral femoral artery cutdowns, thrombectomy, and distal stenting. She was then transferred to the intensive care unit on low-dose inotropic and vasopressor support. On post-operative day (POD) 1, she was found to have left sided hemiparesis, and a CT scan revealed right middle cerebral artery stroke. On POD 6, after worsening mental status, the patient's family decided to withdraw care and she expired shortly after.

**Discussion:** As TAVR expands, the procedure is becoming less invasive (smaller sheaths, avoidance of intubation, fewer monitors) and more streamlined. However, our case highlights the challenges and complications that can still occur in this patient population. These include managing comorbidities such as severe coronary disease and unexpected complications such as vascular problems and stroke. The risk of any 30-day major complication in TAVR remains elevated, and the incidence of these major complications remain similar across preoperative risk classifications.<sup>2</sup> Therefore, it is imperative to remain vigilant and prepared during these cases.

**Conclusions:** TAVR candidates are typically frail, elderly patients with multiple comorbidities. The extent of these comorbidities is a major determinant of additional post-procedural morbidity. Furthermore, unpredictable complications occur despite risk analysis. Despite the use of dedicated management teams to improve outcomes and the significant advancements in TAVR technology, TAVR remains a very risky procedure, and this should be thoroughly discussed with patients and their families.

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## **Anesthetic Considerations of Laparoscopic Colectomy In Patient With VAD**

**Bao C Ha, MD** and Jared W Feinman, MD University of  
Pennsylvania  
Department of Anesthesiology and Critical Care

**Introduction:** Since left ventricular assist devices (LVADs) were initially approved by the FDA in 1994 as a bridge-to-transplantation, there have been an increasing number of patients maintained on mechanical hemodynamic support as destination therapy due to findings of improved hemodynamics, end-organ function, exercise tolerance, and overall improvement in quality of life. LVAD therapy has been shown to transition NYHA Class IV patients to Class I or II, resulting in more patients presenting for elective and non-elective non-cardiac surgery[1]. We present a case of a patient on LVAD destination therapy scheduled for laparoscopic surgery.

**Case:** A 61 year old male with a history of ischemic cardiomyopathy (ICM) with EF 20%, dual chamber ICD for primary prevention, and Heartmate II LVAD placed 5 years prior was found to have invasive sigmoid colon carcinoma and scheduled for laparoscopic colectomy with partial hepatic resection for metastases. He was classified as NYHA Class I, ACC/AHA Stage D and medically optimized by his cardiologist prior to surgery. Chronic anticoagulation was maintained by warfarin.

A pre-induction arterial line was placed, followed by induction, intubation, and central venous cannulation. Intra-operative transesophageal echocardiogram guided fluid therapy. Abdominal insufflation was performed slowly and to a minimal pressure until it was certain the patient could tolerate insufflation. The partial hepatectomy was complicated by significant blood loss requiring pRBC and FFP transfusion. The procedure was eventually converted to open to gain control of the hepatic bleeding. The remainder of the operation proceeded uneventfully and the patient remained stable without requiring vasoactive infusions.

**Discussion:** There are numerous considerations in caring for this patient population. Care for patients with LVAD requires careful coordination between the VAD coordinator, anesthesiologist, surgeon, and nursing teams. Laparoscopic surgery in LVAD patients carries its own set of challenges, as insufflation can dramatically and abruptly reduce preload, leading to hemodynamic instability. In addition, laparoscopic surgery often requires positional changes to optimize visualization, exacerbating shifts in hemodynamics. While preload dependent, LVADs are also afterload sensitive, and an increase in SVR from insufflation may be reflected by changes in flow[2].

The anesthesiologist must have a solid understanding of ICD and pacemaker management intraoperatively, as most of these patients have a device in situ. Mechanical circulatory support also requires maintenance anticoagulation. Current data show bleeding events in 44% to 59% of patients after HM II implantation[3]. Furthermore, studies have shown an acquired von- Willebrand Syndrome exists post-LVAD transplantation, independent of iatrogenic causes. The teams must balance the risks of surgical bleeding and implications of discontinuing anticoagulation. Due to altered anatomy and physiology, ACLS guidelines must be modified in VAD patients to exclude chest compressions. Hemodynamic monitoring can be a challenge noninvasively due to a lack of pulsatile flow and may require arterial line placement for monitoring in addition to the VAD monitor. Understanding the implications of a VAD will help guide management.

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# Management of a Patient with Pallister-Hall Syndrome and a History of Difficult Intubation: A Case Report

Authors: Melanie Catherine Hodge, MD and Li Meng, MD, MPH

## Department and Institution:

Department of Anesthesiology, University of Pittsburgh Medical Center

## Introduction:

Pallister-Hall syndrome (PHS) is a rare, genetic condition that is caused by a defect in the transcription factor gene, *GLI3* (1). Clinical features commonly associated with PHS include polydactyly, hypothalamic hamartoma, and bifid epiglottis. We report a case of a patient with PHS and a known difficult airway and discuss the anesthetic plan and implementation.

## Case Presentation:

A 67 year old male with a history of PHS, hypothalamic hamartoma, gelastic seizures, polydactyly, hypertension, OSA, testosterone deficiency, and diabetes presented to our institution for an MRI-guided laser thermal ablation of his seizure focus. He denied any renal or cardiac disease. His surgical history included amputation of his polydactyly digits as an infant and sinus surgery. He had a known history of a 'difficult airway' requiring a flexible fiberoptic bronchoscope for successful intubation (after multiple attempts with direct laryngoscopy). His blood chemistries, CXR, and EKG were unremarkable. Airway exam revealed a normal cervical range of motion, Mallampati score of IV, reduced mouth opening, and a thyromental distance of 2 cm. Given his history of difficult intubation, the anesthetic plan included an awake fiberoptic intubation. The procedure was fully explained and written consent was obtained.

Standard monitors were applied. Glycopyrrolate was provided for reduction in secretions, midazolam provided anxiolysis, and dexmedetomidine was given for sedation. Lidocaine nebulizer and oxygen was applied via a face mask. For further oropharyngeal anesthesia, pledgets soaked in 4% lidocaine were applied to the base of the palatoglossal arch bilaterally. An awake fiberoptic intubation was successfully performed. General anesthesia was then induced. For further analysis, an evaluation of the airway was performed using a video laryngoscope (size 3 blade), which revealed his bifid epiglottis (Figure 1). The patient tolerated both the anesthesia and procedure without complications.

## Discussion:

First described in 1980, PHS is a rare, genetic disorder that can be diagnosed when a specific combination of clinical features exist (2). Most cases of PHS are inherited in an autosomal dominant manner. However, some cases do result from new genetic mutations of *GLI3*. Confirmation of PHS is obtained via molecular genetic testing (1). Features of PHS may include polydactyly, bifid epiglottis, hypothalamic hamartoma, renal and neuroendocrine abnormalities, imperforate anus, and pulmonary lobulation anomalies (2). In patients with PHS, a possible neurologic complication of hypothalamic hamartoma is gelastic seizures, which are partial complex seizures that simulates laughter via movements of the chest and diaphragm (1).

Airway management of patients with PHS can be complex. A bifid epiglottis, which is a midline anterior-posterior cleft of the epiglottis, is rare in syndromes other than PHS, making it an important diagnostic feature (3). When determining an anesthetic plan, special consideration should be given to an awake fiberoptic intubation due to the possibility of variations of airway anatomy. Direct laryngoscopy in a patient with a bifid

epiglottis may prove to be challenging.

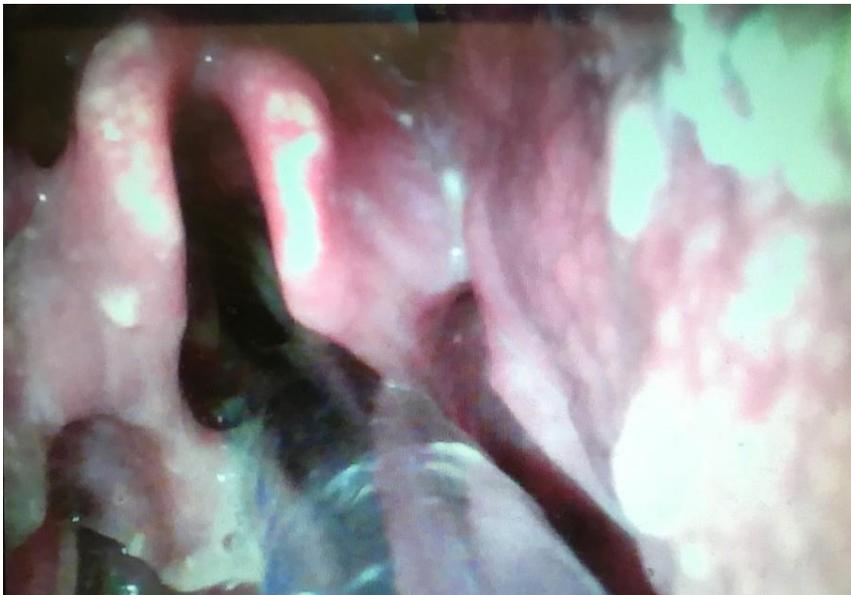
### **Conclusion:**

Administering anesthesia to a patient with PHS presents unique challenges for the anesthesiologist. Due to the possibility of airway anomalies, a comprehensive review of systems and mindful preparation of airway management is imperative.

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**Figure 1:** View of our patient's bifid epiglottis with video laryngoscopy



# Two Unique Approaches to Epidural Blood Patch (EBP) Using Fluoroscopic Guidance on a Post- Laminectomy Patient with Persistent Cerebrospinal Fluid (CSF) Leak Headache

Shilpi Mangla, M.S., M.D., Michael Dorbad, D.O., Abdel Ragab, M.D., and S. Mark Poler, M.D.  
Department of Anesthesiology, Geisinger Medical Center

## Background:

The incidence of dural injury with CSF leak during lumbar surgery may be as high as 17%, one of the most frequent complications. For post-dural puncture headache (PDPH), EBP has high success rates and fewer complications than operative treatment. After spinal surgery with hardware, traditional posterior access to the epidural space may be difficult or is considered contraindicated. Alternative routes may be used for EBP treatment of CSF leaks after spinal surgery.

## Case Description:

A 67 year-old female had 4 previous lumbar surgeries. Already fused L2-S1, she presented with right-sided disk herniation and associated critical canal stenosis at L1-2. She had surgical revision resulting in L1-S1 fusion. Durotomy with CSF leak superior to the L3 pedicle was over-sewn, treated with a DuraMatrix® graft, and spine sealant. All of the above are standard treatments for this scenario. Two days later, she complained of positional headache with photophobia. Midline pitting swelling beneath the sealed incision was consistent with a subcutaneous CSF collection. Due to the impediments of lumbar spinal hardware and fusion, a caudal EBP was performed on post-operative day 3. Isovue® dye was injected during fluoroscopy through an 18-G Touhy-Schliff placed in the sacral hiatus, confirming needle location in the sacral canal. A guidewire from a single lumen central venous access kit was advanced to the lower endplate of L5. The dilator was inserted, then the catheter was advanced to the end of the wire. After withdrawing the guidewire, Isovue® dye was injected and confirmed catheter position. Twenty-five mL of sterile autologous blood were slowly injected through the catheter. The patient's headache initially improved but reoccurred after one day. A second EBP was performed closer to the durotomy site. An 18-gauge Touhy-Schliff needle was inserted perpendicular to the spinal axis at the L2-3 interspace, and advanced towards the epidural space using direct AP and lateral fluoroscopic guidance. A loss of resistance after passage through muscle was identified at needle depth 8 cm, where 4 mL of Isovue® dye was injected to rule out myelogram. Twenty mL of sterile autologous blood were injected at this location. The patient tolerated this procedure well. She subsequently had an episode of severe headache lasting 3 days, 2 months later, but has otherwise not had significant headache.

## Discussion:

The altered spinal anatomy and removal of the ligamentum flavum posed a challenge to utilizing customary posterior approach to the lumbar spine for EBP. Caudal catheters for EBP have enjoyed some success, yet may have more risk of infection than the lumbar approach. Radiologic guidance is helpful to confirm cephalad passage of the catheter and the location in the epidural space. The second higher paramedian approach may have been successful due to administration of the blood near the site of known dural puncture, or simply by adding to the volume of epidural blood.

## Conclusions:

There are few reports employing loss of resistance from paraspinous musculature. We recommend the latter paramedian approach in this case, when treating PDPH for patients with difficult access to the

epidural space.

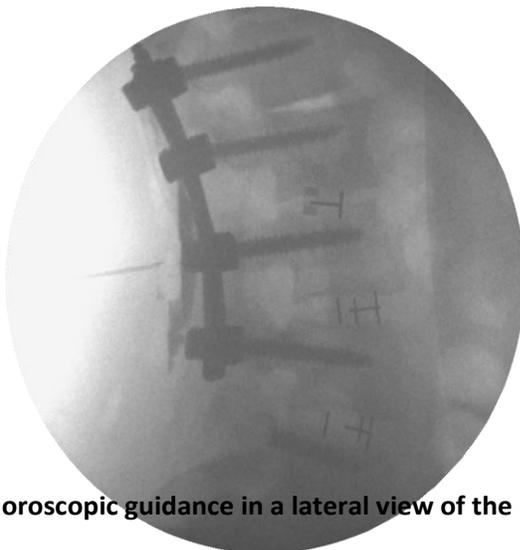
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### Figure 1:



Epiduralgram at L5 during caudal EBP Figure 2:



Fluoroscopic guidance in a lateral view of the needle being placed at the L2-3 interspace.

## Spontaneous Resolution of Presumed Acute Epidural Hematoma Formation After Lumbar Epidural Steroid Injection

Christopher M. Lam MD<sup>1</sup>, Brian Monroe MD PhD<sup>1</sup>, Tonia Novosat MD<sup>1</sup>  
<sup>1</sup>Geisinger Medical Center Department of Anesthesiology and Pain Medicine

**Background:** Epidural Steroid Injections (ESI) are interventional pain procedures often used to treat radicular pain. The most serious complication of this procedure is the formation of spinal epidural hematoma (SEH) which can result in profound permanent neurologic deficits if left untreated.

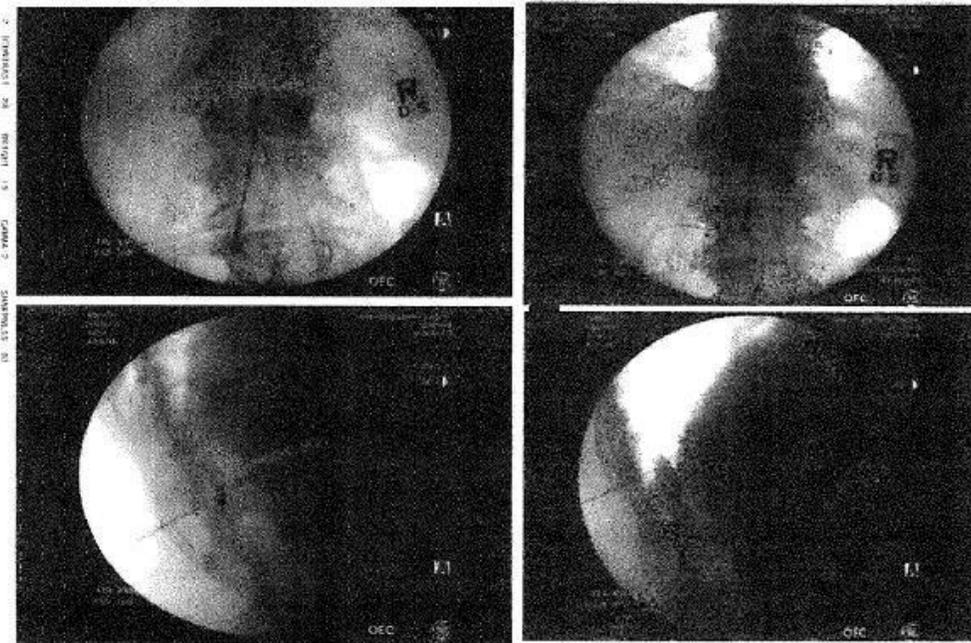
**Case Presentation:** Here we report a case of presumed epidural hematoma formation in a 76 year old female previously on 81 mg daily aspirin (stopped 14 days prior to procedure), not on anticoagulation therapy with mild lumbar spinal stenosis (L4 – L5, L5 – S1) and lumbar dextroscoliosis after a lumbar ESI (T12 – L1) for radicular pain. Post procedurally she developed bilateral leg weakness with inability to walk. Concerned for epidural hematoma, she was sent for an emergent MRI and found to have a fluid collection outside of the epidural space near the injection site, suspicious for epidural hematoma. Neurosurgery was consulted, but at the time of evaluation she had near resolution of her presenting symptoms. Given remarkable improvement of neurologic deficits, the decision was made to not evacuate the fluid collection. After 48 hours of conservative management and monitoring, she was discharged home. Subsequent follow up and imaging three months later revealed no persistent symptoms or radiographic evidence of sequelae from epidural hematoma.

**Discussion:** Here we present a case of presumed epidural hematoma after lumbar ESI. SEH are exceedingly rare complications with potentially devastating long term consequences. Studies have been performed to evaluate the frequency of occurrence of SEH with epidural catheters but the frequency of SEH after ESI are unknown. This case is unique in that this patient has dextroscoliosis with mild spinal stenosis below the level of injection and was not on anticoagulation or antiplatelet agents. Though radiographically a fluid collection was seen, this may represent blood or persistent injectant. Formal diagnosis was not obtained because surgery was not performed. Her symptoms spontaneously improved without further need for intervention. Given the speed of her recovery and dextroscoliosis, we hypothesize that this fluid collection may indeed be injectant compressing her spinal cord resulting in her lower extremity weakness.

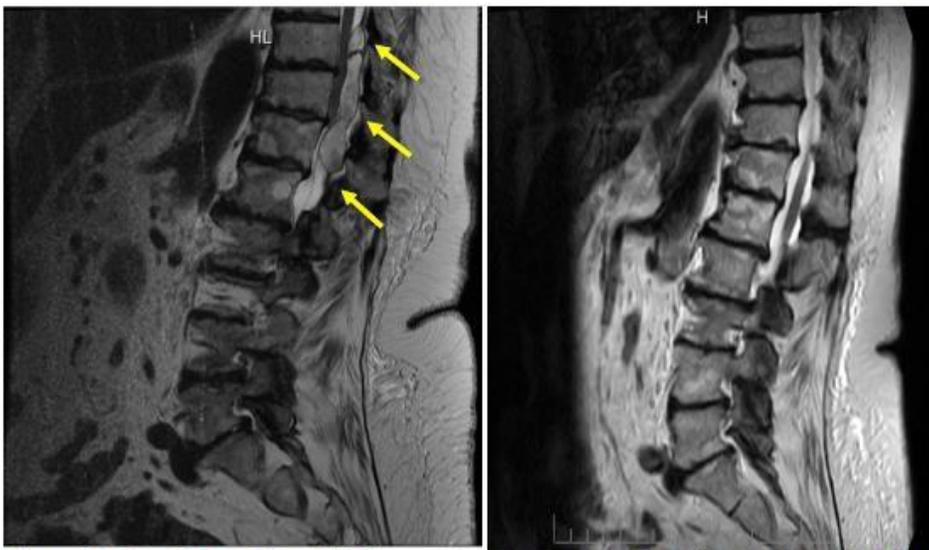
**Conclusions:** Though spinal stenosis and anticoagulation therapy are known risk factors for formation of SEH, here we report the first case of persistent injectant compression of lumbar spinal cord resulting in bilateral lower extremity weakness in a patient with dextroscoliosis mimicking SEH with spontaneous resolution without intervention.

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**Figure 1: Prior (Left L1-L2) and Day Of (Right T12, L1) Intra Op ESI Imaging**



**Figure 2: Post Procedural MRI**



**Figure 3: Three Month Follow Up MRI**

# **Superior hypogastric plexus block as an adjunctive treatment for confirmed endometriosis in a young female with severe debility failing maximal conservative medical and surgical therapies.**

**Matthew Skoblar DO, Brian Monroe MD  
Geisinger Medical Center**

## **Background**

Chronic pelvic pain (CPP) is defined as pelvic pain, localized to the abdomen below the umbilicus, lumbosacral back, or buttocks lasting more than 6 months duration with an intensity that causes debility or necessitates surgery<sup>1</sup>. The two most common etiologies are endometriosis and adhesions<sup>2</sup>. CPP accounts for 40% of all gynecologic laparoscopies performed, 20 % of all benign hysterectomies, and 10% of all gynecologic ambulatory visits with an estimated cost of 2 billion annually<sup>3</sup>. Interruption of the sympathetic nervous system has long been used to treat sympathetically mediated chronic pain of diverse etiologies including neoplastic, non-neoplastic and vascular pain<sup>4</sup>. The superior hypogastric plexus, a bilateral retroperitoneal structure located anteriorly to the lower third of the L5 and upper third of the S1 vertebrae<sup>4</sup>, transmits visceral afferent signals from the right colon, uterus, cervix, fallopian tubes, upper vagina, and bladder. Chronic pelvic pain may be due to direct inflammation, scarring, adhesions or indirectly sympathetically mediated which makes diagnosis and treatment complex. Placarte<sup>4</sup> originally described blocking the plexus for cancer related pelvic pain, and much of the literature regarding this procedure has focused on cancer related pain. However this case report details a hypogastric block in a young female severely debilitated with chronic pain from surgically confirmed endometriosis.

## **Case Description**

A 22 year old female with a 3 year history of endometriosis confirmed by surgical laparoscopy was referred to our pain clinic for persistent, daily, severe, stabbing pelvic pain despite maximal conservative and surgical intervention. Her pain was drastically impacting her ability to function and her quality of life. Conservative options had failed leaving her gynecologist to recommend end stage choices of therapeutic impregnation and hysterectomy. She was referred to our clinic and decided to undergo a fluoroscopically guided bilateral sympathetic hypogastric plexus blockade using 0.5% Ropivacaine. Five days following the initial block she reported a > 50% reduction in pain from a daily 5/10 to an average of 2-3/10 and she experienced a large improvement in functional status. As an example, she was able to ride a bicycle for an extended period with limited pain, whereas before the same activity was unbearable. While the pain was overall better, she continued to have some spikes of pain and the block was repeated 10 days later leading to >3 months of continued pain control.

## Technique

The patient is placed in a prone position. The back is prepped aseptically with chlorhexidine. Under fluoroscopy, the spinous processes of L4 and L5 are identified and marked. The entry point is 5 to 7 cm off midline at the level of the L4-5 interspace. The skin and underlying tissue at this point are well anesthetized with local anesthetic (1% lidocaine and bicarbonate mixture). A 7-inch, 22-gauge needle is introduced at an orientation 30°caudal and 45°mesial off midline. Under fluoroscopy in AP and lateral views, the needle is slowly advanced, with the target the anterolateral aspect of the L5 vertebral body. The iliac crest and L5 transverse process can be obstacles along the needle trajectory. The needle may have to be reoriented slightly to bypass these anatomic structures. Once bony contact is made with the L5 vertebral body, the needle is reoriented to a more mesial angle to walk the needle tip off the body of the L5 vertebra. The tip of the needle should be advanced past the anterolateral border of the L5 vertebral body under direct lateral fluoroscopic guidance. A loss of resistance may be felt as the needle tip passes beyond the psoas muscle fascia and into the retroperitoneal space where the hypogastric plexus lies. Because of close proximity to the bifurcation of iliac vessels, careful aspiration is used to ensure the needle tip is not intravascular. Contrast dye ( 5 ml of omnipaque with 5 ml of 0.5% ropivacaine) is injected to visualize even dye spread to the paramedian space at L5, anterior to the psoas fascia.

## Discussion

As the aforementioned case highlights, endometriosis occurs in young females and limits their ability to function in both a home and work setting with the worst cases ending in infertility. Unfortunately, the treatment of endometriosis is difficult for a variety of reasons. Classical findings of persistent pelvic pain, dysmenorrhea, and dyspareunia have significant overlap with other conditions causing chronic pelvic pain, and laparoscopic biopsy is needed for confirmation of diagnosis, allowing time for scarring<sup>3</sup>. Complicating matters further, even when a diagnosis is made, the amount or location of endometriosis does not always correlate with the symptoms as not all of the endometriosis tissue can be adequately visualized on laparoscopy, with one study showing a PPV of 43-45% when visualization alone is used to diagnose endometriosis.<sup>1,3</sup> Hormonal medical therapies can be effective but may have adverse effects that can limit the long term use of medication with recurrence of pain after discontinuation of therapy<sup>3</sup>. Large RCTs show the benefit of laparoscopic excisional or ablation surgery in terms of significant pain relief (up to 50%) at 6 and 12 months. However reoccurrence rates are estimated to be at 40-60% over 1- 2 years<sup>1,5</sup>, and many authors have questioned the need for recurrent conservative surgical operations, especially for consequent lysis of adhesions, as outcomes are poor, and reoperation can be technically difficult<sup>1</sup>. Treatment with reoperation may also be ineffective because endometriosis pain is often complicated by viscerosomatic, or viscerovisceral sympathetic referred pain<sup>1,2</sup>. The Hypogastric plexus blocks performed<sup>1,2</sup> were able to achieve greater than 50 % pain relief in a young severely debilitated patient substantially improving her quality of

life. While this technique has been described in prior literature, use for endometriosis has been limited. This block can be considered as an adjuvant to medical and surgical therapy, particularly before reoperation, therapeutic impregnation, or hysterectomy are considered as it can help attenuate sympathetic referred pain, but at this time randomized controlled studies are not available and further study is warranted.

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**Title:** A Medically Challenging Case of Ganglion Impar Neurolysis in a Patient with Significant Medical Comorbidities, Coccydynia and Severe Disability

**Author(s):** Kerolos Yousef, DO, MBA, and Brian R. Monroe, MD

**Department and Institution:** Department of Anesthesiology and Pain Management, Geisinger Medical Center, Danville, Pennsylvania

**Introduction:** Coccydynia, pain in the coccygeal region, results from chronic inflammation due to pathologic instability and abnormal coccyx mobility (1). The Ganglion Impar is a solitary retroperitoneal structure anterior to the sacrococcygeal junction. It receives nociceptive inputs from visceral afferents innervating the perineum, anus, vulva, distal rectum, urethra and vagina (2). Ganglion Impar blocks are used to treat chronic coccydynia refractory to conservative therapy (3). We describe a case of Ganglion Impar neurolysis in a medically complex patient.

**Case Presentation:** A 63 Years-Old Male with extensive medical history including pulmonary embolism, on chronic anti-coagulation, diabetes mellitus, hypertension, coronary artery disease, morbid obesity (BMI of 46.58), and partial paraplegia resulting from severe spinal stenosis. He lives with his wife and requires 24-hour care. Patient presented complaining of “tailbone pain.” Pain was in his lower buttocks, radiated bilaterally, throbbing/stabbing in nature, 9/10 in severity, exacerbated by movement and alleviated by nothing. He was unable to sit upright and movement was excruciating. Physical therapy, chiropractic manipulation and medications (including high dose opioids and muscle relaxants) failed to help. He was evaluated for surgery and deemed to be a very high risk surgical candidate.

Initially, a diagnostic and therapeutic Ganglion Impar block was performed under fluoroscopic guidance using the Foye approach (4). A 5-ml 0.5%-Bupivacaine and 80-mg Methylprednisolone solution was injected. Patient experienced 2 days of significant improvement allowing him more mobility; however, his symptoms recurred. The procedure was repeated with similar results.

Due to the disabling nature of his pain, an alcohol neurolytic Ganglion Impar was performed. A test dose of 4-ml 1%-lidocaine was injected resulting in pain resolution within 2 minutes. A 4-ml denatured alcohol and 4-ml 1% lidocaine solution was injected into the presacral space. The patient was discharged with 0/10 pain

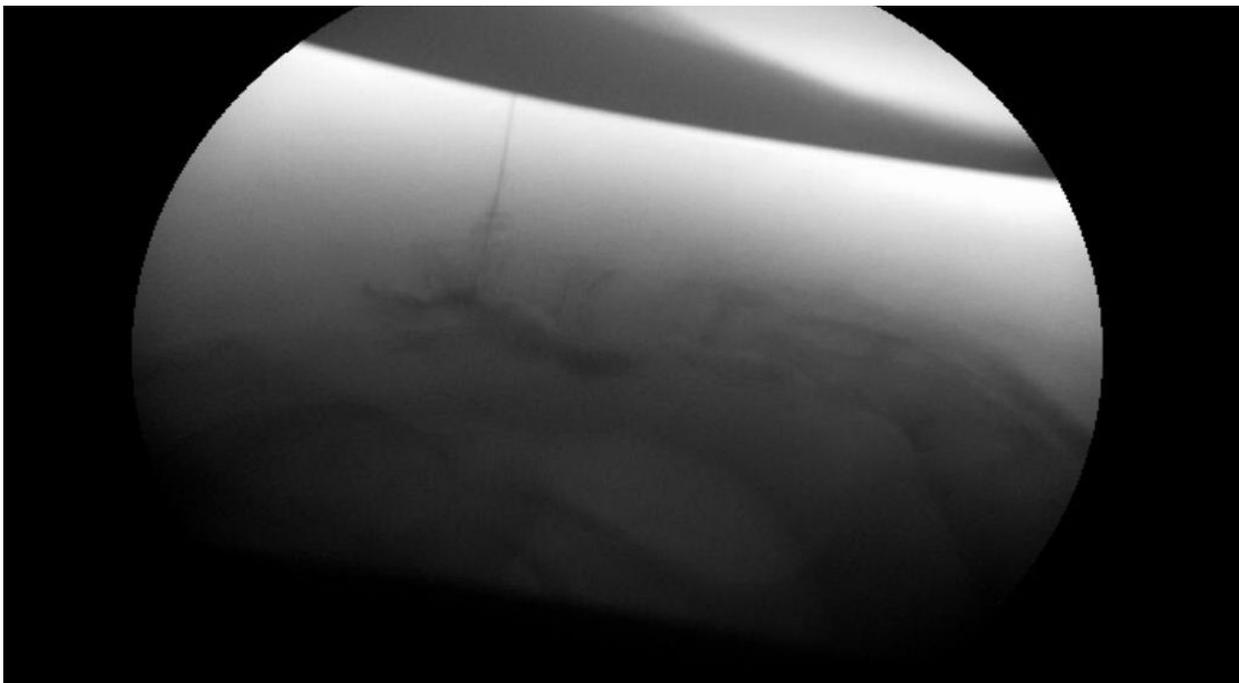
On follow up, patient reported no pain in his tailbone and low back. He reported no new loss of movement or strength. At two months; patient reported continued 100% pain reduction. He had been able to participate in a more intense physical therapy rehab program with an overall increase in his functional status.

**Discussion:** Several factors have contributed to coccydynia in our patient: elevated BMI, back pain with severe spinal stenosis and immobility; all led to worsening luxation injury. Furthermore, his comorbid conditions deteriorated his functional status and quality of life. After failing conservative management, Ganglion Impar block was the reasonable initial approach. It was effective but failed to provide lasting relief. Neurolytic blockade is generally reserved for end of life care due to risk of surrounding nerve damage (5); however, the risk was considered low as our patient was already paralyzed. The use of chemical neurolysis allowed him to regain functionality and participate in physical therapy leading to a positive impact in his overall health condition.

**Conclusion:** Chemical neurolytic of the Ganglion Impar can be considered in select patients with coccydynia.

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Title: Multidisciplinary Management of a Patient with Hypertrophic Cardiomyopathy During Pregnancy

Authors: Shilpi Mangla, MS MD; Mehreen Iqbal, MD; David Fryzel, MD; Qingzhong Hao, MD PhD; Lei Li, MD

Department of Anesthesiology, Geisinger Medical Center

## Background

Hypertrophic cardiomyopathy (HOCM) consists of left ventricular (LV) hypertrophy without LV chamber dilation and LV wall thickness greater than 15 mm on echocardiography. The incidence of this autosomal dominant disease is one in 500 adults<sup>3</sup>. About 70% of patients have LV outflow tract (LVOT) obstruction<sup>1,3</sup>. Subaortic obstruction may occur by systolic anterior motion (SAM) of the anterior mitral leaflet. Alterations in hemodynamics during pregnancy have further implications for anesthetic management. Increased plasma volume (up to 40%) and cardiac output (30-50%) as well as tachycardia and hypovolemia in the third trimester can worsen LVOT obstruction<sup>3,10</sup>. During labor and delivery, each uterine contraction causes a 20% increase in cardiac output<sup>10</sup>. The clinical features for consideration in anesthesia management are outlined in *Table 1*.

## Case Description

A 22 year old G1P0 female with a history of HOCM and idiopathic scoliosis was seen in Obstetrics clinic for routine check up at 36 weeks gestation. Transthoracic echocardiogram (TTE) showed SAM with severe outflow gradient over 100 mmHg and 1.5 cm wall thickness. The patient was continued on

beta-blocker therapy during her pregnancy. After a multidisciplinary evaluation by anesthesiology, cardiology, maternal fetal medicine, and obstetrics-gynecology, she was scheduled for induction of labor at 39 weeks for vaginal delivery. She presented to an outside hospital at 37.5 weeks gestation experiencing contractions, and was then transferred in stable condition to Geisinger Medical Center to resume established care. However, five hours later, fetal heart rate decelerations led to urgent cesarean-section. The patient underwent general anesthesia with an endotracheal tube after placement of a radial arterial line. Tight hemodynamic control was maintained with crystalloid, phenylephrine and metoprolol. The newborn had Apgars of 9 and 9 at one and five minutes respectively and estimated blood loss was 500 mL. She was extubated at the end of the cesarean section. Two days postpartum, TTE was stable from prior. She was discharged home five days later.

## Discussion

There are reports of increased risk of mortality from HOCM in pregnancy such as sudden unexplained death or heart failure<sup>1,10</sup>. Identification of patients with potential for obstruction is a key management principle as risk of deterioration is proportional to degree of outflow tract obstruction<sup>1,2,3,10</sup>. Several modes of anesthesia are available for pregnant patients with HOCM and all have used careful planning, monitoring, and treatment of complications (*Figure 2*). Regional anesthesia is considered to be dangerous in these patients, especially in those with SAM<sup>2,6</sup>. Nonetheless, several modes including general endotracheal anesthesia have been used safely for vaginal deliveries and for C-sections in patients with HOCM.

## Conclusion

Our case demonstrated general endotracheal anesthesia for C-section after a well-planned multidisciplinary approach to anesthesia management led to a safe and positive outcome in an urgent

clinical situation.

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	<b>LV Outflow Obstruction, Mitral Regurgitation</b>
Mechanism	Asymmetric hypertrophied interventricular septum Systolic anterior motion of anterior mitral valve leaflet Small LV outflow tract area
Consequences	Decreased cardiac output
Symptoms/clinical findings	Dizziness Nausea Hypotension Ischemic ECG changes Non-reassuring fetal tracing
Anesthetic considerations	Avoid acute decrease in SVR, hypovolemia, tachycardia
Management strategies	Direct arterial pressure and blood gas monitoring Left uterine displacement Avoid rapid boluses of concentrated local anesthetic Vasopressors: alpha-agonists Beta-blockers to treat tachycardia not related to pain or hypovolemia Administer oxytocin slowly Treat nausea/vomiting Effective pain management

*Table 1: Considerations for Anesthetic Management in Patients with LV Outflow Obstruction and Mitral Regurgitation. Figure Adapted from Ashikhmina et al<sup>1</sup>.*



*Figure 1: Transthoracic Echocardiogram from Post Partum Day 2. A: Parasternal long axis view demonstrating LV hypertrophy and LVOT obstruction, yellow arrow demonstrates that this image is taken during systole; B: Parasternal long axis view with flow Doppler imaging demonstrating mild to moderate mitral valve regurgitation as a result of mitral valve SAM,*

<b>Author</b>	<b>Anesthesia Technique</b>
Autore, C et al. <sup>2</sup>	Epidural for C-section
Minnich, ME et al. <sup>6</sup> , Paix, B et al. <sup>8</sup>	Epidural for vaginal delivery
Ho, KM et al. <sup>4</sup> , Ishiyama, T et al. <sup>5</sup>	Combined Spinal and Epidural for vaginal delivery
Okutomi, T et al. <sup>7</sup>	Intrathecal catheter with opioid for vaginal delivery
Pryn, A et al. <sup>9</sup>	Combined Spinal Epidural for C-section

*Figure 2: Different Reported Modes of Anesthesia. The references reporting use of*

# Pecs I Block in PACU as Primary Postoperative Analgesia for Partial Mastectomy

Joseph Schoenfeldt, MD, Garrett Russell, MD, Rafik Tadros, MD

Department of Anesthesiology, Allegheny Health Network Medical Education Consortium

**Introduction:** Use of regional blocks, such as Pecs I, decrease perioperative narcotic requirements and therefore may play a role in management of patients with a history of postoperative nausea and vomiting (PONV). We present a case of a Pecs I block as primary postoperative analgesia in a patient with history of severe PONV.

**Case:** An 82 year old female presented for partial mastectomy with sentinel node lymphadenectomy because of malignant neoplasm of the central right breast in “12 o’clock” position. Her past medical history was limited to hypertension, GERD, and breast cancer.

However, she did have significant history of severe PONV that included refractory PONV after general anesthesia, as well as admission for PONV after outpatient sedation because of intractable symptoms. To minimize risk of PONV following partial mastectomy, the choice was made for total intravenous anesthesia with propofol and remifentanyl infusions, with LMA for airway management. IV induction included fentanyl 25 µg, midazolam 0.5 mg, lidocaine, and propofol. Antiemetics included scopolamine 1.5 mg patch, decadron 4mg IV, and ondansetron 4 mg IV. The procedure was tolerated well without complications. 25 µg fentanyl IV given twice during emergence, titrated as needed. In PACU patient began with severe PONV and complaints of pain. In first two hours post-op, ketorolac 15mg IV was given with minimal relief and patient had at least 3 episodes of emesis with continued nausea. Therefore, a single shot ultrasound guided Pecs I block was given with injection of 30cc of Ropivacaine 0.5%. Aprepitant 40mg PO also given with block. Shortly after block and aprepitant, patient’s pain became well controlled and nausea subsided. After further monitoring in PACU she was discharged home; follow-up note demonstrated PONV and pain remained well controlled.

**Discussion:** Pecs blocks were first described by Blanco in 2011 as a novel regional technique for analgesia after breast surgery.<sup>1</sup> Injected within the interfascial plane between the pectoralis major and minor muscles, the Pecs I was initially indicated for breast expanders and subpectoral prosthesis as its spread is limited to the lateral and medial pectoral nerves. Its applications have expanded to include chest trauma and placement of cardiac devices, port-a-caths, and chest drains.<sup>3</sup> Pecs II (“modified Pecs”) was developed to expand coverage to the long thoracic nerve and intercostal nerves. While this modified technique does provide more comprehensive sensory coverage, it requires two needle approaches (the additional approach being the more technically challenging).<sup>2</sup>

While the modified Pecs block does provide additional coverage, the single shot type I was sufficient to control this patient’s pain as there was no lateral involvement. This relatively simple ultrasound guided block obviated the need for additional opiates, allowing for control of both pain and PONV.

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# Vascular Erosion from Central Venous Cannulation with Propofol Extravasation

*Will S. Kurtz MD, Daniel Cormican MD*

*Department of Anesthesiology, Allegheny Health Network/Western Pennsylvania Hospital*

**Introduction:** Central venous cannulation is commonly performed in the perioperative and critical care settings, with mechanical complications as high as 33% (1). Vascular erosion is a less commonly recognized complication often with late presenting features, and high mortality rate up to 74% (2). Identifying risk factors associated with vascular erosions are imperative for prevention, and physicians should be familiar with its diagnosis for timely management.

**Case:** A 49 year old female with a history of connective tissue disease on 9 months of steroid therapy for diffuse myalgia, was admitted to ICU for acute hypoxic respiratory failure initially thought to be infectious in origin. Left internal jugular (LIJ) venous cannulation was performed for medication and fluid administration. Initial radiograph showed the catheter tip in the right atrium. After withdrawing the catheter, the tip was positioned in the mid SVC. On day 3, patient developed worsening respiratory failure with hemoptysis, was intubated, and placed on vasoconstrictive agents. Bronchoscopy confirmed diffuse alveolar hemorrhage. Repeat radiograph showed migration of catheter tip to the distal innominate vein.

On day 5, a chest tube was placed with significant transudative fluid output. On day 10, patient suffered a PEA arrest requiring two rounds of ACLS. Pleural fluid output was milky with triglyceride level > 4425 mg/dL, and neutrophilic predominance, inconsistent with chylothorax fluid (3). On day 12, CT chest confirmed contrast extravasation from the LIJ catheter into the right pleural space (Fig 1), and per radiology the catheter tip has penetrated the right innominate vein and SVC junction. The milky fluid drained was suspected to be infused propofol given its appearance and lipid content. All chest tube output stopped after removal of LIJ catheter, but her clinical status continued to deteriorate despite aggressive care. Global hypoxic brain injury was confirmed on MRI; patient expired on day 31.

## **Conclusions:**

The patient's death was attributed to respiratory failure, induced by perivascular exposure to vesicant medications, damaging the pleural membrane and alveoli. Multiple risk factors for vascular erosion were present: female gender (2), vessel fragility due to chronic steroid use, catheter migration from positional change in an obese patient, and left-sided IJ insertion which poses a higher risk for vascular perforation due to the necessity to negotiate two 90 degree turns.

Ensuring proper placement of catheter tip in the extracardiac position of the SVC and parallel to the vessel wall is paramount; daily radiographic interpretation can help identify hazardous catheter migration. Progressive dyspnea, chest pain, and enlarging transudative pleural effusions are important diagnostic signs. Once confirmed, the catheter should be discontinued promptly and therapeutic thoracentesis performed if indicated.

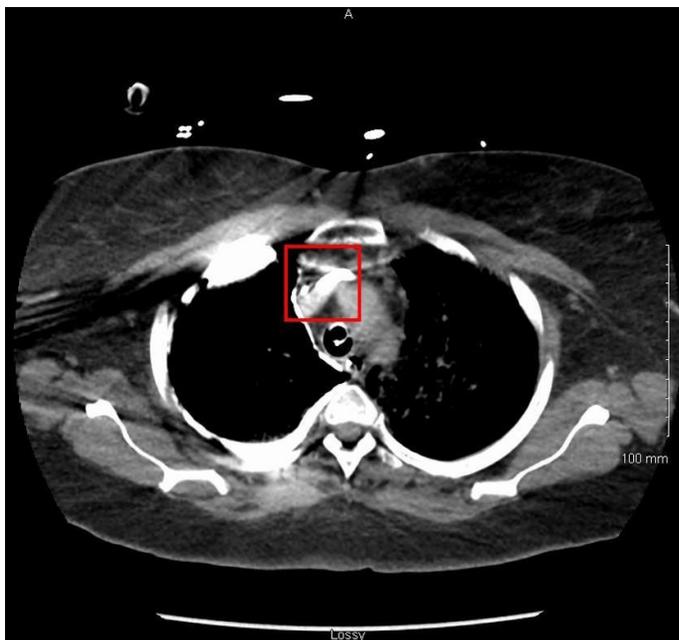
## **Discussion:**

Prevention and management of central line vascular erosions require basic radiographic interpretation

skills, risk factors awareness, and knowledge of relevant clinical features. Good prognosis will rely on early diagnosis, timely discontinuation of the catheter, and performing therapeutic thoracentesis when indicated.

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**Figure 1a** – The left IJ catheter is extravascular, and extravasation of contrast into the right pleural space is observed. Pulmonary arteries cannot be assessed due to extravascular contrast.



**Figure 1b** – Extravasation of contrast into the right pleural space is observed, which drains into the chest tube along the right lower chest.

**Anesthetic Considerations In Disseminated Lyme Disease** Joseph Schoenfeldt, MD, Daniel Cormican, MD, Joshua Baisden, MD Department of Anesthesiology, Allegheny Health Network

Introduction: Lyme disease, caused by the spirochete *B. burgdorferi*, is the most common vector-borne illness in the USA with estimates of 300,000 diagnoses annually.<sup>3</sup> However, literature is limited on anesthetic considerations for patients afflicted by the bacteria's diverse manifestations. We present a case of surgical intervention requiring anesthesia in a patient with disseminated Lyme disease.

Case: Three weeks after camping, a 47 year old male noted erythematous rash on his abdomen, extending to leg, and right facial droop. Initially treated for Bell's Palsy, facial weakness progressed bilaterally, accompanied by tinnitus, chills, and fatigue. Admitted to our hospital three weeks later, he was diagnosed with Lyme disease, immediately starting doxycycline 100mg PO BID. Six weeks later, after finishing 14 days of antibiotics, he presented for post-traumatic ankle arthritis and removal of hardware from previous year. Preoperative sciatic and sub-sartorial nerve block catheters were placed, with 20cc of 0.5% ropivacaine loaded to both. Spinal block initially intended, but two failed attempts by two attending anesthesiologists necessitated alternative management with general anesthesia; IV induction with 200mg propofol, 50mg lidocaine, 50mg ketamine, and airway management with LMA. He received 6mg midazolam IV preoperatively, and 200mcg fentanyl and 2mg hydromorphone intra-op. No changes in Lyme symptoms throughout admission. On four week follow-up, patient reported stable facial nerve palsy and unremarkable orthopedic recovery. On twelve week follow-up, minimal improvement of eyelid strength, but newly documented dysphagia, voice changes, and arthralgias. PICC line placed and 30 days of ceftriaxone started.

Discussion: Among the principal challenges in diagnosing and managing Lyme disease are the myriad ways in which it presents. While erythema migrans remains the best clinical marker, it is not present in 25-50% of cases.<sup>2</sup> Expedient treatment with antibiotics may limit progression, though many will advance to early disseminated disease and later to advanced disseminated disease.

Neuropathies, both peripheral and cranial, are common symptoms of Lyme disease. Cranial nerve VII is the most frequently affected cranial nerve, but most have been reported.<sup>2</sup> Of note, recurrent laryngeal nerve abnormalities have been documented, so a focused pre-op exam is warranted and possible preference of LMA to ETT to minimize inflammation. Peripheral neuropathies seem to have both direct and autoimmune etiologies. While many resolve with time and antibiotics, evidence suggests that steroids may be beneficial.<sup>1</sup>

While less than 10% of patients exhibit cardiac features, 90% of these do so with AV blocks.<sup>2</sup> Presenting in varying degrees and frequently episodic, they can cause arrhythmias or even syncope. Given this possibility, a thorough cardiac history should be taken and we recommend a pre-op screening EKG. As demonstrated by this case, local anesthetics can be safely used, but dosing should be strictly calculated and intra-op EKG closely monitored.

This case demonstrates several anesthetic techniques in a patient with disseminated Lyme disease. While their use caused no immediate complications perioperatively, the subsequent progression of symptoms is worrisome. However unlikely that anesthetics contributed to the disease's delayed advancement, the onset of new symptoms including dysphagia and dysphonia reinforce the benefits of supraglottic management of the airway when possible.

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## Colovesical Fistula Leading to Hyperchloremic Metabolic Acidosis and Acute Kidney Injury

**Meagan M. Horst, M,** James Lamberg, DO

Department of Anesthesiology and Perioperative Medicine, Penn State Health Milton S. Hershey Medical Center, Hershey, PA

### **Introduction**

Metabolic derangements after urinary diversion are common and well documented. However, clinically relevant metabolic complications are rare. Unrecognized metabolic derangements of urinary diversion and fistula can lead to complications and poor patient outcomes.

### **Case Presentation**

A 71-year-old male without history of kidney disease developed colonic obstruction and required Hartmann procedure. Complications of anastomotic leak and development of a colovesical fistula resulted in the need for small bowel resection, supratrigonal cystectomy, and fistula excision.

Preoperative laboratory values included: chloride 112 mmol/L, BUN 45 mg/dL, creatinine 1.42 mg/dL, calcium 10.4 mg/dL, bicarbonate 16mmol/L, and anion gap 16. During his 16 hour procedure, norepinephrine infusion was required despite aggressive fluid resuscitation. His postoperative course was complicated by bowel perforation, complex intra-abdominal abscess, and TPN dependence.

### **Discussion**

This patient was experiencing a hyperchloremic anion gap metabolic acidosis due to his colovesical fistula. The fistula caused metabolic changes known to occur in urinary diversion. Some absorptive and secreting properties of the bowel occur when exposed to urine. In the bowel, sodium is secreted in exchange for hydrogen. Bicarbonate is secreted in exchange for chloride. Ammonium, hydrogen, and chloride ions are reabsorbed in parts of the bowel exposed to urine. This results in a chronic acid load. The inability to excrete ammonium depletes the body's buffers diminishing the capacity to compensate for acid challenges. Compromised kidney function further increases the risk of metabolic acidosis. This patient's lab abnormalities were incorrectly attributed to chronic kidney disease. Preoperative dehydration reflected by his acute kidney failure and hypercalcemia were complicating factors. In this case, suboptimal preoperative management resulted in hemodynamic instability despite high volume resuscitation.

### **Conclusions**

While metabolic derangements after urinary diversion are common, they are rarely clinically relevant. This patient's colovesical fistula, which formed after his original Hartmann procedure, resulted in urinary diversion. The resulting hyperchloremic metabolic acidosis combined with preoperative hypovolemia and prerenal azotemia led to high fluid requirements. His perioperative course was further complicated by intraperitoneal perforation with subsequent abscess formation requiring multiple percutaneous drainages. As perioperative physicians, we should be aware of this common metabolic abnormality, which can lead to uncommon clinical sequelae.

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**Figure 1: Electrolyte Characteristics**

<b>Chronic Kidney Disease</b>	Edema/Hypervolemia Hyperkalemia Hypocalcemia Anion Gap Metabolic Acidosis
<b>Dehydration</b>	Hypovolemia BUN:Cr Ratio >20:1 Hypercalcemia
<b>Urinary Diversion</b>	Hyperchloremia Hypokalemia Anion Gap Metabolic Acidosis
<b>Patient Data</b>	Hypovolemia BUN:Cr Ratio >20:1 Hypercalcemia Hyperchloremia Normokalemia Anion Gap Metabolic Acidosis

# Cardiac Arrest Secondary to Tension Pneumopericardium during Per Oral Endoscopic Myotomy (POEM) Procedure

Matthew S Bell, MD., Bunty Shah, MD.

Department of Anesthesiology and Perioperative Medicine, Penn State Health Milton S. Hershey Medical Center/ Penn State College of Medicine, Hershey, PA

## Introduction

Per oral esophageal myotomy (POEM) is an endoscopic minimally invasive treatment alternative to a Heller Myotomy for relief of achalasia. During POEM, gas is used to insufflate the esophagus to improve visualization.

## Case Report

During the POEM procedure, our patient experienced sudden cardiac arrest shortly after the initial incision was made and gas insufflation was started. ACLS protocol was initiated and return of spontaneous circulation was achieved. Chest x-ray and CT scan revealed tension pneumopericardium. A pericardiocentesis was performed and a drain left in place, which led to clinical improvement.

## Discussion

POEM is a modern procedure for treatment of achalasia. The majority of complications are related to gas insufflation. Use of air as insufflation rather than carbon dioxide can greatly increase risk of significant complications associated with POEM, such as air embolism and mediastinal emphysema. Other complications related to POEM include: mucosal and full thickness injury, subcutaneous emphysema, pneumomediastinum, pneumoperitoneum, pneumothorax, pleural effusion, bleeding and esophageal leak/perforation.

Pneumopericardium associated with POEM is extremely rare. Rapid diagnosis of complications is essential for appropriate treatment. Close communication with the proceduralist can help with timely diagnosis of problems related to the surgical technique.

## Conclusions

Pneumopericardium has been described as a rare, but possible, complication of POEM. Our case is notable for use of a pericardial drain, which has not been reported previously.

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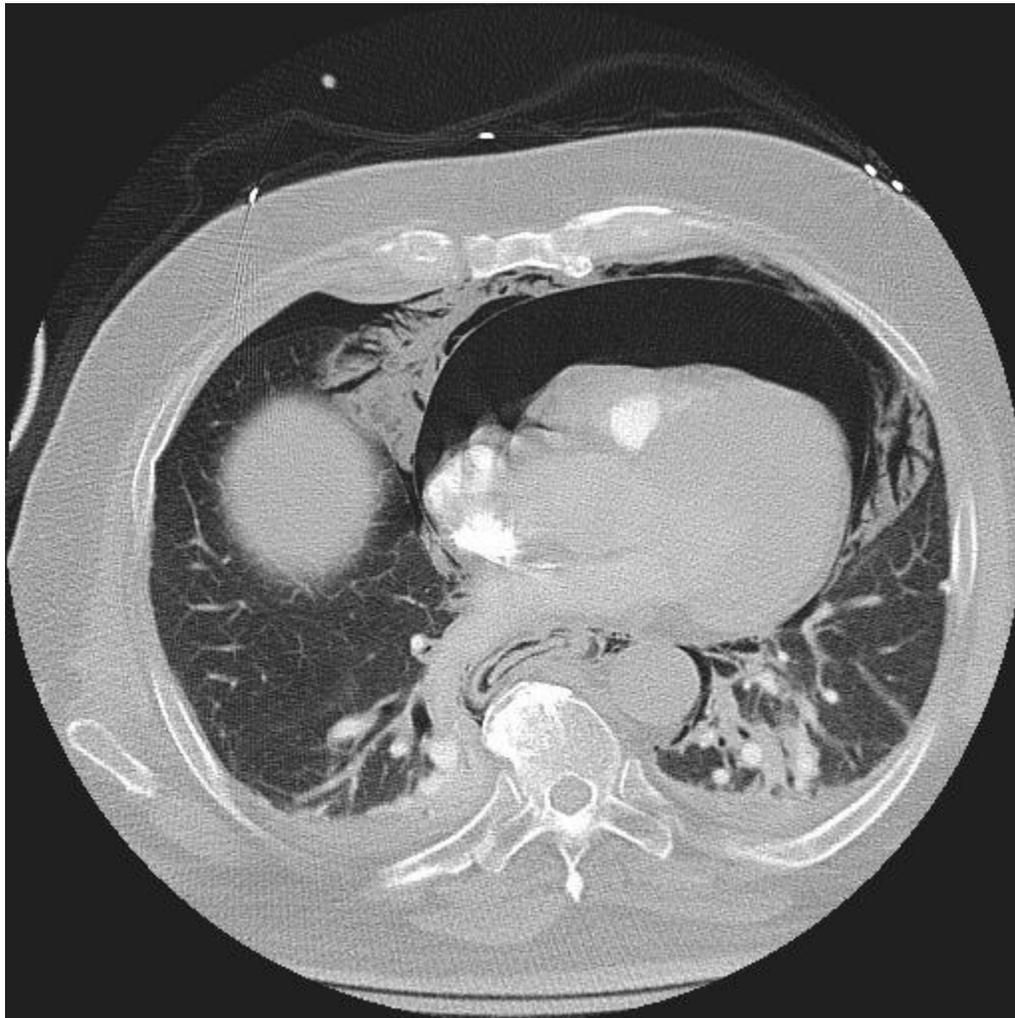


Figure 1. CT scan showing tension pneumothorax after ROSC, prior to pericardial drainage.

*Title: “A Near Miss In A Patient With Respiratory Distress Secondary To Subglottic Stenosis”*

*Authors: Graham M. Fehr D.O.<sup>1</sup>, Matthew Harris D.O.<sup>2</sup>, Kamen S. Rangelov M.D.<sup>3</sup>*

*Department & Institution:*

<sup>1</sup>Penn State Health Hershey Medical Center, Department of Anesthesiology and Perioperative Medicine, Hershey, Pennsylvania

<sup>2</sup>Lakes Region General Hospital, Department of Anesthesiology, Laconia, New Hampshire

<sup>3</sup>Lakes Region General Hospital, Department of Pulmonary and Critical Care Medicine, Laconia, New Hampshire

*Introduction:* Management of the difficult airway remains one of the most feared and challenging aspects of anesthesiology. Several predictors of a potentially difficult airway exist<sup>1</sup>, but these criteria are not always reliable. Understanding the components of difficult airway management allows one to tailor an approach to guarantee positive patient outcomes.

*Case Presentation:* 51-year-old male presented with 10-month history of dyspnea on exertion with inspiratory and expiratory stridor. Flow-volume loops revealed fixed upper airway obstruction (Figure 1), prompting urgent ENT evaluation. Fiberoptic nasopharyngoscopy confirmed 70% circumferential subglottic stenosis. One day after biopsy of stenotic area, patient developed respiratory distress and presented to emergency room. Attempted awake nasal fiberoptic intubation with topical lidocaine resulted in esophageal intubation with removal of endotracheal tube complicated by epistaxis. Oxygen saturation remained in low 90s despite bag mask ventilation with Heliox. As otolaryngologist prepared for surgical airway, oral fiberoptic intubation was successfully performed by anesthesiologist. Biopsy of subglottic mass revealed fibrosis of the submucosa without evidence of amyloidosis and PET scan later showed multiple rib foci, clavicles, sternum, humeri, spine, left thyroid, and laryngeal cartilage infiltration secondary to the myeloma (Figure 2). Subsequent rib and iliac crest bone marrow biopsies confirmed plasma cell myeloma with extramedullary foci.

*Discussion:* Flow-volume loop patterns help differentiate anatomic locations of airway obstruction. Possible mechanisms for upper airway obstruction are edema of oropharynx and larynx, trauma, foreign body, infection, and tongue positioning<sup>2</sup>. A fixed lesion produces a constant degree of airflow limitation during both phases of respiratory cycle recognizable on flow-volume loops. Further diagnostic testing required to determine site of stenosis.

Thorough airway history and physical exam are essential for planning an approach to airway management. This involves the availability and use of specialized airway equipment based on specific patient pathology in addition to understanding and implementing the difficult airway algorithm<sup>3</sup>.

Heliox gas mixture (79% helium and 21% oxygen) is frequently used in the management of extrathoracic obstruction. It reduces turbulent air movement due to a density six times lower than atmospheric air<sup>4</sup> with a greater proportion of laminar air flow, increasing flow rates by up to 50%.

Systemic manifestations of plasma cell myeloma are numerous and variable between patients. Differentiation between extramedullary plasmacytoma vs foci of multiple myeloma is based on presence or absence of other clinical symptoms.

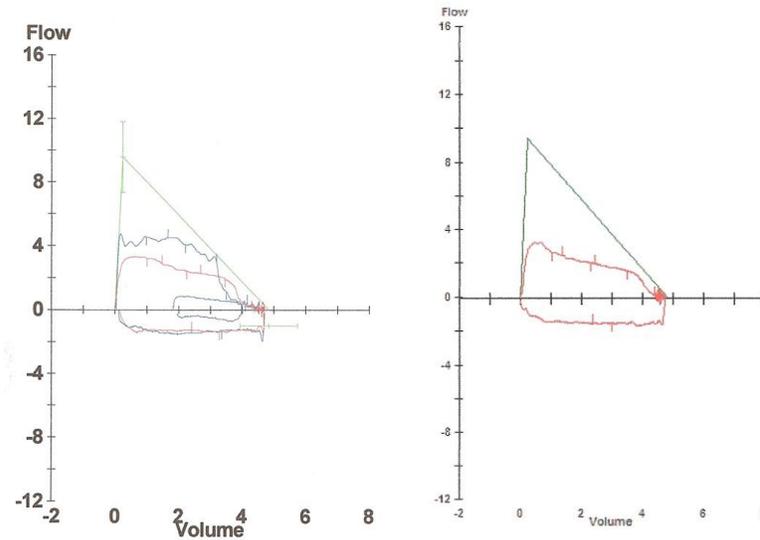
**Conclusions:**

- 1) Flow-volume loops are valuable in identifying the location of airway obstruction.
- 2) Many disease processes can affect the caliber and patency of the airway.
- 3) Rigorous evaluation and planning of a potentially difficult airway is crucial for positive outcomes.

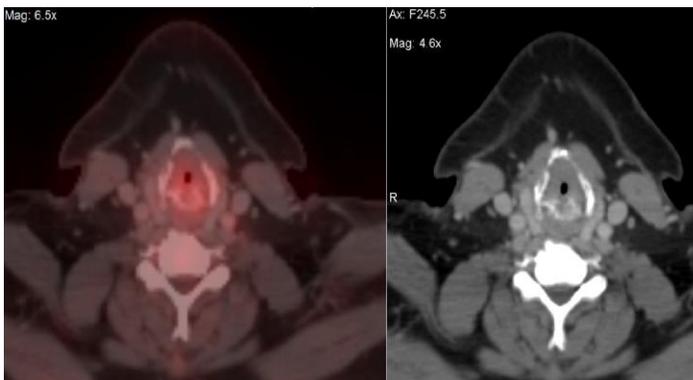
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**4) Figure 1: Flow-volume loops showing fixed upper airway obstruction. Red is pre-bronchodilator; blue is post-bronchodilator.**



**Figure 2: Combined PET and CT scan after biopsy of subglottic stenosis. Circumferential involvement of laryngeal cartilage and left thyroid is seen by increased FDG activity and presumed to be soft tissue involvement secondary to myeloma.**



# Massive Embolic Stroke During Endoscopic Retrograde Cholangiopancreatography in a Liver Transplant Patient

**Authors:** Sadie Smith, MD., Natalia Martinez, MD., Kelly Gidusko, MD.

Affiliation: Department of Anesthesiology & Perioperative Medicine, Penn State Health Milton S. Hershey Medical Center, Hershey, PA

**Author and Presenter Agreement:** I, Sadie Smith, M.D., certify that I was involved in the care of the patient, and preparation and submission of the case report.

## Introduction

Endoscopic Retrograde Cholangiopancreatography (ERCP) is becoming widely used for a variety of gastrointestinal pathologies. The procedure has some specific challenges for anesthesia. We describe a case of a patient with a history of a liver and kidney transplant, as well as a recent hepatic abscess, who remained hemodynamically stable throughout a prolonged ERCP under deep sedation, who fails to wake up at the end of the procedure.

## Case Description

A 52 year old male with a liver and kidney transplant in 2011 due to hepatitis C, presented for an ERCP for placement of a biliary stent due to a recent hepatic abscess that was concerning for a recurrent bile leak. The ERCP on the day of presentation was performed under deep sedation via a propofol infusion and supplemental oxygen. The patient remained hemodynamically stable for the remainder of the procedure that lasted for over 90 minutes.

Extensive debris was found within the biliary system.

Upon returning to the supine position from the swimmers position, the patient's oxygen saturations decreased to the 80's, and quickly improved with placement of a nasal trumpet, and suctioning of large amount of oral secretions. In the recovery room, the patient continued to spontaneously ventilate with 2L of O<sub>2</sub> via a nasal cannula, however, he remained minimally responsive. After one hour of minimal improvement in his neurological status, neurology was called for an immediate evaluation. Because of the lack of improvement in his neurological status, he was intubated for airway protection.

The head CT did not reveal any pathological findings. An EEG ruled out seizure activity, and an ECHO ruled out patent foramen ovale. Magnetic resonance imaging of the head was done after 24 hours. This revealed extensive bilateral supra and infra-tentorial ischemic strokes, likely from a massive embolic shower to both anterior and posterior circulations.

## Discussion

In endoscopy, there are many factors contributing to an air embolism being unrecognized: patient is anesthetized, continuous low volume of air being entrained and right to left shunt, other co-morbidities providing a plausible explanation for mild instability. In the left lateral position there can be gas trapping in the apex of the right ventricle.

Our patient possessed multiple risk factors for air embolism: previous biliary intervention, percutaneous biliary drain present, hepatic abscess, prolonged procedure, and direct cholangioscopy. (1) . It is important to be aware that this exact presentation Failure to awaken after ERCP has been previously reported after stone extraction and sphincterotomy (2)

## Conclusion

Prevention of air embolism is essential. The gastroenterologist should insufflate with carbon dioxide which is more readily absorbed and keep volume and pressure of insufflation to a minimum. Having a high index of suspicion and terminating the procedure if air embolism is suspected is also very important.

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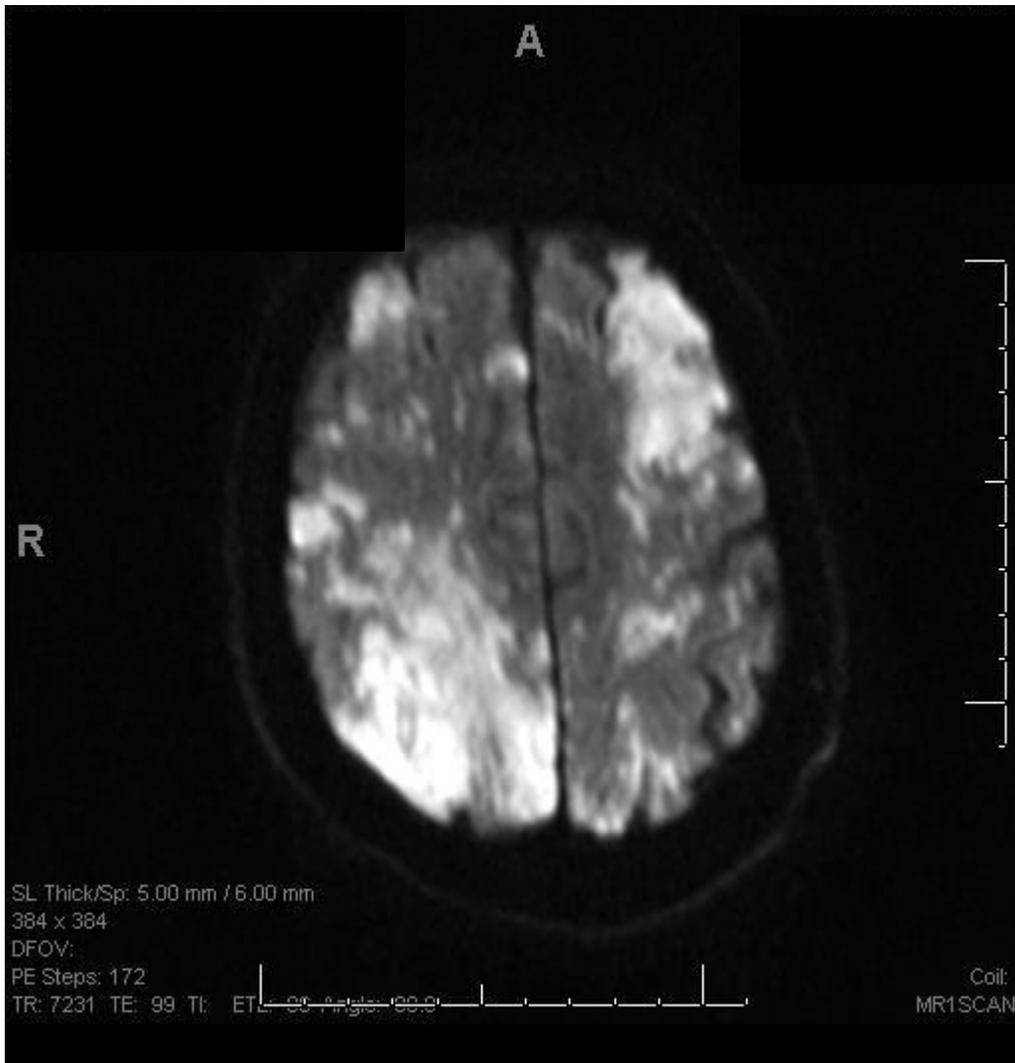


Figure 1. This is a diffusion weighted magnetic resonance image depicting bilateral supra- and infratentorial ischemic infarcts, likely as a result a massive gas and/or septic embolic shower during that occurred during a complex ERCP.

## Pneumothorax after General Anesthesia in an 18-year old with Trisomy 22

Sean M Baskin, DO; Sonia Viada MD

Department of Anesthesiology and Perioperative Medicine, Penn State Hershey Medical Center

**Introduction:** Trisomy 22 is a rare chromosomal abnormality that manifests with multiple severe organ malformations, presenting in a mosaic and non-mosaic form. While median life expectancy for non-mosaic trisomy-22 has previously been reported as 4 days of age, given the rarity of the disease, the life expectancy for the mosaic form is difficult to estimate<sup>1</sup>. We present an 18 years old male presenting for abdominal computerized tomography (CT) under general anesthesia (GA) developing pneumothorax.

**Case Presentation:** An 18 year nonverbal, nonambulatory old male, 24 kg, with known Trisomy-22 presented to the emergency department with 3 days of reported gagging. His chromosomal abnormality manifested with facial abnormalities, congenital cardiac defects including pulmonary valve atresia requiring replacement and a widely patent foramen ovale, requiring suture ligation. Additionally, he suffered from an absent corpus callosum, intestinal malrotation, solitary kidney, and numerous ear infections. His intestinal malrotation was initially corrected with a Ladd's procedure, and chronic reflux required Nissen fundoplication for permanent correction. Accordingly, his gagging was found to be caused by a small bowel obstruction, secondary to adhesions and he underwent an uneventful laparotomy with lysis of adhesions. Six days post-operatively, he experienced several episodes of emesis, and the decision was made to obtain an abdominal CT under general anesthesia. Induction of GA was performed with propofol and endotracheal intubation necessitated the assistance of an Eschmann introducer. A 5.5 endotracheal tube was passed through the glottic opening without apparent airway trauma. Volume controlled mechanical ventilation was initiated with a tidal volume of 250 ml.

The CT was obtained in approximately 10 minutes and the patient was successfully extubated. Immediately after extubation, the oxygen saturations decreased to the mid 80%- low 90s with assisted mask ventilation with 100% oxygen. Despite appropriate motor strength and a patent airway, worsening intercostal, abdominal and clavicular retractions prompted a chest x-ray. A complete right pneumothorax without midline shift was immediately identified (figure 1). Due to tachycardia, tachypnea and further decrease in oxygen saturations, an immediate #14 G needle chest thoracostomy was performed with symptoms improvement. A chest tube was inserted resulting in re-inflation of the right lung with continued improvement in oxygenation levels (figure 2). 60 mLs of straw-colored fluid was drained from the chest. After several days the chest tube was removed and the patient did not experience further adverse pulmonary events.

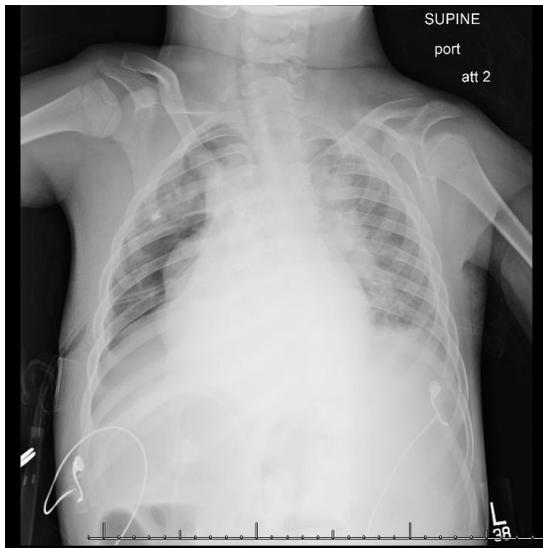
**Discussion:** We were not able to identify the etiology of the pneumothorax. We hypothesized that controlled ventilation even though it was applied for a very short time, could have exacerbated preexisting lung hyperinflation leading to pneumothorax.

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Figure 1: Chest Radiograph showing complete Right Pneumothorax



Figure 2: Chest Radiograph taken immediately after insertion of chest tube



## Sweating Bullets: Intravascular Bullet Embolization

Eric T. Feduska D.O.<sup>1</sup>, Jordan E. Goldhammer M.D.<sup>1</sup>, Adam Setren, M.D.<sup>1</sup> Neil Malhotra M.D.<sup>2</sup>, Linda Sundt M.D.<sup>1</sup>

1. Department of Anesthesiology, Sidney Kimmel Medical College at Thomas Jefferson University
2. Department of Radiology, Sidney Kimmel Medical College at Thomas Jefferson University

### Introduction

Bullet embolization is a rare and potentially disastrous phenomenon. When freely mobile, these foreign bodies tend to drift in the direction of flow. Symptoms result from the bullet's final destination and its effects on the local milieu. Arterial emboli typically present early with evidence of ischemia or thrombosis, and current consensus is that they require prompt surgical intervention and removal. Venous emboli tend to lodge in the right heart or the pulmonary arterial tree and pose more of a diagnostic and therapeutic dilemma. Despite their precarious position, intracardiac bullet emboli can remain asymptomatic; intervention, however, is never wholly benign. We present a case of venous bullet embolism to the right heart and its subsequent management to help add to the building evidence regarding the management of these rare and challenging cases.

### Case Report

A previously healthy 24-year-old male presented to an outside hospital with gunshot wounds to the left third finger, left upper extremity, left lower quadrant of the abdomen, and right buttock (Figure 1). On chest X-ray, a missile fragment was identified overlying the mediastinum. A CT scan of the chest, abdomen and pelvis was obtained and read as showing missile fragments in the left chest wall near the proximal humerus fracture, as well as "a large bullet fragment situated at the inferior aspect of the heart." Due to streak artifact, the radiologist was unable to determine the bullet's location, but commented that it "could be in the lumen of the right atrium."

The patient underwent an exploratory laparotomy which identified two enterotomies in the mid-jejunum, which were addressed with a small bowel resection and primary anastomosis, and a left zone 2 retroperitoneal hematoma which was packed. Rigid sigmoidoscopy was negative for rectal injury. A subxiphoid pericardial window was performed and was negative for blood. Temporary abdominal closure was applied.

Given the patient's history of penetrating missile trauma, the absence of blood on pericardial window, and the remote trajectory of the missile wounds from the heart, a venous bullet embolism was suspected.

On hospital day 1, TTE and TEE were performed. No intracardiac missile was seen. Arterial duplex examinations of the upper extremities were also obtained showing normal waveforms. The patient returned to the OR for abdominal washout and closure.

Subsequent TEE on hospital day 4 identified a new pericardial effusion; a repeat TEE on hospital day 7 found the effusion to be stable in size. A TEE performed on hospital day 10 identified “an echogenic structure in the inferior basal/septal aspect of the right ventricle” as well as an increase in the size of the pericardial effusion, without evidence of tamponade.

The patient remained intubated and ventilator-dependent. He was found to have a right lower lobe segmental and subsegmental pulmonary embolism, for which he was started on anticoagulation. His outside hospital course was additionally complicated by acute kidney injury, which did not require dialysis; and ileus, for which TPN was started.

On hospital day 11, the patient was transferred to our institution for further evaluation by cardiothoracic surgery. Repeat TTE confirmed the presence of an echodense foreign body near the base of the posterior leaflet of the tricuspid valve, in the right ventricle, and a moderate-sized pericardial effusion. Due to concerns about the possibility of further embolization or damage to the tricuspid valve, the decision was made to surgically remove the intracardiac missile.

However, the patient also had persistent fevers, leukocytosis, and a new pulmonary infiltrate on X-ray, consistent with pneumonia, and the operation was delayed for a seven-day course of antibiotic therapy. During this time, he also underwent pericardiocentesis with a follow-up TTE showing resolution of the effusion.

An additional TTE was obtained one day prior to the OR to ensure that the bullet remained in the same location.

## Operative Management and Postoperative Course

General endotracheal anesthesia with cardiopulmonary bypass and intraoperative TEE was planned for the bullet’s removal. Anesthetic management was per our institution's standard cardiac protocol. The patient arrived to the OR intubated, with a left internal jugular vein triple lumen central venous catheter and a radial arterial line as intravenous and intraarterial access. He was on propofol and hydromorphone infusions for sedation and analgesia.

The patient's intravenous sedation was discontinued. Isoflurane was used for an inhalational induction, and was continued at 0.7 to 1 MAC for maintenance of anesthesia. BIS monitoring was used as an adjunct to monitor depth of anesthesia. A second double-lumen central venous catheter was placed in the right internal jugular vein, to provide additional large-bore access for resuscitation. Rocuronium was administered for neuromuscular blockade. Cefazolin was administered as antibiotic prophylaxis. Loading doses of fentanyl and aminocaproic acid were given prior to incision; aminocaproic acid was continued as an infusion at 1 g/hr.

TEE was performed at the start of the case, and showed an echogenic structure located in the right ventricle immediately below the tricuspid valve (Figure 2).

The surgical approach began with a median sternotomy. Dense pericardial adhesions were noted to be present (Figure 3). Heparin was administered and dosed to maintain a goal ACT of at least 450. Cardiopulmonary bypass was established via a bicaval cannulation technique. The right atrium was opened via a longitudinal incision, and the bullet was seen lodged behind the tricuspid valve at the commissure between the septal and posterior leaflets. It was not adherent to the valve, and with gentle retraction of the leaflets, the bullet was readily removed (Figure 4). The atriotomy was closed and the patient was weaned from bypass.

The patient was hemodynamically stable throughout the case. Boluses of phenylephrine were briefly required during discontinuation bypass; otherwise, the patient did not require additional pressors, blood products, or inotropes. Heparin was reversed with protamine. Hemostasis was obtained and the chest was closed.

The patient was restarted on propofol and hydromorphone sedation, and transported intubated to the ICU in stable condition.

On postoperative day 4, the patient underwent percutaneous tracheostomy; he was subsequently weaned from the ventilator and decannulated on postoperative day 21. In addition to his pulmonary embolism, he was diagnosed with a common femoral vein DVT, and a retrievable IVC filter was placed. He was also treated for *Clostridium difficile*-associated diarrhea. Four weeks following his cardiac surgery, he was discharged to acute rehabilitation. He was neurologically intact, hemodynamically stable, on room air, tolerating a regular diet and ambulating with a walker.

## Discussion

Bullet embolization is a rare phenomenon. During the Vietnam War, the incidence of missile embolization among American soldiers who sustained gunshot wounds was 0.3%<sup>1</sup>; during the Iran-Afghanistan Conflict, this incidence was reported as 1.1%<sup>2</sup>. No estimates exist for civilian trauma. However, some authors have suggested that because of the ballistics and lower muzzle velocities of civilian firearms, bullet emboli may be more common in the civilian trauma setting than in combat<sup>3</sup>. Determinants of embolization include: the physics and ballistics of the bullet, its size, and the bullet's proximity to vasculature structures. Although anterograde flow in either the venous or arterial vasculature tree are most common, retrograde and paradoxical embolization have also occurred<sup>4,5,6</sup>.

The diagnosis of bullet embolization begins with a history of penetrating trauma and is confirmed with any number of imaging modalities. An incongruence in the number of wounds, a distant or apparently absent bullet with respect to its trajectory, and a delayed onset of patient symptoms can indicate a possible embolic event. TEE is the ideal imaging modality for an intracardiac embolus because of its accuracy in determining the bullet's location, mobility, and impact on

cardiac function<sup>6</sup>. In our case, serial TTEs were performed to identify if any further embolization occurred, and intraoperative TEE was used to assist CT surgery with its removal.

Traditionally, bullet emboli have been characterized as either arterial or venous. Arterial bullet emboli may be symptomatic in up to 80% of patients<sup>7</sup>. The symptoms and their onset are often related to compromised tissue perfusion. With the impending threats of end organ damage or distal limb ischemia, these emboli require immediate removal. Venous emboli, however, are symptomatic in only 33% of patients<sup>7</sup>. Case reports of successful non-operative management have led some authors to conclude that no intervention should be undertaken in an asymptomatic patient<sup>8,9</sup>.

Management of intracardiac bullet emboli also remains controversial. Similar to peripheral arterial and venous bullet emboli, the bullet's "sidedness" traditionally influenced the decision to intervene, with bullets in the right ventricle or atrium regarded as more benign compared to their left-sided counterparts<sup>10</sup>. However, a recent literature review demonstrated little difference in complication rates between left and right intracardiac emboli<sup>3</sup>. Two interrelated scenarios exist where most authors agree upon removal of the intracardiac bullet, regardless of its sidedness. The first is a symptomatic embolus. The second is a partially embedded or freely mobile intracardiac bullet. Our patient's bullet was precariously located behind the tricuspid valve, and had the potential for distal embolization to the pulmonary arteries. Possible complications of abscess formation, infarction, and hemorrhage necessitated its prompt removal, which was made possible by collaboration among our trauma, cardiothoracic, and anesthesia teams.

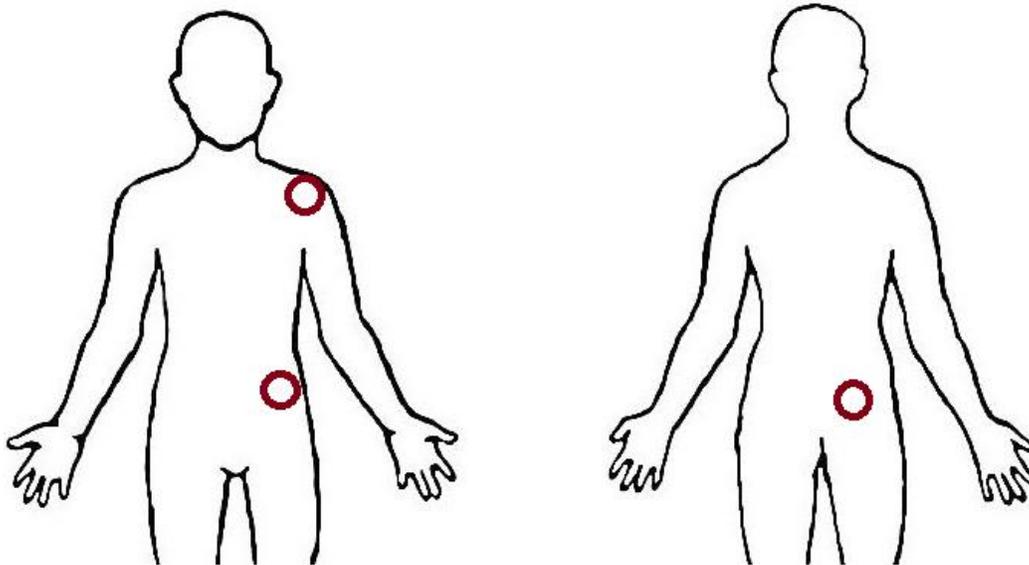
## Conclusion

Intravascular and intracardiac bullet emboli are unusual occurrences. Nevertheless, anesthesiologists should be familiar with these potentially devastating events. Bullet emboli can have serious sequelae including organ & limb ischemia, sepsis, endocarditis, valvular incompetence, PE, stroke, and death. Intravascular bullet emboli can be categorized as arterial or venous. Most authors agree that arterial emboli should be removed. On the other hand, the management of venous bullet emboli remains controversial. Intracardiac bullet emboli can be characterized as right-sided or left-sided. In the case of intracardiac bullet emboli the sidedness primarily determines the surgical approach. Symptomatic, partially embedded, or freely mobile bullet emboli require removal because of their potentially disastrous complications.

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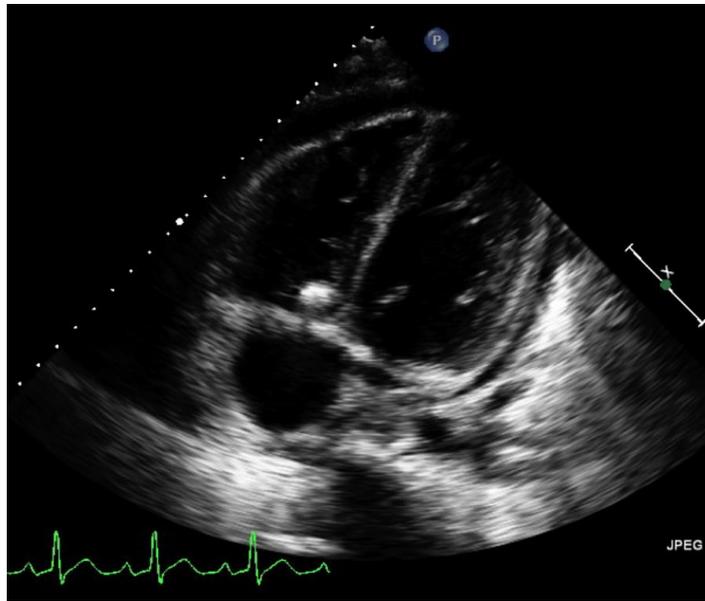
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**Figure 1:** Trauma flow sheet showing the location of the penetrating entry wounds



**Figure 2:** Post contrast chest CT showing the bullet within the right ventricle without an associated thoracic entry wound



**Figure 3:** Transthoracic echocardiogram showing the bullet ensnared by the tricuspid valve at the commissure between the septal and posterior leaflets



**Figure 4:** 9mm or possibly 0.38 caliber bullet specimen after its successful surgical removal

## **Title: Anesthetic Management of a Parturient with Tetraplegia for External Cephalic Version and Subsequent Cesarean Delivery: A Case Report**

Authors: Yousef Hamdeh, D.O., Suzanne Huffnagle D.O., H. Jane Huffnagle D.O., Michelle Mele M.D., John Wenzel M.D.

**Introduction:** 85% of patients with spinal cord injury above T6 have autonomic dysreflexia (unopposed sympathetic discharge below injury) (1). It can be elicited by distention of the bladder, colon, or onset of uterine contractions. We present a parturient with severe autonomic dysreflexia from an incomplete C5-7 spinal cord injury for external cephalic version and subsequent C/S.

**Case report:** A 28 y/o G2P0, 37 1/7 wk female (BMI 28.8 kg/m<sup>2</sup>) presented with pyelonephritis and category 2 FHR trace for IV antibiotic therapy. PMH included C5-7 incomplete spinal cord injury with quadriplegia, severe autonomic dysreflexia, neurogenic bladder, decubitus ulcers, neurogenic diabetes insipidus, depression, and asthma. She developed FHR decelerations, necessitating expedited delivery and since her fetus was transverse lie, external cephalic version followed by induction of labor was planned. C/S would follow a failed version. After placing a combined spinal/epidural (CSE) (intrathecal bupivacaine 2.5 mg, 5 mcg sufentanil) and gentle abdominal pressure, the FHR dropped. A right radial artery catheter was placed and an urgent C/S commenced using epidural anesthesia. An epidural infusion (bupivacaine 0.125%, fentanyl 2 mcg/mL) provided postoperative analgesia.

**Discussion:** Uncontrolled autonomic dysreflexia can lead to intracranial hemorrhage, seizures, MI, pulmonary edema, coma and death (2). Severe hypertensive episodes may compromise uteroplacental perfusion but neuraxial anesthesia can blunt hypertensive responses and increase the success rate of ECV (3). Urgent C/S may become necessary (fetal intolerance, placental abruption, onset of labor) so our anesthetic plan consisted of CSE using a small spinal dose of bupivacaine and sufentanil for ECV, reserving the epidural for labor or subsequent C/S. Since spinal anesthesia for C/S may cause severe hypotension, an epidural permits slow titration and minimal hemodynamic fluctuation. One can monitor disappearance of spastic paresis, quality of BP control, and temperature changes to assess neuraxial anesthetic efficacy (4). Pin prick assessment was adequate in our patient. Since no method of anesthesia is completely effective in abolishing autonomic dysreflexia, we placed an arterial catheter and had short acting agents (nitroprusside, nitroglycerin, labetalol, nicardipine, phenylephrine, ephedrine) available to treat BP swings. Neuraxial anesthesia may not be possible in many spinal cord injured patients (spinal stabilization procedures, obliteration or scarring of epidural space) so general anesthesia with the associated risks of aspiration, possible difficult intubation, acute hyperkalemia from succinylcholine, and transfer of medications to the fetus, may be necessary. A low dose epidural infusion minimizes pain and uterine cramping in the postpartum period.

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## Delivery Sheath Ventricular Perforation During Open, Surgical, Trans-septal Balloon Expandable Mitral Valve Replacement

### Introduction

A 79 year old female presented for mitral valve replacement, aortic valve replacement, tricuspid valve repair, coronary artery bypass graft with endoscopic vein harvest. Moderate calcification was noted on the posterior mitral annulus and the anterior leaflet was heavily calcified. A 29 mm Edwards Lifesciences Sapien 3 (Edwards Life-Sciences, Irvine, CA) bioprosthetic valve was advanced trans-septally via the right atrium into the mitral annular plane. The balloon was gradually inflated and the valve deployed in the mitral position. The aortic valve bioprosthesis, tricuspid valve ring annuloplasty, and coronary artery bypass graft to the distal right coronary artery were completed in the routine surgical fashion.

Prior to separation from cardiopulmonary bypass, TEE imaging showed aortic and mitral trileaflet bioprosthetic valves well seated without regurgitation. Following decannulation, bright red blood was noted in the mediastinum from the posterior aspect of the heart.

The patient was re-heparinized and CPB was resumed. Upon inspection of the decompressed heart, no evidence of an atrioventricular groove disruption was found. Pulsatile bleeding was located at the inferior aspect of the left ventricular apex. The left ventricular laceration was oversewn, hemostasis achieved, and the patient was weaned from CPB support.

### Discussion

In this case, an open mitral valve replacement using a balloon expandable valve resulted in iatrogenic puncture of the left ventricular apex from the deployment apparatus. Mitral valve replacement in the setting of mitral annular calcification is challenging due to the high potential for paravalvular leak secondary to poor seating of the prosthesis sewing ring to the mitral annulus; whereas debridement of the annular calcification results in increased risk of atrioventricular groove disruption and injury to the circumflex artery during debridement.<sup>2</sup> Atrioventricular groove disruption is a potentially fatal complication which occurs at an average of 1.2% of patients undergoing mitral valve replacement.<sup>5</sup>

Open balloon expandable mitral valve replacement has been described in the literature as a method of valve replacement in patients with severe mitral annular calcification.<sup>1, 2, 4</sup> Traditional transcatheter techniques with this technology rely on fluoroscopy for placement, allowing the operator to continuously visualize both the valve and the delivery sheath. Left ventricular perforation due to the delivery sheath has been reported during transcatheter deployment; however its occurrence is exceedingly rare. Additionally, the open surgical use of this technology requires cardiopulmonary bypass resulting in a decompressed left ventricle. A decompressed left ventricle will have a smaller volume than a beating left ventricle; therefore increasing the chance that the delivery system may abut or injure the ventricle.

### Conclusion

This case suggests the need for future evaluation of potential complications secondary to open balloon expandable mitral valve replacement. As technology transforms the delivery of valve prosthesis, perioperative physicians must be aware of the risk and benefit of such procedures and potential resulting complications.

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## Complete Avoidance of Blood Product Transfusion with Single Dose Prothrombin Complex Concentrates in an Anticoagulated Patient Undergoing Redo Cardiac Surgery

Roberts ML, Patel PA, Frogel JK

Characters: Intro (777) Case (1128) Discussion (1300) = Total (3205)

Patients receiving warfarin undergoing emergent/urgent open cardiac surgery present a specific conundrum to anesthesia care givers. Reversal with Vitamin K typically requires too much time until onset of clinical effect to be of use in the immediate perioperative period. Fresh frozen plasma may require large volume transfusions in patients who may not tolerate them. The use of 4-factor prothrombin complex concentrates (PCCs) for emergent warfarin reversal has gained traction in recent years. We present a therapeutically anticoagulated patient who underwent left ventricular assist device (LVAD) explantation/orthotopic heart transplantation (OHT) who received 4-factor PCCs intraoperatively and required no allogeneic blood products intraoperatively or postoperatively.

A 33-year-old male (5'6"; 73kg; BSA 1.82) with a history of idiopathic cardiomyopathy (EF 5%), pulmonary hypertension, s/p AICD placement and s/p LVAD placement presented for LVAD explantation/OHT. On presentation his hemoglobin measured 14.7 and he had an INR of 2.0. In the intraoperative period he received epsilon aminocaproic acid as per our institutional protocol (5g loading dose, 1g/hr continuous infusion). After implantation of the donor heart he was weaned from cardiopulmonary bypass (CPB) (CPB time 118 min, aortic cross clamp time 68 min, total ischemic time 209 min). After CPB heparin was reversed with protamine per protocol. Following protamine administration, the patient received 25 units/kg of 4-factor PCCs (KCentra) for warfarin reversal. The patient received autologous blood, cell saver and 2.5 mg of intravenous phytonadione in the perioperative period. However, no additional allogeneic blood products (red blood cells, plasma, platelets or cryoprecipitate) were administered during his hospital course. He was transferred out of the ICU on postoperative day (POD) 3 and discharged home on POD 17.

Patients presenting for urgent cardiac surgery are often anticoagulated for a host of indications such as atrial fibrillation, artificial cardiac valves and in situ LVAD. The most recent STS/SCA guidelines recommend PCCs for urgent warfarin reversal over plasma transfusion.<sup>1</sup> In addition, recent data suggests that PCCs are a safe and effective treatment of coagulopathic bleeding in cardiac surgery.<sup>2</sup> Cardiac surgical patients may have ventricular dysfunction where high volume plasma transfusion for anticoagulation reversal may be poorly tolerated. Actively anticoagulated patients undergoing cardiac surgery are at elevated risk for blood transfusion which is associated with increased mortality in this setting. Furthermore, reoperative sternotomy is associated with increased blood utilization and mortality as well.<sup>3</sup> Here we describe a rarity: complete avoidance of allogeneic blood products in a warfarin-anticoagulated patient who underwent successful LVAD explantation/OHT. We contend that the use of 4-factor PCCs, in conjunction with intravenous vitamin K, should be given greater consideration as a first line option in vitamin K anticoagulated patients undergoing urgent cardiac surgery as a means of limiting and potentially negating the need for allogeneic blood product transfusion.

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2 Cappabianca, et al. *Critical Care* 2016; 20:5

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Acute Pseudoaneurysm of Right Coronary Ostial Anastomosis and Graft Failure after a Ti Modified Bentall Procedure.

Farias-Kovac, M MD; Balabanoff-Acosta, C MD; Ginsburg, E MD; Yoon, J MD  
and Salamanca-Padilla, Y MD.  
Temple University Hospital

The modified Bentall procedure (MBP) with coronary button technique is associated with decrease in anastomotic complications in patients receiving a composite aortic graft compared

Introduction: with the classical technique. Incidence of coronary ostial anastomoses complications is approximately 3%. We present a case of acute pseudoaneurysm from right coronary button and graft failure following a MBP for an acute Type A aortic dissection (TAD)

A 30-year-old male with PMH of essential hypertension and a FH of aortic aneurysm and dissection transferred from OSH with acute TAD extending into the aortic root and aortic valve leaflets causing moderate aortic regurgitation. The patient underwent emergency MBP with reimplantation of coronary buttons. Patient recovered and discharged home on postoperative day (POD) 20

On POD 30, patient presented to the emergency department complaining of acute SOB, fever, and severe anemia. A TTE showed normal LV function, moderate RV dysfunction, a well-seated mechanical aortic valve, and no pericardial effusion. CTA of the chest revealed a large pseudoaneurysm and hematoma with active extravasation from the right coronary artery (RCA) button site with extrinsic compression of the RCA, SVC, ascending aorta, and main PA.

Case Presentation: Patient was taken back to the OR for urgent repair. Intraoperative TEE showed a large pseudoaneurysm and hematoma with two high-velocity jets from RCA anastomosis. At redo-

sternotomy, surgical team encountered dense adhesions from the innominate vein down to the root of the aorta, and the right atrium was enveloped in the thick hematoma. Due to high risk of pseudoaneurysm rupture during the lysis of adhesions, CPB was initiated via percutaneous

cannulation, and deep hypothermic circulatory arrest was induced for safe takedown of the pseudoaneurysm and repair of the RCA button and graft leak. After evacuating the hematoma and thick peel of pseudoaneurysm around the aortic root, 2 leaks from the RCA button and a small leak from the distal anastomosis were found and repaired. Total bypass time and deep hypothermic circulatory arrest time were 360 and 16 minutes, respectively. Post-op course was uneventful and patient was discharged to home 5 days later

Since implementation of MBP rate of complications due to coronary ostial leaks has diminished significantly. Coronary button technique was advocated as a means to cut pseudoaneurysm rates early in the development of the surgery. Per Milano et al, incidence of coronary ostial anastomoses complications is approximately 3%. Most patients with MBP present with ostial complications years after their surgery. In our patient, coronary button dehiscence presented only 30 days after the repair of a type A dissection. Given significant FH

Discussion: of aortic aneurysm and dissection in family members, it is suspected that he may have an undiagnosed connective tissue disorder. Per Meijboom et al, coronary ostial aneurysms and complications are reported in 42.5% of Marfan syndrome patients undergoing MBP being more frequent in those <35 years of age, fitting our patient's presentation. Intra-op TEE confirmed the and severity of the leaks, guiding the surgeons to modify their surgical plan to incorporate DHCA for safe repair. Following re-operation recovery of our patient was uneventful

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Three: J Cardiothorac Surg. 2016 Jan 22;11:19. doi: 10.1186/s13019-016-0418-y. Men

## Original Research Poster Presentations:

## Caudal Epidural Block vs Peripheral Nerve or Field Block for Postoperative Pain Control in Children Undergoing Bilateral Hernia Repair

**Introduction:** In our institution, some form of regional analgesia is performed in every child undergoing inguinal hernia repair. However, this varies depending on the preferences of the anesthesiologist and surgeon. Some children receive a caudal epidural block, some receive an ilioinguinal/iliohypogastric block, and others receive an intraoperative field block by the surgeon. The aim of this study was to compare postoperative pain scores and opioid use between these groups, mainly focusing on the difference between caudal block and peripheral nerve block groups.

**Methods:** Using a de-identified electronic database of anesthesia and PACU records, we performed a retrospective analysis of postoperative pain scores in all children less than 5 years of age who underwent bilateral inguinal hernia repair at our institution from 1998 through January 2016. We excluded children that had unilateral hernia repair, and those who underwent additional concomitant procedures. In our institution, de-identified database research is exempt from human subjects' board approval. Using categorical statistical methods (i.e., Fisher's exact test), we compared the efficacy of caudal epidural block versus peripheral nerve block (e.g., either ilioinguinal/iliohypogastric block or intraoperative field block) for alleviating postoperative pain. Additional differences between groups were compared using Fisher's exact test for categorical data (e.g., administration of opioid) or parametric methods (i.e., t-test) for continuous data (e.g., age). The primary outcomes included highest postoperative pain scores (FLACC), specifically the percentage of patients in each group with a highest pain score of 0, those with a high pain score of 10, and those with a highest pain score more than 4 but less than 10.

**Results:** During the study period, 507 patients underwent bilateral inguinal hernia repair; 436 received a caudal epidural block, and 71 had a peripheral or field block. The patients in the caudal group were younger than the peripheral block group (mean  $\pm$  SD:  $0.17 \pm 0.55$  years vs  $1.86 \pm 1.42$  years,  $P < 0.001$ ). The difference in pain scores between the group is shown in the Table.

	<u>Caudal (n=436)</u>	<u>Peripheral/Field (n=71)</u>	<u>P value</u>
High FLACC of 0	404 (92.7%)	57 (80.2%)	0.003
High FLACC of 10	3 (0.69 %)	2 (2.8%)	0.15
FLACC > 4	23 (5.3%)	7 (9.9%)	0.17
PACU opioid (Y/N)	5 (1.1%)	6 (8.5%)	0.002

Conclusion: Children who received a caudal block demonstrated better postoperative pain relief than patients who received a peripheral nerve or field block with regard to achieving a pain score of 0 and need for PACU opioids. Further analysis using age stratification will better delineate the types of patients that would benefit from caudal blocks for bilateral inguinal hernia repair.

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Title: Risk factors associated with spinal anesthesia Failure during cesarean delivery after local anesthetic injection into cerebrospinal fluid: a retrospective analysis of 3025 cases

Authors: **Tyler McCambridge**, Ihab Kamel

Department and Institution: Anesthesiology, Temple University Hospital

Introduction: Spinal anesthesia is a reliable and effective technique to achieve surgical anesthesia for cesarean delivery with reported failure rate of 0.5%-2.7%. Most reports of spinal failure are primarily due to technical factors and anatomical abnormalities associated with difficulty in identifying intrathecal space. Failure of spinal anesthesia for cesarean delivery despite evidence of free flow of CSF at various stages of injection of the local anesthetic is one of the most difficult to explain phenomena in obstetric anesthesia practice. The purpose of this retrospective analysis of consecutive cesarean deliveries was to identify risk factors associated with failure of spinal anesthesia after successful injection of local anesthetic into CSF in the obstetric population.

Hypothesis/Objective: The purpose of this retrospective analysis of consecutive cesarean deliveries was to identify risk factors associated with failure of spinal anesthesia after successful injection of local anesthetic into CSF in the obstetric population.

Methods: After obtaining the approval of the institutional review board at Temple University, we retrospectively reviewed all cesarean deliveries performed at Temple University Hospital from January 2008 to January 2014. The following data was collected for each case; age, weight, height, BMI, gestational age, gravida, parity, ASA classification, history of drug abuse, spinal anesthesia failure, type(planned versus cesarean delivery after the onset of labor), urgency of cesarean delivery(urgent versus non-urgent), intrathecal bupivacaine dose, intrathecal fentanyl dose and intrathecal morphine dose. BMI was calculated using the formula  $\text{weight in kg}/\text{height in meters}^2$ . Spinal anesthesia failure was defined as a cesarean delivery in which spinal anesthesia was converted to general anesthesia prior to or at the time of surgical incision due to inadequate anesthesia after successful placement of the spinal anesthetic in the CSF.

Spinal anesthesia failure after successful injection of the local anesthetic medication into the CSF was the primary outcome. Cesarean deliveries in which spinal anesthesia was the initial anesthetic technique and successful injection of Local anesthetic occurred were included in the analysis. Risk factors included in the analysis included; age, weight, height, BMI, gestational age, gravida, parity, ASA classification, history of drug abuse, type(planned versus c-section after onset of labor) and urgency of cesarean delivery(emergency versus non-emergency), intrathecal bupivacaine dose , intrathecal fentanyl dose and intrathecal morphine dose.

Two sample t tests were performed to compare numerical variables between groups (failure vs success). Chi-squared tests were used to determine if there was a significant association between groups and categorical

variables, including ASA-PS status, history of drug abuse, type and urgency of cesarean delivery. We performed a univariate and multivariate analyses to identify predictors for spinal anesthesia failure. First, univariate logistic regression models were used to explore the associations between possible predictors and spinal anesthesia failure. Based on the results of these logistic regression models, we further conducted cut-point analyses to investigate the association between BMI threshold at <30, <25 and < 20 kg/m<sup>2</sup> and spinal anesthesia failure. Finally, multivariate logistic regression models were also used to explore the association between each significant variable identified in the univariate analysis and anesthesia failure after controlling other significant variables. Statistical significance was defined as  $P \leq 0.05$ . All analyses were performed by using the SAS 9.3 software (SAS Institute, Cary, NC).

Results: A total of 5954 cesarean deliveries were reviewed, while 3025 cesarean deliveries were included in the analysis based on selection criteria. The case group (n=58) comprised cases in which a failed spinal anesthetic was converted to GA after successful injection of local anesthetic in the cerebrospinal fluid.

Univariate analysis of risk factors associated with failed spinal anesthesia after successful injection of the medication in the CSF is presented in table 2. Body weight and Body mass index were significantly associated with failure of spinal anesthesia ( $p= 0.013$  and  $P= 0.015$  respectively ). Results of cut-point analysis for significant risk factors are included in table 2. Compared to patient with a BMI< 25, patients with a BMI >25 were less likely to have a failed spinal anesthetic (odds ratio 2.209, 95% CI (1.133 – 4.307),  $p=0.02$ ). Multivariate analysis results are included in table 2. Body mass index history of drug abuse were confirmed independent predictors associated with failed spinal anesthesia ( $p=0.0036$  and  $p=0.05$  respectively).

Discussion: Spinal anesthesia for elective cesarean section is the standard choice of anesthetic in our institution as long as no contraindications exist. Previous studies have focused on patient risk factors, anatomic abnormalities, and local anesthetic characteristics that help determine adequate anesthesia for c-sections (Hocking, 2004). Other studies identified the most common reasons for a failed spinal anesthetic, which include, but are not limited to: poor patient positioning, improper needle placement and position, incorrect local anesthetic dose selection, misplaced injection, and ineffective drug action (Fettes, 2009). Our study focused on a subset of patients who had a spinal needle placed in standard fashion, free-flowing CSF was easily appreciated, LA was injected into the intrathecal space easily, and an adequate dermatomal level upon testing was achieved. By choosing this patient subset, we attempted to eliminate the previously listed failed causes for spinal anesthesia. We found a subset of patients from this group who still did not tolerate surgical incision. Our goal for this study was to identify possible risk factors associated with these patients, who eventually needed conversion from spinal anesthesia to general anesthesia for elective c-section.

The relationship between a low BMI and a failed spinal anesthetic in our study is not completely understood. Chi-Hang and colleagues found that parturients with greater abdominal circumference had a higher level of sensory blockade associated with SA. They attributed this to less lumbosacral CSF volume, higher IVC compression and epidural venous plexus distention, therefore causing a higher sensory blockade (Chi-Hang, 2016). Other studies were not able to correlate patient weight, and weight gain during pregnancy with the

spread of LA in the SA space (Ekelof, 1997). Again, all of our patients had an adequate level of spinal anesthesia with dermatomal testing prior to incision, but those with a lower BMI required conversion to GA more often at surgical incision.

The second group of patients in our study who required conversion to general anesthesia despite an adequately placed spinal were those with a history of IV drug abuse or a positive urine drug screen. A statistically significant percentage had an inadequate surgical blockade even when an adequate dermatomal was appreciated. Case reports and case series have noted previous resistance to LAs in spinal anesthesia (Batas, Kavlock, Schmidt, Woolard). The authors hypothesize that there may be sodium channel mutations in certain patients which could render the LA ineffective, although that mutation has never been described (Kavlock). They also hypothesize that the patients may have had an adequate surgical level, but that anxiety and the want for GA over SA may have predisposed a patient subset to failure (Bakos). None of these studies, however, addressed the relationship between previous drug abuse and a failed spinal.

Conclusions: Although performed in standard fashion with free-flowing CSF present and easy injectability, we found two subsets of patients who exhibited a failed spinal in our retrospective study—those with a low BMI, and those with a history of IVDA. Several papers have suggested reasons why those with low BMI may have a failed spinal anesthetic despite adequate technique. We have several hypotheses why the IVDA subset of patients may have had a failed spinal, but more studies may have to be done in the future to determine a more concrete correlation in this patient subset.

Title: Life threatening Hyperkalemia Following Massive Transfusion: Who is at Risk?

Authors: Akshat Gargya, MBBS, Matthew Troum, DO; and Ellen Hauck, DO PhD

Department and Institution: Department of Anesthesiology, Lewis Katz School of Medicine at Temple University

Introduction: Massive hemorrhage in traumatic injury patients is a major cause of morbidity and mortality in 1<sup>st</sup> 24 hours and blood component support can be lifesaving (1). Potential complications of massive blood transfusions including hyperkalemia have been known for decades (2,3), however studies to date have failed to uncover risk factors associated with the development of hyperkalemia. The current literature lacks sequential following of potassium levels during massive transfusion and adjustments for possible confounding factors such as delivery of lower potassium fluids such as crystalloid, fresh frozen plasma, platelets and albumin, all used commonly during surgery for trauma.

Hypothesis/Objective: Our study focuses on identifying the risk factors associated with hyperkalemia (Potassium levels >5.5 mM/L) in trauma surgery patients receiving massive transfusion in a tertiary care hospital.

Methods: Retrospective chart analysis of 159 patients from 2008-2014 who required initiation of the Massive Transfusion Protocol (MTP) was conducted. Patient demographic data as well as intraoperative vitals, medications, fluids and events were collected. Total potassium load delivered to patients was estimated with a formula accounting for the age and volume of the stored products delivered. Statistical analysis was done to look for independent risk factors for the development of hyperkalemia.

Results: Initial data analysis shows that patient hyperkalemia is linked to the rate and total potassium load given to the patient and therefore to the age of the stored PRBC. Hyperkalemia was also more likely to occur when the ratio of crystalloid to colloid given to the patient was less than one. More detailed data analysis will be presented.

Our study showed that PRBC transfusions were independently linked with hyperkalemia. Patients who were transfused more than 20 units of PRBC had higher intraoperative mortality when compared to patients who were transfused fewer units of PRBC. Duration of surgery was not seen as a risk factor for hyperkalemia and had no correlation with intraoperative mortality. Potassium levels noted in massively transfused patients were also found to be directly related to the storage age of packed RBC units in blood bank with significantly high levels seen in patients receiving PRBC units nearing the end of their storage life.

Discussion: Current literature remains unclear about the causative factors of hyperkalemia in massively transfused patients but these factors likely are multi-factorial. Our study positively links the storage age of PRBC units to high potassium levels, thereby confirming the previous studies (4,5). Our study further looks at the rate of rise of potassium levels during surgery as well as other factors such as the inclusion in total potassium load of other lower potassium containing colloids, the rate of transfusion, the volume of crystalloid delivered, other medications given and the temperature of the patient. Detailed results will be presented.

Conclusion: Infusion of large volumes of stored PRBC units in MTP are independently linked to hyperkalemia and higher intraoperative mortality, particularly with lower volumes of crystalloid

delivery. Prophylactic measures should be started in massively transfused patients to avoid hyperkalemia associated cardiac arrest and subsequent mortality.

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## **Intrathecal Hydromorphone for Post Cesarean Delivery Analgesia – Impact of Lowering the Dose on the Amount of Rescue Pain Medication**

**Jespersen K, M.D., Huffnagle HJ, D.O., Huffnagle SL, D.O., Weber M, M.D., Mele M, M.D., Wenzel J, M.D., Torjman M, PhD.**

### **Introduction:**

Cesarean section (C/S) is usually performed under spinal using bupivacaine and intrathecal morphine (ITM). With the critical shortage of ITM in 2012, we empirically used 200-mcg intrathecal hydromorphone (ITH) and undertook a dose finding study. We found the minimum concentration of ITH to be 60-mcg and the ED 80 to be 130-mcg (1). This study assesses the effect this lower dose has had on post-operative medication usage.

### **Methods:**

After IRB approval, a chart review was conducted to identify 120 matched patients who had primary or repeat C/S under spinal, 60 using 200-mcg ITH and 60 using 130-mcg. The amount of post-operative oxycodone/acetaminophen (5-mg/325-mg), oxycodone, and morphine (via PCA) were converted to oral morphine mg equivalents and totaled for each patient's hospital stay (2). Ibuprofen and acetaminophen amounts were also tallied.

### **Statistical Analysis:**

54 subjects per group were necessary for 80% power to detect a 15% difference in morphine equivalents. Statistical significance was determined using the Student t-test (age, LOS, BMI), Mann Whitney U (number C/S, MSO4 equivalents), and Pearson Chi-Square (race).

### **Results:**

We found no difference in post-operative opioid use ( $p=0.877$ ), age, length of stay, or number of C/S per patient; BMI was higher in the 130-mcg group.

### **Discussion:**

In light of our prior study's results (minimal dose, 60-mcg ITH, ED 80, 130-mcg), we have switched from 200-mcg ITH to 130-mcg. This study's goal was to validate the lower dose by comparing post-operative pain medication use before and after the change. We found no difference in opioid consumption and little variability in ibuprofen and acetaminophen use. This implies that a 130-mcg dose is clinically as effective as 200-mcg. Other literature suggests 130-mcg ITH might be too high and an additional dose finding study may be indicated (3, 4).

As with any chart review, we could have introduced selection bias; our sample might not be representative of, or generalizable to, our whole population. We hoped to lessen this using a relatively large sample size and group matching of patients. We acknowledge the difference in BMI, however long acting IT opioids are not routinely dosed based on patient weight.

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	<b>200-mcg ITH</b>	<b>130-mcg ITH</b>	
<b>Age (years)</b>	33 (26-40)	32.5 (22.5-42.5)	p>0.05
<b>BMI (kg/m<sup>2</sup>)</b>	29.9 (23.3-36.5)	32.2 (20.4-44)	p=0.001
<b>Length of Hospital Stay (days)</b>	4 (3-8)	4 (3-7)	p>0.05
<b>Number of C-</b>	1.5 (0-6)	1.5 (0-3)	p=0.784
<b>CDC Morphine Equivalent</b>	117.75 (3-232.5)	103.5 (3.75-203.25)	p=0.877

## ASA Physical Status, Charlson and Elixhauser comorbidity scores for predicting outcome after orthopedic surgery

Mohammad R. Rasouli MD<sup>1,2</sup>, Diana Bitar MD<sup>2</sup>, Mitchell Maltenfort PhD<sup>2</sup>, Bahar Adeli BA<sup>2</sup>, Camilo Restrepo MD<sup>2</sup>, Eugene R. Viscusi MD<sup>3</sup>, Javad Parvizi MD, FRCS<sup>2</sup>

<sup>1</sup> Department of Anesthesiology, Thomas Jefferson University Hospital, Philadelphia <sup>2</sup> Rothman Institute of Orthopaedics, Thomas Jefferson University, Philadelphia <sup>3</sup> Department of Anesthesiology, Thomas Jefferson University, Philadelphia

**Background:** Several classifications have been developed to evaluate underlying comorbidities. American Society of Anesthesiologists physical status (ASA PS) was developed to standardize and define “operative risk”. Charlson comorbidity score (CCS) consists of 17 medical disorders. Weight assigns to each disorder and sums for each patient to obtain a summary score. Elixhauser comorbidity score (ECS) includes non-weighted 30 comorbidities. CCS and ECS were developed to determine underlying comorbidities in large databases. It is not clear how well these classifications predict outcome of orthopaedic patients. Thus, the present study was conducted to evaluate association between these classifications and perioperative outcome in orthopaedic surgeries.

**Methods:** Using our IRB approved institutional database, we identified 34,260 orthopedic patients (21,095 joint, 7,554 spine, 1,411 shoulder, 1,593 foot and ankle, 922 trauma, 73 sport, 35 hand, and 1,577 other orthopaedic surgeries). Demographics, Intensive Care Unit (ICU) admission and in-hospital mortality were collected. Perioperative complications were identified using ICD-9 coding system and classified into three groups of cardiovascular, venous thromboembolism (VTE) and infection. For each outcome and each group of orthopaedic surgeries, four predictive models including one model for each comorbidity classification and one model for all ASA PS, CCS and ECS together were created; all models also included available demographics. Logistic regression was used to predict binary outcomes and its prediction accuracy was compared between

models using the C-statistic. The Akaike Information Criterion (AIC) was used for all models to determine which of the four models minimized information loss (AIC reflects both model prediction error and model complexity, if two models have the same accuracy but one model has fewer predictors, it will show smaller (better) AIC). We compared model predictive power for any complication between services and within joint and spine surgeries.

**Results:** ICU admission, infection, VTE, cardiovascular complications and mortality rates were 2.1%, 1.6%, 0.9%, 4.1% and 0.2% respectively. Trauma group had the highest complication rate (25.5%), followed by spine (16.5%) and joint (15.2%) surgeries. Considering any complication as outcome, the model including all three scores had the smallest AIC for joint, spine and trauma surgeries by a value of 10 or more, indicating a less than 1% probability that any of the reduced models minimized information loss. However, the ECS model in shoulder was better than the full model (AIC= 564 versus AIC= 571) and the CSS model was better in foot and ankle (AIC =1016 versus AIC= 1022), indicating that the full model had less than 5% relative likelihood of optimizing available information. The C-statistic for the full model was 0.71 in spine and 0.70 in joint, while C-statistic was 0.69 for ECS and 0.60-0.62 for ASA PS or CSS. After pruning less effective predictors using AIC and controlling for optimism or overfitting via bootstrap adjustment, C-statistic of the full model was 0.89-0.90 for cardiovascular complications, 0.73-0.76 for VTE, 0.87-0.90 for mortality, 0.72-0.79 for ICU admission and 0.76-0.79 for infection.

**Conclusions:** A model combining all three (ASA PS, CCS and ECS) scores predicted outcome better than a model including only one of them in majority of events. However, our finding showed that there is not a perfect model for predicting outcome in orthopaedic patients. Each of these three scores have their own weaknesses and strength.

ASA PS is a very simple measure however, CCS and ECS considering higher number of comorbidities and can better predict outcome of orthopaedic patients in majority of cases. Results of this study may help us to develop a specific comorbidity score for orthopaedic patients with a better predictive value by modifying available comorbidity scores.

# High reintubation rate after emergent airway management outside the operating room

Uzung Yoon MD, MPH, Jeffrey Mojica DO, Matthew Wiltshire MS4, Kara Segna MD, Michael Block MD, Anthony Pantoja MD, Marc Torjman PhD, Elizabeth Wolo MD

Department of Anesthesiology, Thomas Jefferson University Hospital, Philadelphia, PA, USA

## Introduction:

Extubation failure is defined as the inability to sustain spontaneous ventilation after removal of the artificial airway and the need for reintubation within a specified time period. This time varies in the literature from 24 hours to 7 days post-extubation[1,2]. Reintubation is common in the intensive care unit (ICU) and the literature reports a reintubation rate between 5% to 20% [3]. Reintubation is associated with higher incidence of morbidity and mortality, prolonged mechanical ventilation, and cost of care [4,5]. Limited data exist on reintubation rates and outcomes in hospital settings outside of the ICU.

**Objective:** The aim of this study was to evaluate the reintubation rate after emergent airway management outside the operating room.

## Methods:

Data was collected retrospectively on all emergent airway management interventions performed outside of the operating room from August 2015 to January 2016. Data recorded included time, location, indication for the intubation, airway management technique, number of attempts, laryngoscopic view and complications. Additional information including demographics, ASA status, comorbidities, reintubation rate, hospital stay, ICU stay, and 30-day in-hospital mortality was obtained from the hospital electronic medical record.

## Results:

In all, 336 intubations were performed in 275 patients during the six-month period. Of the 336 intubations 33.3% (112) were reintubations. Reintubations occurred in 51 of the 275 patients (18.5%) as some patients underwent multiple reintubations during the same hospital admission. Overall, 59% (n=66) of the reintubations occurred in an ICU setting, and 41%, (n=46) occurred on a hospital ward or at a remote location. Median admission ASA physical status of the reintubated patients was 4.0 (IQR 1.0), age 59±15, and BMI 30±11 kg/m<sup>2</sup>. There were no statistically significant differences in admission demographics and comorbidities among reintubated and non-reintubated patients. Reintubation rate was highest 7 to 30 days after extubation (32.8%, n=20), figure1. 13.7% (n=7) were reintubated more than three times, figure

2. Reintubated patients had a significantly longer total ICU stay (24±3 days vs. 12±1 day, p <0.001) and hospital stay (37±3 vs.18±1, p<0.001), and more total intubation days (8±1 vs. 7±0.6, p<0.02) than non- reintubated patients. The 30-day in-hospital mortality was lower in the reintubated patients (13.7%, n=7) than in the non-reintubated patients (35.9%, n=80; p=0.002). There was no difference in reintubation rate and overall mortality, between patients intubated in the ICU vs. non ICU, table 1, 2.

## Discussion

Overall, 33% of the unplanned reintubations were patients who had a prior unplanned intubation. These

reintubated patients had a significantly longer hospital and ICU stay. Almost half of the reintubations occurred in an in a non-ICU setting, which is considered to be a less-than-optimal environment, and more than 24 hours after extubation. The mortality rate among reintubated patients was lower than the non- reintubated population, possibly due to survival bias. Further research is needed to identify the cause for reintubation and the difference in mortality between the two groups.

**Conclusion:**

Unplanned reintubation rate is high outside the operating room leading to significant longer ICU stays.

Figure 1. Time until Reintubation

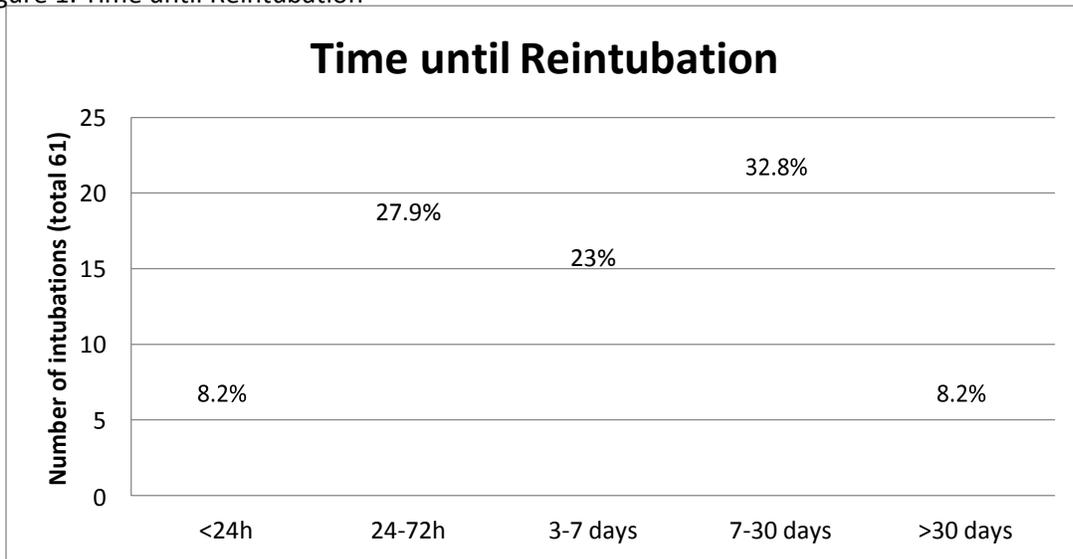
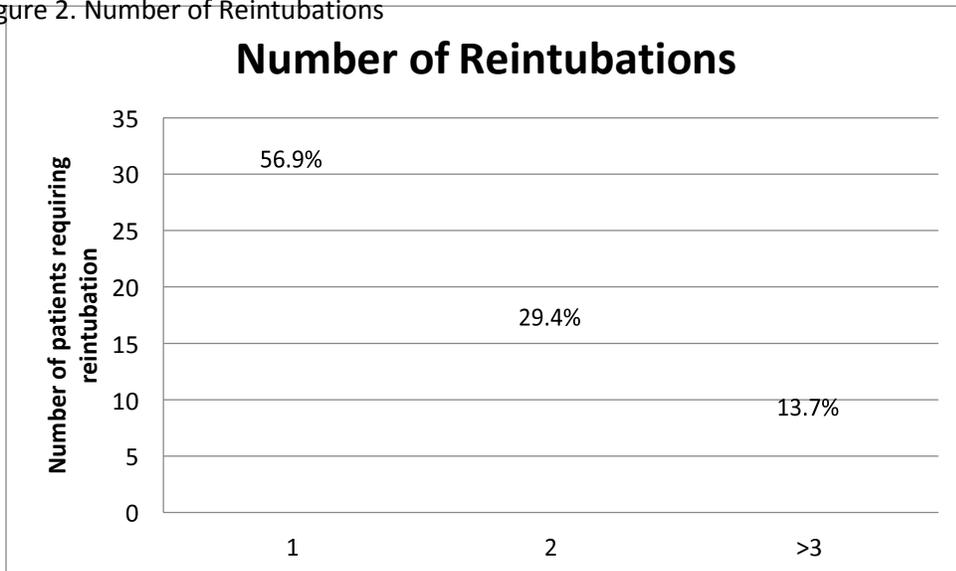


Figure 2. Number of Reintubations



(Total number of intubation = Number of reintubation +1)

Table 1. Reintubation rate in ICU and non ICU setting based on time of reintubation.

	61 reintubations in 51 patients (total intubation = 112)	Intubated in ICU	Intubated in non ICU setting	Statistical Significance
Reintubation <24h	5 (8.2%)	4	1	P=0.329
Reintubation >24-72h	17 (27.9%)	11	6	P=0.601
Reintubation >3-7 days	14 (23%)	9	5	P=0.665
Reintubation >7-30 days	20 (32.8%)	14	6	P=0.269
Reintubation >30 days	5 (8.2%)	1	4	P=0.072

Table 2. Outcome in reintubated patients in ICU vs. non ICU setting.

	Total 51 Patients	Intubated in ICU	Intubated in non ICU	Statistical Significance
Hospital length of stay	22.3±19.6 days	31.5±15.8 days	44.5±30.4	P=0.196
Total ICU days	13.7±15.3 days	22.1±13.0 days	25.6±23.4	P=0.848
Overall mortality	102 (37.1%)	8 (27%)	4 (19%)	P=0.739
30 day mortality	87 (31.6%)	5 (17%)	2 (10%)	P=0.685
Intubation days	7.1±8.8	7.0±7.4 days	7.3±10.5 days	P=0.777

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## Four Years Later... Have We Improved? A Survey of Multimodal Analgesia Utilization by Surgeons and Anesthesiologists

**Amir C. Dayan, MD**, Jaime L. Baratta MD, Eugene R. Viscusi, MD  
 Department of Anesthesiology, Thomas Jefferson University Hospital; Philadelphia, PA

## INTRODUCTION

Post-operative pain is experienced by up to 80% of patients having surgery in the USA. It has been demonstrated that pain management techniques utilizing multimodal analgesia can improve clinical and economic outcomes<sup>2</sup>. Multimodal analgesia, the administration of two or more analgesic agents with different mechanisms of action, has been emphasized by the American Society of Anesthesiologists (ASA). The 2012 ASA Task Force for acute pain management, recommended an around-the-clock regimen of non-opioid agents and regional anesthesia when appropriate<sup>3</sup>. This study aims to compare techniques of perioperative pain management between surgeon and anesthesiologists, particularly the utilization of multimodal techniques as standard practice.

## METHODS

A nine-question survey (Figure 1) was distributed to subscribers of a national surgical magazine targeting anesthesiologists and surgeons. Relevant questions were isolated for the purposes of this study. Categorical data are reported as counts and percentages.

## RESULTS

Fifty respondents completed the survey, equally distributed amongst anesthesiologists and surgeons. Both groups had similar views on limiting opioid use when possible (41.7% vs 42.3%). Regional anesthesia was valued (70.1% vs 68%), with pre-op peripheral blocks being most commonly performed (91.7% vs 88%). Differences arose in regards to approaches to post-op pain. Anesthesiologists preferred perioperative acetaminophen (APAP), NSAIDs and gabapentinoids (45.5%), while the majority of surgeons (42.3%) preferred the use of a combination opioid such as oxycodone/APAP. Anesthesiologists were more likely to use post-op IV APAP (89.5% vs 65%), while surgeons preferred long-acting opioids (30% vs 5.3%). There was limited, but similar use of IV ibuprofen and IV diclofenac.

## DISCUSSION

Our findings indicate that there is discordance between provider opinions and implementation of multimodal approaches to perioperative pain.

We conducted a similar survey evaluation of providers regarding multimodal analgesic techniques in 2011<sup>4</sup>. Survey data from eighty-three anesthesiologists, CRNAs and administrators, demonstrated similar, but limited use of multimodal analgesia. The majority of clinicians (47.6%) reported use of pre-op multimodal analgesia < 25% of the time. Furthermore, < 25% of clinicians used more than two non-opioids in their pain control regimen. Over a four-year period between our successive studies, minimal advancement has been made in the widespread implementation of perioperative multimodal analgesia.

Despite extensive recommendations for multimodal analgesia, the use of multimodal agents for pain is slightly improved but still scarce. This disparity emphasizes the need for further education of practitioners regarding the methods and utility of multimodal analgesia.

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<b>Question</b>	<b>Answer</b>	<b>Anesthesiologist</b>	<b>Surgeons</b>
1. In regard to opioids, which statement most accurately reflects your attitude?	They're still the best way to manage pain, and when called for, they're my first choice.	8.3% (2)	11.5% (3)
	I'm open to reducing opioid use, but I don't hesitate to use them when patients face real pain.	<b>41.7% (10)</b>	<b>42.3% (11)</b>
	I'm actively trying to reduce opioid use by my patients, but they still have a role to play in mitigating pain.	<b>41.7% (10)</b>	34.6 (9)
	I consider opioids only as a last resort.	8.3% (2)	11.5% (3)
2. My usual approach to post-operative pain is	A combination agent (e.g. Percocet, Vicodin)	9.1 (2)	<b>42.3% (11)</b>
	I routinely instruct patients to take acetaminophen and an NSAID around the clock and use opioids only as	18.2% (4)	30.8% (8)
	I routinely "pre-treat" patients with some analgesics before surgery	27.3% (6)	11.5% (3)
	When possible, I give pre-operative and post-operative acetaminophen, NSAIDs and a gabapentanoid drug.	<b>45.5% (10)</b>	15.4% (4)
3. With regard to regional anesthesia/local anesthesia	I prefer to do our cases under regional anesthesia whenever possible.	<b>70.1% (17)</b>	<b>68.0% (17)</b>
	I routinely employ regional anesthesia and send patients home with continuous catheters and	20.9% (5)	12.0% (3)
	I find regional anesthesia too burdensome.	4.2% (1)	4.0% (1)
	I prefer infiltration of local anesthetics over peripheral blocks.	4.2% (1)	16.0% (4)
4. I routinely employ these techniques in my ambulatory patients (choose all that apply):	Spinal	37.5% (9)	28.0% (7)
	Epidural	29.2% (7)	12.0% (3)
	Peripheral Blocks	<b>91.7% (22)</b>	<b>88.0% (22)</b>
	TAP Blocks	45.8% (11)	24.0% (6)
	Paravertebral blocks	25.0% (6)	12.0% (3)
	Infiltration	91.7% (22)	80.0% (20)
5. With respect to local anesthetic infiltration	I use standard bupivacaine	<b>78.3% (18)</b>	<b>79.2% (19)</b>
	I use Exparel for infiltration	8.7% (2)	12.5% (3)
	I prefer to place a catheter in the wound and send the patient home with an elastomeric pump.	13.0% (3)	8.3% (2)
6. I use the following products for routine post-operative pain (choose all that apply):	IV- acetaminophen (Offirmev)	<b>89.5% (17)</b>	<b>65.0% (13)</b>
	IV- ibuprofen (Caldolor)	21.1% (4)	20.0% (4)
	IV- diclofenac (Dyloject)	10.5% (2)	10.0% (2)
	Liposomal bupivacaine (Exparel)	31.6% (6)	35.0% (7)
	Extended release opioid products (OxyContin, fentanyl patch)	<b>5.3% (1)</b>	<b>30.0% (6)</b>

**FIGURE 1**

## Post-Operative Pain Expectations – Are Patients Accurate?

**Amir C. Dayan MD**, Jack Qiu, Marc W. Kaufmann DO, Jaime L. Baratta MD, Eugene R. Viscusi MD. Department of Anesthesiology, Thomas Jefferson University Hospital; Philadelphia, PA

### Introduction

Over 100 million surgical procedures are performed annually in the US and post-operative pain is experienced by about 80% of those patients. Adequate treatment of post-operative pain improves clinical and economic outcomes<sup>1</sup>; thus there is increased effort to improve post-operative pain control. Expectations of post-operative pain may influence its perception. We hypothesize that patients are poor predictors of post-operative pain intensity and expect more severe pain than what's actually experienced. Understanding patients' attitudes of pain can help improve the management of post-operative pain.

### Methods

Following IRB approval, patients 18 years of age or older, undergoing orthopedic, neurosurgical or general surgery procedures, were recruited for this survey study (Table 1).

A questionnaire was distributed to patients immediately prior to surgery asking about the expected severity of post-operative pain. In addition, a pain assessment rating (0-10) was assessed in the post-anesthesia care unit (PACU) one hour following surgery and on the first post-operative day (POD-1).

Pain data are summarized using means  $\pm$  SEM for pain ratings obtained using a numeric rating scale (0-10). The Wilcoxon signed-rank test was used to compare pain data with  $p < 0.05$  set for statistical significance.

### Results

A total of 118 subjects were included in this preliminary analysis of an anticipated 260-subject study. The male to female distribution was similar (51.7% vs. 48.3%) and mean age was  $61.8 \pm 13.8$  years. Before surgery, the mean expected pain rating in the PACU was  $4.72 \pm 0.301$  compared to an actual PACU pain rating of  $2.83 \pm 0.328$ . ( $p < 0.001$  (Figure 1). The mean expected pain rating on POD 1 was  $5.37 \pm 0.247$  compared to an actual POD 1 pain rating of  $4.40 \pm 0.296$  ( $p = 0.002$  (Figure 2).

### Discussion

Patients' expectations of hospital care likely influence their experiences. Pain is experienced by most patients after surgery and is influenced by many factors. Patients' expectations of post-operative pain may

contribute to increased perioperative stress and anxiety.

Our preliminary results confirm our hypothesis that preoperatively, patients expect higher levels of pain than actually experienced. Understanding patients' post-operative pain expectations may guide clinician treatment plans to include a brief discussion regarding pain expectations. This may help ease patient anxiety and improve their ability to cope with post-operative pain.

Recent survey studies have demonstrated that post-operative pain continues to be poorly controlled and is a source of patient dissatisfaction. Gan et al. reported post-surgical pain as the most common pre-procedure complaint and over half of patients noted high/very high pre-operative levels of anxiety about pain<sup>3</sup>.

In summary, our preliminary data demonstrates that patients have statistically significant higher post-operative pain expectations than what they actually experience. This is apparent in the immediate post-operative setting and first post-operative day.

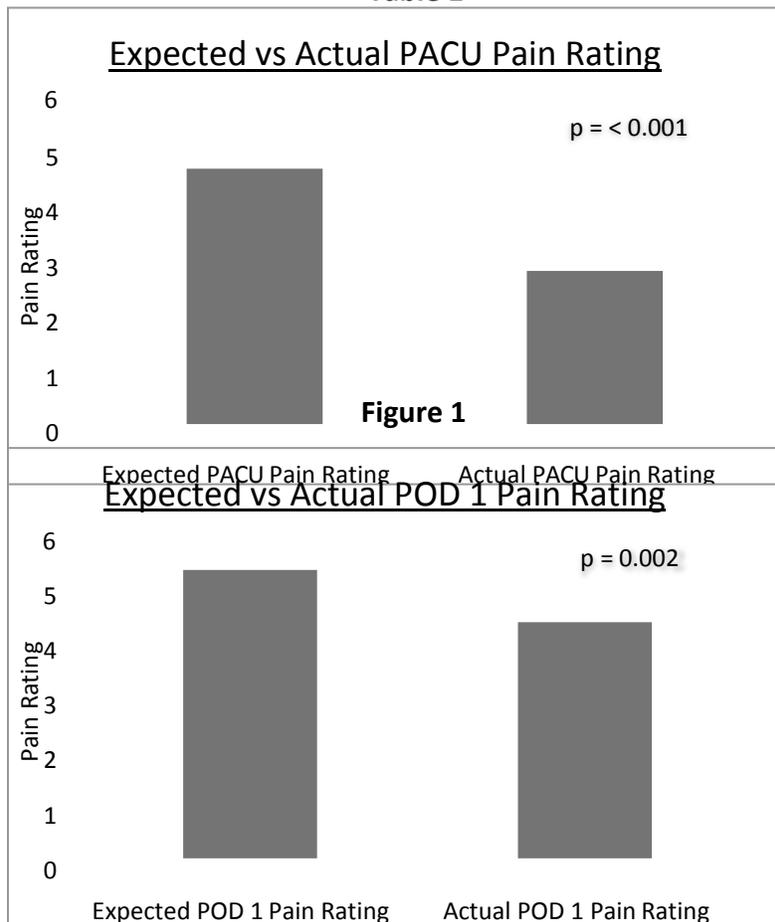
Our next study phase will focus on correlations between other factors, which influence pain expectations and how expectations actually affect the patient experience (anxiety, stress, satisfaction, length of stay).

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<u>Surgery Type</u>	<u>#</u>
Total Knee Replacement	27
Lumbar Spine	25
Other Orthopedic	19
Total Hip Replacement	17
Cervical Spine	12
GI & GU Laparoscopic/Robotic	9
Thoracic Spine	4
Open Abdominal	3
Total Shoulder Replacement	2

**Table 1**



## Figure 2

### Effects of 48 Hours Exposure of Epinephrine on the Cardiac Hypertrophy Related Gene Expressions in Cultured Cardiomyocytes

Scott R. Coleman, DO, Johann Matthew, MD, Michael S. Green, DO, Henry Liu, MD Department of Anesthesiology & Perioperative Medicine, Drexel University College of Medicine

**INTRODUCTION:** Cardiac hypertrophy has been shown to correlate with the incidence of heart failure, coronary artery disease, and stroke [1]. Epinephrine has been shown to be involved in cellular hypertrophic signaling pathways and is an important regulator of cardiac hypertrophy [2], [3]. We hypothesize that epinephrine exposure may alter gene expressions related to cardiomyocyte hypertrophy, leading to adverse clinical outcomes.

**METHODS:** Rat cardiomyocytes (H9C2) were inoculated at the concentration of 0.5M/ml and cultured at 37°C in DMEM. The cells were allowed to settle down overnight and then exposed to epinephrine (1uM) for 48 hours. H9C2 cells without epinephrine exposure served as controls. RNA was extracted from cultured cardiomyocytes for whole genome gene expression study. This array contains 41,000+ rat genes. cDNA were synthesized from RNA samples and then used to synthesize fluorescent cRNA. Labeled cRNA samples were hybridized to the Whole Rat Genome Oligo Microarray slides. After hybridization, arrays were washed and scanned. These data were imported into GeneSpring software as 20 one-color arrays and normalized to the median per chip and the median value per gene across all arrays. Parameter data was added so that microarrays could be grouped by time and treatment. Guided workflow returned several gene lists. These were analyzed for significant Gene Ontology and pathway hits based on passed P value (<0.05 is the cut off).

**RESULTS:** Several epinephrine-induced gene expression changes related to myocardial contraction and hypertrophy were identified. The G protein  $\gamma 12$  (GNG-12) and the  $\gamma$ -subunit of adrenergic receptor G coupled proteins (G $\gamma$ ) were up regulated each by a factor of 3.62 (See Table-1). Genes that were down-regulated encoded L-type voltage dependent calcium channel

subunits. Specifically, the  $\beta$  subunit, the  $\alpha$ -1c/d/f/s subunit (CACNA1c/d/f/s) and the  $\alpha$ -1D subunit (CACNA1D) decreased by factors of 3.14, 2.17 and 2.17 respectively (See Table-1).

**DISCUSSION:** Our study showed that epinephrine exposure alters myocardial hypertrophy- related gene expression in cultured cardiomyocytes. The up-regulated G protein subunits associated with adrenergic receptors are part of a cascade leading to cellular contraction and hypertrophic responses in the cell nucleus (See Figure-1). In contrast to this, genes for L-type calcium channel subunits were down regulated by epinephrine exposure. Multiple studies have shown that loss of L-type calcium channel function results in decreased intracellular calcium and a reduction of cellular hypertrophy [3], [4], [5].

**CONCLUSION:** Given the larger up-regulation of the G proteins relative to the down-regulation of calcium channel subunits, it is likely that some degree of hypertrophy may occur as a response to epinephrine.

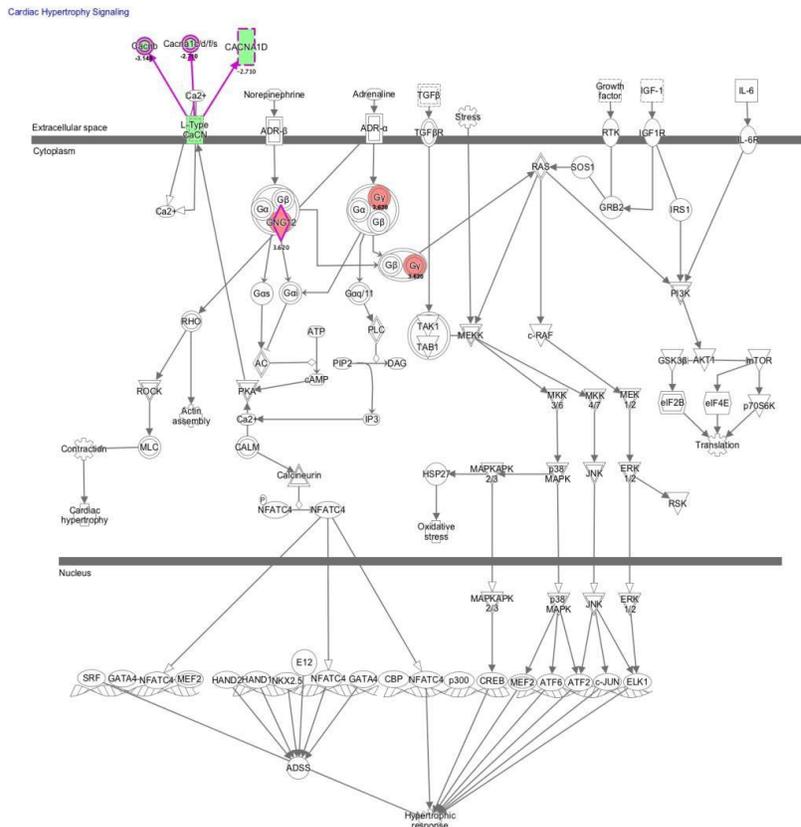
However, these findings may also provide an explanation for calcium channel blockers reducing left ventricular hypertrophy regardless of the decrease in systemic blood pressure [1]. Animal and human clinical studies are needed to further elucidate the in vitro effect of these genetic alterations.

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TABLE 1	Protein Product of Gene	Function	Factor of Regulation by Epinephrine
Up Regulated Genes			
<b>GNG-12</b>	Guanine nucleotide binding protein (G protein) $\gamma$ 12	Causes cardiac contraction and hypertrophy via signaling	+3.62
<b>G <math>\gamma</math></b>	G coupled protein, $\gamma$ -subunit	Causes hypertrophic response in nucleus via	+3.62
Down Regulated Genes			
<b>CACNB</b>	Calcium channel, $\beta$ -subunit	Calcium influx when depolarized leading to muscle contraction & muscle	-3.149
<b>CACNA1C/D/F/S</b>	Calcium channel, $\alpha$ -1 C/D/F/S		-2.71
<b>CACNA1D</b>	Calcium channel, $\alpha$ -1D subunit		-2.71

**FIGURE 1**



**Title:** Resources for Opioid Management among the Top 10 Hospital Systems Christopher

Snell M.D. M.P.H., Jessa Tunaco B.S., Anita Gupta D.O. PharmD Department of

Anesthesiology at Drexel University College of Medicine

**Abstract:** The opioid epidemic is a growing problem in the United States. The Top 10 Hospitals per *The US World and News Report* are among the most well-funded institutions with myriad resources at their disposal. This study considers 5 metrics that could be relevant for a high-risk pain patient: a readily available hospital opioid policy, hospital initiatives to combat the epidemic, the size of the institution's Pain Management division, affiliation with an addiction center, and lastly a 24-hr help hotline. Findings reveal that even among wealthy academic hospital systems, modifications can be made regarding both increased and improved resource allocation towards the opioid epidemic.

Top 10	Opioid	Proactive Initiates	# Physicians	#	Addictio	Hotline
Mayo Clinic, Rochester, Cleveland	Y	-	27	8	Y	N
Massachusetts General	Y	1. Opioid Task Force 2. Year-round Take Back Program	14	*	Y	N
**Johns Hopkins Hospital, Baltimore		1. Development of learning objectives for med students 2. LEAD program diverts low level drug offenders to treatment rather than jail 3. APPx Mobile interventions 4. Co-OP program: non-putative (i.e.	7	*	Y	N
UCLA Medical Center	Y	1. LA Care Health Plan's Collaborative Project: motivational interviewing embedded in medical resident curriculum 2. Project HOPE: provides online peer support 3. Project QUIT: PCP interventions	11	*	Y	N
New York-Presbyterian University Hospital of		-	Cornell – 5 Columbia - 3	Cornell- * Columbia- 1	Y	N
**UCSF Medical Center, San Francisco		1. Training for intervention in PCP curriculum (nurses, residents) 2. Methadone Van 3. Novel morphine analog without side effects	64	12	Y	N
Northwestern Memorial Hospital.		1. Opioid Task Force present 2. Text and Tip anonymous reporting 3. Take Back Program 4. A Way Out: police departments accept drugs and enroll	12	*	Y	N
**Hospitals of the University of Pennsylvania		-	10	1	Y	N
NYU Langone		-	9	2	Y	N
*Other support staff members were not specifically mentioned						
** Center of Excellence in Pain Education by the National Institute of Health's Pain						

<b>Top 10 Hospitals</b>	<b># Inpatient Admissions</b>	<b>Beds</b>	<b># ER Visits</b>	<b>Total # Admissions to Pain Staff</b>	<b>Beds to Pain Staff</b>	<b>Total # ER Visits to Pain Staff</b>
Mayo Clinic, Rochester	54,010	1,243	79,542	9,002	207	13,257
Cleveland Clinic	53,722	1,278	76,623	1535	37	2189
Massachusetts General Hospital	49,482	999	95,764	3534	71	6840
Johns Hopkins Hospital, Baltimore	48,203	998	93,194	6886	143	13313
UCLA Medical Center	23,442	466	46,128	2131	42	4193
UCSF Medical Center, San Francisco	29,175	650	37,560	384	9	494
Northwestern Memorial Hospital	47,139	885	83,805	3928	74	6984
Hospitals of the University of Pennsylvania	36,737	789	64,423	3340	72	5857
NYU Langone Medical Center	32,260	718	50,096	2933	65	4554
NY-Presbyterian University Hospital of Columbia	110,409	2,328	275,592	12268	259	30621

Location	Top 10 Hospital in the State	2015 Age-Adjusted Rate*	2015 # Drug Overdose Related	Health Care Cost
California	UCSF	11.3	4,659	#1: \$4263m
Ohio	Cleveland	29.9	3,310	#5:
Pennsylvania	UPenn	26.3	3,264	#8: \$874m
Florida	-	16.2	3,228	#4:
New York	NY Presbyterian	13.6	2,754	#3: \$1256m
Texas	-	9.4	2,588	#2: \$1,964
Michigan	-	20.4	1,980	#9: \$830
Illinois	Northwestern	14.1	1,835	#7: \$887
Massachusetts	MGH	25.7	1,724	!
North	-	15.8	1,567	!
<b>Proactive Initiatives</b> *Age-adjusted death rates were calculated as deaths per 100,000 population using the direct method and the 2000 standard population.				

(9, 10)

## ***Efficacy of Ketamine Infusion in Patients with Chronic Intractable Pain and Co-morbid Depression***

**Authors:** Onyechi Sylvester Megafu, Gupta Anita, Diego Urdaneta

Department of Anesthesiology Drexel University College of Medicine/HUH

### **ABSTRACT**

**Introduction:** Chronic Pain affects more than 100 million people in the United States and cost the society over \$500 billion annually in health spending. Major Depressive Disorder is one of the most common mental disorders in the United States affecting more than 15 million adults each year. Ketamine has been shown to treat not only chronic pain in previous studies but is also effective in the treatment of major depressive disorder. We now have evidence that chronic pain and depression are closely related and many patients with chronic pain also suffer from co-morbid depression.

**Objective:** We set out to evaluate whether outpatient infusion of ketamine was successful in treating chronic intractable pain of various etiologies while also providing relief from co-morbid depression.

**Methods:** We retrospectively analyzed the records of all outpatients who received ketamine infusion for chronic intractable pain over a period of one year. The data reviewed included demographics, ketamine dose, length of infusion, adverse effects and the numeric rating scale pain scores both pre- and post-procedure. These patients were subsequently contacted and assessed for improvement in mood and symptoms of depression using a depression questionnaire as a screening tool.

**Results:** We identified 13 patients who received outpatient ketamine infusion in our University pain practice. Complex Regional Pain Syndrome (CRPS) was the primary diagnosis in 8 (61%) of the patients. In addition to CRPS, 1 of the 8 patients had co-existing Fibromyalgia. Of the remaining patients, 3 (23%) were diagnosed with chronic pain, 1 (7%) had Behcet's syndrome and 1 (7%) had a diagnosis of Crohn's disease. The majority of these patients reported a significant reduction in pain scores after treatment. The mean reduction in pain was 6.23 with 10 (76%) of the patients reporting a score of 0 (no pain) post infusion. Of the 13 patients in our study, 9 (69%) reported current or previous problems with depression. 4 (31%) of the patients reported no improvement in mood and symptoms of depression after the ketamine infusion. 4 (31%) others reported a mild improvement, 5 (38%) reported a moderate improvement. 9 (69%) of the patients reported being satisfied overall with the treatment.

**Discussion:** The retrospective nature of our study was a limitation that precluded the evaluation of long-term relief from pain and depression after ketamine infusions. Of note is that the same 4 patients who were not satisfied overall with the treatment were the 4 who reported no improvement in mood or symptoms of depression. Our inability to objectively assess the severity of these patients' depression and use of anti-depressants both before and after the treatment was a limitation.

**Conclusion:** We conclude that in patients with chronic intractable pain as well as co-morbid depression, outpatient infusion of ketamine can significantly decrease pain and provide improvement in mood or symptoms of depression that are often present in the chronic pain population.

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**TITLE:** Utilization of Blackboard in Medical Education

**AUTHORS:** Maimouna Bah, MD; Anita Gupta, DO, PharmD; Celeste Swain; & Logan Blunk Department of Anesthesiology and Perioperative Medicine; Drexel University College of Medicine & Hahnemann University Hospital

**PURPOSE:** To investigate medical student and resident physician usage, along with overall opinions and level of support regarding Blackboard, an online Learning Management System (LMS), as a superior tool for delivery of didactic educational content.

**METHODS:** The study occurred at Hahnemann University Hospital in Philadelphia, Pennsylvania, in 2016. The authors created a two-page survey with a Likert-type scale questionnaire on the first page and open-ended questions on the second page to gauge overall satisfaction and support of Blackboard use. 20 participants completed the survey, divided into four different groups of five participants in each. The groups were Clinical Anesthesia (CA) Residents in years CA-1, CA-2, and CA-3 of their training and five medical students. Once the survey was completed, results were coded (5 = Strongly Agree to 1 = Strongly Disagree) and analyzed.

**RESULTS:** Due to the ordinal nature of the Likert-style data, the authors analyzed the data in regards to central tendency, which were summarized by the mode. The most frequent response to the questions was "Agree" (Mode=4), indicating support of Blackboard across many aspects.

Additionally, open ended questioning yielded favorable aspects of the LMS along with suggestions for improvement to benefit future resident physicians and medical students.

**CONCLUSION:** This small-scale study supports the use of Blackboard as an online LMS. Utilizing the data acquired from the Likert-style questionnaire as well as the open-ended questions offers perspective on how to improve Blackboard for future implementation in online didactic medical residency education.

## **Computational studies of ketamine interaction with mu opioid receptor Thomas T.**

Joseph<sup>1</sup>, Grace Brannigan<sup>2</sup>, Roderic Eckenhoff<sup>1</sup>

<sup>1</sup> Department of Anesthesiology and Critical Care, Perelman School of Medicine, University of Pennsylvania

<sup>2</sup> Department of Physics, Rutgers University Camden

### **Introduction**

The clinical effects of ketamine are mediated largely by the NMDA receptor. It is suggested that ketamine can ameliorate opioid-induced hyperalgesia. Radioligand inhibition experiments [1, 2] suggest that ketamine has micromolar affinity for opioid receptors, although the clinical relevance of this is not clear. In the setting of ketamine binding, dimerization of opioid receptors with other opioid receptors or other G-protein coupled receptors (GPCRs) is theorized to play a role in ketamine's effects. A first step to exploring these unknowns would be to determine the atomic-level structural basis of ketamine binding to opioid receptors. In the absence of an experimentally determined ketamine-bound GPCR structure, a computational approach is useful to predict this bound conformation.

### **Objective**

Determine the structural basis of the affinity of ketamine to mu opioid receptor.

### **Methods**

In order to predict one or more stable bound conformations, we conducted equilibrium molecular dynamics (MD) simulations, starting from an docked conformation of S-ketamine to a crystal structure of mu opioid receptor [3]. Docking was done with AutoDock Vina [4]. For subsequent molecular dynamics (MD) simulations, the molecular mechanics parameters for S-ketamine were chosen by analogy with existing functional groups in the CHARMM General Force Field [5], supplemented by quantum chemistry energy calculations to fit bonded terms and dihedral interaction energy corrections. We used equilibrium molecular dynamics simulations to observe stable bound conformations of ketamine to mu opioid receptor. Finally, free energy perturbation (FEP) MD was used to derive estimates for the standard free energy of binding to mu opioid receptor.

### **Results**

The most highly scored binding modes obtained by docking for ketamine were in the common orthosteric binding site, shared with opioid agonists and antagonists. Equilibrium MD simulation revealed stabilizing interactions of ketamine with several residues, including D147 and H297, that are also observed with opioid ligands. Repeated simulations suggest multiple closely related binding orientations. FEP calculations suggest a high micromolar affinity of ketamine to mu opioid receptor, roughly comparable to existing experimental data, although repeating the calculations produces free energy changes varying on the order of 1 kcal/mol, which results in wide variance in calculated equilibrium constants.

## Discussion

This study contributes a carefully constructed parameterization of S-ketamine that can be used in future MD studies. We also suggest a structural conformation for ketamine binding to mu opioid receptor that shares critical elements with opioid binding. Our binding energy calculations suggest micromolar affinity of ketamine with mu opioid receptor, but the calculated affinities do not agree exactly with experiment. This may be because the experiment used a peptide as its radioligand to be inhibited, which would have a different binding configuration than an opioid. It could also be because of inaccurate ketamine parameterization, or that the FEP calculations may require significantly more simulation time to produce well-converged results. Overall, however, this represents a first step in understanding the structural basis of ketamine interaction with mu opioid receptor.

## Conclusion

When bound to the mu opioid receptor, ketamine shares key ligand-protein interactions with opioids.

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Taxane modulation of anesthetic sensitivity in surgery for non-metastatic breast cancer.

**Regina E. Shannon, M.D.**, Warren J. Levy, M.D., Ivan J. Dmochowski, Ph.D., Roderic G Eckenhoff, M.D.,  
Rebecca M. Speck, Ph.D., MPH

University of Pennsylvania

Department of Anesthesiology and Critical Care

The mechanism of action of commonly used general anesthetics is largely unknown. One hypothesized mechanism is through modulation of microtubule stability. Taxanes, a subset of chemotherapeutic drugs known to alter microtubule stability and commonly used to treat breast cancer, offer a natural experiment to test our hypothesis that patients exposed to taxanes prior to surgery, as compared to after surgery, would have a partial resistance to general anesthetics.

The anesthetic records of adult women with non-metastatic breast cancer were used to obtain changes in heart rate and blood pressure surrounding incision, and the amount of inhaled anesthetic agent, induction, and rescue drugs administered.

Change in blood pressure in response to incision was significantly higher in the neoadjuvant group ( $p=0.03$ ), while change in heart rate was not ( $p=0.53$ ) (Table 2). A greater amount of morphine was administered in the neoadjuvant group (26.3 vs. 15.5 mg,  $p=0.02$ ) (Table 4), though not a higher concentration of inhaled anesthetics ( $p=0.15$ ) (Table 3).

Once the initial response to noxious stimulation is noted by the anesthesiologist, he or she reacts by tailoring subsequent anesthetic delivery. Thus, our secondary hypothesis was that elevated hemodynamics after incision would be followed by elevated amounts of inhaled anesthetic or “rescue” drugs (additional propofol, opioids). Again, while not statistically different, the inhaled anesthetic data trends in this direction at the 1 hour time point (Table 3). This secondary hypothesis was also supported in that significantly more morphine was used in the neoadjuvant group (Table 4), suggesting these patients had more pain, perhaps as a result of relative resistance to the delivered anesthetics. With respect to these “trends”, note that we have used the more conservative two-tailed statistical approach, when our unidirectional hypothesis justified a one-tailed approach.

These results suggest that the alteration of microtubule stability is one of a number of mechanisms of inhaled anesthetics. Thus, consistent with the recent data on this subject, our results are consistent with the premise that the mechanism of anesthetics is a distributed mechanism using many targets in different signaling pathways.

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Table 2: Absolute Change in Hemodynamic Values in Response to Surgical Incision

Vital Sign	Time measured <sup>1</sup>	Adjuvant	Neoadjuvant	Original <sup>2</sup>	Matched <sup>2</sup>	2:1 Matched <sup>2</sup>
				N=339	N=156	N=234
HR	-5min to +5min	4.8	5.6	.53	.97	.91
	-10min to +10min	5.0	5.7	.64	.73	.98
SBP	-5min to +5min	6.2	9.3	.12	.43	.27
	-10min to +10min	6.7	11.1	.02	.20	.10
DBP	-5min to +5min	7.6	12.7	.04	.23	.14
	-10min to +10min	7.5	14.1	.003	.09	.03
MAP	-5min to +5min	7.2	12.0	.03	.12	.06
	-10min to +10min	7.1	12.5	.01	.15	.05

HR-heart rate, SBP-systolic blood pressure, DBP-diastolic blood pressure, MAP-mean arterial pressure

<sup>1</sup>Time measured = measurement window in reference to time 0, which is time of surgical incision

<sup>2</sup>values presented are P-values

Table 3: Comparison of Time-averaged, Minimum Alveolar Concentration-adjusted Inhaled Anesthetic Agent

Time-averaged Gas	All Subjects	Adjuvant	Neoadjuvant	P-value
30 min (N=326)	0.98 (0.40)	0.98 (0.41)	0.98 (0.37)	0.97
1 hour (N=308)	0.98 (0.42)	0.96 (0.41)	1.04 (0.47)	0.15
2 hours (N=196)	0.97 (0.42)	0.97 (0.46)	0.99 (0.33)	0.80

Table 4: Comparison of Propofol and Opioid Use

	Adjuvant	Neoadjuvant	Original <sup>1</sup>	Matched <sup>1</sup>	2:1 Matched <sup>1</sup>
			N=339	N=156	N=234
Propofol Rescue	21 mg	20 mg	0.84	0.37	0.94
Fentanyl Rescue	100 mcg	94 mcg	0.77	0.25	0.32
Hydromorphone	2.16 mg	2.07 mg	0.76	0.38	0.31
Morphine	15.5 mg	26.3 mg	0.02	0.19	0.09

Rescue dose- difference between induction dose and total dose

<sup>1</sup>values presented are P-values

Fascia Iliaca Block versus Lumbar Plexus Block after Hip Arthroscopic Surgery  
**Stephanie Huang MD**, Ignacio Badiola MD, Jiabin Liu MD PhD, Nabil Elkassabany MD Department of Anesthesiology and Critical Care, University of Pennsylvania

## INTRODUCTION

Hip arthroscopy is an increasingly common procedure for the diagnosis and the treatment of a variety of hip pathologies.<sup>1</sup> This procedure, despite its less invasive nature, is associated with moderate to severe postoperative pain due to the complex innervation of the hip joint. Obtaining adequate perioperative pain control with minimal side effects is essential to patient satisfaction and the ability to discharge a patient home. This can be achieved with a multimodal approach to pain management that includes local anesthetic, systemic opioids, and regional anesthetic techniques. Regional anesthesia blocks the sensory innervation to an area and can reduce the amount of narcotic consumption, which in turn reduces opioid-related side effects like respiratory depression and nausea and vomiting. The lumbar plexus block (LPB) and the fascia iliaca block (FIB) are two blocks described to target the innervation of the hip- specifically the lateral femoral cutaneous nerve, the femoral nerve, and the obturator nerve.<sup>2,3</sup>

Studies have shown that the LPB and FIB, when compared in isolation to systemic analgesia, improve postoperative analgesia after hip arthroscopy.<sup>2,3</sup> However, there are no studies comparing these two regional anesthetics head-to-head. The FIB is a relatively easy block to perform with minimal adverse events and side effects. The LPB is also an effective method of providing postoperative analgesia. However, it is considered to be an advanced block, technically more demanding, and may be associated with potentially serious adverse effects. Which block is performed depends on the practitioners' preference/past training and the institution's culture.

## OBJECTIVE

This study aims to compare the analgesic efficacy between FIB and LPB after hip arthroscopy.

## METHODS

50 patients undergoing primary hip arthroscopic surgery were randomized to receive either a postoperative LPB or FIB if there was moderate to severe pain (>4/10 on the NRS or greater) on arrival to the post anesthesia care unit. Both blocks were performed using ultrasound and previously described techniques. After determination of an adequate block, a blinded research assistant assessed pain scores 15 minutes post block (primary outcome).

Secondary outcomes included change in PACU scores (before block pain score minus after block pain score), PACU opioid use, PACU length of stay, Quality of Recovery (QOR-9) and opioid use on Postoperative day 0 and 1.

## RESULTS

1. There was no significant difference in pain scores between the FIB and the LPB 15 minutes post block (FIB 4 [2-4], LPB 2.5 [0-4];  $P=0.2$ ).
2. Amongst our secondary endpoints there was no differences noted between the two regional anesthetic techniques except for change in pain score (comparing pre block pain to post block pain at 15 minutes) which noted a larger change in pain score for the lumbar plexus block (FIB 1 [0-2], LPB 2 [1-4];  $P=0.02$ )

## DISCUSSION

There was no difference in postoperative pain scores between the FIB and the LPB groups fifteen

minutes post block which was this trial’s primary outcome. Of note, there was a statistically significant difference between the two groups with the change in pain score (i.e. pre block pain score – post block pain score). The LPB had a greater decrease in pain scores post block (2 points) compared to FIB decrease in pain scores (1 point). However, a difference of only 1 point on the NRS is likely clinically insignificant. There were no other differences in secondary outcomes measured between the two blocks.

**CONCLUSION**

The FIB is noninferior to the LBP for postoperative pain after hip arthroscopy. The FIB is a safe and easy to perform block and can be considered a first line technique in providing analgesia following hip arthroscopic surgery.

**Table 1. Clinical Outcomes**

	Fascia Iliaca Block		Lumbar Plexus Block		P-value
	Average	Interquartile Range	Average	Interquartile Range	
Pain score fifteen minutes post block	4	2-4	2.5	0-4	0.2
Pre-block pain score	6	4-7	7	4-8	0.2
Change in pain score (pre block vs post block)	1	0-2	2	1-4	0.02
PACU Opioids - morphine milliequivalents (mg)	14	6-22	11	6-24	0.9
POD 0 -oxycodone milliequivalents (mg)	10	7.5-20	10	5-20	0.5
POD 1-oxycodone milliequivalents (mg)	20	13-32	19	11-32	0.7
Quality of Recovery-9	16	14-17	16	13-17	0.2
PACU Length of stay (min)	146	104-164	160	127-193	0.054

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# **Does Socioeconomic Status predict Anesthesia Type for Cesarean Sections?: A Retrospective Cohort Study**

**Benjamin Cobb MD**, Nathaniel Hsu MD, Richard Month MD, Meghan Lane-Fall MD  
MSHP Department of Anesthesiology and Critical Care, Perelman School of Medicine,  
University of Pennsylvania

## **Introduction:**

General anesthesia for Cesarean section (GACS) is often used as “back-up” anesthesia because GACS prevents a parturient’s participation in delivery and risks failed intubation. For this reason, neuraxial anesthesia for Cesarean section (NACS) is used primarily. Maternal comorbid factors have clearly been defined as risk factors for GACS, but maternal socioeconomic status (SES) has not.

## **Hypothesis/Objective:**

The aim of this research is to identify maternal markers of SES that are risk factors for GACS. We hypothesize that lower SES and minority patients are at an increased risk of receiving GACS compared to non-Hispanic white patients.

## **Methods:**

We performed a retrospective cohort study to evaluate if SES markers are associated with increased risk of GACS. We reviewed all Cesarean sections (CS) performed at our major university hospital between July 2013 and June 2016. SES markers extracted from health records included race/ethnicity, marital status, smoking status, and practice location for prenatal care. We excluded patients with multi-gestational pregnancy, intraoperative fetal demise, or missing exposure data. We used chi-square to compare exposure variables between GACS and NACS groups. We used logistic regression to generate odds ratios (OR) of each exposure variable in relation to GACS. p-value <0.05 was considered significant.

## **Results:**

Among a total of 3,417 CS included in our study, 9.1% (n=311) of patients had GACS and 90.9% (n=3,106) of patients had NACS. Race/ethnicity of the patients was as follows: Black (n=2,224; 65.1%), White (n=376; 19.8%), Asian (n=212; 6.2%), other (n=198; 5.8%), and Hispanic (n=102; 3.0%). We found no statistically significant associations between GACS use and age or ASA status. Using univariate logistic regression, the SES-related risk-factors for GACS were black race (OR=1.7, 95% CI 1.29- 2.2), smoking status (OR= 1.47, 95% CI 1.13-1.91), single marital status (OR= 1.68, 95% CI 1.28-2.20), low-income prenatal care practice (OR=1.61, 95% CI 1.24-2.09), and outside care network prenatal care (OR=2.23, 95% CI 1.48-3.27). After using multivariate logistic regression, only Black race (aOR=1.58, 95% CI 1.11-2.23) and current smoking status (aOR=1.53, 95% CI 1.17-1.99) remained statistically significant (p<0.05).

## **Discussion:**

This single-center study shows statistically significant associations between use of GACS and race/ethnicity and smoking, a marker of low SES. Limitations of this analysis include generalizability, residual unmeasured confounding related to maternal parity, anesthesiologist-related factors and obstetrician-related factors, and not excluding patients with multiple Cesarean sections within the study period.

## **Conclusion:**

Black race and current smoking status are associated with higher use of GACS. Further research is needed to understand how maternal socioeconomic status may influence anesthetic choice for Cesarean section.

## **References:**

None.

## **Pennsylvania State Core Competencies for Education on Opioids and Addiction**

**Ronnie Henry Zeidan, MD\***, Jeanmarie Perrone, MD, FACMT<sup>+</sup>, Rachel Levine, MD<sup>φ</sup>, Michael A. Ashburn, MD, MPH\*

\*Department of Anesthesiology and Critical Care, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, Pennsylvania;

<sup>+</sup> Department of Emergency Medicine, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, Pennsylvania

<sup>φ</sup> Physician General of the Commonwealth of Pennsylvania; Departments of Pediatrics and Psychiatry, Penn State College of Medicine, Hershey Pennsylvania

## **Introduction**

The use of opioids has become a mainstay therapy option for chronic pain despite the limited evidence available on their safety or efficacy in the general patient population. As the use of prescription opioids has increased over the last several years, prescription drug abuse has increased [1]. “The opioid epidemic” has made a tremendous negative impact on the public health of this country. The United States Center for Disease Control and Prevention reported that in 2014, 47,055 died from drug overdose and that 61% of these deaths (28,647) involved some type of opioid, including heroin [2].

## **Objective**

The objective of this project was to implement educational processes at the University of Pennsylvania Perelman School of Medicine that addressed the core competencies for education on opioids and addiction created by the Pennsylvania Physician General task force.

## **Methods**

The Pennsylvania Physician General created a task force consisting of representative of all the Pennsylvania allopathic and osteopathic medical schools, as well as representatives of selected state and federal governmental agencies. A literature review was completed, and a survey of graduating medical students was conducted. The task force then developed, reviewed, and approved core competencies. A comprehensive review of the medical school curriculum evaluating the education of opioids and addiction was completed to identify areas of opportunities to further develop curricula to satisfy the Pennsylvania Core Competencies.

## **Results**

Utilizing the core competencies as a guide, innovative curricula addressing opioids and addiction were

developed and adopted into the Perelman School of Medicine medical curriculum. Through the use of small group discussions, lectures, and standardized patients medical students gained knowledge regarding opioids and addiction by addressing potential gaps previously not covered as it pertains to the Pennsylvania Core Competencies.

## **Discussion**

It has been reported the US medical schools provide on average 11.1 hours of education on pain management during the duration of medical school [3]. Medical students have reported that pain is a topic of major concern early in their clinical experience and that a large majority of the medical students' interactions with patients with pain were viewed as negative [4].

Efforts such as the creation of core competencies for pain management [5] and the medical education collaborative effort based in Massachusetts [5] aim to improve physician and knowledge and attitudes. We hope that this education effort during medical school can be enhanced and reinforced through additional learning during residency training.

## **Conclusion**

Ultimately, the goal of this effort is to improve the lives of people we serve through improved pain therapy, proper opioid prescribing, effective screening of patients for substance use disorder, and proper referral for treatment of patients identified with substance use disorder. Our future goals for evaluating the efficacy of the education is to survey medical students who have matched at the Hospital of the University of Pennsylvania for their graduate medical education training to compare their knowledge and attitudes of opioids and addiction once they have completed a portion of their training.

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# Endothelial Glycocalyx Disruption in Pediatric Congenital Heart Disease: Effect of Fontan Physiology

**Susanna Shaw, MD;** Joshua Blinder, MD; Ariel Vincent, BS; William England, BA; Paula Hu, RN, MBAMD; Yoav Dori, MD; Francis X, McGowan, MD

Department of Anesthesia and Critical Care Medicine, Children's Hospital of Philadelphia

**Introduction:** The endothelial glycocalyx (EG), an acellular layer comprised of glycoproteins and carbohydrates on the luminal side of blood vessels, is a critical determinant of multiple aspects of vascular physiology including vascular smooth muscle tone, platelet and leukocyte interactions, and permeability. EG damage can be caused by excessive vascular distention, inflammatory mediators and reactive oxygen species. The consequences of EG damage include capillary leak, decreased endothelium-dependent vasodilation, impaired organ perfusion, and thrombosis. Many of these processes are major long-term complications of Fontan physiology (total cavopulmonary connection, resulting in a passive pulmonary blood flow circuit), which is the final stage of surgical palliation of hypoplastic left heart syndrome and other "single ventricle" lesions. Fontan patients frequently experience recurrent thrombotic events and have impaired regulation of vascular tone and end-organ dysfunction. The role of glycocalyx injury in these complications is unknown.

**Hypothesis/Objective:** We hypothesize that Fontan physiology causes progressive damage to and loss of the endothelial glycocalyx layer, and that this injury is an important cause of vascular dysfunction, end-organ damage, and thrombotic complications in Fontan patients.

**Methods:** This study is currently enrolling children age 3 to 18 years of age with Fontan physiology undergoing cardiac catheterization or other procedures that require general anesthesia and age-matched healthy children undergoing elective surgery. Study measurements include a) plasma concentrations of EG components and their breakdown products, specifically EG proteoglycan and glycosaminoglycan constituents, using liquid chromatography-mass spectrometry (LC-MS); and b) sublingual EG thickness, capillary density, and capillary perfusion using sidestream darkfield (SDF) imaging with automated image analysis and quantitation.

**Results:** Thus far (first month of enrollment), 3 Fontan and 3 healthy subjects have been studied (planned enrollment = 20 in each group). We expect to find that Fontan patients will have a) decreased glycocalyx thickness and perfusion (SDF imaging); b) an abnormal plasma EG breakdown product "signature"; and c) that the magnitude of these abnormalities will correlate with the duration and severity of indices of Fontan circulatory dysfunction.

**Discussion:** Pathophysiologic derangements in Fontan patients that can directly or indirectly lead to damage of the EG include chronically low cardiac output, elevated venous pressure, and systemic inflammation. Finding that there is EG damage in these patients is likely to be important for several reasons. First, several EG breakdown fragments are themselves pro-inflammatory and potentially cytotoxic. Second, "glycotherapeutics" are an emerging field of investigation and may have the potential to restore EG composition and function. Finally, SDF imaging could represent a non-invasive method to assess the severity of EG damage and therapeutic response in patients after the Fontan.

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## A Feasibility Pilot to Objectively Characterize the Perioperative Recovery of Elective Shoulder Arthroscopy Patients (PREP)

**Shahid Ali MD<sup>1\*</sup>, Sushmitha Diraviam<sup>2\*</sup>, Nabil Elkassabany, MD MSCE<sup>3\*</sup>, Lee Fleisher, MD FACC FAHA<sup>4\*</sup>**

Introduction: Survey instruments have been developed and validated to monitor the perioperative period and to detect common postoperative complications but suffer from several limitations. Many surveys are only used to facilitate PACU discharge and are not routinely administered in the post-discharge period except in research settings, suffer from bias, are cumbersome to administer, and have poor completion rates due to fatigue. Furthermore, they only capture temporal snapshots of the patient and miss the continuous evolution of patient recovery.

Hypothesis: We hypothesize that objective continuous assessment using wearable technology, specifically Fitbit Charge HR™ (Fitbit), can serve as a scalable supplement to current methods for assessing perioperative recovery while circumventing gold standard survey limitations. Additionally, we hypothesize that wearables can provide important in-time trends to postoperative recovery that can be used to directly impact patients' return of function without requiring extensive resources for monitoring.

Methods: To test the feasibility of the Fitbit in assessing postoperative recovery, we identified shoulder arthroscopy patients to be an optimal surgical population to study based upon their relatively short recovery period, suspected wide ranges in pain scores over small time intervals, and periods of extended sleep disturbance. Each subject was administered a set of gold standard surveys 2-5 days prior to surgery and provided a Fitbit. Anesthesia record was used to obtain intraoperative details such as type of anesthetic, analgesics and anxiolytics. Table 1 outlines the surveys administered preoperatively, and on POD1,2,3 and postop clinic visit by phone calls or self-administered based on patient preference. Survey results were compared to Fitbit metrics.

Results: We tested the utility of the Fitbit for assessing postoperative recovery by comparing its activity and sleep metrics with related gold standard survey items and attempted to create quantitative postoperative summaries for study subjects. Figure 1 illustrates the relationship between Fitbit Activity (step count), Fitbit heart rate, Pain Scores (NRS based Pain Diary), and QOR15 Sleep and Rest component scores for one participant. Over the postoperative recovery, heart rate trends down, consistent with decreasing pain scores after the immediate postoperative period. Fitbit step count weighted against preop step count drops initially postoperatively and begins to trend up. Figure 2 illustrates the relationship between Fitbit sleep metrics (cumulative sleep and interruptions in sleep) with survey reported sleep and QOR15 rest and sleep components. There is an expected drop in QOR15 component scores and Reported sleep postop followed by a rise and return to preop values. Fitbit measured sleep demonstrates similar trends with notable exception on night of surgery during which there is increase in reported sleep interruptions from the device likely due to improper wearing of Fitbit.

Discussion: Results combining trends across the subject population require further enrollment to demonstrate trends due to significant gaps in the collected data limiting analysis. Furthermore, in comparison to automatically gathered, easily accessible Fitbit metrics, survey data is challenging to obtain because it requires extensive coordination with patient schedule, utilizes often unreliable telecommunication infrastructure, and requires manual data collection, prone to errors. In conclusion, wearables may play a useful role in monitoring patients postoperatively.

<sup>1</sup> PGY4 Anesthesia Resident Physician

<sup>2</sup> Research Assistant

<sup>3</sup> Director, Section of Orthopedic Anesthesiology

<sup>4</sup> Robert D. Driggs Professor & Chair of Anesthesiology and Critical Care

\* Department of Anesthesia Critical Care, University of Pennsylvania Hospital System

Table 1: Study Protocol

Study Phase	Screening	Study Phase					
		0	1	2	3	4	5
<b>Visit Number</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
<b>Postoperative Day</b>		<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>6</b>	
Informed Consent/Assent	X						
Review Inclusion/Exclusion Criteria	X						
Demographics/Medical History/Medications	X						
CESD	X						
PSQI	X						
QOR15	X			X	X	X	X
Simple Shoulder Test	X						
Delivery and setup of device		X					
Intra-op Data collection			X				
Sleep Survey				X	X	X	X
Pain Diary				X	X	X	X
Compensation/return device							X
Exit Interview							X

Figure 1: Subject 08 Fitbit Activity vs. Fitbit Heart Rate vs. Numeric Pain Rating Scale vs. QOR15 Components

SU08 Fitbit Activity and HR vs. NRS vs. QOR15

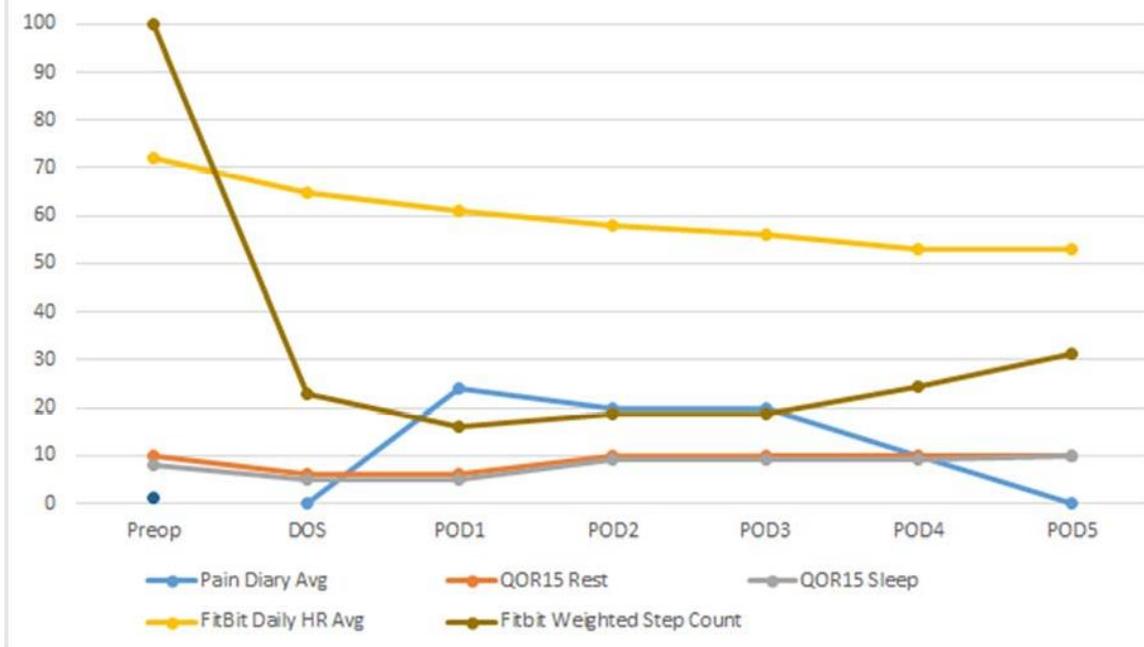
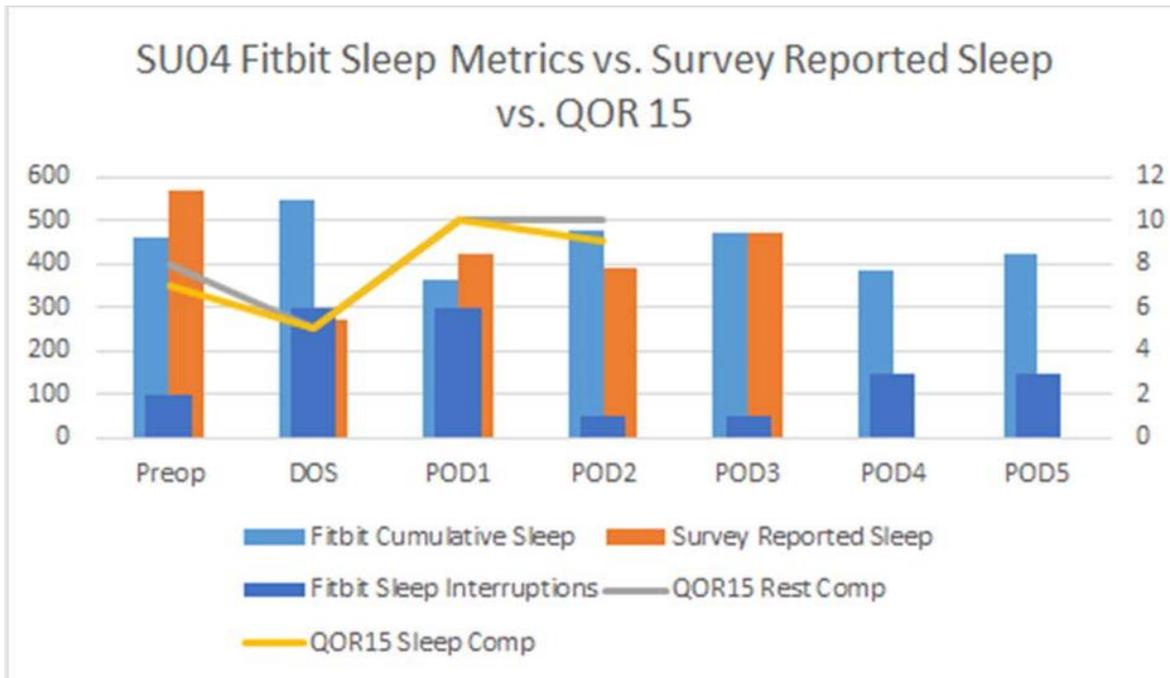


Figure 2: Subject 04 Fitbit Sleep Metrics vs. Survey Reported Sleep vs. QOR15 Components



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# Can sublingual microcirculation predict microvascular and tissue responsiveness to usual resuscitation in a porcine model of sepsis?

Rachel Pool<sup>1</sup>; Håkon Haugaa<sup>2</sup>; Ana Maria Botero<sup>3</sup>; Daniel Escobar<sup>4</sup>; Donald R Maberry<sup>1</sup>; Tor I Tønnessen<sup>2</sup>; Brian Zuckerbraun<sup>1</sup>; Michael R Pinsky<sup>1</sup>; Hernando Gomez<sup>1</sup>

<sup>1</sup> University of Pittsburgh, Anesthesiology, Pittsburgh, United States, <sup>2</sup> Oslo University Hospital, Emergencies and Critical Care, Oslo, Norway,

<sup>3</sup> Staten Island University Hospital, Obstetrics and Gynecology, New York, United States, <sup>4</sup> Bronx-Lebanon Hospital, Obstetrics and Gynecology, New York, United States

## Introduction:

Common clinical markers of sepsis severity and treatment efficacy have been called into question, including CVP, systemic lactate, MAP, mixed venous oxygen saturation, and veno-arterial carbon dioxide difference.<sup>1-7</sup> Additionally, the general practice of high volume intravenous fluid bolus with early resuscitation has been questioned regarding increased mortality risk.<sup>8-10</sup> Focus has shifted from systemic circulatory parameters to the microcirculation, with the goal of directly addressing the foci of sepsis pathophysiology.<sup>11</sup>

## Hypothesis/Objective:

We hypothesized that sublingual (SL) microcirculatory parameters 1. Can predict microvascular response to resuscitation during sepsis; and 2. Are associated with tissue level lactate, lactate/pyruvate ratio (L/P) and tissue to blood lactate gradient (T-BLac).

## Methods:

Lipopolysaccharide (LPS) was administered to 23 anesthetized Yorkshire-Durock pigs for 45 minutes. Thirteen animals received late (90 min after LPS) and 10 early (immediately after LPS) resuscitation. Five animals per group had available data for this opportunistic study. Sublingual microcirculatory parameters (microvascular flow index (MFI) and perfused vessel density (PVD)) were collected. Tissue level lactate and pyruvate were measured using microdialysis catheters inserted in the liver, kidney and tongue at baseline and pre-/post-resuscitation (Pre-R, Post-R). Resuscitation was driven by MAP and SvO<sub>2</sub> targets, with SVV for fluid responsiveness. Data are shown in median (interquartile range).

## Results:

Pre-R MFI correlated with Post-R MFI ( $r^2=0.562$ ,  $p=0.008$ ). Microvascular 'responsive' animals (i.e. increase in MFI>50% or any increase in PVD) had lower Pre-R MFI and PVD (Fig 1). The presence of Pre-R systemic hyperlactatemia did not predict microvascular fluid responsiveness ( $p=0.05$ ) as defined by an increase MFI>50% (Fig 2). A higher Pre-R MFI (>2.5) was associated with lower SLT-BLac (-0.42 (0.74) vs. 3.49 (0.34),  $p=0.008$ ) (Fig 3). An increased Post-R T-BLac was associated with a lower Pre-R MFI in the kidney ( $p=0.06$ ) (Fig 4). Post-R PVD was associated with Post-R L/P in the liver ( $p=0.04$ ) (Fig 5).

## Discussion:

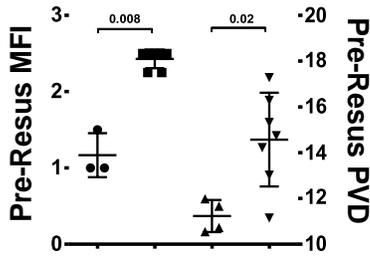
Pre-resuscitation MFI and PVD were associated with post-resuscitation microvascular changes, but not pre-resuscitation systemic lactate levels. Pre- and post-resuscitation sublingual MFI and PVD were associated with local metabolic changes in the tongue as well as in the kidney and the liver.

## Conclusion:

Pre-resuscitation MFI and PVD may predict post-resuscitation microvascular responsiveness.

**Figures:**

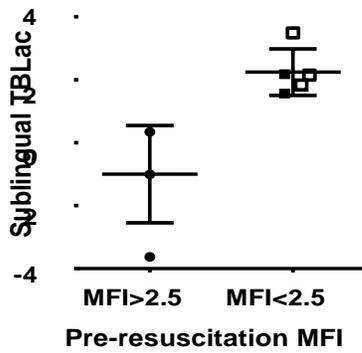
1-



Changes in microvascular parameters post-resuscitation

MFI > 50%  
MFI < 50%  
PVD up  
PVD down

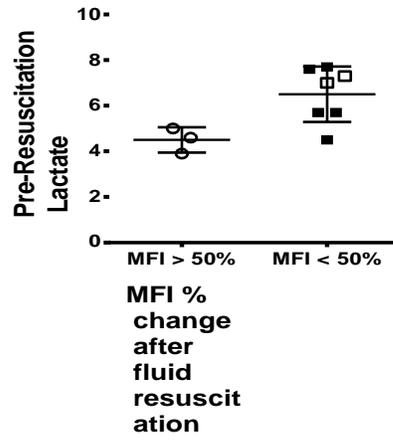
3-



Pre-resuscitation MFI

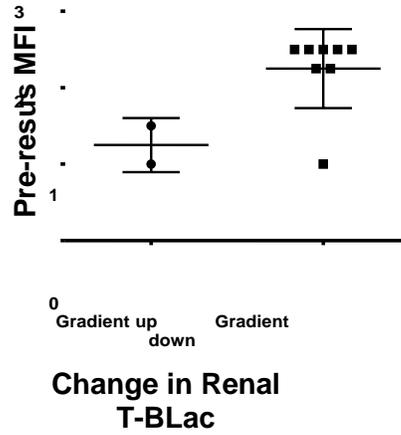
5-

2-

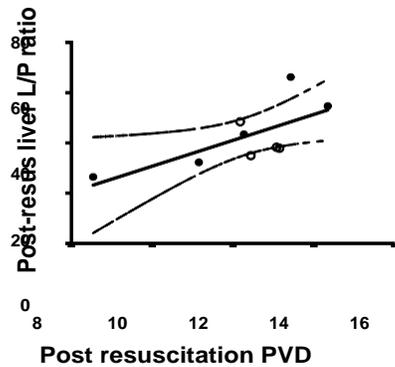


MFI % change after fluid resuscitation

4-



Change in Renal T-BLac



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## Teaching Residents to Perform Ultrasound-Guided Cricothyroidotomy on Porcine Trachea: A Novel

### Training Modality

Daniel Mandell MD, David Nelson MD MBA, Steven Orebaugh MD

University of Pittsburgh Medical Center, Department of Anesthesiology

**Introduction:** Cricothyroidotomy is a risky but potentially life-saving procedure. Adjunctive use of ultrasonography may increase safety and procedural success. Because cricothyroidotomy is rarely encountered in a clinical setting, anesthesiology residents have limited exposure to learning this procedure. We propose a novel training model utilizing both porcine cadaveric trachea and ultrasonography.

**Hypothesis:** Residents will find our novel training model to be both realistic and valuable.

**Methods:** Ten anesthesiology residents (post-graduate year three) were chosen for the study. Residents first underwent a brief didactic about procedural steps of cricothyroidotomy and performing ultrasound-guided airway examination. Next, our tracheal model was constructed by pinning a layer of chicken skin over the porcine larynx. Residents performed a percutaneous cricothyroidotomy on the trachea model. After successful completion of the first percutaneous technique, bacon fat was added between the chicken skin and larynx. This was done in order to simulate a difficult airway with poor landmarks. Residents used ultrasonography to identify the cricothyroid membrane, and then performed an open cricothyroidotomy technique. A post-session survey was given to assess resident impression of the training.

**Results:** All residents were able to palpate the cricothyroid membrane on the “easy” model, as well as identify the cricothyroid membrane by ultrasound on the “difficult” model. All residents were able to perform cricothyroidotomy using both techniques. Results from the post-session survey indicated that residents found the training session to be useful (Table 1).

**Conclusions:** We present a novel method of teaching anesthesia residents how to perform ultrasound-assisted airway exam and cricothyroidotomy. Anesthesia residents found this method to be invaluable to their training.

Table 1: Post-session survey results

	Mean score
The exercise introduced new information to me about emergency cricothyroidotomy	4.75
The exercise provided important hands-on experience that cannot be replicated with plastic mannequins	4.88
The exercise taught me to utilize ultrasound to locate the laryngeal cartilages and the cricothyroid membrane	4.63
The exercise improved my overall confidence in locating the cricothyroid membrane	4.88
The exercise augmented my skills in exposing and incising/entering the cricothyroid membrane.	4.88
The exercise augmented my skills at placing a tracheal tube into the airway during cricothyroidotomy	4.63

Table 1: Post-session survey given to 10 residents. Residents gave each question a numeric score from 1-5, with “1 – strongly disagree” and “5 – strongly agree.” Left column shows mean score of responses among 10 residents.

**Title:** Analysis of PACU Times Following ACL Surgery for Various Nerve Block Techniques

**Authors:** Andrew R Hulme MD, Michael L Kentor MD, Steven Lorebaugh MD Department of Anesthesiology, University of Pittsburgh School of Medicine

**Introduction:** Patients undergoing anterior cruciate ligament (ACL) surgery have varying levels of pain and nausea in the PACU. Patients with less pain/nausea leave the PACU and are discharged home more quickly, which is a desirable outcome for both the patient and hospital. One factor influencing the amount of pain/nausea following ACL surgery is the choice of preoperative nerve block.

**Objective:** Our goal was to investigate the effect of choice for regional anesthesia on PACU time following ACL surgery. Four nerve block groups were studied as follows: none, adductor canal (AC), femoral (Fem), femoral plus sciatic (FS). Secondary outcomes included opioid doses, nausea, PACU pain scores, time to discharge home.

**Methods:** After obtaining IRB approval, we performed a retrospective chart review of all ACL surgeries at the UPMC Southside Outpatient Center from 2012 – 2017. Relevant exclusion criteria included secondary procedure (ex: meniscus repair) and age < 18. We gathered data from each of the most recent surgeries, until the goal number of cases per each nerve block group was met. For the AC group, only 17 cases total were available considering all exclusion criteria. Opioid doses were converted to IV morphine equivalents. Transfer time to Phase 2 recovery was used as PACU stop time, and the last timestamp in nursing documentation was used for discharge home time. Administration of post-op anti-emetics was used as a surrogate for PONV.

**Results:** The demographic data concerning patients was not significantly different among groups. However, surgery duration and surgeon did vary significantly ( $P < 0.001$ ) between the nerve block groups. Using an ANOVA test, choice of nerve block did have an effect on PACU duration ( $P = 0.012$ ).

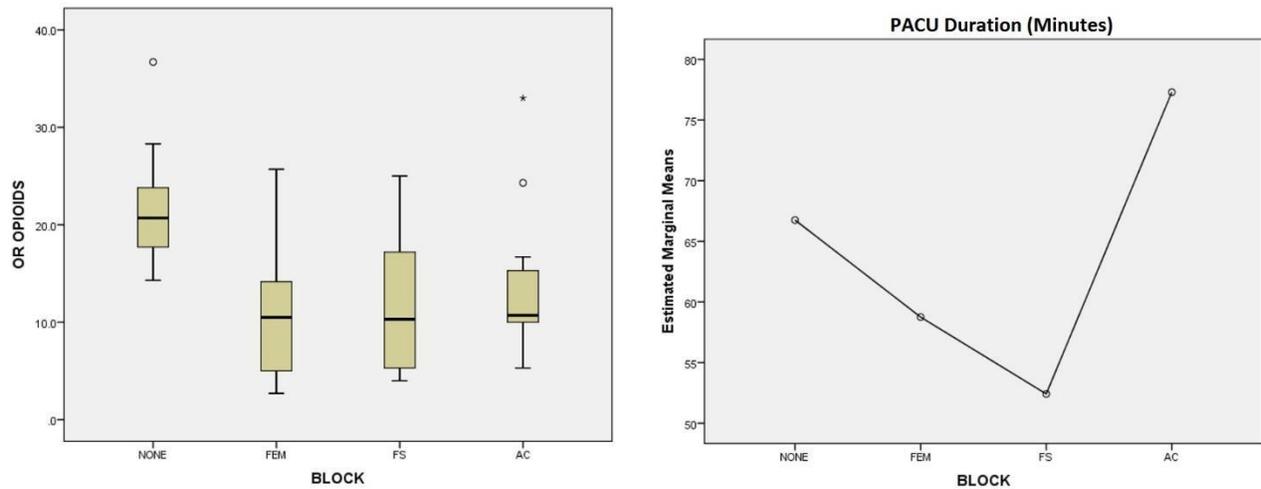
However, when analyzing comparisons among groups on PACU time, the only significant comparison was FS vs AC with AC being longer. Pertinent secondary outcomes showed a significantly higher dose of intraop opioids for the 'none' group compared to all other groups. Nausea and non-opioid mediations were not a significant factor. Initial PACU pain was significant, but when compared, only significant between FS and AC, with AC having more pain. Final PACU pain was comparable among all groups.

**Discussions:** Patients without a nerve block received more intraop opioids than those with a nerve block. However, pain scores were eventually made equivalent with opioid use, as the final PACU pain scores were comparable among all groups. Interestingly, the AC group appeared to have higher initial PACU pain scores and longer PACU stays. This may indicate that the AC block did not help pain as much as FS or FEM, and may have hindered by reducing OR opioids, since the patient was perceived to have a block. Our main limitation by this study is the correlation between type of nerve block and surgeon.

Surgeon preferences occasionally dictate the type of nerve block used, to the point where it may be unclear if we are studying PACU times based on differences in nerve block or differences between surgeons. Other limitations included the availability of information extracted from the electronic medical record, the sample size for the AC group, and theoretic delay in PACU discharge based on transport personnel instead of patient symptoms.

**Conclusions:** Use of extra opioids appeared to mitigate any effect on PACU duration, however the best mix of pain control and minimizing opioids seemed to occur with the FS block. Given the limitations of surgical preference for block type, further study is likely warranted.

**Figures/Tables:**



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## Predictors of Unexpected Post-operative Intensive Care Unit Admission: A Retrospective Study

**Joshua B Knight MD, Evan E Lebovitz MD, Ibtesam A Hilmi MB CHB, Theresa A Gelzinis MD**

Department of Anesthesiology, University of Pittsburgh Medical Center (UPMC), Pittsburgh PA

**Introduction:** Postoperative admission to an intensive care unit (ICU) is standard for patients undergoing certain highly invasive surgeries such as coronary artery bypass grafting, or patients with significant medical comorbidities such as severe congestive heart failure. For most patients, however, immediate post-op ICU admission is unnecessary as it is expensive, utilizes major resources, and is associated with worse overall outcomes(1,2). Nevertheless, certain factors or events can change a patient's post-operative disposition from the post-anesthesia care unit (PACU) to an ICU. Indicators in neurosurgical(3), thoracic(4), and vascular(5) surgery populations have been well-studied. Few studies, however, have examined determinants of ICU admission across many surgical subtypes.

**Objective:** To determine which pre-operative patient characteristics contribute significantly to unexpected post-operative ICU admissions in a large university hospital system.

**Methods:** UPMC electronic medical record data between 2011-2015 were analyzed. Using anesthesiology quality improvement (QI) databases, a list of surgeries resulting in unexpected ICU admissions was compiled. This list was used to filter system-wide ICD-9 data for patients experiencing one of these surgeries plus an ICU admission. Patients with cardiac/trauma/transplant surgeries and an ICU room acquisition time outside the intraoperative period were excluded. A corresponding patient group undergoing the same surgeries without an ICU admission was obtained. Demographics, presence of key comorbidities, length of stay, and in-hospital mortality data were collected for both groups.

Propensity score matching was performed to minimize differences between the ICU and non-ICU groups; outcomes of ICU admission and in-hospital mortality were determined using multivariate regression analyses.

**Results:** We identified 125 unexpected ICU admissions in the QI databases. In the system-wide records 18,464 patients underwent one of these surgeries plus a concurrent ICU admission. After excluding cardiac/trauma/transplant surgeries, 1,192 (6.4%) patients had an intraoperative disposition change to an ICU. There were 28,498 patients that underwent the same surgeries that did not have an ICU admission. Propensity score matching resulted in an ICU and non-ICU group each with 1,191 patients (Table 1). Patients with congestive heart failure (CHF), acute or chronic kidney injury, peripheral vascular disease (PVD), and heart valve disease were all associated with increased unexpected ICU admission (Table 2). Acute/chronic kidney injury and history of stroke (CVA) were associated with increased mortality in all patients (Table 3), with CVA also associated with increased mortality specifically in the ICU population (Table 4).

**Discussion:** This is the first study to our knowledge to utilize a large data set to identify patient-related factors pertaining to unplanned ICU admissions across many surgery specialties in an academic center. Age and gender had no effects on admission or mortality. Certain factors had unexplained protective effects, such as insulin-dependent diabetes on admission or PVD on ICU mortality. Knowledge of interplay with intraoperative factors such as blood loss, not in the scope of the database, would assist in the application of these results.

**Conclusion:** CHF, acute/chronic kidney injury, PVD, and valve disease are significantly associated with increased unexpected ICU admission, with stroke increasing mortality in those admitted.

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Figures and Legends:

Variable	Total n=238		No n=119		ICU n=119		SMD
	n	%	n	%	n	%	
Age, mean (SD)	60	16.7	59.6	16.6	60.8	16.9	<b>0.05</b>
ICU LOS (mean, SD)	1.9	4.2			1.9	4.2	<b>0.05</b>
Total LOS (mean, SD)	6	12.2	4	5.5	10.2	14.9	<b>0.87</b>
Mortality	158	6.6	29	2.4	129	10.8	<b>0.34</b>
LOS 10 DAYS	742	31.2	135	11.3	607	51.0	<b>0.95</b>
Age >70 years	589	24.7	276	23.2	313	26.3	<b>0.07</b>
Gender, Male	1402	58.9	709	59.5	693	58.2	<b>0.14</b>
CAD	435	18.3	197	16.5	238	20.0	<b>0.09</b>
History of MI	216	9.1	88	7.4	128	10.7	<b>0.12</b>
CHF	252	10.6	75	6.3	177	14.9	<b>0.28</b>
Valvular disease	159	6.7	45	3.8	114	9.6	<b>0.23</b>

<b>Pulmonary Hypertension</b>	2	0.1	0	0.0	2	0.2	<b>0.06</b>
<b>Peripheral Vascular</b>	186	7.8	71	6.0	115	9.7	<b>0.14</b>
<b>COPD/Asthma</b>	302	12.7	138	11.6	164	13.8	<b>0.07</b>
<b>History of CVA</b>	39	1.6	14	1.2	25	2.1	<b>0.07</b>
<b>Acute or Chronic Kidney</b>	448	18.8	145	12.2	303	25.4	<b>0.34</b>
<b>İDDM</b>	498	20.9	250	21.0	248	20.8	<b>0.00</b>
<b>ESLD</b>	119	5.0	46	3.9	73	6.1	<b>0.10</b>
<b>Anemia</b>	67	2.8	36	3.0	31	2.6	<b>0.03</b>

Table 1: Results of Propensity Score Matching and Demographic Characteristics of Unexpected ICU Admissions and non-ICU Patients. LOS = length of stay, CAD = coronary artery disease, MI = myocardial infarction, CHF = congestive heart failure, COPD = chronic obstructive pulmonary disease, CVA = cerebrovascular accident, İDDM = insulin dependent diabetes, ESLD = end-stage liver disease.

<b>Predictors of ICU Admission</b>								
<b>Parameter</b>	<b>D</b>	<b>Estimat</b>	<b>Error</b>	<b>χ<sup>2</sup></b>	<b>Parameter&gt;χ</b>	<b>Odds</b>	<b>Lower</b>	<b>Upper</b>
						<b>Ratio</b>	<b>Limit</b>	<b>Limit</b>
<b>Intercept</b>	1	-0.1505	0.1542	0.9527	0.329			
<b>Age</b>	1	-0.00183	0.0026	0.495	0.4817	0.99	0.99	1.00
<b>Male Gender</b>	1	0.0805	0.0855	0.887	0.3463	1.08	0.91	1.28
<b>CHF</b>	1	0.586	0.1602	13.386	0.0003	1.79	1.31	2.45
<b>Acute or Chronic</b>	1	0.7884	0.1158	46.374	0.0001	2.2	1.75	2.76
<b>İDDM</b>	1	-0.2182	0.1078	4.0993	0.0429	0.80	0.65	0.99
<b>PVD</b>	1	0.3403	0.1652	4.2424	0.0394	1.40	1.01	1.94
<b>Valvular</b>	1	0.6639	0.1951	11.581	0.0007	1.94	1.32	2.84

Table 2: Predictors of Unexpected ICU Admission. Only significant values displayed. PVD = peripheral vascular disease.

In-Hospital Mortality, All Patients								
Parameter	DF	Estimat	Error	$\chi^2$	Parameter>> $\chi$	Odds	Lower	Upper
Intercept	1	-3.022	0.3161	91.384	0.0001			
Age	1	0.00474	0.00508	0.8689	0.3513	1.005	0.995	1.015
Male	1	-0.0961	0.17	0.3196	0.5718	0.908	0.651	1.267
Acute or Chronic Kidney	1	0.4844	0.1887	6.592	0.0102	1.623	1.121	2.35
CVA	1	1.11	0.4273	6.7467	0.0094	3.034	1.313	7.012

Table 3: Predictors of In-Hospital Mortality, All Patients.

In-Hospital Mortality, ICU Patients								
Parameter	D	Estimat	Error	$\chi^2$	Parameter>>	Odds	Lower	Upper
Intercept	1	-2.3115	0.3527	42.9416	0.0001			
Age	1	0.00608	0.0057	1.1302	0.2877	1.00	0.99	1.01
Male	1	-0.2953	0.195	2.2929	0.13	0.74	0.50	1.09
CVA	1	1.1467	0.4886	5.5088	0.0189	3.14	1.20	8.20
PVD	1	-1.0069	0.4403	5.2302	0.0222	0.36	0.15	0.86

Table 4: Predictors of In-Hospital Mortality, Unexpected ICU Admissions.

## Cerebral Vascular Thrombospondin-1 Associates with the Epsilon 4 Allele of Apolipoprotein E in Alzheimer's Disease

<sup>1</sup>Jessica Cassavaugh, MD, PhD, <sup>2</sup>Caitlin A. Czajka, PhD, <sup>2</sup>Grace Lee, <sup>3</sup>Caterina Rosano, MD, <sup>4</sup>Julie Kofler, MD, <sup>5</sup>Eric McDade, OD, <sup>2</sup>Jeffrey S. Isenberg, MD, MPH

<sup>1</sup>Department of Anesthesiology, <sup>2</sup>Heart, Lung, Blood and Vascular Medicine Institute, <sup>3</sup>Graduate School of Public Health, <sup>4</sup>Department of Pathology, University of Pittsburgh School of Medicine, Pittsburgh PA, <sup>5</sup>Department of Neurology, Washington University School of Medicine, St. Louis, MO

**Background:** Alzheimer Disease (AD) is a global epidemic expected to affect over eight million people in the United States by 2030<sup>1</sup>. Inhaled anesthetics have been shown to increase beta ( $\beta$ )- amyloid in pre-clinical models<sup>2</sup>.  $\beta$ -amyloid deposition within cerebral blood vessels, termed cerebral amyloid angiopathy (CAA), is found in up to 80% of patients with AD, and alters vascular integrity promoting micro- and intralobar-hemorrhage and stroke<sup>3</sup>. The matricellular protein thrombospondin-1 (TSP1) is a dominant inhibitor of the pleiotropic effects of vascular nitric oxide (NO) and has been linked to aging vasculopathy in animals and people<sup>4</sup>.

**Hypothesis:** TSP1 is induced in AD-associated cerebral amyloid angiopathy.

**Methods:** Quantification within cerebral vessels of immunofluorescent TSP1, as well as CCA and markers of reactive nitrogen and oxygen species (RNS and ROS) was performed in post- mortem brain tissue sections from a cohort 24 individuals with clinically document advanced AD and further assessed in relation to expression of epsilon alleles 3 and 4 of apolipoprotein E (ApoE3 and 4). Samples were histologically graded for the severity of CAA.

**Results:** Immuno-reactive  $\beta$ -amyloid and TSP1 were significantly elevated in sections from individuals with the ApoE4 allele (ApoE3/4) when compared to individuals with only ApoE3 alleles (ApoE3/3). Additionally, vascular TSP1 expression was significantly decreased in women greater than 80 years old compared to women over 80. Conversely, vascular TSP1 expression was stable in cerebral vessels from elderly men suggesting an age-dependent sex association.

Markers of ROS and RNS were significantly elevated in cerebral vessels with severe CAA compared to mild CAA burden, but were not altered as a function of ApoE allele expression. **Discussion/Conclusions:** These results for the first time demonstrate (1) a strong association in cerebral vessels of AD patients between anti-angiogenic TSP1 and the clinically more severe ApoE4 allele and (2) an association between vascular ROS and RNS with severe CAA burden. Future directions include examining the possible relationship between CAA and inhaled anesthetics with post-operative microhemorrhage and cognitive decline.

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**Title:** Isoflurane Effects on Pro-Inflammatory Interleukin-23 Activity in Mice

**Authors:** Lindsay M. Stollings\*, M.D., Li-Jie Jia\*, M.D., Ph.D., Pei Tang, Ph.D., Huanyu Dou, M.D., Bin Feng Lu, Ph.D., Yan Xu, Ph.D.

\* These authors contribute equally as co-first authors

**Institution:** Department of Anesthesiology, University of Pittsburgh School of Medicine, Pittsburgh, PA

## Introduction

Although perioperative stress pre-exposes patients to immune vulnerability, general anesthetics also modulate the immune system.<sup>1</sup> Whether exposure to anesthetics causes an elevated sensitivity to inflammation is an important clinical question, especially considering the recent implications linking volatile anesthetic exposure to the early onset of certain neurodegenerative diseases, which are possibly associated with neuroinflammation. In this study, we focus on isoflurane's modulation of IL-23, a key pro-inflammatory cytokine essential for both acute and chronic inflammation.

## Hypothesis

Isoflurane modulates IL-23, a pro-inflammatory cytokine involved in acute and chronic inflammatory pathways.

## Methods

The bone-marrow-derived dendritic cells (BMDCs) were exposed to 1.5% isoflurane for 4 h with or without lipopolysaccharide (LPS) challenge. The gene expression of inflammatory cytokines was quantified by quantitative reverse transcription PCR. The effects of isoflurane on the LPS-induced signaling pathways were also analyzed using Western blot. In parallel *in vivo* experiments, the levels of inflammatory cytokines and downstream signaling in the spleen and lung were quantified in CD1 mice treated with 1.5% isoflurane for 4 h with and without LPS. Analysis of variance followed by Fisher's least-significant difference post hoc test was performed to determine the effects of isoflurane. A  $p < 0.05$  was considered statistically significant.

## Results

As expected, 0.1 and 1 ng/ml LPS enhanced IL-23 mRNA level in BMDCs. Isoflurane further increased IL-23 mRNA expression ( $p < 0.001$ ). Even in the absence of LPS, isoflurane exposure increased the IL-23 mRNA level by twofold. Isoflurane increased levels of phosphorylated p38 (p-p38) regardless of LPS treatment. In contrast, levels of p-ERK, p-JNK, IRF3, p-IRF3, I $\kappa$ B, or p-I $\kappa$ B were not affected by isoflurane. Pretreating BMDCs with 5  $\mu$ M SB203580, a specific p-p38 inhibitor, abolished LPS- and isoflurane-induced IL-23 mRNA, suggesting that the isoflurane-induced enhancement of IL-23 expression is dependent on p-38 MAP kinase. Consistent with *ex vivo* results, *in vivo* measurements showed that isoflurane administration increased levels of IL-23 mRNA and p-p38 in splenic tissue.

## Discussion

This study shows that isoflurane has the ability to modulate the function of a critical immune cell, the dendritic cell, *in vitro*. Furthermore, *in vivo* study confirmed that isoflurane exposure increases the expression of the pro-inflammatory cytokine, IL-23. Finally, this increased expression is likely to be a result of p38 MAPK cell signaling, which was demonstrated both *in vitro* and *in vivo*. Further work with other volatile agents and further mechanistic investigation to better understand the pathways through

which these agents operate is necessary.

## **Conclusion**

A clinically relevant dose of isoflurane modulates the function of dendritic cells by increasing the expression of the pro-inflammatory cytokine IL-23, likely through p38 MAPK activation. Similar elevation of splenic IL-23 mRNA and p-p38 protein expression in isoflurane-anesthetized animals suggested the possibility of adverse immune modulation by isoflurane. Further clinical investigations are warranted to determine whether an isoflurane-induced increase in IL-23 expression occurs in humans and, if so, what impact this might have on the short- and long-term outcomes of surgical patients.

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**Title:** Teaching anatomy to preclinical medical students utilizing regional anesthesia instruction: A pilot study.

**Authors:** Hubbard, Richard, MD; Michaelsen, Kaarin, MD, PhD; Ondecko Ligda, Kristin, MD; Orebaugh, Steven, MD.

**Department & Institution:** Anesthesiology, University of Pittsburgh Medical Center

**Introduction:** For centuries, anatomical education of medical students emphasized dissection of cadavers, supplemented with didactic lectures; however new interactive and 3-dimensional learning tools have begun to change this paradigm.<sup>1-3</sup> Concurrently, clinically-relevant learning has become a major emphasis in undergraduate in medical education<sup>4</sup>. Extant research on medical student instruction in regional anesthesia remains extremely sparse, and, to date, no work has yet been published correlating anatomic knowledge in pre-clinical medical students with regional anesthesia education.

**Hypothesis/Goals:** This study seeks to determine if multimodal instruction in regional anesthesia results in improved knowledge neck and axillary anatomy pre-clinical medical students. It was hypothesized that using clinically-relevant, multimodal anatomy training as part of a designated regional anesthesia course would demonstrate improved understanding of relevant anatomic structures, as assessed on written exams.

**Methods:** Pre-clinical medical students who voluntarily enrolled in a regional anesthesia course were included in the study. The class met for 90 minute sessions weekly for one month. Each session included a brief lecture, followed by interactive modules including: gross anatomic review with ultrasound image correlations, 3-D anatomical review of the neck and axilla, training in ultrasound probe and needle manipulation, and ultrasound scanning on live models. Participants were given an identical 12-question multiple choice exam on gross and ultrasound anatomy before and after the course (Table 1). A paired, two-tail T-Test was used to compare scores. A survey on student perceptions of the course was also completed, utilizing a five-level Likert scale.

**Results:** 14 students completed the course. Average scores improved from 6.21 to 9.14 correct answers when comparing the pre and post-course samples ( $p < 0.001$ , 95% CI 1.52-4.33). 85.7% of respondents reported that the course met their expectations to a "considerable" or "very high" degree, and 100% assessed the course as "good" or "outstanding." A significant difference was found in Likert scores for hands-on learning sessions (mean 4.85/5) versus instructional teaching sessions (mean 4.15/5,  $p < 0.001$ , unpaired two sample T-Test, Figure 1).

**Discussion/Conclusion:** As medical education evolves, methods of making anatomy both clinically-relevant and interactive have been sought. This study suggests that combining instruction in regional anesthesia with the teaching of anatomy will improve anatomic knowledge, as demonstrated on written exams. Further, participants' subjective experiences of the course was strongly positive, in particular those portions which involved hands-on learning.

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## Tables:

Table 1: Structures tested on pre-course and post-course tests

Structures Tested
<b>Gross Anatomy: Neck</b>
Anterior Scalene
C5-C6/Brachial Plexus
Subclavian Artery
<b>Gross Anatomy: Axilla</b>
Axillary Artery
Median Nerve
Pectoralis Major Muscle
<b>Ultrasound: Interscalene</b>
Anterior Scalene Muscle
Brachial Plexus
<b>Ultrasound: Supraclavicular</b>
Brachial Plexus
Subclavian Artery
<b>Ultrasound: Axilla</b>
Axillary Artery
Median Nerve

Figure 1: Likert score variation based on “hands-on” vs “instructional” learning



0 1 2 3 4 5

Likert Score\*

\* 5=Outstanding,4=Good,3=Satisfactory,2=Fair,1=Poor

# ADHERENCE TO SURGICAL ANTIMICROBIAL PROPHYLAXIS AND SURGICAL SITE INFECTIONS

**Authors:** Kyle Barden, MD, Jansie Prozesky, MB, ChB, Kunal Karamchandani, MD

**Department and Institution:** Department of Anesthesiology and Perioperative Medicine, Penn State Hershey Medical Center

**Introduction:** Surgical site infections (SSIs) are a major perioperative complication and add markedly to the cost of health care.<sup>1-2</sup> Prevention of SSI has been part of the Surgical Infection Prevention Project (SCIP) instituted by the Centers for Medicare and Medicaid (CMS) and administration of perioperative prophylactic antibiotics has been one of the important measures of SCIP. Guidelines have been set forth for surgical antimicrobial prophylaxis; however it is unclear if these guidelines are truly being adhered to in order to prevent SSI's. We sought to determine whether patients who developed SSIs during 30 days after a surgical procedure, had received appropriate surgical antimicrobial prophylaxis based on the prescribed guidelines.

**Methods:** A retrospective chart review of patients who developed SSIs over a course of two years at a tertiary care academic medical center was conducted, to assess whether the surgical antibiotic prophylaxis matched the guidelines recommendations. Data analyzed included: appropriate choice of antibiotic, administration of correct dose, whether the antibiotic administration was done within one hour of the surgical incision and redosing of antibiotics if applicable.

**Results:** A total of 284 SSIs were identified. Use of antibiotics was 'check marked' in the electronic medical record in all patients. Appropriate type of antibiotic was administered in 77% of patients; appropriate dose was used in 45% of patients. The most common reason for inappropriate dosing was administration of a lower than recommended dose. The timing of antibiotic administration in compliance with the recommended guidelines (within one hour of surgical incision) was observed in 84% of the patients. Of the patients that met the criteria for re-dosing of antibiotics (34%), the antibiotics were appropriately re-dosed in only 15%. Overall, out of the 284 patients that were observed, only 20% had adhered to the prescribed guidelines.

**Discussion:** Despite heightened awareness and multiple initiatives by national healthcare regulatory organizations, the incidence of SSI remains high. About 40-60% of SSI's are preventable. One of the ways to prevent SSI's, which has been deemed effective, is the use of antimicrobial prophylaxis during surgery. For the measure to be effective, the antibiotic needs to be appropriate in choice, dosing, timing and should be re-dosed based on pharmacokinetics.

However, as our study has shown that is unfortunately not the case.

**Conclusion:** Based on our findings, it appears that merely, "checking a box" for antibiotic administration during surgery is not enough and a multidisciplinary approach should be followed to ensure the "appropriateness" of antibiotics administered.

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## **Influence of culture on pre-operative expectations and post-operative experience of pain**

**Brittany Marie McCann, MD, MA**, Harjit Singh, MD, Christie Mulvey, Nancy Ruth Jarbadan, BS, Sanjib Adhikary, MBBS, MD

Department of Anesthesia, Penn State Milton S. Hershey Medical Center, Hershey, Pennsylvania

**Introduction:** It has long been noted that cultural context exerts an influence on the experience of pain. However, little research has been performed to isolate the most influential cultural factors on patients' expectations and experience of pain in the perioperative period.

**Objective:** Our goal is to assess the cultural factors that can mediate the expectations and experience of pre- and post-operative pain through a questionnaire at Penn State Hershey Medical Center (PSHMC). It will also provide a perspective on pain experienced both immediately pre- and post-operatively and at a later follow-up to assess persistent experience of pain. This may influence the way in which clinicians choose to treat surgical pain for patients of different cultural groups in the future.

**Methods:** Patients undergoing minimally invasive, cardiothoracic, gynecologic, or orthopedic operative procedures at PSHMC during a three month period were invited to participate in an IRB approved prospective longitudinal study at the time of their pre-operative visit. At that time, they were given a survey (S1) containing questions about demographics, pain experience, and post-operative pain expectations. The participants were given another survey (S2) in the post-operative period to address aspects of their pain experience and pain expectations for when post-op pain had subsided. Finally, participants were assessed at 3 weeks post-op with another survey (S3) about their pain experience since the procedure. Patients' pain experiences were analyzed based on answers to pre-op cultural questions. Statistical analysis was conducted by the Biostatistics and Bioinformatics Core at PSHMC.

**Results:** Fifty-two patients (17 male, 35 female) were enrolled in the study. Results were analyzed according to participants' gender, spiritual/religious belief, belief in herbal supplements for pain relief, education, and income. On S1, spiritual/religious participants expected significantly more pain than non-spiritual/religious participants in the immediate post-op period ( $p=0.02$ ). On survey S1, more educated participants showed a significant modestly lower pain expectation for after post-operative pain had subsided ( $p=0.05$ ). On S2, they expressed a significantly lower effect of pain on general activity ( $p=0.03$ ) and a significantly lower pain expectation for pain levels after post-operative pain had subsided ( $p=0.02$ ). On S1, patients who self-reported a lower income also indicated a significant modestly increased expectation of pain after post-op pain had subsided ( $p=0.05$ ).

**Discussion:** Spirituality, education, and income mediated expectations of post-operative pain, while only education influenced the experience of pain. A complex interplay was noted between spirituality and income that is associated with a lower expectation of pain, but which does not influence post-operative pain. It appears that education exerts a more powerful effect on perioperative pain than either spirituality or income through its influence on both expectations and experience of pain.

**Conclusion:** Specific cultural factors influence expectations and experience of pain in the perioperative period, including spirituality, education, and income. This understanding may help clinicians to better understand and treat perioperative and chronic pain in the future. However, a larger-scale study, in an area that is more culturally heterogeneous, should be conducted to confirm these influences and to analyze other potential factors that may impact this experience.

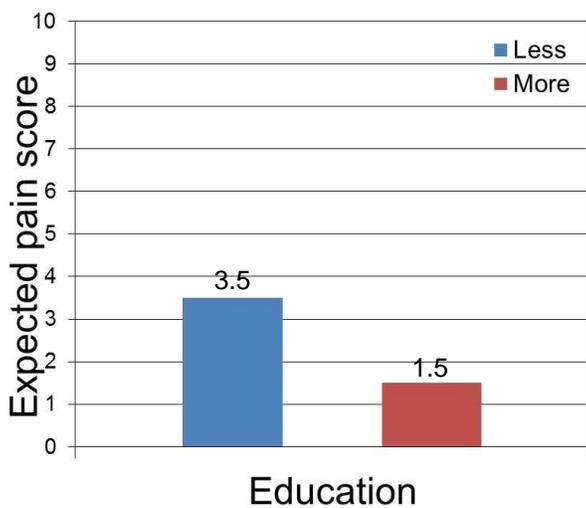
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**Figure 1. Survey S1 Results.** Influence of spirituality on pain expected in the immediate post-op period.

**Figure 2. Survey S1 Results.** Influence of education and income on pain expected 3 weeks post-op.



**Figure 3. Survey S2 Results.** Influence of education on pain expected 3 weeks post-op.



**Figure 4. Survey S2 Results.** Influence of education on experienced pain.

## 3D Printing and Patient-Specific Airway Simulation

Rosa Perez, MD and James Mooney, MD

Department of Anesthesiology & Perioperative Medicine, Penn State Health Milton S. Hershey Medical Center, Hershey, PA

### Introduction

3D printing technology is gaining popularity within the medical field due to its relative affordability, ease of use, and almost unlimited potential applications. One promising avenue of use has been the creation of personalized implants, prosthetics, and anatomic models. These models have been successfully used for surgical planning and as a teaching tool. We present a method by which to build a patient-specific airway simulator, from CT scan data, using 3D printing and casting.

### Objective

Combine 3D printing technology and casting techniques to create a low cost, haptically realistic, patient-specific head and airway model for intubation training.

### Methods

A DICOM image series of an adult head CT scan was segmented, in 3D Slicer, into four parts: the skull, the mandible, the airspace, and the head. The models were edited to allow suspension of the skull and mandible in the head and assembly with casting materials. The solid head, skull and mandible were printed on various 3D printers. A mold was created using the solid head. The skull, mandible, and airspace were suspended in the mold and platinum-cured silicone was used to make a cast. After curing, the mold was carefully removed from the silicone cast of the head. The airspace model was then removed from the head.

### Results

A model of an adult head and airway, capable of being intubated, was created using DICOM data. Total cost of fabrication was \$382.00. Total time spent on model creation was 44 hours and 30 minutes, although 85% of the time did not require active participation or monitoring.

### Discussion

Compared to commercially available intubation trainers, this model has several current and predicted advantages. It costs hundreds of dollars less than even low-fidelity manikins, (\$894.00 from <https://www.simulaid.com>). It can express a vast range of clinical features, limited only by the availability of CT images. Foreseeable limitations to this method are time required to create the model and access to a 3D printer.

### Conclusion

3D printing is playing an ever-expanding role in the creation of medical models. To date, these processes have relied on expensive proprietary software. Individuals outside of academic institutions are unlikely to have access

to such resources. Here, we present a low-cost method using open source software, 3D printing, and casting, to create a patient-specific airway simulacrum. Health professionals, teachers, and interested laypeople can utilize these methods to create and improve upon this model.

## **Title: FACTORS AFFECTING THE EFFICACY OF EPIDURAL BLOOD PATCHES**

**Authors:** Pradeep S. Singanallur M.D., Tiffany Yeh M.S., Milena Pilipovic M.D

**Department and Institution:** Department of Anesthesiology and Perioperative Medicine, Penn State Hershey Medical Center

**Introduction:** Epidural blood patches (EBP) have a long record of safety and efficacy to treat post dural puncture headache (PDPH). The reported success rate of EBP varies largely.<sup>1-3</sup>

The objective of our study was to identify factors associated with successful resolution of the PDPH treated with EBP.

**Hypothesis:** Similar to the factors that predispose patients to postdural puncture headaches, there are factors that predispose patients to obtaining an epidural blood patch that successfully cures the postdural puncture headache.

**Methods:** A retrospective chart review was performed to identify EBP's performed in our institution between October 2010 and March 2015. Data collected included: age, body mass index, pregnancy status, prior history of PDPH, timing (in days) of performing EBP after dural puncture, intentional or unintentional dural puncture, and Tuohy needle gauge used to perform the EBP.

**Results:** 157 cases of EBP's were identified. 13 cases were excluded from the analysis due to missing data in the medical record. There were 104 cases of intentional dural puncture and 40 cases of unintentional dural puncture, resulting in PDPH. The EBP success rate, measured in resolution of PDPH after 24 hours was 92%. Patients presenting resolution of PDPH had the EBP performed 3.8 days after the dural puncture. Patients with no resolution of PDPH had the EBP performed 2.1 days after the dural puncture. ( $p = 0.0365$ ). For every 24 hours delay after dural puncture, the success of the EBP increased by 3.3 times ( $p = 0.0026$ ). Furthermore, patients who received the EBP with a 17-gauge Tuohy needle were 8.6 times more likely to have resolution of their PDPH as compared to an 18-gauge Tuohy needle ( $p = 0.026$ ).

**Discussion:** The overall success of treating PDPH, with EBP in our study was 92%. One of the limitations of our study is that we measured successful resolution of PDPH only for 24 hrs and have not check for recurrence of symptoms. Our results are consistent with previous studies by Safa-Tisseront et al<sup>1</sup> and Kokki et al<sup>2</sup> reporting an increased success rate of treating PDPH, when the EBP is delayed for 3 days after the dural puncture. That can be potentially be explained by a greater cerebrospinal fluid leak occurring closer in time to the dural puncture.<sup>4</sup> In addition, EBP performed using a larger gauge needle demonstrated an increase in success rate of PDPH resolution, probably due to a wider distribution of the blood injectate, covering a greater patch area.

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# DYNAMICS OF NOCICEPTIN DISTRIBUTION DURING LIVER TRANSPLANTATION

Seth M Eisenberg MD, Dmitri Bezinover MD PhD, Gregory Weller MD PhD,

Department of Anesthesiology and Perioperative Medicine, Penn State Health Milton S. Hershey Medical Center, Hershey, PA

## Introduction:

Orthotopic liver transplantation (OLT) is associated with significant intraoperative hemodynamic instability and is known to induce an inflammatory response contributing to perioperative morbidity and mortality. Nociceptin (NC) is an endogenous opioid neuropeptide known to mediate pain responses (1), immunomodulation, inflammation, sepsis (2), and cardiovascular problems, including bradycardia and severe hypotension secondary to vasodilatation (3). NC levels have been observed to be elevated in patients with hepatocellular carcinoma (HCC).

## Objective:

We hypothesized that plasma levels of NC in patients undergoing OLT would significantly change in different stages of the procedure and that may have an effect on hemodynamic stability.

## Methods:

Blood samples were collected, at the following times and from the indicated locations, from adult patients undergoing OLT and plasma NC levels were measured with an ELISA immunoassay.

0: Pre-incision, from the radial artery;

1: 20 minutes prior to reperfusion, from the radial artery (1a) and portal vein (1b); 2:

From graft "flush" blood;

3: Immediately after reperfusion, from the radial artery; 4:

20 minutes after reperfusion, from the radial artery; 5: At

the end of surgery, from the radial artery;

6: 24 hours post-operation, from the radial artery.

## Results:

Plasma NC levels were measured in 53 OLT patients. Plasma NC levels prior to reperfusion increased significantly ( $P < 0.01$ ) above baseline levels, then, over the next 24 hours they fell back to just below baseline levels (Figure 1). The highest level of NC was found in the plasma at 20 minutes before reperfusion and in the plasma immediately after reperfusion. There were also statistically significant higher preoperative NC levels in HCC patients than in non-HCC patients ( $p = 0.02$ ).

## Discussion:

OLT are associated with substantial hemodynamic instability. Causes of this event is multifactorial but NC might be an important factor contributing to post reperfusion syndrome. Plasma NC levels increase significantly up to the time of reperfusion, then rebound to baseline values post-reperfusion and post-operatively. Administration of NC antagonists (currently available as an experimental medication) might be a therapeutic option in the future. NC level can be also an important HCC marker.

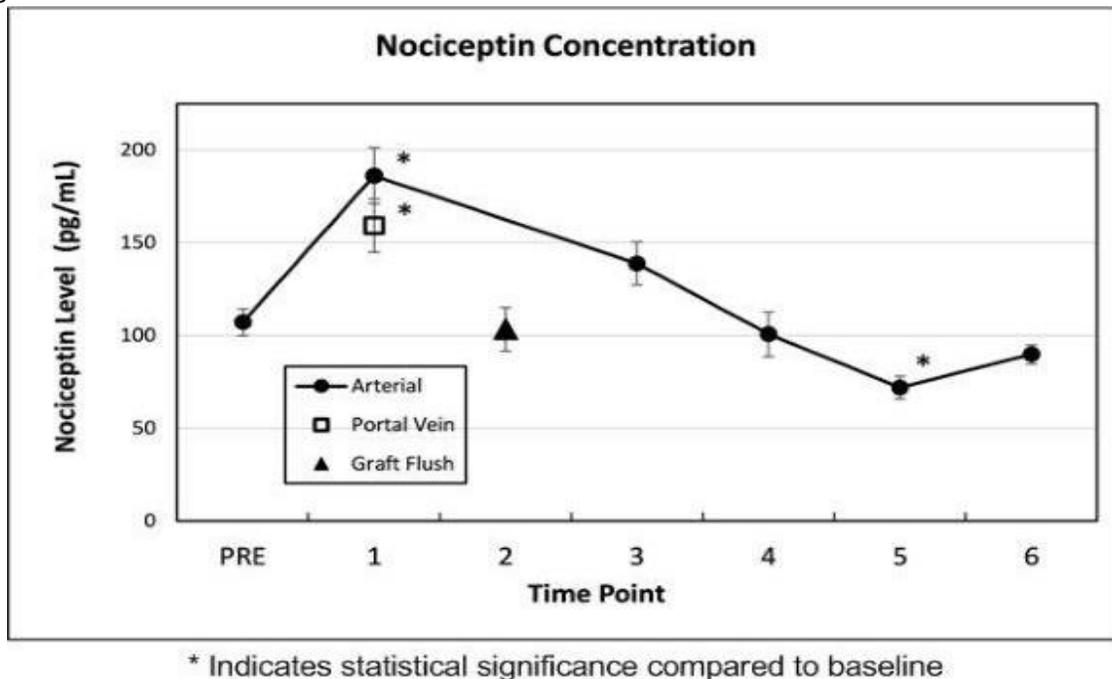
## Conclusion:

Based on NC's known role in inflammatory signaling, NC may have potential as both a biomarker for OLT-induced inflammation which can be used for perioperative risk stratification and as a target for novel therapeutic agents.

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Figure 1:



Prevalence of inappropriate continuation of atypical antipsychotic medications in ICU patients discharged from the hospital

**Robert S. Schoaps, M.D.;** Ziad Carr, M.D.; Anthony Bonavia, M.D.; Amit Prasad, M.D.; Ashley Quintili, Pharm.D.; Kunal Karamchandani, M.D.

*Department of Anesthesiology & Perioperative Medicine, Penn State College of Medicine, Hershey, PA*

**Introduction:** ICU delirium repeatedly has been associated with increased mortality, length of stay, and overall

costs, stimulating increasing usage of atypical antipsychotics (AAPs) to reduce its duration. Chronic use of AAPs, however, is associated with significant adverse effects, perhaps most notably increased all-cause mortality in patients over 65-years of age. For this reason, AAPs prescribed for ICU delirium should be discontinued following resolution of symptoms.

**Objective:** We hypothesized that these medications may frequently be continued inappropriately following discharge, and sought to determine the incidence of this patient safety issue.

**Methods:** A retrospective analysis was conducted of all adult ICU patients who were initiated on AAPs for ICU delirium over a two-year period at our institution. We reviewed discharge medication reconciliations for all surviving subjects to determine if the AAPs were continued following hospital discharge. We also examined whether patients  $\geq 65$ -years of age were at elevated risk for initiation and/or continuation of AAPs.

**Results:** We identified 12,984 adult ICU admissions over the two-year study period, of which 346 were initiated on AAPs. 314 patients met inclusion criteria, 55% of which were discharged from the hospital with a prescription for continued AAP therapy. Seventy-five (43%) of those patients were aged  $\geq 65$ -years.

Patients  $\geq 65$ -years of age were not more likely to have been initiated on AAPs during their ICU stay and did not have a statistically significant difference in continuation of these agents after discharge.

**Discussion:** The associations between ICU delirium, mortality, and overall costs have been validated in numerous studies. This has prompted aggressive treatment strategies using AAPs based on a number of small clinical trials. However, the same studies advocated for discontinuation of AAP therapy at either resolution of symptoms or discharge from the ICU.

In our tertiary care academic medical center, greater than 50% of the patients initiated on AAPs during their ICU stay had these medications continued following discharge from the hospital. There are multiple long-term risks associated with chronic AAP use, and in 2008, the FDA released a black box warning that AAP use was an independent risk factor for increased mortality in patients  $\geq 65$ -years of age. While it is encouraging that no significant differences were found in prescribing practices between age groups at our institution, it is concerning that 43% of our patients who were continued on AAPs after discharge were over the age of 65.

Improper medication reconciliation at discharge is most likely the greatest contributor to inappropriate continuation of AAPs following ICU delirium, a problem which may be compounded in academic hospitals where house staff at various levels of training are entrusted with this responsibility.

**Conclusion:** Over half of our patients initiated on AAPs for ICU delirium were discharged from the hospital on these medications. AAPs may be associated with significant adverse effects when taken on a chronic basis including increased mortality. As such, we feel safety measures should be in place in order to minimize inappropriate continuation of high-risk medications following discharge from both the ICU and the hospital.

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## Anticoagulation on hospital discharge in critically ill patients with new-onset atrial fibrillation

**Robert S. Schoaps, M.D.;** S. William Hazard, III, M.D.; Kunal Karamchandani, M.D.  
*Penn State Health, Department of Anesthesiology and Perioperative Medicine*

**Introduction:** Atrial fibrillation is one of the most common arrhythmias noted in patients admitted to intensive care units. Although long term risks of new onset atrial fibrillation associated with critical illness were previously poorly elucidated, recent findings have validated an association with significant long term risk of ischemic stroke and overall mortality.

**Objective:** With these observations in mind, we sought to investigate the incidence of new onset atrial fibrillation (NOAF) in the non-cardiac intensive care units in a tertiary care academic center and evaluate whether appropriate long-term anticoagulation therapy was initiated on discharge based on the risk factors for thromboembolism using the CHA<sub>2</sub>DS<sub>2</sub>-VASc score.

**Methods:** A retrospective chart analysis was conducted to identify all patients between the ages of 18 and 100 who developed NOAF in the non-cardiac ICUs at Penn State Hershey Medical Center from 2009 to 2016. Additional diagnoses were obtained in order to calculate CHA<sub>2</sub>DS<sub>2</sub>-VASc scores for each patient (Congestive heart failure, Hypertension, Age, Diabetes, Stroke, Vascular disease). Patients diagnosed with AF or taking anticoagulants prior to admission were excluded, as were patients who did not survive to discharge. The remaining charts underwent additional review to identify whether or not these patients were prescribed long-term anticoagulation therapy following discharge from the hospital.

**Results:** We identified 38,708 admissions to our non-cardiac ICUs during the noted time frame with 640 (1.65%) who developed NOAF during their ICU stay; 183 patients did not survive to discharge. This resulted in 457 eligible patients, all of which had CHA<sub>2</sub>DS<sub>2</sub>-VASc scores of  $\geq 2$  warranting anticoagulation. Of those eligible, 142 (31%) were discharged on low molecular weight heparin and only 31 (6.8%) of those patients were subsequently prescribed oral anticoagulants. An additional 59 patients (13%) were discharged on oral anticoagulants without bridging therapy, leaving a total of 90 patients (20%) who were prescribed oral anticoagulants after discharge.

**Discussion:** At "PARRC 2016" the preliminary data for this study was presented, citing the incidence of new onset atrial fibrillation to be significantly high in critically ill patients in our tertiary care academic center. At that time we also noted a significant number of patients who had CHA<sub>2</sub>DS<sub>2</sub>-VASc scores high enough to warrant initiating anticoagulation therapy in order to minimize long term risk of ischemic stroke. This final dataset demonstrates that despite their relatively high long-term risk for thromboembolic stroke and mortality, only a minority of our patients were initiated on oral anticoagulants – or anticoagulants of any kind – following discharge from the hospital.

**Conclusion:** In light of our data and other findings in existing literature, we feel intensivists should endeavor to address long term management of atrial fibrillation in the ICU through initiation of anticoagulation therapy when appropriate and take steps to ensure initiation of long-term therapy and follow-up after

discharge.

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## The Use of 3D Printed Airway Models in the Informed Consent Process: A Pilot Study

**Amanda Dudak, MD**, James Mooney, MD, Department of Anesthesiology and Perioperative Medicine, Penn State College of Medicine, Hershey, PA

**Introduction:** The informed consent process, a cornerstone of modern medicine, has been shown to benefit from the use of educational aids<sup>1,2</sup>. The use of 3D printing is a new and rapidly evolving technology which has been used for multiple applications in the medical field for education, training and patient care<sup>3-6</sup>.

**Objective:** The objective of this pilot study was to explore the acceptability and utility of using 3D printed models of a pediatric airway in the informed consent process.

**Methods:** We used previously developed models of a normal and abnormal pediatric airway when engaging new parents in a mock informed consent process. We first engaged in a traditional unaided verbal process, and then used the models of the two airways for comparison and education. Participants completed a survey about their experiences before and after use of the models.

**Results:** 20 participants were surveyed. Prior to the use of models, all participants felt they had an acceptable level of understanding of the condition and most (79%) felt they understood the proposed surgery. All participants rated their ability to make a decision about treatment as adequate. Their satisfaction with the consent process was neutral (11%) to positive (89%). All participants reported improved knowledge of the condition, understanding of the reason surgery was needed, and understanding of the planned surgical intervention after the use of the models. All participants indicated that the models were a beneficial part of the consent processes. Some participants (32%) indicated concerns over privacy whether the models represented internal or external anatomy. Others were neutral (6%) to unconcerned (52%) about privacy.

**Discussion:** In this study, all participants felt their understanding was improved with the use of the models, despite most reporting they had an adequate understanding to make treatment decisions prior to the use of the models. Their reported confidence in their ability to make a treatment decision prior to the models, but the neutral to positive rating of their overall satisfaction with only verbal consent may reflect an awareness of the limits of their knowledge. This may be further reflected in their uniform positivity toward the use of models as an educational tool, as well as its use in future consent processes for themselves and others.

One area of potential concern was privacy. There was no difference in privacy concerns for internal vs external anatomy. Despite some individuals indicating they would be concerned about privacy, they indicated they would want models used in future consent processes. Participants were uniformly positive in their attitudes toward the use of 3D printed models.

**Conclusion:** The results of this pilot study showed that, while participants felt their understanding was sufficient to provide informed consent when no models were used, all participants reported improvement in understanding when 3D printed models were used to augment the verbal explanations. These results suggest that the use of 3D printed models can enhance the consent process in the medical setting and help patients to increase their understanding of medical interventions for which they may have no prior knowledge.

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Noise in the operating room: examination of measured and perceived noise during three anesthetic periods

**Andrey F Bilko, MD**, Elbert Mets, Michael Akerley, DO, Brandon Rein, DO, Vernon Chinchilli, PhD,  
Sonia Vaida, MD, Julia Caldwell, MD

Department of Anesthesiology and Perioperative Medicine, Penn State Hershey Medical Center, Hershey PA,  
USA

Introduction: Increasing evidence has shown that noise pollution in the operating room is detrimental to patient care.<sup>[1-3]</sup> Crucially, the surgical team must be able to communicate effectively and focus intensely during the intraoperative period.<sup>[2]</sup> High noise levels generated by surgical tools, pagers, entry and exit from the operating room, as well as loud conversations unrelated to patient care, can hamper communication during this critically important period.<sup>[1-4]</sup>

Objective: Our objective was to determine sound levels in ORs of our institution during the periods of induction, maintenance, and emergence from anesthesia, in addition to examining whether noise interfered with induction and emergence as perceived by the anesthesiologist.

Methods: A Casella CEL-631 Environmental Noise Meter was used to record sound pressure in the operating room during 52 random surgical cases, where general anesthesia was administered. The anesthesia resident and attending anesthesiologist were asked to rate noise levels (1-10) during anesthesia induction and emergence, whether mask ventilation or intubation were difficult, and if noise distracted them or interfered with their task performance.

Results: Emergence from anesthesia was the loudest period, (mean sound pressure =  $67.5 \pm 2$  dBA), followed by induction (mean =  $65.2 \pm 2$  dBA) and maintenance (mean =  $64.9 \pm 2$  dBA). Maximum absolute noise levels during induction and emergence reached 101.1 and 114.7 dBA, respectively. The difference in mean noise level during emergence compared with induction and maintenance was statistically significant ( $P < 0.0001$  and  $P < 0.0001$ , respectively). There were no correlations between perceived and measured noise levels. In cases in which anesthesiologists reported that noise interfered with induction, they perceived the operating room to be significantly louder ( $P = 0.002$  and  $P < 0.0001$ , for resident and attending anesthesiologist, respectively) despite no actual difference in the measured noise levels.

Discussion: Our operating rooms exceed a suggested limit of 55 dBA, and a concerted effort should be made to quiet our operating rooms in the interest of patient safety.<sup>[1]</sup> Impaired communication and attentiveness are two frequently cited faults in surgical and anesthetic errors, respectively, with excessive noise playing an important role.<sup>[1,5]</sup>

Conclusion: Verbal communication has been shown to be hindered by background noise of  $\sim 67$  dBA and understanding speech at 90% accuracy requires conversation levels 10-15 dBA above background. Our findings indicate that average OR background noise levels were sufficient, during emergence from anesthesia, to potentially impede communication and increase the risk of anesthesia provider distraction and error.

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□ **For Original Research:**

**Understanding the Causes of 30 Day Hospital Admission and ED Presentation Following Pediatric Outpatient Surgery**

**Sydney E.S. Brown**, Allan Simpao, Mohamed Rehman

Department of Anesthesiology and Critical Care Medicine, Children's Hospital of Philadelphia

Introduction: Hospital readmissions remain a costly problem, and may be indicative of suboptimal care<sup>1</sup>. While it remains controversial whether unplanned admissions to a pediatric hospital within 30 days of discharge are an indicator of hospital quality<sup>2-4</sup>, this has nonetheless been widely adopted as a quality indicator. Emergency department (ED) presentations are also costly, and may represent missed opportunities for improved care delivery post-discharge<sup>5</sup>. Critics argue that after the patient is discharged, there may be little that providers can do to prevent an admission or ED presentation from occurring, however evidence in the adult literature suggests that novel interventions for patients at high risk of admission can reduce their incidence and improve health outcomes overall<sup>6</sup>. ED presentations and hospital admissions following pediatric outpatient surgery is an underexplored domain within this broad topic.

Hypothesis/Objective: Determine the causes of unplanned hospital admission in the 30 days following outpatient surgery, whether they were related to the surgery or an external problem, and whether causes of hospital admission varied depending on the duration of time between surgical procedure and hospital admission. Our secondary objective was to determine whether the causes of ED presentations following outpatient surgery not resulting in an inpatient admission differed from those that did.

Methods: We used the electronic medical record to identify children who presented to the ED or had a hospital admission within 30 days of outpatient surgery. A guide for coding hospital admission / ED presentation causes was developed prior to the start of the study; we used constant comparison methods to continue development of the guide as data collection progressed and the content and themes extracted from the chart review emerged.<sup>7</sup> Our main outcome measure was the cause of the ED presentation or hospital admission identified by the provider team, family, and/or patient during the visit. Descriptive statistics were used to summarize the data, and comparisons were made between groups using a t-test, Wilcoxon Rank Sum, or chi-squared test as appropriate.

Results: TBD

Discussion: TBD

Conclusion(s): TBD

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Utility of Pectoral Block for Anterior Rib Fractures Douglas Curphey

University of Pittsburgh

## Abstract

There is significant mortality associated with multiple rib fractures, particularly with advancing age. Regional analgesic techniques such as thoracic epidural block or paravertebral block are recommended for analgesia and to minimize risk of post traumatic pneumonia. Pectoral nerve block (Pecs block) is a ultrasound-guided interfascial plane block intended to provide anesthesia or analgesia of the upper anterior chest wall. Here we successfully utilized Pecs blocks to achieve clinically significant analgesia in two patients with anterior rib and sternal fractures. The Pecs block is advantageous because it avoids that neuraxial region, it provides good coverage of the anterior chest wall, and requires minimal patient positioning. Our findings suggest a viable alternative regional-anesthetic option in polytrauma patients with pain originating from the anterior chest.

## **Critical Evaluation of Clotting Times of Rotational Thromboelastometry**

E. Abuelkasem, M.B.B.Ch, MSc<sup>1</sup>, S. Hasan, M.H.S<sup>2</sup>, S. Singh, BS<sup>3</sup>, K. Tanaka, MD, MSc<sup>2</sup>

Department of Anesthesiology, <sup>1</sup>University of Pittsburgh Medical Center, <sup>3</sup>University of Maryland School of Medicine and <sup>3</sup>University of Central Florida College of Medicine.

### **Abstract**

#### **Background:**

Coagulopathy and bleeding are major challenges after complex cardiac surgery using cardiopulmonary bypass (CPB). Thromboelastometry (ROTEM<sup>®</sup>) has been shown to be effective in guiding hemostatic therapies after CPB. Decreased plasma coagulation factor levels are usually diagnosed by prolonged CT on EXTEM which is often used interchangeably with FIBTEM CT. However evaluation of EXTEM and FIBTEM CT for interchangeability has not been done before.(1,2)

#### **Hypothesis:**

FIBTEM-CT is shorter than EXTEM-CT because FIBTEM reagent contains cytochalasin-D (CD) which speeds up thrombin generation.

#### **Aims:**

Specific aims of this study are:

1. To investigate if there a difference between EXTEM and FIBTEM CT values at the clinical level (retrospective).
2. If there is difference, investigate if CD is responsible for EXTEM and FIBTEM CT difference (ex-vivo experiment).

#### **Methods and results:**

##### A-Retrospective part:

Methods:

Retrospective part: retrospective chart review included ROTEM® data from cardiac surgical patients at the University of Maryland Medical Center from October 2015 to May 2016. The measurements were done either at baseline, during rewarming on CPB, or after protamine reversal of heparin anticoagulation. The difference between the mean EXTEM-CT and FIBTEM-CT (Seconds [sec]) values were calculated and were compared by Mann Whitney test and P-value of < 0.5 was considered to be significant.

Results:

CT(sec)		Mean	SD	P-value
<b>Baseline</b> <b>(N=118)</b>	EXTEM	76.1	31.1	
	FIBTEM	71.4	30.5	<0.0001
<b>CPB</b> <b>(N=73)</b>	EXTEM	89.8	32.8	
	FIBTEM	110.7	189.7	0.906
<b>Post</b> <b>protamine</b> <b>(N=111)</b>	EXTEM	82.5	17.3	
	FIBTEM	74.9	18.4	<0.0001

Table-1: Paired statistics of retrospective EXTEM and FIBTEM CT values.

B-Prospective Ex-vivo part:

Methods:

Thrombin generation (TG) assays were run using platelet rich plasma which was diluted in 1:3 volume ratios with normal plasma (NP). Plasma samples were tested for TG using Calibrated Automated Thrombinscope (CAT®) before and after addition of CD at a volume of 5.33 µM (which matches the amount of CD in FIBTEM reagent). The median and IQR (sec) of Lag times of TG were compared using Mann Whitney test and P-value of <0.05 was considered statistically significant.

Results: Tables 2

<b>N=10</b>	<b>Median</b>	<b>IQR(25-75)%</b>	<b>P-value*</b>
<b>Lag time-NP(sec)</b>	220.2	(210.7- 236.8)	
<b>Lag time-NP+CD(sec)</b>	139.8	(71.8-178.6)	0.023

Table-2: Ex-vivo TG data (NP vs. NP+CD). Data expressed in Median and IQR.\* Mann Whitney test.

### **Discussion:**

The prelim analysis indicates FIBTEM-CT is shorter than EXTEM-CT for cardiac surgical patients at baseline and post protamine but not during CPB which may be secondary to extreme inhibition of TG by systemic heparinization. This finding was reproduced on ex-vivo experiment which showed shorter lag time of TG in samples mixed with CD compared to NP only. This CD “enhancing” effect on TG and hence shorter FIBTEM CT may be due release of pro-coagulant MPs from the surface of activated platelets. (3)

### **Conclusion:**

In conclusion, EXTEM-CT and FIBTEM-CT do not appear to be interchangeable because of the effect of CD on FIBTEM-CT.

### **Potential implications:**

Patients with significantly discrepant EXTEM/FIBTEM CTs may have highly functioning platelets and may not need any hemostatic interventions despite prolonged EXTEM CT, so combined EXTEM/FIBTEM assays may be recommended. Further studies are needed.

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**Jashen Patheja, Maimouna Bah, Matthew Dukewich, Logan Blunk, Anita Gupta. Next Generation Medical Education Via Novel Technology Software Platform for Anesthesiology, Pain Management and Regional Anesthesiology Training, Education, Skills Evaluation and Performance Improvement.**

**OBJECTIVE:** To evaluate medical student and resident physician usage, along with overall opinions and level of support regarding use of a novel software technology platform for training, education and performance improvement in anesthesiology, pain and regional anesthesiology.

**METHODS:** The study was performed at Drexel University College of Medicine at Hahnemann University Hospital. The included participants were ranging from fourth year medical students to senior anesthesiology residents in final year of training. The participants were provided with the specific software platform to evaluate and utilize prior to completing a detailed evaluation of the software. The participants completed a validated questionnaire and additional open-ended queries to gauge overall satisfaction and support of product. 20 participants completed the survey, divided into four different groups of five participants in each. The groups were Clinical Anesthesia (CA) Residents in years CA-1, CA-2, and CA-3 of their training and five medical students. Once the survey was completed, results were coded (5 = Strongly Agree to 1 = Strongly Disagree) and detailed statistical analysis was performed and thoroughly analyzed.

**RESULTS:** Due to the ordinal nature of the data, the authors analyzed the data in regards to central tendency, which were summarized by the mode. The most frequent response to the questions was "Agree" (Mode=4), indicating support of platform broadly over several educational spectrums. Additionally, open ended questioning yielded overall favorable suggestions for improvement to benefit future physicians and medical students and to include nurses and allied health professionals and to consider more advanced technological platforms.

**CONCLUSION:** Our study supports the use of our novel software platform as a integrated solution for graduate medical education for the next generation of anesthesiologists. Utilizing the data acquired from this study as well as the open-ended questions offers clear perspective on how to improve the technology for future next generation of medical education in anesthesiology.

On Apr 2, 2017, at 7:11 PM, Hauck, Ellen <[Ellen.Hauck@tuhs.temple.edu](mailto:Ellen.Hauck@tuhs.temple.edu)> wrote:

Please see list below. And send the amended abstract directly to me. I will see that it gets onto the flash drive for the conference with the corrected list of authors.

Ellen

Research Scott Coleman Effects of 48 Hours Exposure of Epinephrine on the Cardiac Hypertrophy Related Gene Expressions in Cultured Cardiomyocytes

Case Report Shweta Yemul Golhar Severe Lactic Acidosis in a Liver Transplant Patient

Research Christopher Snell Resources for Opioid Management Among the Top 10 Hospital Systems

Research Farshad Rashidian Novel Application of Interventional Pain Procedures for Peripheral Nerve Hyperexcitability Syndromes

Research Onyechi Megafu Efficacy of Ketamine Infusion in Patients with Chronic Intractable Pain and Co-morbid Depression

Research

Case Report Rayhan Tariq A Case of Non-Lethal Air Embolism During Bone Marrow Harvesting

Case Report Onyechi Megafu Sodium Glucose Co-Transporter-2 Inhibitor Associated Perioperative Euglycemic Diabetic Ketoacidosis: The Case for a Perioperative Guideline

## Creating a System-wide Operating Room Running Cap in a Large Multi-Hospital System

David F. Nelson, MD, MBA<sup>2</sup>, Robert Boretsky, MD<sup>1</sup>, Trent Emerick, MD<sup>1</sup>, Andrius Giedraitis, MD, MBA, MSE<sup>2</sup>, Mark Hudson, MD, MBA<sup>1</sup>

<sup>1</sup>University of Pittsburgh Physicians, <sup>2</sup>Resident, Department of Anesthesiology, Pittsburgh, PA

Contact info: David Nelson [nelsondf@upmc.edu](mailto:nelsondf@upmc.edu)

**Introduction:** Current economic conditions in health care increasingly demand cost-reductive strategies requiring improved operating room (OR) management.

Anesthesiology Departments are ideally positioned to participate in these efforts because of their intimate familiarity with OR operations and because of the desirability of gain sharing with hospital leadership. The University of Pittsburgh Medical Center (UPMC) Dept. of Anesthesiology provides anesthesia services for the system's 14 core hospitals and can shift anesthesia providers between hospitals depending on need. Historically, the daily number of providers varied dramatically, both between hospitals and on different days of the week at the same hospital. In an effort to address this variability, UPMC sought to emphasize system-wide OR efficiency by tracking overall OR utilization and instituting a "sites-running" cap that would represent the maximum number of anesthetizing locations allowed across the system for a given day. This "cap" attempts to minimize the day-to-day variability in the total number of anesthesia providers.

**Methods:** For September—December 2015, daily anesthesia sites running data was collected for each of 14 core facilities in Allegheny County in the UPMC system. Using site-specific operating-room utilization as a benchmark for efficiency, individual hospital performance was calculated for each day using surgical minutes (wheels-in to wheels-out) divided by total available surgical minutes (number of rooms staffed to run at given site multiplied by 8 hours per room). Then, using "system-wide rules" already established for block management, optimum target caps for number of rooms running were created for each site based on historical data showing a number in which OR utilization was maximized. These individual site caps were then used to create a system-wide cap of 200 operating rooms in May 2016.

**Results:** In the six months prior to the implementation of a system-wide cap, average daily OR's running ranged from 165—224, with a monthly average mean of 203 and average standard deviation of 9. (see Table 1). Average system-wide utilization during this time was 62%. After establishment of the cap, daily running OR's decreased to an average of 191 (max 207, min 162, standard dev. 7). This is accompanied by an average system-wide utilization of 63%. The decrease in average daily anesthesiology sites running from 203 prior to the cap to 191 after the cap represents yearly cost savings of approximately \$14.4 million (12 operating room reduction multiplied by avg. operating cost of \$1.2 million per room)

**Discussion:** In today's healthcare landscape there are many incentives to develop novel cost-reducing measures, as well as to optimize resource management.

Nowhere in healthcare is this more relevant than in the operating room. While generally considered the highest revenue area of a health system, inefficiently used ORs can be a tremendous cost. In a large health system, capitalizing on data availability and resource sharing to develop and implement system wide "best- practices" is vital to financial success. By developing system-wide management goals based simply on utilization data, millions of dollars can be saved over the course of the year, all while preserving revenue and safety standards. It is evident that management strategies such as these are of critical importance not just for individual health systems but also for the field of anesthesiology as we strive to demonstrate value.

## Case Reports for Oral Presentation:

## Title: Successful Airway Management with Laryngeal Mask Airway (LMA) in a Two Week Old Patient with Prader-Willi Syndrome for Gastrostomy Tube Placement

**Authors: David Fryzel M.D.; Shilpi Mangla M.S., M.D.; Thomas M. Schieble M.D. Department of**

**Anesthesiology, Geisinger Medical Center**

### **Background:**

Prader-Willi Syndrome (PWS) has a prevalence of 1 in 10-15,000 individuals<sup>4</sup>, and is caused by deletion of paternal copies of genes on chromosome 15. Patients with PWS have two main clinical phases<sup>2,4</sup>. The first phase from the newborn to infancy period is characterized by hypotonia, coughing, crying and episodes of asphyxia. The second phase from age 2-5 years is characterized by hypogonadism, mental retardation, and obesity from hyperphagia. Patients with PWS may exhibit respiratory problems consistent with congenital hypoventilation syndrome. They may also have a depressed ventilatory response to carbon dioxide and hypoxia during awake and asleep states. A primary abnormality in peripheral chemoreceptors, or secondary dysfunction of hypothalamic modulation of the central respiratory centers in the central nervous system may cause this<sup>2,3</sup>. Other features such as macroglossia and hypotonia can cause obstruction of the airway during induction of anesthesia. These factors pose challenges for airway management during anesthesia (*Table 1*) and often warrant postoperative respiratory monitoring<sup>3,6</sup>.

### **Case Description:**

This case describes a 2.9kg, two week old male who presented for elective gastrostomy tube placement for failure to thrive after birth. He had associated symptoms of hypotonia, weak cry, and hypoglycemia since birth. Genetic testing revealed 15q11.2->q13.1, consistent with a diagnosis of PWS. The patient was taken to the operating room and had application of standard monitors. After mask inhalational induction with sevoflurane, an oral airway was inserted to alleviate airway obstruction during mask ventilation. An intravenous catheter was placed, and then a #1 Ambu LMA was inserted and seated on the patient's hypopharynx. There was no obvious stridor or air leak during spontaneous ventilation. During the course of the surgery, 1mcg of Fentanyl, 0.05mg Morphine, and 28mg Acetaminophen were given for analgesia. Sevoflurane was titrated to maintain regular respirations at 30-40 breaths per minute. Tidal volumes were consistently 11-15 mL throughout the operative procedure; and end-tidal CO<sub>2</sub> levels ranged from 36-46 mmHg while the LMA was in place. Hemodynamic instability, or hypoxia were not apparent during the case. After completion of the case LMA was removed under deep anesthesia when the end tidal sevoflurane was 3.05. The patient maintained saturations greater than 98% with blow by oxygen. No post-operative airway difficulties were noted, and the patient was returned to the NICU in stable condition.

### **Discussion:**

Respiratory complications secondary to hypotonia and hypoventilation can be a major cause of mortality in patients with PWS<sup>5,6</sup>. Prevention of respiratory complications such as challenging endotracheal intubation and risk of perioperative respiratory failure requires the anesthesia provider to carefully consider alternatives to airway management.

### **Conclusions:**

The anticipation of complicated airway anatomy led to a detailed perioperative anesthetic plan to

minimize respiratory complications for this patient with PWS. The decision was made to avoid paralytics and maintain spontaneous ventilation. An oropharyngeal airway assisted in relieving airway obstruction during mask ventilation on induction of anesthesia in this case. LMA proved useful in this case to prevent airway obstruction by the tongue.

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**Table 1:**

Airway	Respiratory
• Difficult tracheal intubation	• Hypotonia
• Small glottic opening	• Poor cough with ineffective clearance of secretions
• Narrowed subglottic area	• Thick bronchial secretions
• Redundant epiglottis	• Intraoperative bronchospasm
• Limited neck mobility	• Central/obstructive apnea
• Macroglossia	• Restrictive lung disease (obesity, kyphoscoliosis)

**Table 1: Specific organ system involvement with Prader-Willi syndrome. (Table adapted from Legrand et al<sup>4</sup>.)**

**Title:** Preterm Pregnancy Complicated by ARDS and Sepsis Requiring Emergent Cesarean Section: A Case Report

**Authors:** Ireton, Jordan; Boden, Jessica; Karamchandani, Kunal

**Department and Institution:** Penn State Hershey Medical Center, Department of Anesthesiology and Perioperative Medicine

**Introduction:** Acute respiratory distress syndrome (ARDS) has been reported to occur in less than 0.07% of pregnancies. Although maternal mortality is comparable between pregnant and non-pregnant patients, the effects on the fetus can be devastating (1). The management of pregnant patients with ARDS is complicated by the unique nature of maternal physiology, including high volume status, altered pulmonary mechanics, hemoglobin dissociation, IVC compression impeding venous return, and the need for simultaneous management of the fetus (2,3,4). Our case report will detail the patient's hospital course, including her time in the surgical intensive care unit and intraoperatively for cesarean section.

**Case Presentation:** A previously healthy twenty-seven year old female G4P2012 at 27 weeks gestation presented to our Emergency Department with abdominal pain and sudden-onset hypoxic respiratory failure requiring intubation. Workup revealed severe ARDS and sepsis of unknown etiology, with ventilator management requiring a potential need for extracorporeal membrane oxygenation (ECMO). The question arose as to the viability of the fetus and its effect on the patient's respiratory status, whether the fetus would survive if a cesarean section were to be performed, and how to optimize the patient and fetus should ECMO be needed. The decision was made to perform an emergency cesarean section requiring complex perioperative management. The 27 week old infant was delivered with initial Apgar score of 9 and 9, breathing spontaneously, and taken to the NICU. After cesarean section, the patient's respiratory status improved allowing for extubation within one week postoperatively.

**Discussion:** Acute respiratory distress syndrome in pregnant patients has comparable mortality to non-pregnant patients (2); however, the critical care and perioperative management is significantly different. In this patient, we chose to perform emergency cesarean section despite the young gestational age of the fetus. This resulted in near immediate improvement in the patient's clinical status and prevented the need for ECMO.

**Conclusions:** Perioperative management of pregnant patients with ARDS and sepsis is a complex clinical challenge. This case demonstrates the significant contribution of maternal physiology to the course of ARDS in these patients, and serves as an example of successful perioperative management in a critically ill parturient.

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## Anesthetic Management of a Cesarean Section in a Parturient with New Onset Multiple Myeloma Complicated by a Sacral Plasmacytoma, a Case Report

Abraham Oommen, M.D., H. Jane Huffnagle, D.O., Suzanne Huffnagle, D.O., Michele Mele, M.D., John Wenzel, M. D.

**INTRODUCTION:** Multiple myeloma (MM) is a condition involving the neoplastic growth of plasma cells which produce immunoglobulins. There is little data about pregnant women diagnosed with MM because it usually occurs after the 5<sup>th</sup> decade of life. Only one case report has addressed the anesthetic considerations (1). We present a case of newly diagnosed MM in a parturient, complicated by a sacral plasmacytoma, and the anesthetic management for her delivery.

**CASE:** A 26 year old G1P0 at 31<sup>0</sup> weeks gestation presented with a five week history of progressive low back pain which acutely intensified on the day of presentation. Routine laboratory studies showed hypercalcemia (18.2 mg/dL) and acute renal failure (Cr 2.09 mg/dL). An MRI of the abdomen/pelvis revealed a lytic mass in the right sacral ala measuring approximately 4.4 x 3.0 cm and extending across the right sacroiliac joint, with extraosseous spread of tumor to the adjacent soft tissue, and extensive marrow replacing lesions throughout the sacrum.

Pathology from a CT guided biopsy of the mass showed plasma cells positive for CD138 and exhibited kappa light chain restriction. Her urine free kappa light chains were markedly elevated at  $5.1 \times 10^3$  mg/L (normal range 1.3-24 mg/L) as well. These results established the diagnosis of MM in our patient. There was no other radiographic evidence of axial disease. A delivery plan was formulated by a multidisciplinary team. At 32<sup>5</sup>, a combination of factors necessitated an operative delivery. Because her disease process (to our knowledge) did not involve the lumbar spine, we planned a spinal anesthetic. We successfully placed a spinal at the L3 – L4 interspace using bupivacaine 0.75% 15 mg, fentanyl 10 mcg, and hydromorphone 200 mcg. A successful cesarean (CS) section was performed. Following her CS, she underwent radiotherapy targeting the sacral plasmacytoma and chemotherapy (borlezomib plus dexamethasone) to treat the MM. Unfortunately the plasmacytoma resulted in cauda equina syndrome requiring operative decompression two weeks following the CS. She has not responded favorably to chemotherapy and her prognosis remains very poor.

**DISCUSSION:** The pathobiology of MM is a complex process leading to the replication of a malignant clone of plasma cell origin (3). MM is responsible for approximately 1% of all malignancies and accounts for up to 10% of hematologic malignancies (5). Diagnosis during pregnancy is uncommon as the median age of diagnosis is 66 with just 2% diagnosed younger than 40 (6,7). Only 32 previous cases of MM diagnosed during pregnancy have been reported from 1965 to 2014 (8), and only one of these cases has discussed the anesthetic considerations (1). Most cases of MM presenting during pregnancy are delivered by CS (82%), often due to extensive bone disease and pelvic instability (8,10), with a mean gestational age of 35 weeks (8).

Because our patient's MM did not involve the lumbar spine at the time of delivery and coagulation profile/platelet counts were normal, we planned a single injection spinal. A CSE or epidural were possibilities,

but challenges in positioning would have likely led to unsuccessful attempts. We describe the successful placement of a spinal anesthetic for CS in a young parturient with rapidly progressing MM. This complicated patient required the input of a multidisciplinary team for the successful delivery of a healthy neonate. Unfortunately her disease continues to advance despite extensive treatment.

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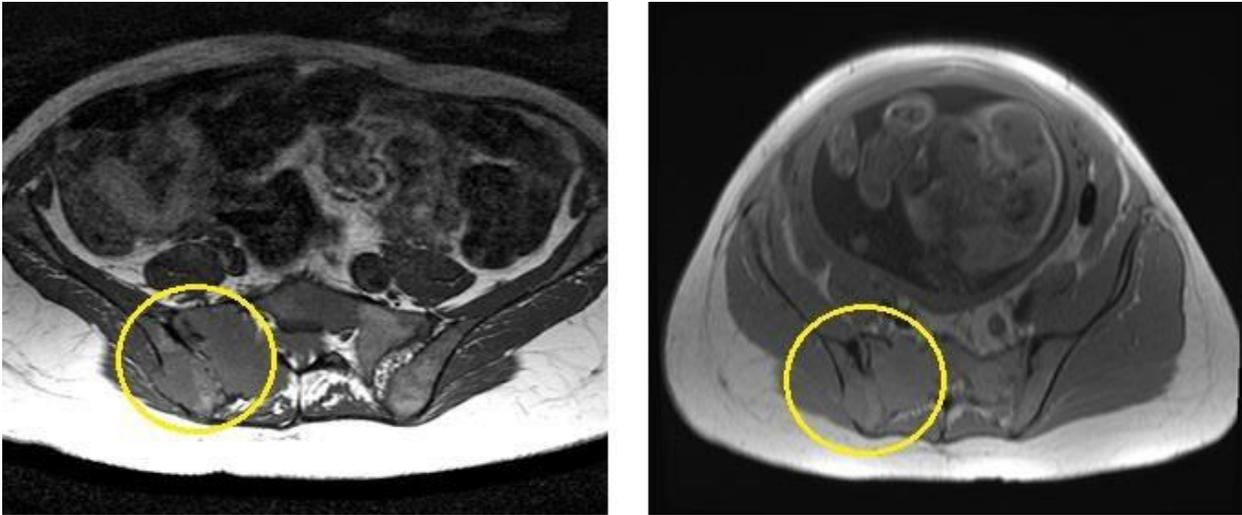


Figure 1

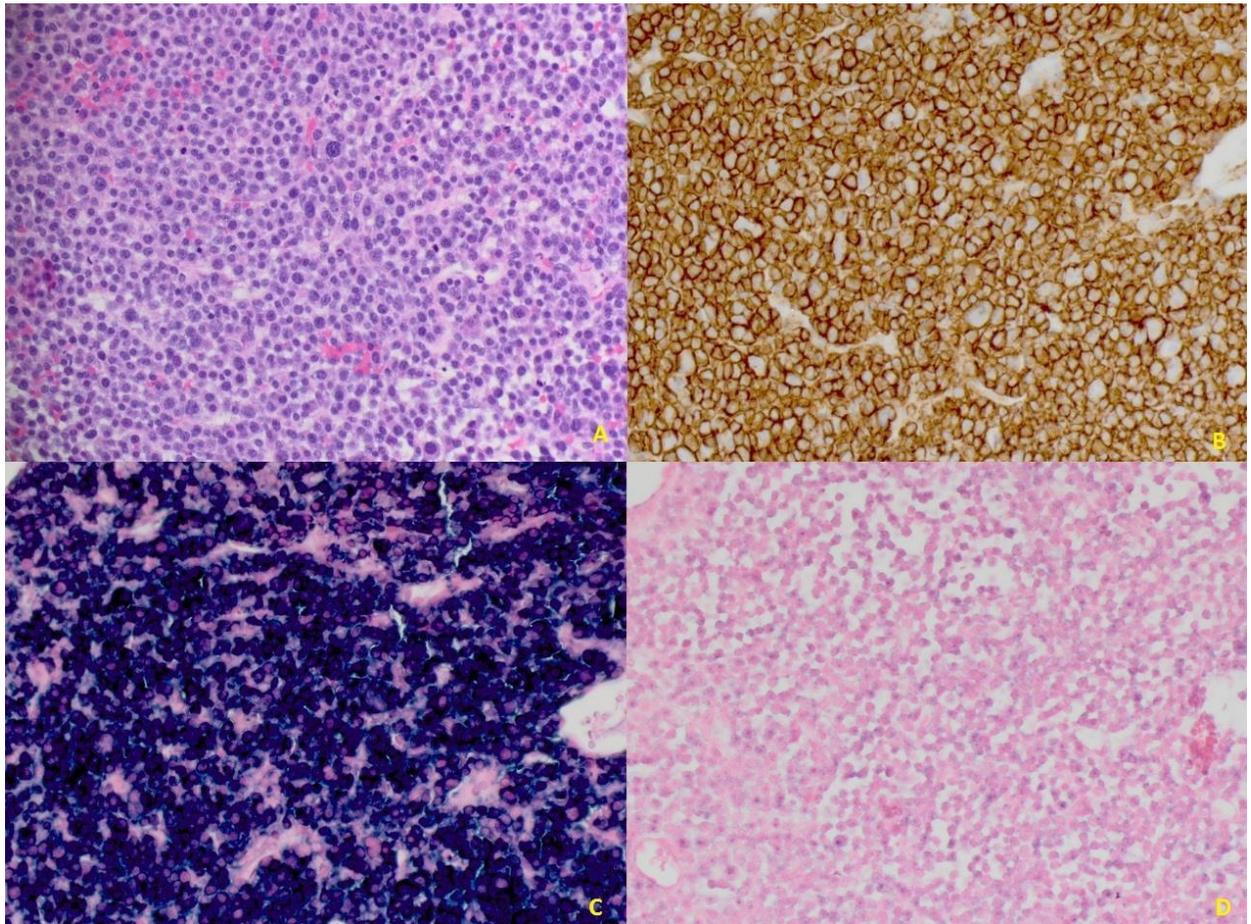


Figure 2

Intraoperative cardiac arrest secondary to pulmonary thromboembolism following graft reperfusion during an orthotopic liver transplantation: A case report

**Andrew K. Gold, MD**, Jared W. Feinman, MD, Elizabeth A. Valentine, MD

Department of Anesthesiology and Critical Care, Hospital of the University of Pennsylvania

Introduction:

Orthotopic liver transplantation (OLT) is a life-saving treatment for end stage liver disease patients. Intraoperative cardiac arrest (ICA) is a catastrophic complication, occurring in 1% – 5.5% of procedures.<sup>1,2</sup> ICA is most often attributed to post-reperfusion syndrome (PRS).<sup>3</sup> Venous thromboembolism (PE) is reported as the second most common cause of ICA during OLT, occurring in 1.2 – 6.2% of OLTs.<sup>4</sup> Intraoperative transesophageal echocardiography (TEE) is useful to aid diagnosis and treatment of PE, but TEE is not always used as a routine monitor during OLT.

Case Description:

A 48-year-old female with a history of sarcoidosis presented to the operating room for OLT. The patient tolerated the dissection and anhepatic stages well. The donor organ was implanted via caval-sparing technique with the assistance of venovenous bypass. Several minutes after reperfusion, the arterial blood pressure acutely dropped from 100/45 mmHg to 65/32 mmHg. At the same time, end tidal carbon dioxide decreased and central filling pressures increased. The hemodynamic derangements did not respond to escalating vasoactive support, culminating in a pulseless electrical activity arrest. ACLS was initiated with return of spontaneous circulation.

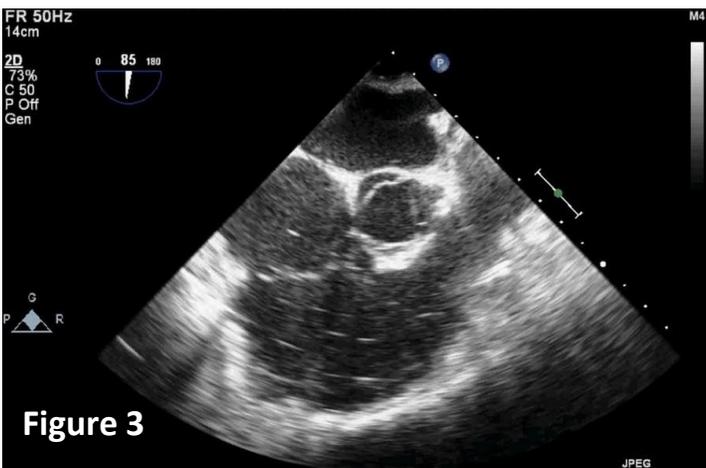
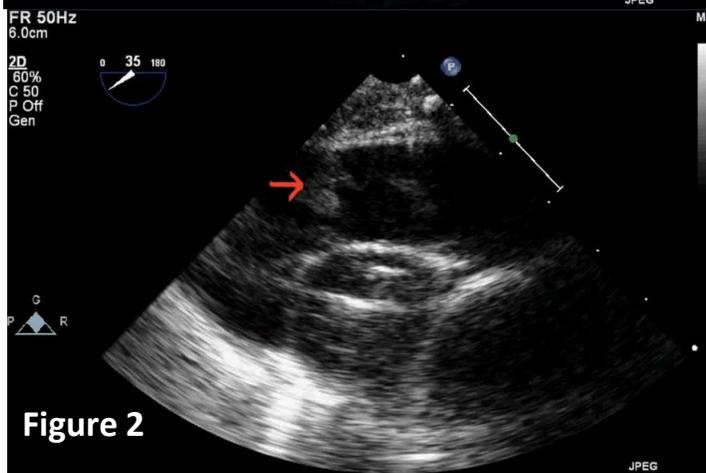
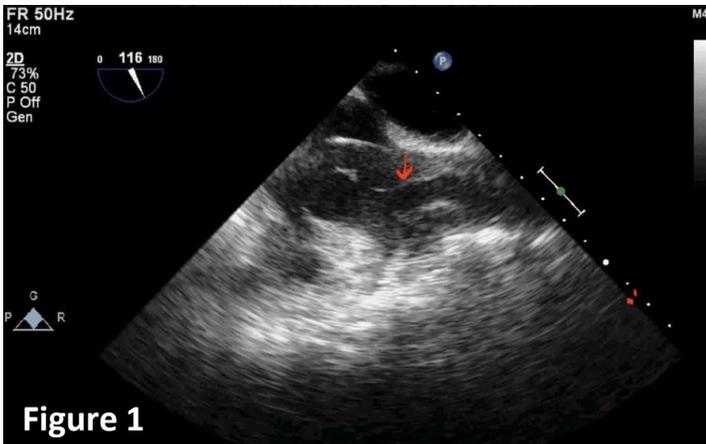
A TEE was obtained which demonstrated normal biventricular function, no regional wall motion abnormalities, and adequate intravascular volume. TEE also demonstrated thrombi adherent to the superior vena cava and right atrium (RA) (Figure 1) and additional clot burden in the right main pulmonary artery (PA) (Figure 2). The patient gradually stabilized with a reduction in vasopressor requirement. At this point, additional right atrial clot was seen to embolize from the RA to the main PA, followed by a second drop in arterial blood pressure and rise in central filling pressures. TEE at that time was notable for a dilated right ventricle with reduced motion of the midportion of the free wall (Figure 3). The thrombus in the main PA was seen to move distally, and hemodynamics improved. The patient tolerated the remainder of the procedure well, and was transferred to the surgical intensive care unit.

Discussion:

The hemodynamic derangements seen with PRS – a significant decrease in MAP, associated with a concomitant increase in central filling pressures – are indistinguishable from the those seen with PE. The clinical diagnosis of PE requires TEE to identify either thromboembolic material in the PA or acute right heart pressure overload +/- intra-cardiac clots, *in addition to* acute systemic

hypotension with elevated PA and CVP pressures.<sup>4</sup> In this case, intraoperative TEE confirmed the diagnosis of PE.

Visualization of dynamic cardiac function via TEE can be a valuable monitor during OLT. TEE allows for rapid qualitative assessment of cardiac function<sup>5</sup>. TEE can be especially helpful to manage hemodynamics after PE has occurred, monitor clot lysis, and guide the surgeon during embolectomy<sup>6</sup>. The American Society of Echocardiography (ASE) endorses TEE as a monitoring modality in OLT<sup>7</sup>, but high volume liver transplant centers vary in the routine use of TEE during OLT.<sup>8,9</sup> The risks and benefits of routine TEE must be weighed on an individual case basis, but TEE is an invaluable rescue tool in case of cardiovascular collapse.



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## Title: Anesthetic Management of Sequential Mitral Valve Replacement, Tricuspid Valve Repair, and Living-Donor Liver Transplantation

Authors: **Kristen K. Burton, MD** and Gaurav Malhotra, MD

Department of Anesthesiology and Critical Care, Hospital of the University of Pennsylvania

Introduction: Liver transplantation (LT) is relatively contraindicated in the setting of severe cardiac

disease. Similarly, the presence of end-stage liver disease confers significant risk to patients undergoing major cardiac surgery. Therefore, a select subset of patients with comorbid cardiac and end-stage liver disease benefits from combined cardiac surgery and liver transplantation. We present the successful anesthetic management of a patient with complex valvular pathology including severe mitral stenosis (MS) and tricuspid insufficiency (TI) with comorbid decompensated alcoholic cirrhosis who underwent sequential redo-sternotomy, mitral valve replacement (MVR), tricuspid repair (TR), and orthotopic LT from a living donor.

Case Report: JD is a 50-year-old female with a history of congenital aortic coarctation, subaortic stenosis, and parachute mitral valve status post remote coarctation repair, subaortic membrane resection, and MVR who presented with volume overload and heart failure secondary to severe MS and TI with comorbid decompensated alcoholic cirrhosis. Her liver disease was complicated by hepatorenal syndrome with a peak serum creatinine of 2.9mg/dL, hepatic encephalopathy, and refractory ascites with a Model for End Stage Liver Disease (MELD) score of 28 (Child Class C). Transthoracic echocardiography (TTE) additionally demonstrated mild to moderate mitral and aortic regurgitation, a moderately dilated right ventricle (RV) with normal function, severely elevated pulmonary arterial systolic pressure of 62mmHg, and a left ventricular ejection fraction of 65%. Right heart catheterization corroborated severe volume overload, severe TI, and elevated pulmonary arterial pressures (PAP) secondary to volume overload and elevated cardiac index (CI) in the setting of a normal peripheral vascular resistance. The patient was felt to be too high risk for staged valve replacement and LT. However, an allograft from a living donor was offered. Therefore, after multidisciplinary consultation with cardiac and transplant surgery and cardiac and transplant anesthesia, an elective combined procedure was planned. A pre-induction brachial arterial line was placed and after an uneventful induction and intubation, inhaled epoprostenol was initiated for RV afterload reduction. Opening pressures included central venous pressure of 20mmHg and PAP of 48/28mmHg with a CI of 3.5L/minute/m<sup>2</sup> and mixed venous oxygen saturation of 77%. Transesophageal echocardiography (TEE) confirmed preoperative TTE findings in addition to mild aortic stenosis. Aminocaproic acid and methylene blue were

administered for prophylaxis of fibrinolysis and vasoplegic syndrome, respectively. The patient required a vasopressin infusion for mean arterial pressure support during cardiopulmonary bypass (CPB) but underwent uneventful MVR and TR. She successfully weaned from bypass after a total of 88 minutes on vasopressin at 0.04 units/minute and epinephrine at 4mcg/minute. Postoperative TEE revealed normal gradients across the mitral and tricuspid valve prostheses and preserved RV function. Systemic anticoagulation was reversed with protamine. The patient's underlying cardiac rhythm was complete heart block; she was therefore ventricular-paced with intracardiac wires. The chest was left open, and after hepatic dissection the patient was placed on veno-veno bypass using the right atrial cannula as the venous return cannula. During transplantation she underwent an uneventful reperfusion, requiring one gram of calcium chloride and 24mcg of epinephrine. The hepatic artery was anastomosed microscopically by plastic surgery. Ten units of packed red cells, 1600mL cell saver, 11 units fresh frozen plasma, 5 doses of platelets, and 5 units of cryoprecipitate were administered in addition to 2,000mL of crystalloid. She was transferred to the intensive care unit intubated on epoprostenol and stable doses of

epinephrine and vasopressin. The patient was extubated on postoperative day #1 and epinephrine and vasopressin infusions were discontinued on postop day #2. She underwent dual chamber permanent pacemaker implantation on postop day #6 for persistent complete heart block. Three weeks post-operatively, she continues to do well with likely imminent discharge from the post-surgical floor. Discussion: Despite advances in medical therapy, liver transplantation remains the sole effective treatment for end-stage liver disease. Severe cardiac disease is a relative contraindication to liver transplantation secondary to expected hemodynamic and intravascular volume derangement associated with the procedure<sup>1</sup>. On the other hand, coagulopathy from advanced liver disease confers significant risk for major cardiac operations. Further, the use of cardiopulmonary bypass is associated with serious perioperative morbidity and mortality from resultant liver failure<sup>23</sup>. Therefore, a select subset of patients with comorbid cardiac and end stage liver disease benefits from simultaneous cardiac surgery and liver transplantation, including our patient, JD. While rare overall, on literature review most case reports describe combined orthotopic liver transplantation with orthotopic heart transplantation, coronary artery bypass grafting, and aortic valve repair<sup>4</sup>. Our experience with a patient with both complex cardiac valvular pathology and advanced decompensated liver disease reflects the importance of careful perioperative planning and coordination among a multidisciplinary team of anesthesiologists and surgeons.

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Title: Minimally invasive temporary Tandem Heart-right ventricular support device (CF-RVSD) in a patient with right ventricular failure (RVF) during complex left ventricular assist device (LVAD) exchange.

## Introduction

RVF is one of the serious complications following LVAD surgery and is associated with significant morbidity and mortality. (1) We report a case of a successful temporary Tandem heart (RVSD) for RVF in a setting of LVAD exchange surgery.

## Case Presentation

A 33 year-old female with diabetes, Hypertension, peripartum cardiomyopathy (EF15%) with a HeartMate II LVAD implanted in January 2016 as a destination therapy (DT), was admitted with fever, nausea, vomiting, chest tightness, and abdominal pain. Her postoperative course (8 months) was complicated with multiple admissions for methicillin susceptible staphylococcus aureus (MSSA) bacteremia, recurrent wound wash outs, a pectoral flap surgery. Physical examination was significant for abdominal wall tenderness and induration related to drive line infection confirmed to be MSSA. Ultrasonography and CT demonstrated a 4.1 x 2.5 cm fluid around LVAD driveline. Patient was deemed non curable after aggressive antibiotic therapy by the infectious disease consultants and underwent a device exchange.

Under general anesthesia, a radial arterial line and Rt internal jugular pulmonary artery catheter and trans-esophageal echocardiography (TEE) were placed. After Full flow cardiopulmonary bypass the device was switched off. Two clamps were applied to the outflow graft, one close to the device and another as distal as possible on the exposed part. The graft was divided between these clamps closer to the device. New driveline course was created for Centrimag LVAD. Patients RV function deteriorated during the course of surgery. TEE demonstrated refractory pulmonary hypertension and RVF and PA catheter showed CVP of 27 mmHg, PA of 82/36(29) mmHg, CCO of 3.5 L/min, CCI of 1.56 L/min/m<sup>2</sup>, SVR of 575 dyn.s.cm<sup>-5</sup>

Inotropes and vasodilators failed to augment RV function; a percutaneous Tandem RVAD placement with a 29 Fr PROTEKDuo cannula was performed emergently under fluoroscopy. A 0.025 T-J wire was passed through the PA catheter extending from the IJV, via brachiocephalic vein and superior vena cava, into the right atrium and ventricle, then through the pulmonary valve into the PA. The cannula was passed over the wire and positioned in the RA with outflow port beyond the pulmonary valve. The proximal and distal cannulae were then connected to the Tandem system and RVAD was established with stable flow (3.5 L/min, 3000 rpms). LVAD flow was also increased (5.6 L/min, 7400 rpms). Cardiac output and hemodynamics improved exponentially after RVAD placement, reducing the need for pharmacologic support. Stabilized RV function overcame the patient's pulmonary hypertension, and sufficient LV filling thereby enabling proper LVAD function, which improved cardiac output. The Tandem device was weaned off on POD 5.

## Discussion

LVAD exchange may be an option for the treatment for severe and persistent infections despite antimicrobial treatment but is a complex procedure. The incidence of RVF is 0.1% post cardiopulmonary bypass, 2- 3% post cardiac transplant, and as high as 30-40% following LVAD.

(1) Despite significant improvements in medical management, 6 % of patients do require a temporary RV mechanical support. (2) Temporary support of the failing RV after LVAD explant and or exchange using temporary vein and the pulmonary artery (RVAD) is a promising therapeutic option. (3) For our case a minimally invasive Tandem (RVSD) offered an easily deployed quick support avoiding the field of infection (LVAD driveline path).

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## Veno-Arterial ECMO as a Bridge to Surgical Repair in the Setting of Post-Infarct Ventricular Septal Defect

Regina Linganna, MD and Jared Feinman, MD University of Pennsylvania

Department of Anesthesiology and Critical Care

Post-infarct VSD is a known complication of myocardial infarction with a mortality rate of greater than 90% at 30 days if managed medically.<sup>1</sup> Death results from cardiogenic shock, and bridging interventions are aimed at managing the cardiogenic shock until a definitive surgical repair can be performed. It has been shown that patients undergoing repair 72 hours after the initial incident have a 3-fold decrease in mortality compared to those undergoing repair at 24 hours<sup>2</sup>. We present a case of a patient with post-infarct VSD, who was bridged to surgical repair with peripherally cannulated veno-arterial extracorporeal membrane oxygenation (VA-ECMO).

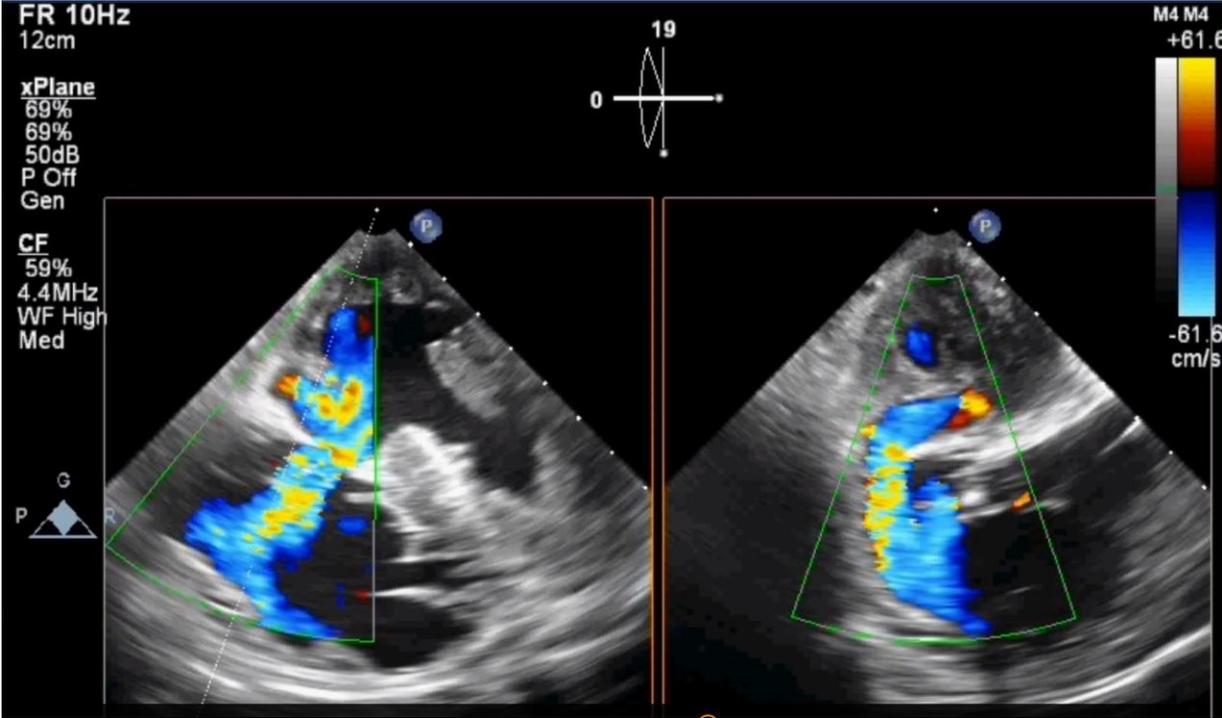
A 63 year old female was transferred from an outside hospital with an inferior wall STEMI, a post-infarct VSD, and cardiogenic shock with an intraaortic balloon pump (IABP) in place. Cardiac catheterization revealed occlusion of a dominant right coronary artery (RCA) and a Qp/Qs ratio of 3.8:1. The patient began to show signs of end-organ dysfunction, including rising creatinine and liver function tests. The decision was made to place this patient on peripheral VA-ECMO. The intraoperative transesophageal echocardiogram (TEE) at this time revealed a large postero-basilar VSD with severe right ventricular (RV) dilation and hypokinesis (Image 1). Over the course of three days, the end-organ dysfunction gradually improved, and the decision was made to take the patient to the operating room to repair the VSD, bypass the RCA, and decannulate from ECMO. The VSD was repaired with a pericardial patch, and the RCA bypassed with a saphenous vein graft. The patient was decannulated and the IABP remained in place. The postoperative TEE revealed no residual leak around the VSD and improved RV function on inotropic support. Two days after the VSD repair, the IABP was removed.

Post-infarct VSD is an uncommon, high-mortality complication of myocardial infarction. The ischemic septum results in a VSD and left-to-right shunt, significantly increasing the work of the right ventricle. Placement of an IABP can improve the resultant cardiogenic shock as it will decrease the left ventricular afterload, decreasing the left-to-right shunt. Simultaneously, it increases perfusion to the coronary arteries, which aids in healing the ischemic tissue, helping to create healthy tissue to sew the VSD patch. Given that this patient's cardiogenic shock progressed despite an IABP, peripheral ECMO was indicated. Systemic perfusion improved while the heart rested on VA ECMO, allowing the end-organs to recover. It additionally allowed for healing of the ischemic tissue surrounding the VSD, optimizing placement of the pericardial patch. Resting this patient on VA-ECMO optimized her hemodynamics prior VSD patch placement, ultimately preparing her for a successful outcome.

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Image 1: Transesophageal echocardiogram (TEE) of large postero-basilar VSD with severe right ventricular (RV) dilation and hypokinesis



## SGLT-2 inhibitor-associated Perioperative Euglycemic Diabetic Ketoacidosis: The Case for a Perioperative Guideline

**Authors:** Onyechi Sylvester Megafu, Michael Green

Department of Anesthesiology

Drexel University College of Medicine/HUH

### Abstract

**Introduction:** Sodium glucose cotransporter-2 Inhibitors (SGLT-2) are a class of oral hypoglycemic agents approved for the treatment of type 2 Diabetes Mellitus in the United States. These drugs work by inhibiting the reabsorption of glucose in the proximal tubule of the kidneys. The Food and Drug Administration listed **Euglycemic Diabetic ketoacidosis** as a rare adverse reaction of SGLT-2 inhibitors since its approval for use. Euglycemic diabetic ketoacidosis is defined as ketoacidosis in a diabetic with a normal or near-normal blood glucose level (<15mmol/l). Few studies have also associated the use of SGLT-2 inhibitors with increased risk of Diabetic ketoacidosis (DKA) as well as polyuria and glycosuria. The stress of surgery, anesthesia, reduced insulin secretion coupled with starvation (fasting), which is an important perioperative requirement for most elective surgeries have been identified as triggers for diabetic ketoacidosis. DKA has a high mortality rate and perioperative recommendations to limit the risk of developing DKA in type 2 diabetic patients on SGLT-2 inhibitors have yet to address the risk.

**Case Presentation:** We report a 55-year-old caucasian female with a history of type 2 diabetes mellitus treated with invokana, a sodium glucose cotransporter-2 inhibitor for elective breast reconstruction surgery under general anesthesia who developed perioperative euglycemic diabetic ketoacidosis with prolonged polyuria.

**Discussion:** Our patient developed perioperative Euglycemic Diabetes Ketoacidosis despite good glycemic control and adherence to existing recommendations. Previous studies have attributed the increase in the incidence of DKA in diabetics on SGLT-2 inhibitors to factors like the spike in gluconeogenesis, glucose clearance, volume depletion and ketogenesis caused by SGLT-2 inhibitors. Gastroparesis, which is a major complication of diabetes mellitus, low carbohydrate diet, starvation, surgery, anesthesia and acute illness have also been identified as triggers for DKA. Our patient had type 2 diabetes mellitus and some of these triggers noted in previous studies like starvation since she had to fast for about 12 hours prior to surgery, gastroparesis as evidenced by a history of GERD as well as surgery and anesthesia. SGLT-2 inhibitors have a half-life of about 10-13 hours even though their effect has been reported to last up to 11 days. Our patient had polyuria and glycosuria for a few days while she was on admission.

**Conclusion:** We conclude that a type 2 DM patient on SGLT-2 inhibitor can develop perioperative euglycemic DKA, prolonged polyuria and glycosuria despite good glycemic control and adherence to existing recommendations. There is a need for high vigilance in type 2 DM patients taking SGLT-2 inhibitor as normal blood glucose level does not preclude the presence of DKA as seen in our patient. Our case report makes the case that more perioperative studies and clinical reviews of cases of type 2 Diabetes mellitus patients taking SGLT-2 inhibitor are needed to come up with a standard guideline that will prevent or reduce the risk of

perioperative DKA as this will not only reduce morbidity and mortality but will significantly reduce costs and length of hospital stay.

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## Successful Intraoperative Use of Low-Pressure Continuous Positive Airway Pressure With A Mapleson D Breathing Circuit To Identify An Invisible Bronchopleural Fistula In A Post-Lobectomy Patient

Christopher Lam, MD<sup>1</sup>, Kevin Wong, DO<sup>1</sup>, Matthew A. Facktor, MD<sup>2</sup>, and Xiaopeng Zhang, MD, PhD<sup>1</sup><sup>1</sup>Division of Anesthesiology, Geisinger Medical Center, Danville, PA

<sup>2</sup>Division of Thoracic Surgery, Geisinger Medical Center, Danville, PA

**Introduction:** Bronchopleural fistula (BPF) is a well-documented complication associated with pulmonary resection. Postoperative incidence of BPF varies from 1.3% to 34.3% with mortality rates up to 67%. Common etiologies of BPF include surgical procedures, chest trauma, and pulmonary infection. Most air leaks spontaneously resolve within hours to days. However, patients with prolonged air leak (PAL) require conservative management. When these measures fail, surgical repair with a transposed extra thoracic muscle flap is required. Here we describe the use of low-pressure continuous positive airway pressure (CPAP) with a Mapleson D circuit to identify an air leak at the bronchial stump that was otherwise not visibly evident.

**Case Description:** A 58-year-old male with 60-pack-year smoking history and severe chronic obstructive pulmonary disease underwent a scheduled video-assisted thoracoscopy (VATS) for right lower lobectomy. Postoperatively, he developed a large right pneumothorax due to persistent air leak despite two weeks of chest tube drainage. Subsequently he returned to the operating room (OR) on postoperative day 18 for further evaluation. Anesthetic induction was uneventful and airway was secured with a 39-French left-sided double-lumen endotracheal tube (DLT) using direct laryngoscopy. Proper DLT placement was confirmed using bronchoscopy. Diagnostic bronchoscopy revealed a grossly intact right lower lobe bronchial stump and normal-appearing airway anatomy. Careful inspection of the lung parenchyma and bronchial stump via right-sided VATS demonstrated an intact staple line without obvious air leak. A discussion between the surgeon and anesthesiologist to further delineate the source of air leak resulted in the plan to fill the right pleural space with water while providing low-pressure CPAP to the non-ventilated lung using a Mapleson D circuit. An exposed area of the right lower lobe bronchus demonstrated a small air leak with no visible opening or staple line disruption. With the air leak identified at the bronchial stump, the ipsilateral latissimus dorsi muscle flap was transposed to cover the BPF. The patient tolerated one-lung ventilation (OLV) and extubated uneventfully in the OR. Following the removal of chest tube at his one-month follow-up visit, he had no recurrent pneumothorax.

**Discussion:** A prolonged air leak from disruption of lung parenchyma or staple line is a complication that causes significant morbidity, prolonged hospitalization, and mortality. Our patient had a significant right pneumothorax due to PAL despite prolonged period of conservative treatments. Intra operative one-lung ventilation was uneventful, but identification of the air leak proved to be challenging. Low-pressure CPAP of the non-ventilated lung facilitated identification of the air leak at the bronchial stump that was otherwise not visibly evident.

**Conclusion:** Low-pressure CPAP through a simple Mapleson D circuit applied to the surgical lung coordinated by the anesthesiologist and surgeon can help visualize an invisible air leak.

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# A Case of non-lethal air Embolism during Bone Marrow Harvesting.

Rayhan Tariq, M.D; Mian Ahmad, M.D.

## **Drexel University College of Medicine/ Hahnemann University Hospital. Department of Anesthesiology**

### Introduction:

Bone Marrow harvesting is generally recognized as a safe procedure and is traditionally performed as an ambulatory surgery.[1][2] complications such as hemorrhage or infection at the puncture sites exists A survey of 493 volunteer via donors National Marrow Donor Program (NMDP) showed that bone marrow harvesting has minimal complications; Acute complications related to the *collection procedure* occurred in 5.9% of donors; only one donor had the serious complication of apnea during anesthesia.[3] The outpatient setting offers cost and time advantages to the patients.[4]

### Case Presentation:

We describe the case of a healthy 23-year-old male who was undergoing bone marrow harvest for an allogenic bone marrow transplant. He was an ASA-I patient with no past medical or surgical history. Patient was stable under general endotracheal anesthesia in a prone position and case was proceeding normally. Ten minutes after the start of aspiration of bone marrow from both posterior inferior iliac spine areas suddenly his blood pressure fell from 125/90 to 60/26 and EtCO<sub>2</sub> from 36 to 12. An assumption of air embolism was made and surgeon was immediately notified to stop the procedure and flood the operative area with saline. A bolus of 12 mcg of Epinephrine was administered intravenously. The patient was immediately put into Reverse-Trendelenburg position while prone, in order to displace the position of wound on PSIS inferior to the right atrium. Blood pressure returned to normal level within three minutes and EtCO<sub>2</sub> also returned to normal value albeit slowly. Rest of the procedure was completed uneventfully. Patient was extubated at the end of the procedure and was discharged home the same day.

#### Discussion:

The primary physiological effects of VAE are elevated pulmonary artery pressures, increased ventilation-perfusion inhomogeneity, and right ventricular failure. [5] The exact cardiovascular, pulmonary, and neurologic effect is dependent on the rate and entrained volume of air. There are various methods for detecting embolism described in the literature. The most sensitive method is TEE, detecting as little as 0.02 ml/kg of air. The precordial Doppler is the most sensitive of the noninvasive monitors.

However, for most low to moderate risk surgeries it is sufficient to rely on EtCO<sub>2</sub>. EtCO<sub>2</sub> unfortunately lacks specificity, especially in scenario of systemic hypotension. In addition, monitoring of Et nitrogen, PA pressure, Cardiac output and/or CVP, blood pressure, and EKG changes of RV strain pattern or ST depression can all point to a VAE.

#### Conclusion:

We theorize that in our case either the PSIS level was higher than the heart or one of the operators inadvertently injected air via the 50 CC syringe they were using to aspirate the bone marrow. Another possibility is that correctly placed supports for the chest and pelvis could have created negative pressure in the free hanging abdomen and inferior vena cava. [6] Vertical gradient between PSIS and vena cava under these circumstances could have predisposed our patient to entrainment of air.

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Figures:



