

# Anesthetic Considerations & Management for MitraClip® Implantation

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## Introduction

Mitral regurgitation (MR) is one of the most prevalent valvular heart diseases in the US, affecting more than 2.5 million adults in 2014, and is expected to double by 2030.<sup>1</sup> MR occurs when the mitral valve (MV) fails to close completely, resulting in retrograde blood flow from the left ventricle (LV) into the left atrium (LA). There are two types of MR: 1.) Primary (aka, Degenerative) MR, which occurs when the MV itself is dysfunctional, and 2.) Secondary (aka, Functional) MR, occurs when an abnormality outside of the MV, such as LV or LA dilation, causes the regurgitation.<sup>2</sup> Without surgical intervention, the prognosis for patients with moderate-to-severe MR is poor. However, nearly 50% of patients with severe MR are considered too high risk for traditional valve replacement surgery.<sup>3,8</sup> Fortunately, there are now minimally invasive options available to treat these patients.

Transcatheter Edge-to-Edge Repair of the mitral valve (mTEER) is a minimally invasive percutaneous treatment option for patients with moderate-to-severe MR. mTEER technology is based on the Alfieri stitch (aka "Bow-Tie Repair"), a surgical technique that involves placing a single suture between the middle segments of the anterior and posterior MV leaflets (A2-P2), resulting in the creation of two MV orifices and a considerable reduction in MR.<sup>4,8</sup> Currently, there are only two devices approved by the US Food and Drug Administration (FDA) for mTEER – PASCAL and MitraClip.

The MitraClip (Abbott Vascular) is an mTEER device used to treat MR in high-risk surgical patients. Since receiving FDA approval for primary and secondary MR in 2013 and 2019 respectively, MitraClip implantation volume has grown significantly, and MitraClip therapy has become a reliable treatment option for patients with MR.<sup>4</sup> As the prevalence of MR continues to rise, anesthesia providers will become more likely to encounter the MitraClip procedure and will increasingly be called upon to provide care for these high-risk patients. The intent of this presentation is to educate anesthesiologists on the MitraClip procedure and provide practical information to improve the anesthetic management of patients undergoing MitraClip implantation.

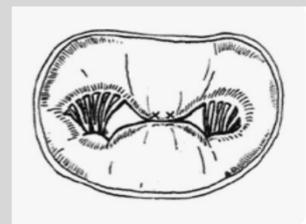


Figure 1.) Alfieri stitch<sup>8</sup>



Figure 2.) MitraClip<sup>8</sup>

## MitraClip Prevalence

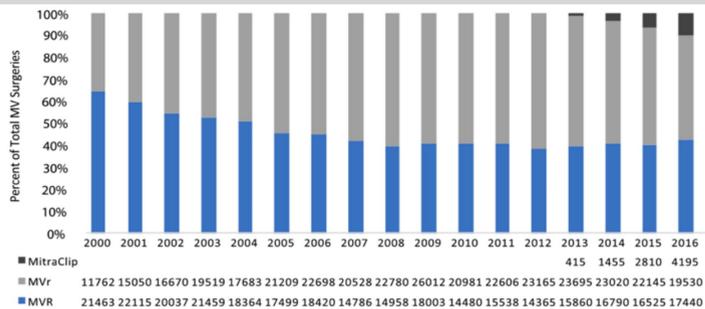


Figure 3.) Distribution of Mitral Valve Interventions<sup>5</sup>

Since receiving FDA approval for Degenerative MR, the number of MitraClip implantation procedures increased by ~80% annually from 2013 to 2016, while the total number of MV surgeries remained relatively consistent. Importantly, this data was collected prior to the FDA expansion approval of MitraClip for Functional MR in 2019. Therefore, it is reasonable to believe that MitraClip implantation now accounts for >20% of all MV surgeries in the US.

## Anesthetic Considerations

Table 1.) Baseline Characteristics of Patients Who Underwent MV Intervention from 2000 – 2016 by Procedure Type<sup>5</sup>

	MVR (N = 298,102)	MVr (N = 349,053)	MitraClip (N = 8,875)
<b>Average Age (years)</b>	64.7	64.4	77.0
<b>Comorbid Conditions (%)</b>			
• Rheumatic Heart Disease	31.2	16.6	9.6
• Congestive Heart Failure	51	44.5	69.9
• Hypertension	48.8	51.3	66.3
• Peripheral Vascular Disease	7.1	7.1	12.5
• Chronic Lung Disease	21.3	17	26.3
• Diabetes Mellitus	24	17.4	33.5
• Diabetes Mellitus with Complication	14.4	14.3	17.6
• Obesity	3.3	3.3	6.8
• Liver Disease	7.9	7.6	8.8
• Chronic Kidney Disease	1.4	1.1	2.6
• Anemia	11.2	10.1	35.6
• Neurologic Disease	12.7	12.5	21.1
• Hypothyroidism	3.7	3.1	4.3
• Rheumatoid Arthritis	9.3	8.2	17.8
• Alcohol Abuse	2.5	1.9	4.2
• Drug Abuse	1.5	1.8	1.0
• Depression	1	0.9	0.6
	4.7	4.4	6.8
<b>Elixhauser Comorbidity Score, Median [IQR]</b>	6.8 [2.6-11.5]	6.2 [0.8-10.5]	10.1 [6.2-14.3]
<b>Severity of Illness (2002-2016)* (%)</b>			
• Minor	0	23.6	1.3
• Moderate	23.3	10.6	52.1
• Severe	76.7	65.8	46.7
<b>Risk of Mortality (2002-2016)* (%)</b>			
• Minor	0.1	17.8	7.4
• Moderate	47.2	37.9	46.3
• Severe	52.6	44.2	46.4
<b>Observed Outcomes:</b>			
• Length of Stay (Days), Median [IQR]	9.7 [6.4-15.9]	7.6 [5.0-12.9]	2.2 [0.9-5.0]
• Died During Hospitalization (%)	7.8	4.2	1.7

MVR = Mitral Valve Replacement; MVr = Mitral Valve repair  
\*Data was not available before 2002

**Key Findings:** MitraClip patients are considerably older and have more comorbidities yet demonstrate significantly better observed outcomes compared to patients who undergo traditional MV interventions (MVR + MVr).

The most common comorbidities in MitraClip patients are CHF, HTN, CKD, DM, and Chronic Lung Disease, which are present in >25% of all cases. These conditions must be considered when formulating and implementing a safe anesthetic plan.

**Risk Stratification:** Preoperative risk assessment is performed using MitraScore, a simple 8-item algorithm that reliably predicts postoperative mortality and supports clinical decision-making for patients treated with mTEER. The MitraScore assigns one point to each independent predictor, as shown below. With each point of the MitraScore, the relative risk of postoperative mortality increases by 55%.<sup>3</sup>

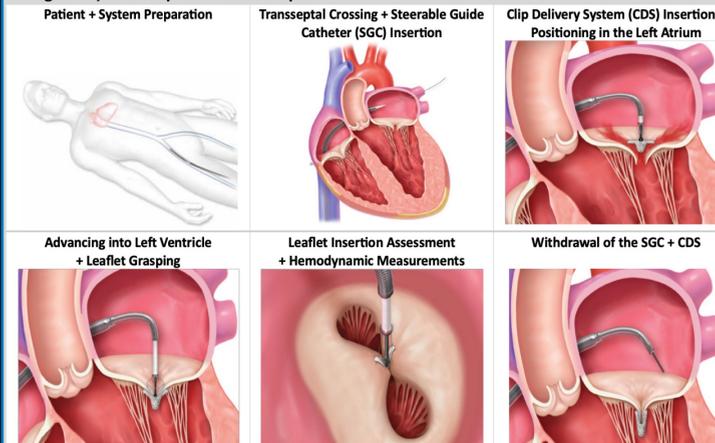
Variable	MitraScore	Points
Age ≥ 75 years		1
LV EJ < 40%		1
Anemia		1
eGFR < 60 ml/min/1.73m <sup>2</sup>		1
Peripheral Artery Disease		1
CPD		1
High Diuretic Dose		1
No therapy with RAS inhibitors		1
<b>Total:</b>		<b>8</b>

Table 2.) MitraScore Preoperative Risk Assessment Algorithm

## Anesthetic Management

MitraClip implantation is typically performed in cardiac catheterization laboratories under transesophageal echocardiographic (TEE) guidance. Due to the need for TEE guidance and careful device manipulation, the procedure is usually performed under general anesthesia with ETT placement, though several studies have demonstrated the feasibility of deep sedation as well.<sup>6</sup> Patients typically receive a pre/post-induction radial arterial line and defibrillator pads. Anesthetic induction strategies are patient-specific; however, the presence of severe MR and other comorbidities typically direct the hemodynamic goals. Optimization of anesthetic management is best achieved when providers understand the hemodynamic goals and potential complications associated with different steps in the procedural process.

Figure 4.) MitraClip Procedural Steps:



**Patient + System Preparation:** Defibrillator pads should be placed before induction of anesthesia. A cardio-stable induction technique utilizing high-dose opioids and low-dose propofol or etomidate is preferred for MitraClip patients due to their significant cardiac comorbidities. Arterial line placement is standard to allow for hemodynamic surveillance and activated clotting time (ACT) monitoring intraoperatively.<sup>4,8</sup>

**Transeptal Crossing + SGC Insertion:** Heparin is given to prevent clotting of the SGC and CDS. The procedural team will inform when to dose Heparin initially. An ACT goal of > 250 seconds should be maintained for the duration of the procedure. To minimize the risk associated with transeptal puncture (TSP), many anesthesiologists give ~3000 U of Heparin before TSP and wait to fully heparinize until access to the LA has been achieved without complication.<sup>4,8</sup>

**CDS Insertion + Positioning in the LA:** The primary anesthetic goal during this portion of the procedure is to optimize/maintain hemodynamics. Anesthetists should be aware that arterial hypotension may occur when the device crosses the MV (see below). Treatment should consist of IV crystalloids and vasopressors only if necessary.<sup>4,8</sup>

**Advancing into the LV + Leaflet Grasping:** As the clip is positioned and placed, it may occlude blood flow from the LA to the LV. Be prepared to treat the consequent hypotension but communicate with the procedural team as this phenomenon may be transient and you do not want to overtreat and cause hypertension. The procedural team may request a temporary suspension of mechanical ventilation to facilitate grasping of the mitral leaflets.<sup>4,8</sup>

**Leaflet Insertion Assessment + Hemodynamic Measurements:** Return the patient's vital signs to their baseline levels to allow for assessment of any residual MR and determination of the mean diastolic pressure gradient. If the clip requires repositioning, the previous steps will be repeated.<sup>4,8</sup> It is important to be aware that MR allows a systolic unloading effect by providing a low-resistance outlet for blood to travel back into the LA, presenting as a falsely elevated LV ejection fraction (EF) and potentially masking LV failure.<sup>7</sup> Therefore, patients may present postoperatively with a considerably reduced LVEF secondary to increased afterload from removing the low-resistance regurgitant pathway and may require inotropic support.

**Withdrawal of the SGC + CDS:** Protamine may be considered to reverse heparinization if required to facilitate hemostasis. If indicated, administer a test dose (1mg) and evaluate for signs of anaphylactoid reaction. Be cautious not to exceed an administration rate of 50 mg over 10 minutes. Before extubating, evaluate the patient's airway for possible bleeding from TEE probe manipulation.<sup>4,8</sup>

## Case Report

An 82-year-old M with known 3v CAD, severe degenerative MR, pAF s/p Watchman, and recent GI bleed with NYHA Class II DOE considered too high risk for MVR/CABG and therefore presents for mTEER.

The procedure was performed under general anesthesia. The patient was intubated via direct laryngoscopy with a MAC 3 blade and 7mm oral, cuffed ETT. A post-induction radial arterial line was placed under ultrasound guidance for intraoperative hemodynamic monitoring. The procedural team instructed intraoperative ACT goals of > 250 seconds and HR goals of 80-100 bpm. Intraoperative TEE was performed to facilitate MitraClip placement and evaluate efficacy. The procedure was uncomplicated and lasted approximately 2.5 hours.

Induction:	Maintenance:	Emergence:
Fentanyl: 200 mcg	Sevoflurane: 1.2% @ 2 L/min	Ondansetron: 4 mg
Lidocaine: 100 mg	Phenylephrine: 0.5 mcg/kg/min	Sugammadex: 150 mg
Propofol: 50 mg	Dobutamine: 1-2 mcg/kg/min	Protamine: 20 mg
Rocuronium: 100 mg	Dexamethasone: 4 mg	
	Vancomycin: 1g	
	Hydromorphone: 1 mg	
	Heparin per procedural team	

The next morning the patient received a TTE, which demonstrated a good position of the MitraClip and a stable ejection fraction. He was deemed stable for discharge and was sent home with recommendations to follow up in approximately one week, one month, and one year with echocardiograms.

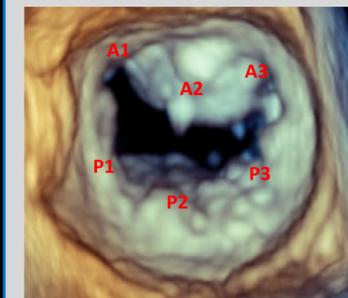


Figure 5.) Preoperative View of the MV

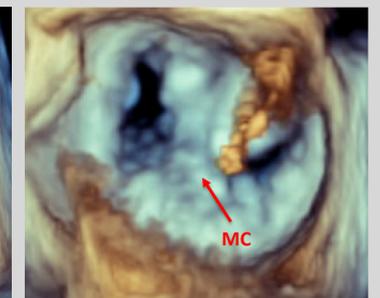


Figure 6.) Postoperative View of the MV

**Preoperative TEE Interpretation:** Severe, anteriorly directed mitral regurgitation due to flail P2 posterior leaflet. PISA = >10mm; consistent with Grade 4 mitral regurgitation.

**Postoperative TEE Interpretation:** Successful implantation of one clip along the A2-P2 scallops with mild residual mitral regurgitation. Mitral regurgitation is anteriorly directed and just lateral to the MitraClip. Mean diastolic gradient 3-4 mmHg.

## Conclusions

MitraClip implantation is an increasingly popular mTEER procedure used to treat moderate-to-severe MR in high-risk surgical patients and anesthesia providers play a key role in caring for these patients. With a comprehensive understanding of common patient comorbidities, potential intraoperative complications, and opportunities to optimize perioperative care, anesthesiologists can help maximize procedural success and minimize the risk of procedural complications in this high-risk patient population.

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# Opioid Sparing Techniques Impact on Patient Recovery After Abdominal Surgery

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## Introduction

This research proposal aims to explore the impact of implementing non-opioid medications in managing postoperative pain for patients undergoing abdominal surgeries. Traditional pain management often relies on opioids, which can lead to adverse effects and dependence. By conducting a prospective observational study, we will assess the effects of non-opioid medications on pain management, opioid use, and patient recovery. This study aims to provide valuable insights for clinicians to optimize patient care and promote enhanced recovery in this surgical population.

## Methods

Prospective study on opioid-sparing techniques in abdominal surgery: 100 patients aged 18-75, ASA score 1 or 2, divided into intervention and control groups. Intervention: epidural anesthesia or ketamine-lidocaine; Control: opioid-based analgesia. Postoperative pain assessed with VAS/NRS scales at 6, 24, and 48 hours. Opioid use recorded and recovery outcomes (ambulation time, hospital stay, bowel movement, complications) noted. Statistical analysis to compare groups. Goal: Assess impact of opioid-sparing techniques on pain management, opioid use, and patient recovery.

## Results

Anticipated Outcomes of Opioid-Sparing Techniques in Abdominal Surgeries:

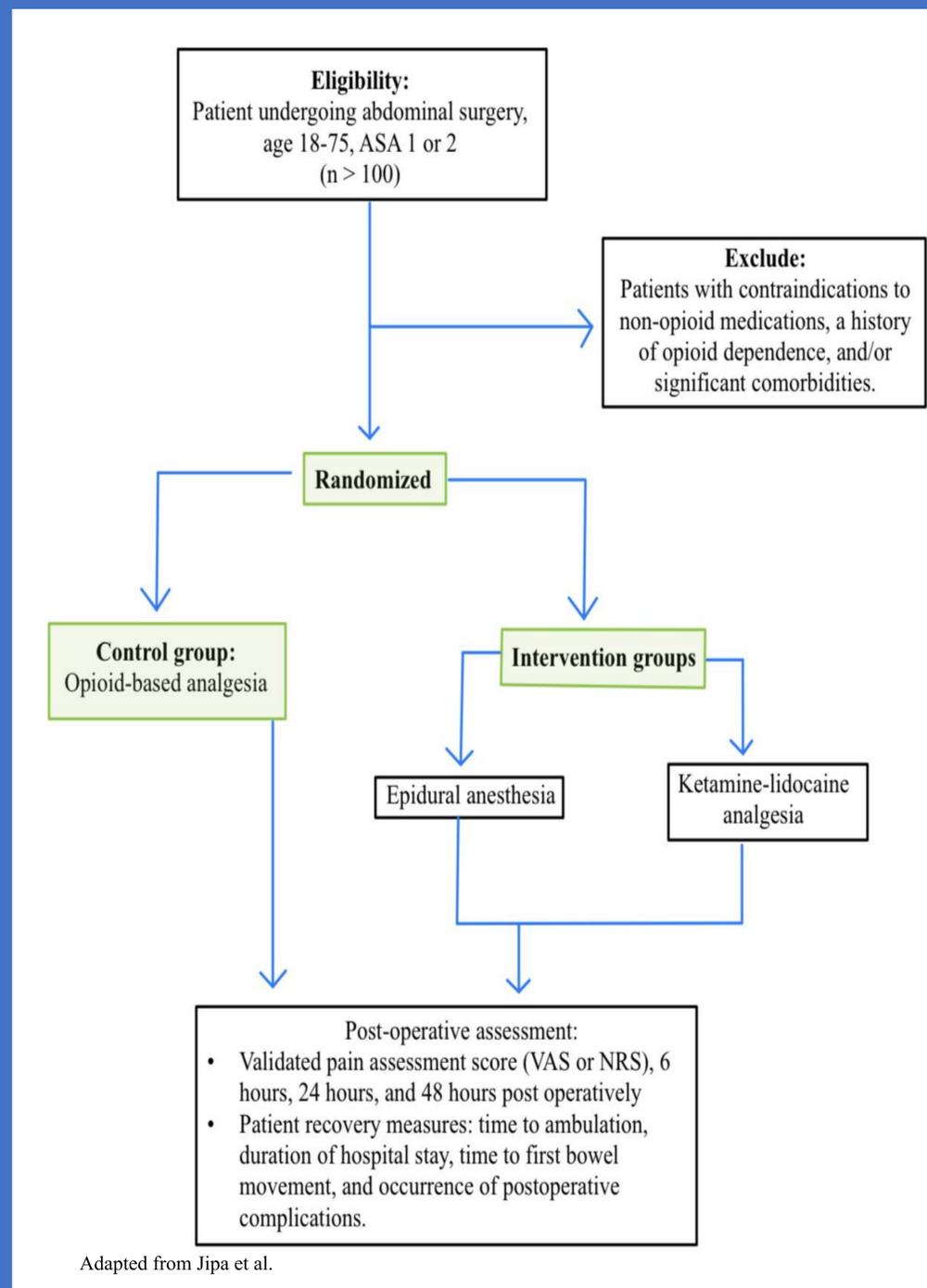
1. Pain Management: Non-opioid medications expected to have improved pain relief compared to opioids (Ready et al., 1994).
2. Opioid Use: Anticipated lower opioid consumption with non-opioid medications (Aryaie et al., 2018).
3. Patient Recovery: Expected faster ambulation, quicker bowel movement, shorter hospital stay, and fewer complications (Aryaie et al., 2018). This research can enhance pain management and patient care in abdominal surgery patients.

## Discussion

This study investigated the impact of opioid-sparing techniques, particularly non-opioid medications, on postoperative pain management, opioid use, and patient recovery in abdominal surgery patients. Results supported the effectiveness of non-opioid medications in pain management, reducing opioid use, and enhancing patient recovery. The intervention group showed improved pain control with lower pain scores on validated scales. Additionally, they required fewer opioids during the perioperative period. Patient recovery outcomes, including faster ambulation, earlier bowel movement, shorter hospital stays, and fewer complications, were also observed in the intervention group. These findings highlight the potential benefits of implementing opioid-sparing techniques with non-opioid medications, leading to improved patient care and safety in abdominal surgeries. Further research with standardized protocols is needed to validate these results and optimize pain management strategies in this population.

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Adapted from Jipa et al.



# Does Bispectral Index (BIS) Monitoring Reduce Recovery Times for Patients Postoperatively?

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## Purpose

- To determine whether BIS monitoring can more optimally aid the anesthesia provider in determining the depth of the anesthetic compared to clinical parameters alone.
- Improved assessment would enable more precise intraoperative sedation administration and, ultimately, a quicker recovery time for the patient.

## Background

- The Bispectral Index (BIS) is a specialized electroencephalogram (EEG) parameter that has been specifically designed to monitor the impact of anesthetics on the hypnotic state of the brain.

## Materials & Data Sources

- Bispectral Index (BIS) Monitoring Device<sup>1-3,5-6</sup>
- MEDLINE, CENTRAL, & EMBASE databases<sup>2</sup>
- Anesthesia and nursing perioperative records<sup>3</sup>
- OR and PACU data sheets were completed during each case tracking drug use, case milestones (eight OR and four PACU), perioperative events (16 OR and 12 PACU), and PACU recovery scores (Modified Aldrete).<sup>3</sup>
- PubMed, EMBASE & Cochrane Library databases<sup>6</sup>

## Introduction

- Postoperative recovery times for patients are variable but are heavily influenced by intraoperative pharmacologic interventions.
- Without the addition of cerebral activity monitoring, the assessment of anesthetic depth must be approximated solely based on clinical parameters.
- Studies have revealed correlations between shorter extubation duration, faster eye opening, and early discharges from the Post-Anesthesia Care Unit (PACU) in patients who underwent anesthesia guided by Bispectral Index.<sup>1-3,5</sup>
- One study demonstrated the BIS group had faster extubation rates and *shorter durations in the operating room* compared to the unmonitored control group.<sup>2</sup>
- Postoperative Delirium (POD) was prevented in one study<sup>6</sup>; another demonstrated reduction in POCD.<sup>2</sup>



<sup>4</sup>Figure 1. BIS Monitoring (Medtronic & Covidien, 2018)

## Methods

- A systematic review, meta-analysis, and trial sequential analysis. Ten trials (N = 3,891) were included for quantitative meta-analysis.<sup>2</sup>
- Open, observational trial with retrospective analysis. Data were analyzed from 1,552 adult patients receiving general anesthesia with surgical times of at least 1 hour. Staff were trained using a simple decision matrix, which integrated BIS titration goals with anesthetic management.<sup>3</sup>
- Systematic meta-analysis using a random-effects model examining eight separate trials (N = 2,536). Mixed, cardiac and colon surgeries were represented.<sup>6</sup>

## Results

- Elderly patients with BIS-guided anesthesia were significantly associated with a lower incidence of postoperative cognitive dysfunction (POCD) (OR 0.64, 95% CI 0.46-0.88, p = 0.006), extubation time (mean difference [MD] -3.38 minutes, 95% CI -4.38 to -2.39, p < 0.00001), time to eye opening (MD -2.17 minutes, 95% CI -4.21 to -0.14, p = 0.04), and time to discharge from the PACU (MD -10.77 minutes, 95% CI -11.31 to -10.23, p < 0.00001).<sup>2</sup>
- When BIS values were maintained between 50 and 65, extubation time from end of surgery decreased by 2.1 minutes from 5.7 ± 7 (37%); OR exit time decreased by 2.2 minutes from 9.3 ± 6 (24%); eligibility for phase 1 PACU discharge decreased by 4 minutes from 22 ± 42 (23%); and actual PACU discharge decreased by 15 minutes from 130 ± 78 (7%).<sup>3</sup>
- Compared with control group, intraoperative BIS monitoring reduced incidence of POD from 22.0% to 17.7% (OR 1.32, 95% confidence interval 1.11-1.57, P=0.001, I<sup>2</sup>=51%).<sup>6</sup>

## Citations

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## Discussion

- BIS monitoring will prove itself to be an efficacious monitoring adjunct to the anesthesia professional. Its unique capacity both to preserve hospital resources and improve patient outcomes solidifies its value in each and every operating room.

# Anesthetic Management of a Severe Bronchospasm

Morgan Davis SAA2 // Mentor: Alex Castillo CAA - MGUH

## Bronchospasm Management<sup>1</sup>

### Learning Objectives:

- ✓ The learner will be able to define a bronchospasm.
- ✓ The learner will be able to recognize situations in which there is an increased risk of bronchospasm and implement methods to decrease this risk.
- ✓ The learner will be able to identify perioperative events indicative of a bronchospasm and apply appropriate interventions in a step-wise manner based on severity.

### Defining Bronchospasm<sup>1</sup>

Contraction of bronchial smooth muscle that results in reversible narrowing of medium and small airways.

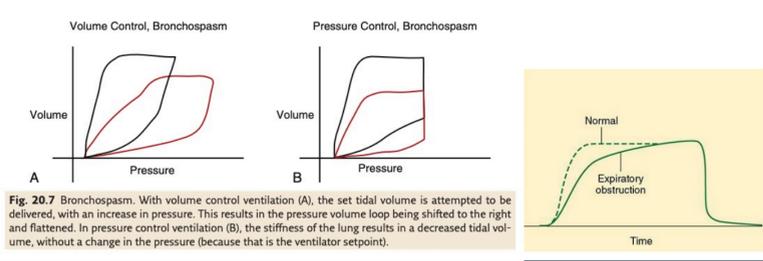
- Fast facts<sup>7</sup>: *Incidence*: ~0.2% - GA, ~6% - asthmatics // *Occurrence*: most frequent = induction // *How*: mechanical or pharmacological // *Quick recognition avoid complications* → ↓SaO<sub>2</sub>, ↑PaCO<sub>2</sub>, hypotension (↑ITP), barotrauma, CV

### Physiology<sup>2</sup>

- Bronchial tone maintained by PNS
  - PNS overactive/↑ cGMP → vagal activation (sensitive to histamine, noxious stimuli) → bronchoconstriction
    - Noxious stimuli: cold air, inhaled airway irritants, airway manipulation<sup>6</sup> (especially when airway reflexes are not adequately depressed)
- Chemical mediators/Immune mediated degradation of bronchial mast cells → bronchoconstriction
  - Histamine, bradykinin, leukotriene, prostaglandins, platelet activating factor

### Presenting Characteristics<sup>1</sup>

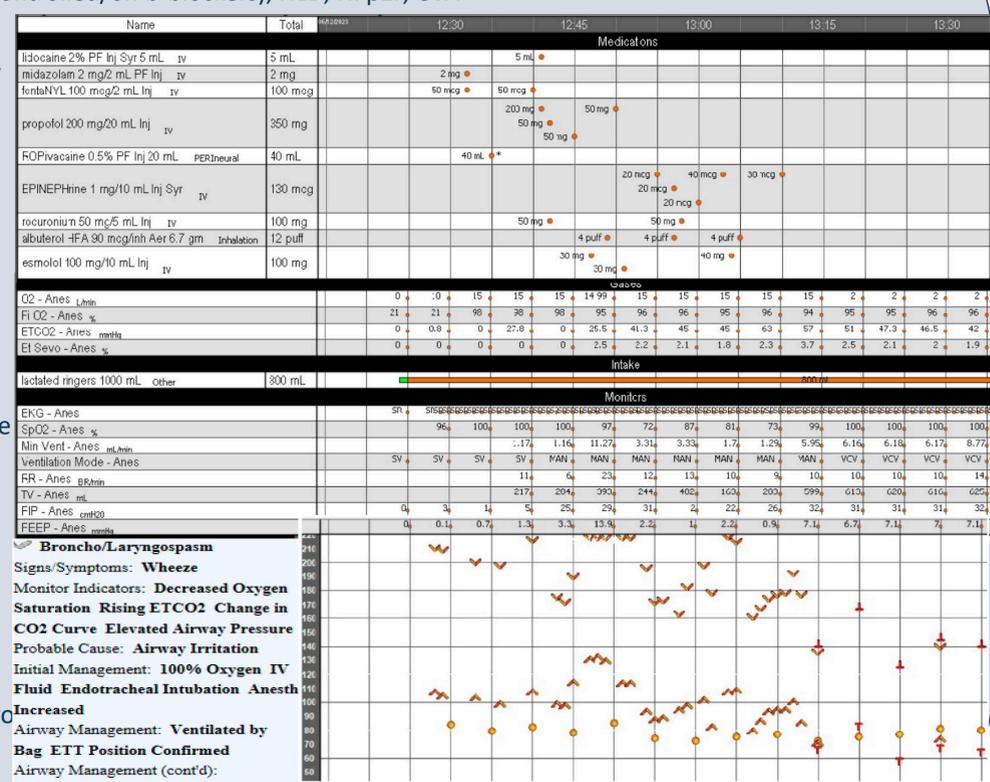
- ↑ PIP
- Wheezing → usually heard on exhalation
  - Severe → possible absence of gas movement = no audible wheezing
- Upward sloping EtCO<sub>2</sub> waveform (figure 2)
  - Severe → may be diminished or absent
- ↓ PaO<sub>2</sub> and SpO<sub>2</sub>
- ↓ TV, inability to achieve adequate TV's despite mechanical ventilation parameters (figure 1)
- ↑ PaCO<sub>2</sub> and EtCO<sub>2</sub> gradient
- Poor lung compliance/difficult mask ventilation
- Hypotension



- 100% FiO<sub>2</sub>
- Quickly assess compliance with manual ventilation. Call for help.
  - Mechanical ventilation → adjust RR and I:E as needed (maximize E) - avoid auto-PEEP (hyperinflation/air trapping)
- Differentials/Verify diagnosis
  - Auscultate, verify ETT position/patency, soft suction ETT → clear potential obstruction, ✓ pilot balloon
  - Aspiration, kinked/obstructed ETT, pneumothorax, foreign body, amniotic fluid embolism, pulmonary edema, PE, endobronchial intubation (mainstem), anaphylaxis, breath stacking, carcinoid syndrome
- Mild bronchospasm:
  - Increase anesthetic depth: ↑ concentration of non-pungent gas, propofol, opioids, ketamine<sup>2</sup>
  - B2 agonist: albuterol 4-8 puffs (repeat as needed) note: manual + pressure breaths to ensure it's getting to lungs
    - Combo therapy: Ipratropium bromide + albuterol
- Moderate to severe bronchospasm:
  - Add to differentials: silent aspiration possible → suction ETT
- Bronchospasm not resolving → SEVERE**
  - Inform surgeon
  - B2-agonists: albuterol 4-8 puffs
  - IV bronchodilator therapy:
    - Epinephrine IV → 0.1 mcg/kg bolus then titrate infusion<sup>2</sup> of 5-20 ng/kg/min if not resolving
    - MgSO<sub>4</sub> IV → 2g
  - Corticosteroids → methylprednisolone 125 mg IV bolus
  - Stop surgical stimulation
  - Cancel case or proceed? Can we extubate?<sup>2</sup>
    - No → Transfer to ICU
    - Yes → optimize, lidocaine 1.5 mg/kg IV, albuterol puffs via ETT, continue epi if needed, deep extubation<sup>2</sup>, continue bronchodilator therapy in PACU
  - Heliox (lower density = improve airflow)

### Case Study

- **Pt:** 53 y/o M, 139 kg presenting for bilateral lower extremity debridement
- **PMHx:** DM2, CAD, PVD w/stents, HTN (poorly controlled/on b-blockers), HLD, HFpEF, CVA
- **Plan:** GA/ETT (CMAC in room), prone, extubate
- **Timeline of Events:** In room – 2 V/50 F → LA by surgeon → induction with 50 F/100 lido/200 prop → bag mask ✓ → 50 roc → bag masking difficult → intubation 1- DL → intubation 2 - CMAC → suctioned secretions, pt light → bag mask + ↑ depth → intubation 3 - CMAC → ✓ placement = wheezy + mainstem → pull back tube → ↑ PIP, ↓ SpO<sub>2</sub>, poor compliance - bronchospasm high on differential → severe bronchospasm management → called for help after interventions not improving SpO<sub>2</sub> → IV + a-line, increased epi dose → case canceled once stable → transport to ICU intubated → close call airway emergency in ICU → CXR
- **Tx:** 100% FiO<sub>2</sub>, manual vent, deepened anesthetic (sevo, propofol, rocuronium), bronchodilator therapy - albuterol + epi, fluids
  - ICU: Neb tx, corticosteroid: Solu-Medrol
- **What went wrong:** appropriate anesthetic depth not achieved before intubation (↑ dose of propofol and rocuronium, bag mask with sevo on), didn't optimize initial intubation attempt with CMAC, could have treated HTN earlier<sup>4</sup>, esmolol?<sup>3</sup>, optimize transport, verify EtCO<sub>2</sub><sup>5</sup>



**Dx:** Acute Hypoxic Respiratory Failure 2/2 bronchospasm

### Identify Increased Risk<sup>1</sup>

- Patient comorbidities:
  - Asthma → thorough Hx<sup>3</sup>, inhaler use<sup>2</sup>, imaging/diagnostics
  - COPD
  - Recent URI → pediatric pts ↑ risk
  - Smoker<sup>2,3</sup>
- Perioperative Events
  - Mechanical airway manipulation/irritation → oral airway, LMA, ETT, endobronchial intubation
  - Pungent anesthetics gases, soda lime dust
  - Aspiration, PE, anaphylaxis
  - Light anesthesia, inadequate pain management<sup>2</sup>
- Drugs
  - β<sub>2</sub>-antagonists (nonselective) → labetalol, propranolol
  - Anticholinesterases
  - Common drug allergies (anaphylaxis) → abx, NMBs, latex, adenosine, contrast dye
- Histamine releasing drugs<sup>2</sup>: morphine, demerol, protamine, atracurium, thiopental

### Prevention<sup>1</sup>

- \*\*Cancel elective surgery if: active bronchospasm, recent URI, exacerbations of asthma or COPD
- ↑ risk and urgent surgery:
  - Supplemental O<sub>2</sub>
  - RA if possible → avoid airway stimulation but note: high spinal/epidural may potentiate bronchospasm
  - LMA + GA → LMA > ETT but pt still needs to be deep
  - Induction: ketamine IV 1-2 mg/kg (bronchodilator)
  - Adjunct ketamine infusion at 0.25 mg/kg/hr
- Optimize patients with risk factors before surgery: preop treatment with bronchodilators/steroids
  - Inhaled B<sub>2</sub>-agonists: 4-8 puffs albuterol, albuterol neb tx
  - Glucocorticoid therapy (prednisone, dexamethasone), leukotriene modifiers, mast-cell stabilizers<sup>2</sup>
- Get them DEEP before intubation → blunt reflex bronchospasm<sup>2</sup>
  - \*\*Larger dose of propofol → +30-50 mg if ↑ risk
  - Lidocaine IV 1-1.5 mg/kg 1-3 mins before intubation
  - Ventilate with sevo before intubation (AVOID pungent agents), 5 minutes
  - NMBs, opioids
- Know your risks! Thorough preop exam and H&P<sup>3</sup>!
- Auscultate!<sup>5</sup> Throughout the perioperative period!
- Diagnostics<sup>2</sup>: FVLs → early detection/tx, CXR
- Vent<sup>2</sup>: PEEP, adjust I:E → ↑ E & ↓ air trapping, TVs 6 mL/kg

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## Introduction

Adrenal crisis can lead to a rapid decline in vital body functions, and without prompt and appropriate treatment, can be fatal. The adrenal glands, located on top of each kidney, produce hormones such as cortisol and adrenaline that are essential for various bodily functions. Adrenal crisis can lead to a rapid decline in vital bodily functions, and without prompt and appropriate treatment, it can be fatal. This case is being reported as healthcare professionals and individuals with adrenal insufficiency need to be educated about the signs and symptoms of adrenal crisis along with treatment options. Prompt recognition and early intervention depend on awareness and preparedness, which can significantly impact patient outcomes. Chilkoti (2019) describes drastic variations in outcomes when stress dose steroids are used vs when they are not used, which will play a crucial part in my case presentation. Anesthesia providers often encounter a surgical patient receiving chronic steroid therapy. Perioperative use of steroids is associated with major complications such as acute adrenal crisis in the perioperative period secondary to adrenal insufficiency. Chilkoti (2019) also emphasizes the importance of administering perioperative stress-dose steroids to mitigate this rare but potentially fatal crisis.

## Learning Objectives

1. Recognize the signs & symptoms of adrenal crisis
2. Outline treatment interventions for adrenal crisis
3. Importance of perioperative stress-dose steroids

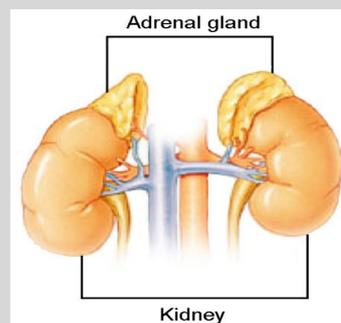
## Uniqueness of Case

The complications experienced were unique and required critical communication between the surgeon and anesthesia team.

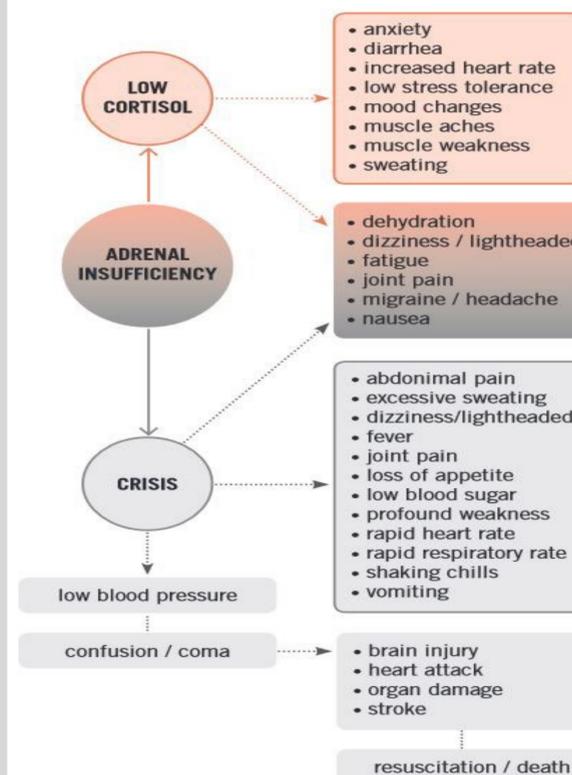
- First sign noticed was severe drop in ETCO2
  - 100% FiO2 and cycled BP
- Severe hypotension
  - Gave fluid and pressors
  - Started a-line for monitoring and ABGs
- No sign of improvement
  - Communicated with surgeon and no signs of major blood loss
- Due to the lack of response to fluid and pressors, team went through differential diagnosis
  - Possible adrenal insufficiency
  - Gave 100 mg hydrocortisone

## Patient Description

- Scheduled procedure: ORIF FEMORAL SHAFT FX W/ PLATE & SCREW SYSTEM
  - Sustained fall from wheelchair
- 65-year-old male
- Height = 5'10
- Weight = 111 kg
- BMI = 36.0
- Neuro = Hx of seizures, tremors
- Cardiovascular = Mets>4, hypertension, CVA
- Smoker = never
- Endocrine = T2DM, chronic steroid use, anemia
- GI/Hepatic/Renal = GERD, liver disease (NASH s/p OLT in 2014), Chronic, S/P transplant, renal disease, esophageal varices, increased aspiration risk
- Pysch = depression, mood disorder, suicidal ideation
- Sleep apnea assessment = HTN, BMI>35, Age>50, and male
- Airway exam-
- Mallampati = II
  - Oral Opening: >=3FB
  - TM Distance: >3 FB
  - Normal Cervical ROM: No
  - ETT/Trach in place: No
- Medication = 5 mg prednisone daily for greater than 3 months, Trulicity, Amlodipine, Sertraline, omeprazole
- Laboratory tests =
  - Blood glucose was 425 two days before procedure
  - Day of surgery was 214



## SPECTRUM OF ADRENAL INSUFFICIENCY



## Intervention

- Significant drop in ETCO2 and Hypotension during procedure = started pt on norepinephrine and vasopressin infusions
- Gave 100 mg of hydrocortisone
- Sent ABGs; Lactate came back elevated at 2.6 (normal range 0.5-1.6); treated with sodium bicarbonate
- TEE showed no clots and RV hypokinetic = gave albumin and crystalloid
- Kept intubated after the aborted procedure
- Continued on pressors until hemodynamically stable
- Taken to the ICU
- CT PE = negative, no pneumonia

## Response to Treatment

The patient was stabilized in the ICU and successfully weaned off the ventilator. The patient was taken back to the OR few days later to complete the intended procedure.

## Discussion

This patient admitted to the hospital after falling from his wheelchair and fracturing his femoral shaft. He presented with poorly controlled diabetes and greater than 3 months steroid use. During the surgery, there was a drop in ETCO2 from 36 to 20, severe hypotension, and decrease in oxygen saturation. The attending was called and continued to give vasopressors, 100 mg hydrocortisone, lowering sevoflurane, going to 100% oxygen, and increasing fresh gas flow. The attending started an arterial line and sent a blood gas to help guide therapeutic interventions. A cardiac anesthesiologist was called to complete a TEE, which showed hypokinesis of the right ventricle implying hypovolemia. The procedure was aborted, and patient was taken to the ICU intubated. The outcome for this patient ended in a positive note with no long-term illnesses or deficits as he was taken back to the OR after a few days when he was hemodynamically stable.

## Conclusions

Identifying adrenal crisis intraoperatively is crucial because adrenal crisis is a life-threatening condition that can have severe consequences if not promptly recognized and treated. Stress-dose glucocorticoids become essential during the perioperative period due to potential cortisol secretion failure to meet increased requirements from surgical stress, adrenal insufficiency, hemodynamic instability, and the risk of adrenal crisis. While existing recommendations suggest approximately 100 mg of hydrocortisone for major surgery, more studies are needed to refine stress-dose glucocorticoid guidelines. Some other steroid options include methyl prednisone, dexamethasone, prednisone. Evaluating patients for possible adrenal insufficiency and tailoring glucocorticoid administration based on surgical stress can contribute to improved patient outcomes.

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# Fluid Resuscitation in a Trauma Patient and Anesthetic Considerations

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## Introduction

Trauma mortality expands across all age groups and is the third most common cause of mortality. Due to this, it remains a major public health concern and leads to high-cost expenditures (Dattatri et al., 2021). Understanding trauma and management to improve mortality rates has advanced due to an improved understanding of shock pathophysiology, changes in hemodynamics, fluid resuscitation, and response to resuscitation. The importance of anesthetic involvement with trauma patients is now acknowledged since anesthesia practitioners provide clinical care in a perioperative space. Therefore, pre-hospital care, emergency department resuscitation, surgical procedures, and rehabilitation treatment are of importance to anesthetic management and impact the choice of anesthetic treatment.

Given that trauma patients present with different forms of trauma, emphasis will be placed on a fundamental understanding of the pathophysiology of hypovolemic shock, the dangers of uncontrolled hemorrhaging, standard fluid resuscitation, monitorization of patient response, and anesthetic considerations. Factors that support hemodynamic targets depending on the types of traumas will be presented along with resuscitation strategies and their transition over time upon evidence of improvement in mortality rates. The intent is to gear knowledge obtained within academic training towards the concept of trauma and its implications.

## Resuscitation Monitoring

	Rapid Response	Transient Response	Minimal or No Response
Vital Signs	Return to Normal	Recurrence of decreased BP and increased HR	Remain Abnormal
Estimated Blood Loss	Minimal (<15%)	Moderate and ongoing (15% – 40%)	Severe (>40%)
Need for Blood	Low	Moderate to high	Immediate
Blood Preparation	Type and Crossmatch	Type – Specific	Emergency Blood Release
Need for Operative Intervention	Possibly	Likely	Highly likely
Early Presence of Surgeon	Yes	Yes	Yes

Responses to Initial Fluid Resuscitation (Adewale et al., 2009).

## Shock

	Class 1	Class 2	Class 3	Class 4
Blood Loss (mL)	Up to 750	750 – 1,500	1,500 – 2,000	> 2,000
Blood Loss (% Blood Volume)	Up to 15%	15% – 30%	30% – 40 %	>40%
Pulse Rate (bpm)	<100	>100	>120	>140
Blood Pressure	Normal or Increased	Decreased	Decreased	Decreased
Respiratory Rate	14 – 20	20 – 30	30 – 40	>40
Urine Output (mL/hr)	>30	20 – 30	5 – 15	Negligible
CNS/Mental Status	Slightly Anxious	Mildly Anxious	Anxious, confused	Confused, lethargic
Fluid Replacement	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and Blood

Classification of Hemorrhagic Shock (Facs et al., 2018)

## Target Goal Resuscitation

Damage Control Resuscitation (DCR) is the accepted strategy of fluid resuscitation. It consists of permissive HOTTN, hemostatic resuscitation, and damage control surgery (Chang et al., 2017). There are three types of traumas: penetrating, blunt, and trauma associated with a traumatic brain injury (TBI). For each type of trauma, a systolic blood pressure target goal is set: 60-70mmHg for penetrating; 80-90mmHg for blunt trauma; and 100-110mmHg for trauma with TBI (Ramesh et al., 2019). Permissive hypotension isn't acceptable for TBIs in comparison to the other traumas. In TBI the priority goal is to prevent secondary brain injury by maintaining adequate perfusion pressure. Intracranial pressure is increased in TBI which will impact cerebral perfusion pressure (CPP). Therefore, in addition to the target systolic pressure, Wise et al. (2017) recommends a target mean airway pressure (MAP) greater than 80mmHg and CPP approximately 60mmHg. The consensus of fluid administration established by the Advanced Trauma Life Support (ATLS) is 1L of warmed balanced crystalloid such as lactated ringer (LR) which expands the extracellular volume. After initial resuscitation the patient is monitored for response to resuscitation. The patient is assessed for a Rapid Response, Transient Response, or Minimal to No response.

## Conclusion

Hemorrhagic shock may progress fast with rapid blood loss of the patient and prompt adequate fluid administration of warmed 1L of balanced crystalloid fluid is necessary. The patient should be monitored for their response to resuscitation to assess their progression via invasive and non-invasive techniques. DCR is the standardized strategy approach to prevent secondary injury from dilutional coagulopathy or dislodging soft clots. From lab results, blood loss, and the patient's physical presentation, blood administration is prompted. MTP ratio of RBCs, FFP/cryoprecipitate, and platelets in a 1:1:1 should be timely initiated to maintain the physiological constitution of blood and replace intravascular loss. Patients should be continually assessed for hemodynamic considerations to be transitioned to post-resuscitation.

## Anesthetic Consideration

All patients should be pre-oxygenated with 3-5 vital capacity breaths or 3-5 minutes on high oxygen flows. In the incidence of facial deformity from trauma or unable to pre-oxygenate patient, do not delay induction. The same applies to invasive monitoring such as central lines and arterial lines. Peripheral access should already be obtained in the emergency room and if invasive monitoring isn't, do not delay induction. Obtain invasive access after the patient is asleep. In hypovolemic shock, the patient typically presents as tachycardic with hypotension due to loss of blood and the heart's attempt to get blood to oxygen-deprived tissue. The provider should be mindful of administering drugs that further decrease systemic vascular resistance. Tobin et al. (2018) suggest reducing the propofol dosing and considering using ketamine for patients in hypovolemic shock. In addition, all trauma patients are automatically deemed a difficult airway and full stomach which indicates an RSI induction. Adjuncts to intubation are always available but it is crucial to select devices with prior experience. Awareness of the contraindications for RSI muscle relaxants succinylcholine and modified RSI muscle relaxants with rocuronium should be considered (Tobin et al., 2018). Maintenance and resuscitation consist of their considerations as well. POC testing and ABGs, previously mentioned, are ideal to begin at the start of the case to guide the maintenance phase of fluid and blood administration.

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# Anesthetic Management of Premature Neonate for Open Abdominal Surgery

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## Introduction

Premature neonates often have congenital disorders and underdeveloped physiology that make them more prone to morbidity and mortality in the perioperative period. Specifically, patients born prior to surfactant development in the lungs (35-36 weeks gestational age (GA) have problems with maintaining ventilation and oxygenation, leading to ventilator dependence in the NICU, which can in turn cause weakened lung tissue via atelectrauma and cause respiratory issues later in life.<sup>1</sup> Commonly, premature patients have congenital heart defects that can require intervention and careful management in the perioperative period to maintain appropriate oxygenation and circulation status.

Healthy patients of any age maintain a core temperature in a narrow range of around 37 deg C. Neonates rely on non-shivering thermogenesis (NST), or brown-fat-dependent lipolysis, to regulate their central temperature as their muscles are immature at this stage of life. Brown fat is deposited throughout the body after 28 weeks gestation in utero, and babies born earlier have limited ability to regulate temperature due to the lack of appropriate tissue<sup>2,7</sup>. These patients experience a notable amount of radiant heat loss via their head due to the large surface area and lack of insulating hair and tissue. In addition, a neonate can experience heat loss to the environment, contact with the OR table and tools, and vapor loss to the surrounding air<sup>2</sup>.

Patients maintained on inotropes, mechanical ventilation, born at or before 24 weeks GA, female sex, and/or at an ASA class of 3 or higher are significantly associated with 30-day mortality following emergency abdominal surgery<sup>5</sup>. Respiratory events including laryngospasm, apnea of prematurity, upper airway obstruction, and post-intubation stridor are most commonly linked to perioperative mortality in the neonate population<sup>5</sup>. This case highlights multiple common physiologic challenges when managing a neonate in the OR and the difficulty of maintaining appropriate core body temperatures in an unregulated individual.

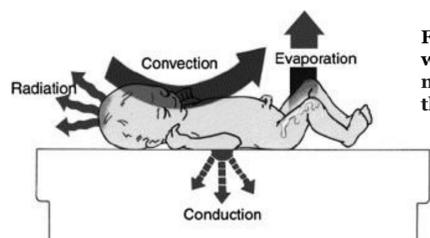


Figure 1. Four ways a newborn may lose heat to the environment.<sup>2</sup>

## Learning Objectives

1. Explore the general concerns of neonates undergoing abdominal surgery.
2. Understand the management of patients with congenital heart deformities (i.e. PDA, PFO).
3. Discuss pulmonary complications of neonates with limited surfactant availability and lung development.
4. Examine the importance and common practices of temperature management in pediatric patients.

## Case Significance

As medicine advances, preterm infants can receive better treatment, and progress into childhood and beyond. Challenges faced in this case included the management of acyanotic shunts, maintaining proper oxygenation and ventilation on a non-NICU-equipped ventilator with premature lung tissue, and optimizing the patient's core temperature.

The primary goals of managing acyanotic shunts are to prevent increasing pulmonary vascular resistance (PVR) while decreasing systemic vascular resistance (SVR) and myocardial dysfunction.<sup>5</sup> Similarly, bronchopulmonary dysplasia (BPD) is managed perioperatively by using lung-protective ventilation and reducing over circulation of the pulmonary system by controlling patent ductus arteriosus (PDA) hemodynamically.<sup>1</sup> The management of cardiac shunts and immature lungs both involve a steady balance between oxygen optimization, ventilation, and pulmonary blood pressures of the patient. Neonates of any GA have a reduced capacity to regulate central temperature changes, making it crucial for the provider to actively warm the patient. Hypothermia in neonates eventually leads to hypoxemia, hypoglycemia, acidosis, and right-to-left shunting via pulmonary vasoconstriction. This can result in sepsis, decreased healing, arrhythmias, increased risk of infection, and poor neurological outcomes<sup>8</sup>.

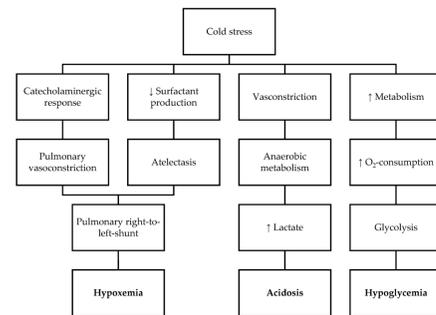


Figure 2. Pathophysiological pathways resulting from adverse events induced by cold stress in neonates.<sup>8</sup>

## Patient Description

A 17-day old, ex-24 wk GA male (0.835 kg), ASA 4, presents for an exploratory laparotomy with hemicolecotomy, drainage of abdominal abscess, appendectomy, and illeumectomy due to presence of pneumoperitoneum from perforated bowel. Patient has PDA and PFO treated with IV Acetaminophen, apnea of prematurity treated with caffeine infusion, developing BPD, and a holosystolic murmur on auscultation. He is intubated and on continuous supported ventilation of 15/5 cmH<sub>2</sub>O PIP/PEEP, 10 cmH<sub>2</sub>O PS at FiO<sub>2</sub> 23% with V<sub>T</sub> of 6 mL in NICU. PICC line, 24G PIV, and OG in place already. On presentation to the OR, patient is on continuous infusions of fat emulsion 3 g/kg, TPN, IV Acetaminophen, 15 mg/kg q6 hr, and caffeine citrate 8 mg/kg q 24 hr. Orders for 25 mL PRBCs to begin in the OR are completed in the perioperative period. All vital signs were within normal range for age and prematurity status upon arrival to OR.

## Anesthetic Intervention

- The patient arrived to the perioperative holding area in an isolette with a transport ventilator from the NICU bay where the anesthesia team took over care and was transported to the OR with all lines and continued infusions in place.

- The OR was preheated to 30°C, a pediatric-sized underbody Bair Hugger was running at 43°C on the OR table, and the radiant warmer was turned to the maximum intensity on the area of the bed that the patient would be positioned. These measures were continued throughout the procedure with the exception of the radiant warmer being removed for continuity of sterility. The surgical team had prewarmed irrigation fluid available for the case.

- The patient was disconnected from the transport ventilator, positioned on the OR table on top of the Bair hugger, and reconnected to the anesthesia machine ventilator. He maintained 100% SpO<sub>2</sub> and stable vital signs throughout the transition.

- All ASA monitors were switched from the isolette transport monitor to the anesthesia machine and a temperature probe was placed in the patient's esophagus for the duration of the operation. The patient's head continued to be covered by a knitted hat to minimize heat loss from the large surface area.

- Induction of anesthesia with sevoflurane at FiO<sub>2</sub> of 49%, 2 mg rocuronium, and 10 mcg fentanyl for proper pain control and paralysis. FiO<sub>2</sub> continued at 30% for the remainder of the procedure. When the patient was ready for transport back to the isolette, the FiO<sub>2</sub> was increased to 100% for optimal oxygenation before ventilator reconnection.

- Ventilation of patient remained at set parameters from NICU (PIP/PEEP 15/5 cmH<sub>2</sub>O, TV 6 mL) on PCV via anesthesia ventilator. Pressure support parameters were avoided due to interference from the operative area. ETCO<sub>2</sub> remained within the normal range (35-40 mmHg) throughout the case.

- Transfusion of 25 mL (30mL/kg) PRBCs started as ordered by the NICU team for mitigation of blood loss and correction of anemia present in most preterm neonates<sup>3</sup>. This was not given through a warmer, assuming a temperature of less than 20 deg C (room temperature)<sup>4</sup> as it was cold to the touch from storage.

- Vitals remained stable and constant through the perioperative period, yet core body temperature gradually decreased to 33.2 deg C (see Figure 3).

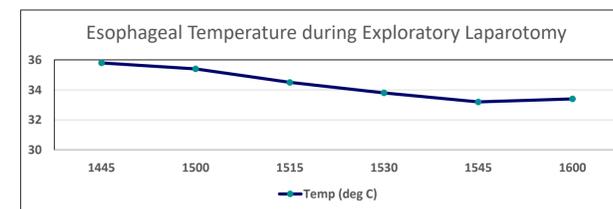


Figure 3. Esophageal temperature (°C) during open abdominal case of 17 day old premature male

- Upon the end of the operation, irrigation was pooled around the patient's abdomen, chest, and extremities. Despite the use of prewarmed irrigation, it did not remain warm as it pooled on the OR table.

- The radiant warmer was returned to the bedside and warm blankets covered the body and head to rewarm the patient before transport back to NICU. The Isolette was prewarmed to 38°C before moving the patient back. Rewarming attempts continued for approximately 15 minutes before leaving the OR, at which point the patient's core temperature had only reached 34°C.

## Discussion and Conclusion

**Neonates born before a GA** conducive to life without invasive support require closer management than the typical patient. This 17-day-old, 24-week GA male required intervention to comply with his existing PDA, PFO, poor lung development, and inability to regulate his temperature.

**The acyanotic left-to-right shunting** in his cardiovascular system was being treated with a 15 mg/kg IV Acetaminophen infusion per NICU team orders. Higher pressures in the aorta than the PA allow blood flow through the PDA resulting in higher pulmonary blood circulation, pulmonary artery (PA) overload, elevated left heart filling and pressures. Higher left atrial pressure than right atrial pressure allows blood flow through the PFO which is typically asymptomatic. This patient's holosystolic murmur suggests a moderately sized PFO<sup>8</sup> which similarly overloads the PA and left heart. To prevent the worsening of the PDA and PFO, the primary goals were to avoid increasing PVR via hypoxia, hypercarbia, acidosis, pain, and elevated PEEP<sup>8,9</sup>.

**Managing the patient's immature lungs** simply required the continuity of controlled ventilation from NICU protocol. Basic ventilator settings were maintained from NICU parameters to avoid unnecessary volutrauma or barotrauma. A slightly higher FiO<sub>2</sub> of 30%—as opposed to 23% in the NICU—was used intraoperatively to maintain 100% SpO<sub>2</sub> on a non-NICU-equipped ventilator. A relatively higher FiO<sub>2</sub> in preterm neonates can cause hyperoxia-induced changes in the immature vasculature and alveoli<sup>1</sup>. The transport and anesthesia ventilators have less precision than ICU ventilators, so the slightly higher FiO<sub>2</sub> allowed for the variation. The patient's ETCO<sub>2</sub> remained within normal limits (35-40 mmHg), avoiding the presence of hypercarbia. Transfer of the patient from the NICU to the OR and back required a minimum of four ventilator changes. The use of less precise ventilators for a prolonged duration can compromise oxygenation in a heart rate-dependent patient during the transition, leading to unnecessary lung tissue stress. Open abdominal surgeries have been performed in the NICU safely in similarly equipped hospitals, which would have aided in reducing the risk of extubation, improper monitoring, and ventilatory throughout the patient's entire perioperative experience<sup>6</sup>.

**The primary issue of the case was temperature management** in this patient. Our anesthesia and OR teams took every prophylactic measure available to us at the time to preheat the environment and maintain core body temperature. Between the prewarmed irrigation fluid pooling around the bulk of the body and the administration of 25 mL of cold PRBCs amounting to roughly 1/3 of the EBV (835 mL), the core body temperature dropped 3°C and the patient was relatively resistant to reheating from the return of the radiant warmer and warm blankets. The patient only started to more rapidly rewarm when placed in the Isolette set to 38 deg C for transport. Radiation is recognized as the best form of patient warming, and the most abundant type of heat loss<sup>8</sup>. As suggested in *Neonatal Thermogenesis*, moderate hypothermia can be treated by a warm cot, incubator, radiant warmer, warm room, warm water-filled mattress, or finally skin-to-skin contact<sup>8</sup>. In cases with similarly incapacitated patients, efforts should be made to warm the OR to the suggested 32 dec C<sup>8</sup> and transition the patient to the Isolette warming device as soon as safely possible. If the surgery and sterile field allow, it would be advantageous of the surgical team to keep fluids from surrounding the patient. Warming the PRBCs even to room temperature, if not having them run slowly through a fluid warmer with a continuous crystalloid infusion would prevent the temperature from dropping, if not warm the patient more. Finally, the administration of such a large dose of opioids (10 mcg fentanyl— 12 mcg/kg) contributed to the hypothermic response seen in this patient. The activation of kappa opioid receptors via nitric oxide second messengers is directly correlated to lower core temperatures in patients receiving relatively large opioid doses<sup>10</sup>. This case illustrates that temperature management in pre-term neonates is multifaceted, and merits significant consideration when developing an anesthetic plan for patient care and perioperative management.

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# Aspiration During Pediatric Burn Dressing Change

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## INTRODUCTION

A 3-year-old ASA 2 male presents for a burn dressing change in a procedural unit on the floor, outside of the OR. The emergency treatment report stated that the patient had initially spilled a cup of hot tea over himself a few days ago, sustaining a 2<sup>nd</sup> degree (partial thickness) scald burn to the posterior torso. After initial burn debridement was performed under Ketamine sedation, the patient was admitted for further treatment & monitoring.

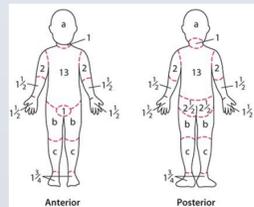
## LEARNING OBJECTIVES

- Discuss preoperative evaluation of the burn patient
- Outline ASA requirements & preparation for NORA
- Discuss physiologic effects of aspiration
- Describe anesthetic management of aspiration

## BACKGROUND

**Non-OR Anesthesia (NORA):** anesthesia outside of a traditional OR, requiring providers to work in remote locations of a hospital, where ease of access to patient & equipment may be limited (Butterworth et al., 2022)

**Rule of Nines:** used to calculate % body surface area (BSA) burned



Body part	0yr	1yr	3yr	10yr	15yr
a = 1/2 of head	9.12	8.12	6.12	5.12	4.12
b = 1/2 of thigh	2.34	3.14	4	4.14	4.12
c = 1/2 of lower leg	2.12	2.12	2.34	3	3.14

Smith E.B., & Hunsberger J (2021). Intraoperative complications and crisis management. Ellinas H, & Matthes K, & Arayashi W, & Bilge A(Eds.), *Clinical Pediatric Anesthesiology*. McGraw Hill. <https://accessanesthesiology-mhmedical-com.su.idm.oclc.org/content.aspx?bookid=2985&sectionid=250592587>

- In pediatric patients, proportions change with age (Jones, 2021)
  - Head is a large proportion of BSA during infancy
  - As they age → legs larger portion of BSA

### Different Types of Burns:

- Scald burns: caused by hot water or steam
  - 65% of burns in children < 5 YO
- Treatment (2<sup>nd</sup> & 3<sup>rd</sup> degree burns):
  - Fluid replacement indicated once ≥ 20% TBSA involved
  - Skin grafting & debridement



Superficial (1 <sup>st</sup> degree)	Partial thickness (2 <sup>nd</sup> degree)	Full thickness (3 <sup>rd</sup> degree)
Do NOT penetrate epidermis	Penetrate epidermis & part of dermis, blistering	Penetrates dermis & destroys nerves / vessels

## CASE DESCRIPTION

### Preoperative Evaluation:

- Non-labored respirations, stable & cooperative
- Rule of Nines: 4.5% (301.5 cm<sup>2</sup>) BSA
- Dentition & airway exam WNL
- No anesthetic hx or familial hx of complications
- **NPO > 8 hours (food & drink) → reported by mother**
  - Consent for sedation obtained following confirmation of NPO status
- Anesthetic plan: MAC w/ propofol infusion

### ASA NPO Guidelines

Timing Before Surgery	Guidelines
8 hours	Fatty food
6 hours	Light meals, infant formula, non-human milk
4 hours	Breast milk
2 hours	Clear liquids

Prior to procedure start, supplemental O2 was administered via nasal cannula at 4 L/min. After administration of 15 mg IV lidocaine, the propofol infusion was started at 250 mcg/kg/min and the patient was moved into left lateral decubitus position. About 5 minutes into sedation, the patient began coughing, prompting a 30 mg propofol bolus. Patient expelled a high volume of thick, chunky, pink emesis out of the nose & mouth, prompting immediate suction. While suctioning, the tubing became clogged, and the patient quickly desaturated (SpO<sub>2</sub> = 20-30%) during replacement of suction equipment.

Nasal cannula was stopped, and the patient was supported with 100% O2 via AMBU bag mask ventilation. After advancing a flexible suction catheter into the stomach, emergent intubation was required as the patient's saturations were not improving. The patient's airway was secured atraumatically using a miller 1.5 laryngoscope and a 4.5 microcuffed ETT.

### Post-Operative Care:

- CXR:
  - Streaky perihilar opacities → vascular congestion / edema vs. atelectasis
  - Leftward tracheal deviation
- PICU admission for overnight observation

## DISCUSSION

After further questioning, mother admitted that the patient had received a "high volume of water" at 12:00 pm → procedure began at **12:15 pm**

- Pediatric patients regurgitate in ~1/200 procedures
- Gastric emptying rates decrease by **37-42%** after burn injuries as soon as 6 hours post-injury (Smith & Hunsberger, 2021)
  - If bowel sounds are present & there is no ileus, RSI may not be necessary
  - Opioids avoided → respiratory depression & slowed gastric emptying

### Signs & Symptoms of Aspiration:

- Coughing
- Wheezing
- Cyanosis
- Hypoxia w/ increased O2 requirements
- Fever
- Tachypnea

### Physiologic Effects of Different Aspiration Contents

Acidic Fluid	Non-Acidic Fluid	Particulate
<b>FIRST PHASE:</b> Chemical pneumonitis (lung tissue reacts to acid)	Less severe than acidic fluid aspiration	Physical obstruction of the airway
<b>SECOND PHASE:</b> Inflammatory response (to original pneumonitis)	Atelectasis Alveolar collapse	Hypoxia Hypercapnia Hyperinflation & atelectasis on CXR

### Treatment for Aspiration:

- Supportive:
  - Immediate suctioning
  - Ventilation & supplemental O2 → secure airway if necessary
  - PEEP → decrease atelectasis & alveolar collapse
  - Antibiotics & steroids NOT routinely administered
- Bronchoscopy → may be required if large particulates aspirated & cause obstruction
- Lung lavage → NOT recommended
  - May push particulates further down into lungs

## CONCLUSIONS

Prepare for all adverse outcomes **REGARDLESS** of how "unlikely" it may seem for certain events to occur (especially when outside of OR):

- Pediatric crash cart wasn't appropriately stocked
- Equipment for NORA:
  - Appropriately sized ETTs, LMAs, OAWs, laryngoscope blades, pediatric transport mask
  - Syringes, blunt tip & IM needles, flush syringes, infusion tubing, infusion pump
  - **ALWAYS** check suction prior to procedure start
- Emergency medications:
  - Epinephrine
  - Atropine
  - Succinylcholine

### Risk Factors for Aspiration (Jones, 2021)

Emergency surgery → especially abdominal surgery	Recent ingestion of food	Trauma
Decreased consciousness	Neuromuscular diseases	Delayed gastric emptying, bowel obstruction, ileus
Difficult airway	Increased ASA status	Young age

### ASA Minimal Requirements for NORA

Reliable O2 source, delivery method (nasal cannula, face mask), & backup supply
Adequate suction
Self-inflating resuscitator bag that can administer at least 90% O2 & PPV
Anesthetic drugs, monitoring, & supplies
Scavenging when inhaled anesthetic agents required
Adequate lighting & electrical outlets for proper visualization & operation of equipment
Sufficient space for anesthesia provider, unobstructed a/w access
Emergency cart w/ defibrillator & emergency drugs for cardiopulmonary resuscitation
Adequate post-anesthesia care

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## Abstract

This review will focus on a growing issue within the medical community: patients with acute or chronic marijuana use. There are a variety of pharmacological and physiological concerns that come with these patients including respiratory, cardiovascular, and neurological pathophysiology. There are also several things that need to change within the anesthesia plan including drug selection, changes to the preoperative interview, intraoperative considerations, and postoperative considerations. In addition, there are unique considerations to marijuana use such as its antiemetic and analgesic potentials and how those might affect the anesthesia that a patient is receiving due to tolerance or dysfunction of normal systems.

## Introduction

Marijuana use leads to a variety of physiological changes, including respiratory, cardiovascular, and neurological changes, that can affect the anesthetic plan preoperatively, intraoperatively, and postoperatively<sup>4</sup>. Marijuana use can also lead to a variety of pharmacological interactions with anesthetic agents that anesthesia care providers use on a regular basis<sup>6</sup>. Anesthesia providers must have increased awareness of these pharmacological and physiological changes and how they affect the anesthetic plan in the chronic or acute marijuana user. Acute marijuana use is determined based on if the patient is actively under the influence of marijuana and is treated very differently than a patient with chronic marijuana use who is not currently under the influence of marijuana, but both will require adjustments to the anesthetic plan put in place by the anesthesia care provider<sup>4</sup>. From obtaining a consent to which drugs to consider for post-operative analgesia, marijuana use should be an important factor to consider when making all these choices.

## Significance

Patients using marijuana, the THC containing derivative of the cannabis plant<sup>6</sup>, in the United States is becoming increasingly common<sup>2</sup>; and anesthesia providers need to be aware of the physiological and pharmacological changes that this may present when treating a patient using cannabis medically or recreationally<sup>4,6</sup>. According to the CDC, in 2019 18% of Americans used marijuana at least once<sup>2</sup>. According to King et al., this number is also increasing yearly<sup>7</sup>. Additionally, there has been a recent increase in emergency room visits due to use of marijuana<sup>7</sup>. This trend is likely due to the increased potency of marijuana related to the strain or the method for THC extraction used to prepare the marijuana for consumption<sup>6</sup>. Considering these developments, anesthesia providers need to be ready to adjust anesthetic plans in patients with either acute marijuana intoxication or chronic marijuana use either recreationally or medically<sup>6</sup>.

## Learning Objectives

1. Understand pathophysiology of marijuana use
2. Learn how to approach a preoperative interview for a patient with a history of marijuana use
3. Understand the anesthetic considerations of marijuana use intraoperatively
4. Understand the anesthetic considerations of marijuana use postoperatively



**Figure 1.** Safety label placed on THC containing products for oral consumption (Massachusetts)<sup>3</sup>.



**Figure 2.** An example of a "vaporizer" used for inhalational consumption<sup>8</sup>.

## Results - Preoperative Interview

One of the most critical elements of the anesthetic plan when it comes to acute or chronic marijuana use is identifying this use in the preoperative interview via a thorough evaluation of the patient's social history.

When developing an anesthetic plan when marijuana use is suspected, an important first step is to identify if use is acute or chronic<sup>6</sup>.

**Acute:** If marijuana has been used within 72 hours of an elective procedure, the procedure should be postponed<sup>6</sup>.

**Chronic:** If a patient has been identified as a chronic marijuana user, there are additional questions that need to be asked to create the best plan for the patient<sup>6</sup>:

- Frequency of marijuana use
- Time since last use
- Typical products and dose
- History of adverse effects when using or missing doses
- Evaluation of withdrawal symptoms or signs of acute intoxication

## Results - Perioperative Considerations

Preoperative Considerations<sup>6</sup>:

- Follow preoperative interview guidelines identified in the previous section
- Assess the patient for indications of acute intoxication such as:
  - Increased anxiety
  - Paranoia
  - Psychosis
- Identify if the patient has any history of angina or CAD
- Consider running coagulation studies

Operative Considerations<sup>6</sup>:

- Potential sevoflurane tolerance
- Be careful with sympathomimetics and beta blockers (see "Cardiovascular Concerns")
- Be cautious with the patient airway (see "Respiratory Concerns")

Postoperative Considerations<sup>6</sup>:

- Potential need for increased analgesia due to cross-tolerance of opioids
- Monitor for any signs of withdrawal such as anxiety or abdominal pain

## Results - Physiological Changes

Results - Physiological Changes	
<b>Respiratory Concerns<sup>4</sup></b>	Changes due to CB1 and CB2 agonism as well as damage from inhalation: <ul style="list-style-type: none"> <li>• Airway ossification (chronic)</li> <li>• Increased carboxyhemoglobin (acute)</li> <li>• Bronchodilation (acute)</li> <li>• Increased bronchial sensitivity (chronic)</li> <li>• Operative obstruction (chronic - mucus plug)</li> <li>• Postoperative obstruction (acute - uvulitis)</li> </ul>
<b>Cardiovascular Concerns<sup>4</sup></b>	Changes due to amplification of sympathetic and attenuation of parasympathetic response: <ul style="list-style-type: none"> <li>• Increased systolic blood pressure (20-100%)</li> <li>• Tachycardia</li> <li>• Increased CO</li> <li>• Uncommonly: peripheral vasodilation, position-based hypotension, and bradycardia (high dose, chronic users)</li> </ul>
<b>Neurological Concerns<sup>4</sup></b>	<ul style="list-style-type: none"> <li>• Increased CBF</li> <li>• Decreased CBF (when hypoxic/hypercapnic)</li> <li>• Increased risk of cerebrovascular ischemia and ischemic stroke (particularly young males)</li> </ul>

**Table 1.** Physiological changes of the respiratory, cardiovascular, and neurological systems due to marijuana consumption. Chronic or acute use is noted.

## Limitations and Future Research

The greatest limitation in the study of marijuana use and anesthetic administration is the reliance on retrospective studies due to the ethical concerns of causal studies.

One common discrepancy in the research of anesthetic interaction with marijuana is evaluating if there is a need for an increase in propofol in chronic users. Some sources indicate that there is a theoretical need for additional propofol due to cross-tolerance related to interactions between CB1 and CB2 and GABA. Others argue that retrospective studies have shown no difference in propofol needs for chronic users versus non-users. There is a need for future studies on the potential for increased anesthetic use in chronic marijuana users.

### New Users



- Tachycardia and systolic hypertension (within 2 hours from consumption)
- Malignant arrhythmias (AFib, VFib, VTach, Brugada pattern)
- Coronary spasm if previous CAD
- Airway hyperreactivity or UAO (uvulitis)

### Chronic Users



- Bradycardia → Tachycardia
- Postural / Orthostatic hypotension
- Sinus arrest
- Hyperreactive airway
- Intraoperative hypothermia → PO "shivering"
- Coronary vasospasm / myocardial infarction

**Chart 1.** Physical changes noted during acute and chronic marijuana use that may affect the anesthetic plan<sup>4</sup>.

## Conclusions

Marijuana use is common among the general population, and anesthesia care providers will be seeing patients with both acute and chronic marijuana use. To best treat these patients, perform a careful and thorough preoperative evaluation, and determine how to apply what the patient says to the anesthesia plan to provide the most safe and effective anesthetic.



**Figure 3.** An example of the cannabis plant from which marijuana is derived<sup>5</sup>.

## Contact

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# Difficult Intubations with Double Lumen Tubes

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## Introduction

A 45-year-old ASA 2 woman presented for a robotic left diaphragmatic plication. In 2022, she experienced a motor vehicle accident, leading to a cervical fusion procedure. Throughout the year, the patient developed worsening dyspnea, and imaging studies showed an elevated left hemidiaphragm. Patient does not present with any other significant medical history. Her medical record noted that she was a difficult intubation from previous procedures. She exhibited very limited range of motion due to her cervical fusion, reduced thyromental distance, and Mallampati III score. In her previous procedures, intubation required three attempts, with success achieved through fiberoptic intubation. Patient refused an awake fiberoptic intubation because she was always induced in past procedures and wished for the same approach.

## Learning Objectives

- ▶ Outline the ASA difficult airway algorithm guidelines
- ▶ Discuss double-lumen endotracheal tube placement
- ▶ Review adjunct airway devices utilized for difficult airways

## Background

- ▶ A double-lumen endotracheal tube (DLT) is a bifurcated tube with a tracheal and bronchial lumen and commonly used for one lung ventilation. A left double-lumen tube is commonly used, irrespective of the operative side. (Butterworth et al, 2022)
- ▶ **LEMON scale evaluation for difficult intubations** (Butterworth et al, 2022)
  - ▶ L: Look Externally – poor dentition, edentulous, and obesity
  - ▶ E: Evaluate – 3-3-2 rule
  - ▶ M: Mallampati Score
  - ▶ O: Obstruction – abscess, tumor, and swelling
  - ▶ N: Neck Mobility

### Left-Sided DLT Placement Verification

 (Butterworth et al, 2022)

Inflate tracheal cuff (5-10 mL). Check for bilateral breath sounds.

Inflate bronchial cuff (1-2 mL) and clamp tracheal lumen.

Check for unilateral left breath sounds.

- Tube should be advanced if right sided breath sounds are indicated.
- Unilateral right sided breath sounds indicate right bronchus entry
- Absence of both right and left breath sounds indicate tube is too far

Unclamp tracheal lumen and clamp bronchial lumen.

Check for unilateral right sided breath sounds

- Absence indicate tube is not far enough and bronchial cuff may be occluded.

## Case Description

### Intubation

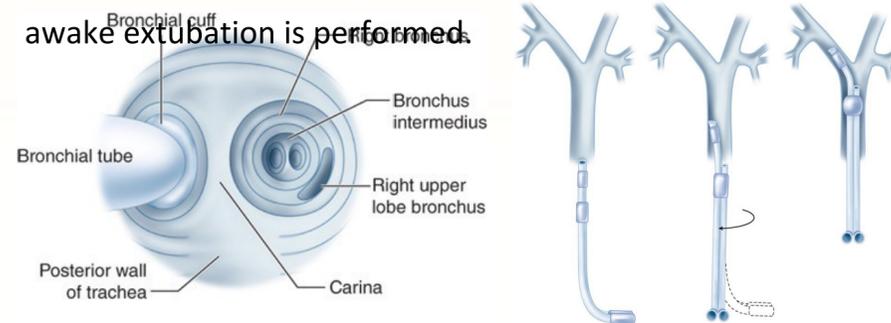
Following a smooth induction of the patient, bag-mask ventilation was performed and shown to be adequate. The first intubation attempt using a Glidescope with a single lumen endotracheal tube produced a grade III view and was unsuccessful. The attending anesthesiologist attempted a second intubation with a Glidescope but also fails. A senior attending is called for assistance as patient continues to be bag masked ventilated with an oral airway between attempts. The senior anesthesiologist turns to the flexible fiberoptic bronchoscope, but after several minutes of attempts, a clear view could not be established. A size 4 laryngeal mask airway (LMA) is inserted to assist with ventilation, and an Aintree intubation catheter is utilized to switch the LMA with a single lumen tube, leading to a successful intubation. Throughout these intubation attempts, additional Decadron is given to reduce swelling.

A cook airway exchange catheter was then inserted into the size 7.0 single lumen endotracheal tube to exchange for a size 35 French double lumen endotracheal tube. Correct placement was then confirmed using the fiberoptic bronchoscope.

### Extubation

Initial management plan was to keep her intubated and transfer her to the intensive care unit due to swelling from intubation attempts. However, after performing an adequate leak test, attending anesthesiologist decides extubation is possible.

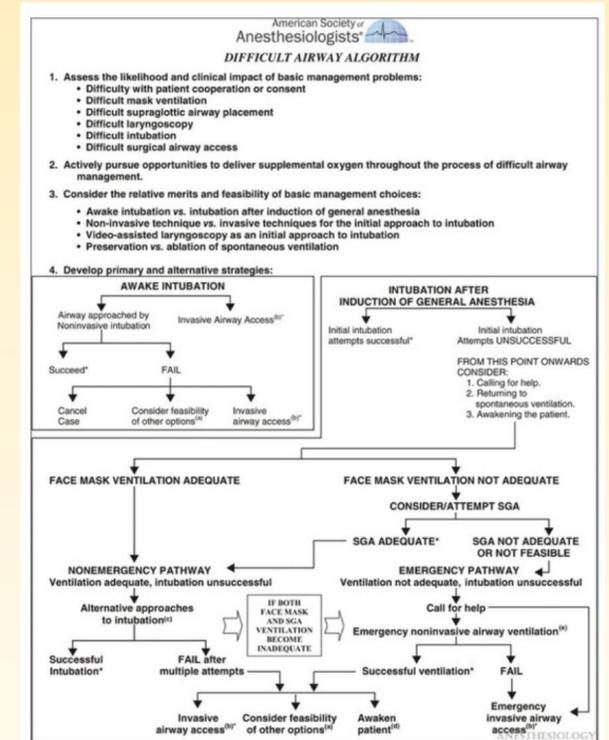
Additional Decadron is given, and patient is suctioned well. An awake extubation is performed.



Chapter 25 Anesthesia for Thoracic Surgery, Butterworth IV JF, Mackey DC, Wasnick JD. *Morgan & Mikhail's Clinical Anesthesiology*, 6e; 2018. Available at: <https://accessanesthesiology.mhmedical.com/content.aspx?bookid=2444&sectionid=193560771>

## Discussion

### ASA Difficult Airway Algorithm



2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway (2022) [Figure 1] Received February 2017, 2024

- ▶ Airway devices for difficult airways include laryngeal mask airways, fiberoptic bronchoscopes, video laryngoscopes, Aintree intubation catheters, gum elastic bougies, and cook airway catheters.
- ▶ Given the documented difficulty of her airway in her medical record, the difficult airway cart and fiberoptic scope was prepared in advance.

### Conclusion

- ▶ Since this patient had a suspected difficult airway, it was ideal to initially establish a safe airway first with a single lumen tube. A DLT may have been more difficult to place and worsen view.
- ▶ An awake fiberoptic bronchoscope intubation would have been a possible option, but patient had refused.
- ▶ For any future procedures, it would be ideal if the patient strictly undergoes awake intubations.

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# Neuraxial Anesthesia for Delivery in a Parturient with Fontan Physiology

## OBJECTIVES

- Review characteristics of Fontan physiology
- Discuss neuraxial anesthetic considerations
- Optimize an anesthetic plan for a high-risk patient undergoing a concerning procedure

## CASE PRESENTATION

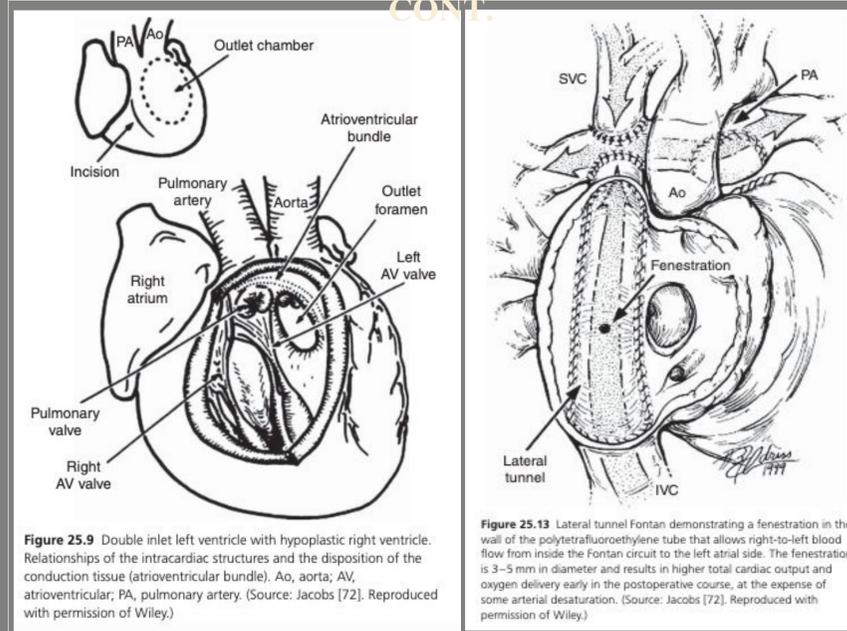
A 27-year-old parturient (G3P1011; ASA Class IV) was transported to the Riley Hospital OB floor after presentation with full-term, 5 days premature rupture of membranes and labor contractions at an outside hospital. She was 2 centimeters dilated and requesting an epidural upon arrival. All fetal monitoring results were within the normal range. Her past medical history included congenital heart disease, double inlet left ventricle, complete transposition of great vessels, pulmonary atresia, and questionable history of pulmonary emboli. She is currently taking ASA 81, pantoprazole, and is s/p lateral caval Fontan procedure with fenestration in the first year of life. Vitals all WNL. Lab results notable for platelet count of 93 k/cumm. An ECHO from two months prior revealed normal LV systolic function and a patent connection between the SVC and right pulmonary artery. A note from cardiology indicated a vaginal birth without pushing should be attempted but did not include an anesthesia consult. The anesthesia team admitted the patient to the OB ICU and prepared a plan for management.

## FONTAN PHYSIOLOGY

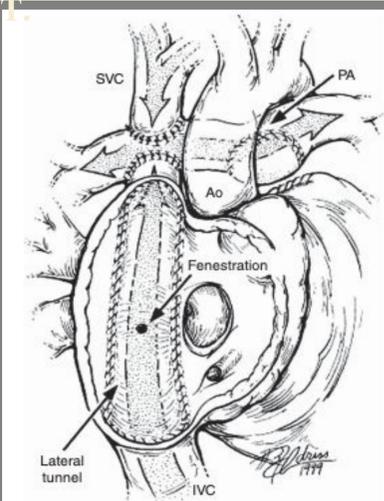
Many forms of congenital heart disease exist, and all necessitate special attention from the anesthesia care team, even when surgically managed decades prior. As shown in Figure 25.9, a double inlet left ventricle forms when both atria are connected to the left ventricle, with a hypoplastic right ventricle. In addition, complete transposition of the great vessels indicates that the anatomic locations of the pulmonary artery and aorta are swapped. Both types of lesions ultimately disrupt systemic and pulmonary circulation by causing blood to flow through the system in parallel, rather than in series. Patients with serial circulation present with arterial desaturation and cyanosis due to deoxygenated blood bypassing the pulmonary system and mixing with oxygenated blood. Prior to surgical intervention, the balance between pulmonary and systemic vascular resistances must be optimized to prevent preferential blood flow throughout only one system. Factors that can increase pulmonary vascular resistance and should be avoided include hypercapnia, acidemia, hypothermia, and increased concentrations of circulating catecholamines. One surgical technique performed to manage these issues is the Fontan procedure, usually completed in sequential steps throughout the first year of life. In the final procedure, the patient undergoes cardiopulmonary bypass as the right atrium is opened, and a lateral tunnel is fed through to connect the IVC and SVC to the pulmonary artery. Sometimes, a hole, or fenestration, is made in the wall of the tunnel present within the atrium to act as a pop-off valve for the system in the instance of pressure overload. After the procedure, the single ventricle pumps blood only into the systemic vasculature, with

## FONTAN PHYSIOLOGY

CONT.



**Figure 25.9** Double inlet left ventricle with hypoplastic right ventricle. Relationships of the intracardiac structures and the disposition of the conduction tissue (atrioventricular bundle). Ao, aorta; AV, atrioventricular; PA, pulmonary artery. (Source: Jacobs [72]. Reproduced with permission of Wiley.)

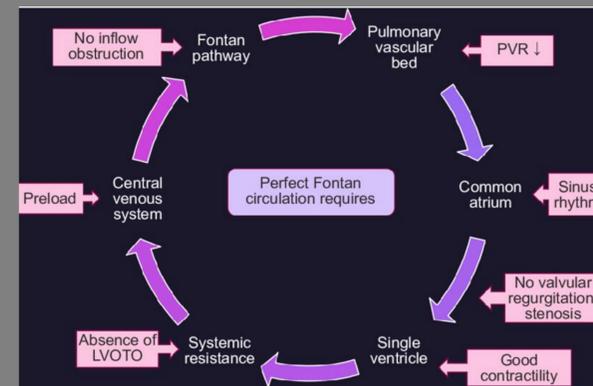


**Figure 25.13** Lateral tunnel Fontan demonstrating a fenestration in the wall of the polytetrafluoroethylene tube that allows right-to-left blood flow from inside the Fontan circuit to the left atrial side. The fenestration is 3–5 mm in diameter and results in higher total cardiac output and oxygen delivery early in the postoperative course, at the expense of some arterial desaturation. (Source: Jacobs [72]. Reproduced with permission of Wiley.)

## FONTAN PHYSIOLOGY

CONT.

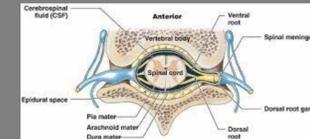
pulmonary blood flow becoming completely passive and dependent upon venous return from the periphery. In these patients, it is important to maintain their baseline blood pressure to prevent hypoxemia. Additionally, avoidance of positive pressure ventilation (PPV) and high positive end-expiratory pressure (PEEP) is beneficial to prevent elevated intrathoracic pressures and subsequent decline in venous return. The same can be said of patient positioning in steep Trendelenburg, or positions that directly decrease venous return, such as extreme reverse Trendelenburg and “beach-chair”. Long-term issues that may arise after the Fontan procedure include atrial arrhythmias, reduced cardiac output, heart failure, and frequent air or thrombus embolization.



## BASIC NEURAXIAL

CONSIDERATIONS

As stated by the ASA, “In the absence of a medical contraindication, maternal request is a sufficient medical indication for pain relief during labor.” Neuraxial anesthesia, namely epidurals, are the most common and often safest anesthetic technique available for parturients. Due to concerns about anesthetic agents crossing the blood-placental barrier, avoidance of intravenous administration of medications as such as possible is ideal. Placement of a catheter within the epidural space allows for continuous or intermittent bolus injection of analgesics directly to the location of spinal nerve roots and allows for spread of the medication both above and below the puncture site. General disadvantages associated with epidural use mainly focus on the high incidence of sympathectomy, especially in hypovolemic or hypertensive patient populations. Signs of sympathectomy include profound hypotension, reflex tachycardia, hypothermia, and decreased response to stress. There is some debate as to what contraindications there are for neuraxial anesthesia; therefore, the only widely accepted contraindication is patient refusal.



## FONTAN + PREGNANCY +

NEURAXIAL

Cardiovascular disease has been named as the leading cause of death in the parturient, with pre-existing heart disease resulting in the highest risk. Pregnancy induces many cardiovascular changes that can endanger even the healthiest of patients, such as an increased blood volume and stroke volume, increased heart rate, and increased cardiac output demands. For the parturients at an elevated risk, the World Health Organization (WHO) established a classification of cardiovascular disease in pregnancy; those listed as Class III or higher must have their pregnancy closely monitored by a team including a cardiothoracic anesthesiologist. Prior to labor and delivery, this team creates a detailed birthing plan in which labor is induced in a controlled environment. Class III and higher cardiac lesions include mechanical valves, cyanotic heart disease, Fontan circulation, pulmonary hypertension, severe mitral stenosis, and a left ventricular ejection fraction less than 30%. Moms that fall in the classes above may even be advised to terminate their pregnancy due to the significant risk for maternal mortality and morbidity. WHO suggests that the ideal management for these parturients is vaginal delivery aided by early neuraxial anesthesia, with ICU monitoring for 24-to-72 hours post-partum. The hope for early use of an epidural is to minimize cardiac swings in response to pain and contractions, decreasing risk for arrhythmia and thromboembolic events.

Despite the suggestions made by WHO, our patient presented without a detailed birthing plan or consultation by an anesthesiologist. Additionally, premature presentation to a pediatric institution meant that there was no access to cardiology or ECMO should the need arise.

## CASE CONTINUED

Prior to the initiation of neuraxial anesthesia, an awake arterial line was placed in the right radial artery in order to monitor blood pressure more closely. An appropriate waveform was noted and her preprocedural blood pressure was recorded to be 131/76 with a heart rate of 96 beats per minute. Placement of the epidural catheter went smoothly and was secured at the skin 5 cm past where loss of resistance was felt. A test dose of 3 mL 1.5% lidocaine with 1:200,000 epinephrine was given, and no response was observed. Common practice is to then give a loading dose through the epidural; however, due to this patient’s high-risk cardiac history, no boluses were given throughout her labor, and she was not given the option for patient-controlled epidural analgesia (PCEA). Instead, the epidural infusion of Fentanyl-Bupivacaine (2 mcg/mL – 0.1% premix) began relatively low at 5.3 mL per hour and was gradually increased in 2 mL per hour increments until adequate analgesia was achieved. Over the 6-hour course of her labor, a total of 43.33 mL of the anesthetic was given. After dosing the epidural, her blood pressure was recorded to be 133/76, with a heart rate of 86 beats per minute. Due to the possible implications associated with this patient “bearing down”, a vacuum-assisted delivery was performed by the OB team. Any potential elevations in intrathoracic pressure were avoided, and mom and baby made it through delivery without any serious complications. Mom was subsequently monitored in the ICU with the arterial line remaining in place for three days and was instructed to visit cardiology within two weeks. No issues with recovery were recorded.

## CONCLUSIONS

Although rare congenital defects and their perioperative management may seem most relevant to the pediatric anesthesia care team, as surgical interventions improve and patients are able to live longer, healthier lives, these patients will continue to present to our operating rooms and still deserve the meticulous care we give to their younger counterparts. Additionally, the parturient patient presents unique challenges for the anesthesia team, when what is thought to be best for the patient does not align with patient goals and expectations.

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# Can the use of Botulinum Toxin A be more beneficial than local anesthetic blocks when treating chronic pain syndromes?

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## Introduction

- Rikard et al. reported that 20.9% of American adults were affected by various forms of chronic pain disorders that caused a substantial decline in their quality of life.
- A common form of treatment includes sympathetic nerve blocks with local anesthetics that require patients to receive recurrent injections up to one to two times a week which can disrupt their daily lives, become expensive, and may not provide long-term relief.
- Researchers have begun looking into alternative forms of treatment including the use of Botulinum Toxin A as an adjuvant to local anesthetics in sympathetic nerve blocks to provide more efficacious and longer-acting analgesia.

## Materials

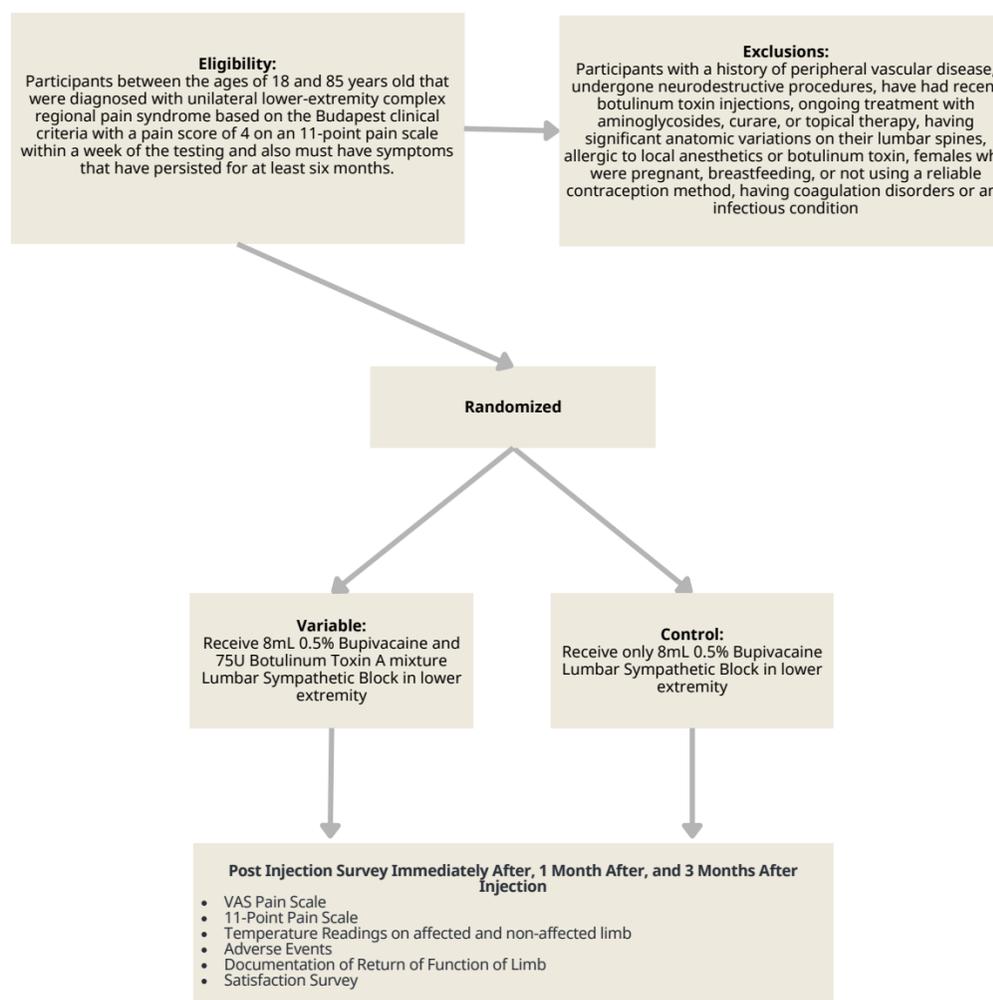
- Visual Analog Pain Scale
  - A measurement tool to assesses a person's pain intensity by asking them to mark a point on a horizontal line corresponding to their level of pain, with one end indicating "no pain" and the other end representing "worst pain imaginable."
- 11-Point Numerical Pain Scale
  - A measurement tool to assesses a person's pain intensity by asking them to mark a number corresponding to their level of pain, with 0 being indicating "no pain" and 10 representing "worst pain imaginable."
- Materials for Lumbar Sympathetic Block
  - Sterile gloves and prepping, 21-gauge 15-cm needle, 0.5% Bupivacaine, Normal Saline, Botulinum Toxin A, fluoroscopy and x-ray to confirm placement
- Temperature Probes
  - To gauge level and amount of block

## Predicted Results

- Addition of Botulinum Toxin A or using it alone as a sympathetic nerve block will outperform common local anesthetics alone in providing pain relief in effectiveness and longevity in patients with chronic pain.
- Botulinum Toxin A's muscle relaxation, reduction of peripheral sensitization, and potential modulation of neurotransmitter release may lead to sustained and effective pain relief in order to provide more options for treatment.



## Methodology



Adapted from Yoo et. al.

## Discussion

- Current research suggests that adding Botulinum Toxin A to long-acting local anesthetics provides longer and more effective analgesic coverage in sympathetic nerve blocks compared to local anesthetic alone.
- Despite the benefits observed, the cost and stigma associated with Botulinum Toxin A still remains as a hinderance for patients to consider it as a secondary option for treatment.
- Physicians could consider these findings along with individualized treatment plans in consultation with patients, taking preferences, medical history, and cost into account while recognizing the growing evidence supporting the use of Botulinum Toxin A for chronic pain management.
- These findings could implicate a new standard of care which entails decreased clinic visits, decreased costs, and improved quality of life as well as further the understanding of treatment for different types of chronic pain disorders and Botulinum Toxin A's long term effects.

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# Anesthetic Management of a Systemic Right Ventricle

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## Introduction

This study will review anesthesia management in a patient who has significantly outlived their life expectancy after a correction for Transposition of the Great Arteries (TGA) with a Mustard procedure. The patient presents for robotic inguinal hernia repair post Mustard procedure (1964).

Learning objectives:

1. Increased anesthetic risk factors due to cardiac and pulmonary function.
2. Patient risk factors from lifestyle choices.
3. The overlap of personal and cardiac risk factors and their effect on anesthetic risk.

## Why we care

Patient had a Mustard procedure in 1964. Patient's Mustard procedure was performed shortly after the procedure's invention. Studies show long-term survival beyond 20 years post procedure is considered extremely uncommon and there is a lack of data concerning patients in this group. Patients followed in the studies typically experienced loss of sinus node function due to the stress put on the right ventricle after the operation. A study by Jensen et al. indicated the most common cause of death in adolescence was sudden cardiac death, and in children >10 years old it was heart failure. Patient has led a relatively unrestricted life for approximately 60 years with a complex cardiac physiology. He presents for a non-cardiac surgery, but now has additional complicating factors due to health choices including smoking, chewing tobacco, and obesity.

## Patient Description

A 60 year old male who is 5'10", 100kg, and BMI of 32.5 presents for robotic inguinal hernia repair.

Past medical history:

- Atrial Flutter/Fibrillation
- Obstructive Sleep Apnea with the use of CPAP
- Transposition of the Great Arteries status post Mustard procedure in 1964
- Pulmonary Hypertension
- Eisenmenger's Syndrome
- Stage 3 Chronic Kidney Disease
- Acute respiratory failure with hypoxia and hypercapnia
- Peripheral vascular disease

The patients most recent right heart catheterization indicated:

- pulmonary capillary wedge pressure of 28
- Fick cardiac output 5.9
- Fick cardiac index of 2.6
- Pulmonary Vascular resistance 9.3

The most recent echo indicated:

- chronic combined systolic and diastolic heart failure
- Severe right atrial dilation
- mild regurgitation of the systemic Av valve.

The most recent Pulmonary Function Test:

- Moderate Restrictive Diseases,
- Total Lung capacity of 60-69%.

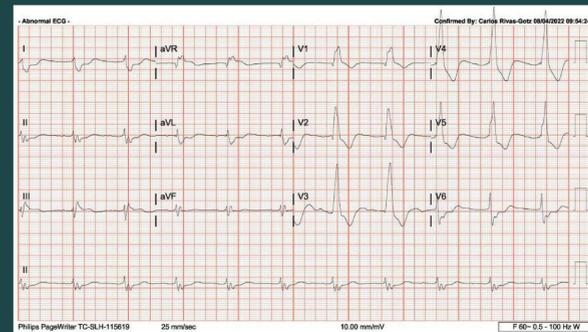
Labs were unremarkable for stage 3 chronic kidney disease.

The patient takes Albuterol, Coreg, Digoxin, Eplerneone, Hydralazine, Warfarin.

Social history:

- 0.5 pack years smoking
- current smokeless tobacco
- 1 drink a week

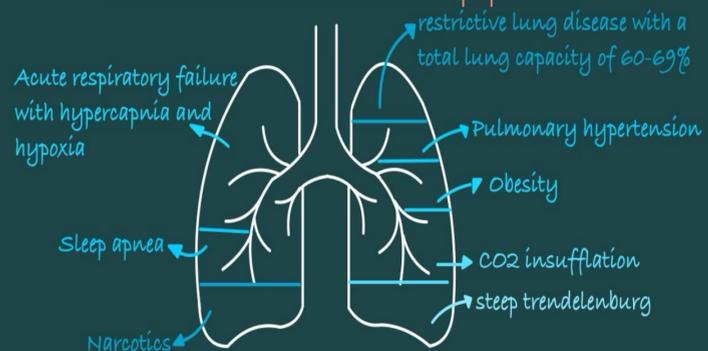
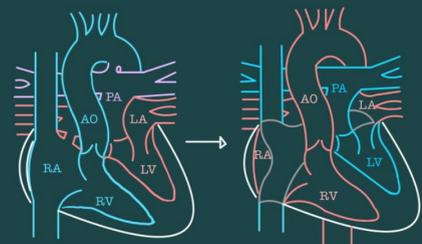
## Physiologic concerns



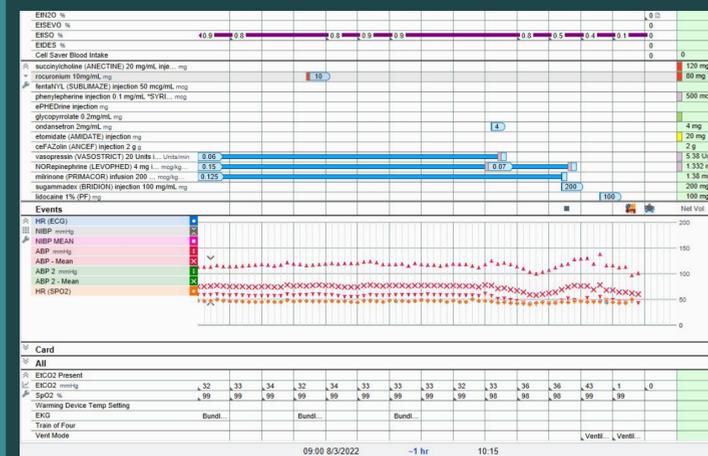
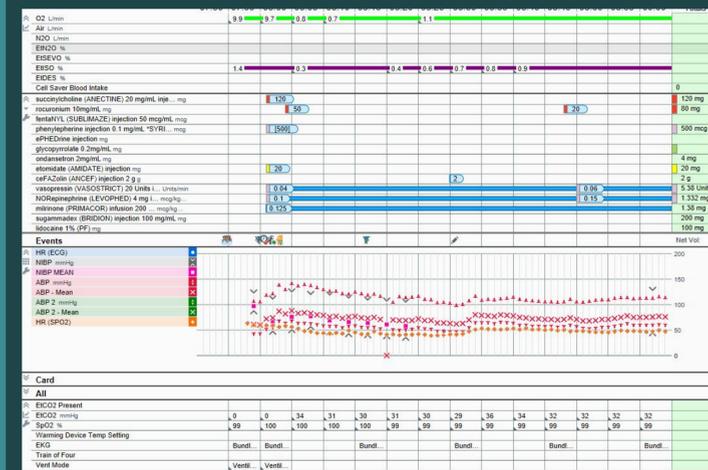
Gellatt et al. noted patients developed sinus node dysfunction/ atrial fibrillation/ atrial flutter due to the excessive work that is put on the right ventricle caused by a mustard procedure. Another common side effect noted was pulmonary hypertension. Both are present in this patient.

These physiologic changes not only cause concern for safely securing the airway, but also for various pressure changes within the abdomen and thorax during a robotic case. In a study of COPD patients by Kilic et al. discussed the effect of steep Trendelenburg and CO2 insufflation on lung compliance, and discovered a p value of <0.0001. This study noted that lung compliance was decreased, and the effects lasted longer than five days in those with illness, while those without illness recovered in five days.

The other main cardiac risk factor is the understanding the physiologic right ventricle is responsible for systemic circulation. Christensen et al. performed a retrospective analysis of general surgical procedures on patients post correction for TGA, while most patients had an arterial switch procedure, five had undergone a mustard procedure. In these adult patients the surgical team decided on invasive monitoring because of the risk for heart failure and other cardiac complexities observed.



## Anesthetic Plan



### Preoperative Management

The patient received a pre-induction arterial line and central line for hemodynamic monitoring as well as medication administration. Placement of these lines were uneventful.

### Induction:

This patient underwent an uneventful induction of anesthesia. The induction sequence included: 20 mg of Etomidate, 120 mg of succinylcholine, 500 mcg of phenylephrine. Succinylcholine was the relaxant of choice to allow for rapid securing of the airway. Prior to induction the following drips were started and maintained throughout the case: 0.04 units/ min of Vasopressin, 0.1 mcg/kg/min of Levophed, 0.125 mcg/kg/min of Milrinone.

### Maintenance

Maintenance of anesthesia was achieved with isoflurane as well as the previously mentioned drips, as well as redosing of rocuronium to achieve paralysis for the robotic portion of the case.

### Emergence

Emergence was uneventful with termination of drips when end tidal isoflurane was at 0.5 and sugammadex was given. 100mg of lidocaine was also given proactively to help blunt coughing on the tube.

## Discussion

Overall the patient had a successful outcome following surgery. The patient was optimized to the best of the team's ability. The anesthetic team believes their plan was thorough and took into account the complex physiology of this patient. The team reflected on the potential of trying to optimize the patient better in terms of smoking cessation and ensuring he quit several months prior to surgery. The plan included appropriate pressors, inotropic support, as well as ventilatory management to ensure the patient remained as close to his physiologic normal as could be accomplished. Due to the potential for adrenal suppression by etomidate, the team speculated about a potential combo of propofol/ketamine or propofol/etomidate to potentially reduce this risk. Along with choice of induction agent, the team reflected on their use of succinylcholine due to the potential for histamine release as well as the potential issues this could have caused in a patient with chronic kidney disease. The care for this patient required an intimate understanding of the anatomy of his heart and what those implications would be in terms of support. Milrinone was the choice because of its ability to support right heart function, which was critical in this patient as his right ventricle is the systemic ventricle. Everything in this case was dependent on control and taking steps to prevent things from getting to the point the anesthetic team could not correct. This planning had to involve some very honest discussions with the patient and the risks associated with undergoing surgery in his state of health. The patient understood the risks and was comfortable proceeding as well as the anesthetic team felt that had a good plan to keep the patient safe under anesthesia.

## Conclusions

The medical field has vastly improved since 1964 and will only continue to improve throughout our careers. The major accomplishments we have seen in congenital heart defect repair since the sixties will only continue to improve. While the mustard procedure has since fallen out of favor, I suspect this will be a common trend we will see throughout our careers as medical techniques continue to advance. It will become more common to help treat these patients who are living long after their initial life expectancy thanks to the advent of new surgical techniques.

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# Which Tape Best Prevents Skin Tears in Routine Anesthesia Procedures?

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## Why are skin tears an issue?

Corneal Abrasions and Skin Tears are common perioperative injuries and concerns for patients undergoing anesthesia procedures.

Skin Tears are wounds resulting from shear, friction, or blunt force, causing a separation of skin layers

Adhesive tape used to secure endotracheal tubes and protect eyes while under anesthesia can cause skin tears during tape removal.

Elderly people and patients with delicate skin conditions are particularly vulnerable groups.

Patient positioning and length of surgery create additional challenges.

## Skin Tear Classification

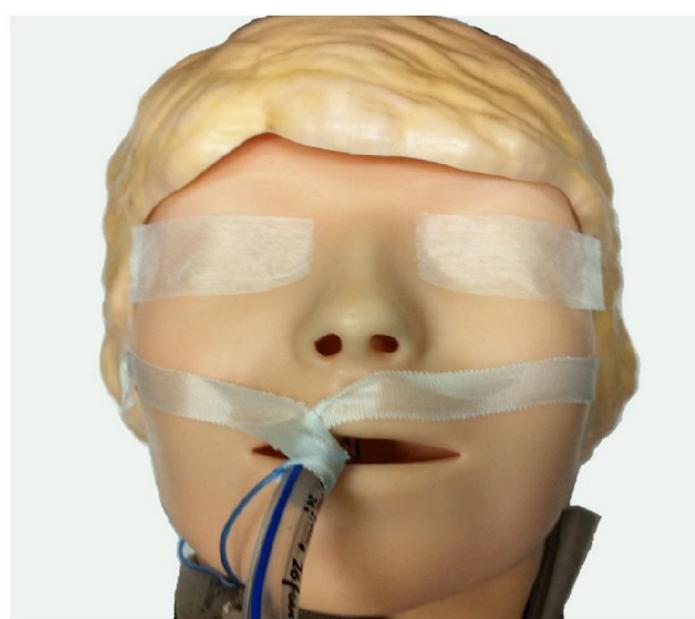
The International Skin Tear Advisory Panel (ISTAP) Skin Tear Classification System.



Linear or Flap\* Tear which can be repositioned to cover the wound bed  
 Partial Flap Loss which cannot be repositioned to cover the wound bed  
 Total Flap Loss exposing entire wound bed

\*A flap in skin tears is defined as a portion of the skin (epidermis/dermis) that is unintentionally separated from its original place due to shear, friction, and/or blunt force. This concept is not to be confused with tissue that is intentionally detached from its place of origin for therapeutic use e.g. surgical skin grafting.

## Comparison of Medical Adhesive Tapes



## Skin Tear Studies and Classification

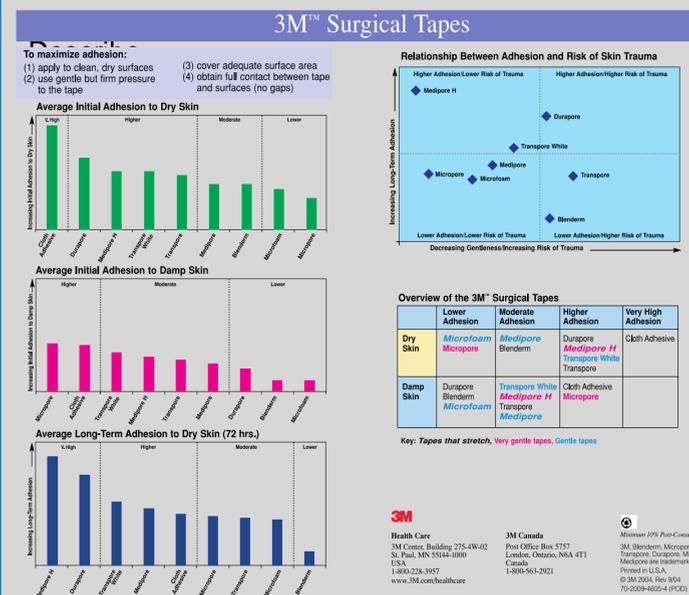
The primary objective of the International Skin Tear Advisory Panel (ISTAP) was to develop a quantifiable classification system for qualitative measurements to establish a common language for classification of skin tears.

The findings of their classification system have been further investigated and validated for intrarater reliability among healthcare providers.

## 3M Tape Options for Consideration

3M™ Surgical Tapes—Choose the Correct Tape HYPOALLERGENIC, LATEX FREE, PRESSURE SENSITIVE		
<b>3M™ Blenderm™ Surgical Tape "Waterproof Plastic" Tape</b> Flexible, occlusive, transparent tape made from polyethylene film. For protecting sites from external fluids and contaminants.		Blenderm tape—clear, waterproof
<b>3M™ Micropore™ Surgical Tape "Paper" Tape</b> Gentle, breathable tape with rayon backing. For general dressing applications and repeated taping on fragile, at-risk skin.		Micropore tape—gentle, breathable
<b>3M™ Transpore™ White Dressing Tape</b> Gentle, breathable, multi-purpose tape with a rayon-polyester blend backing. Perforated for quick, bi-directional tear. Easy to handle with gloves. Holds well to dry or damp skin. For securing dressings, tubing, and devices. Great standardization tape.		Transpore White tape—standardization tape
<b>3M™ Transpore™ Surgical Tape "Plastic" Tape</b> Transparent, perforated polyethylene film with bi-directional tear. Easily tears into very thin strips. For securing tubing and dressings that need to be monitored.		Transpore tape—clear, easy bi-directional tear
<b>3M™ Durapore™ Surgical Tape "Silk-like" Tape</b> High strength, conformable, taffeta-backed tape with convenient bi-directional tear. Adheres well to dry skin. For securing bulky dressings, heavier tubing and small splints.		Durapore tape—strong backing, high adhesion to dry skin
<b>3M™ Microfoam™ Surgical Tape "Foam" Tape</b> Highly conformable, water resistant, closed cell foam tape that stretches in all directions. For compression applications and securing dressings in challenging areas.		Microfoam tape—compression, stretch, water resistant
<b>3M™ Medipore™ Family of Soft Cloth Surgical Tapes</b> Soft, gentle, breathable, conformable tapes in easy tear, perforated rolls. No liner or scissors needed. Excellent cross and diagonal stretch. Medipore H tape has stronger adhesion, yet is gentler for repeated taping. For comfortable dressings and securing over areas where skin may stretch.		Medipore family of tapes—soft, comfortable, stretch
<b>3M™ Cloth Adhesive Tape "Latex Free Cloth" Tape</b> High strength, cotton-backed tape with bi-directional tear. Unlike most "cloth adhesive" tapes, this tape is breathable, hypoallergenic, and latex free. For securing medical devices and light immobilization support.		Cloth adhesive tape—breathable, strong, high adhesion, latex free

## Methods and Results



Which tape had decreased incidence of skin injury and higher patient satisfaction?

## Discussion Questions

Can the results of the 3M tape study be further validated using the ISTAP classification system?

Would other tapes yield similar findings?

Can these methods and findings be generalized to other common procedures in the OR?

Would patients with a prior history of skin tears present with similar findings?

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University of Colorado  
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# LMA and Videolaryngoscopy-Assisted Nasal Fiberoptic Intubation in the Management of

## Concomitant Le Fort, Mandibular and Thoracic Spine Fractures

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### Introduction

Blunt force, mid-face trauma can result in mandibular and Le Fort pattern fractures that can cause facial disfiguration and complex anatomy. Le Fort fractures account for around 15% of all facial fractures and follow suture lines within the maxillary, mandibular, zygomatic bone processes as well as the pterygoid plate. These fractures complicate airway management in the perioperative period and require careful consideration of any craniofacial manipulation, the delivery of positive pressure ventilation, as well as the potential presence of laryngeal swelling, airway bleeding, deformity, cervical and thoracic spine instability, cribriform plate injury, CSF leak and more. This case presentation describes the successful airway management utilizing a combination of techniques for a patient with bilateral mandibular and Le Fort III craniofacial fractures, as well as an unstable T6 Chance fracture, subdural hematoma, and multiple rib fractures.

### Learning Objectives

- Discuss relevant airway management considerations for patients with maxillofacial trauma
- Describe the relevant anatomy delineating Le Fort fractures
- Describe acute and long term complications of craniofacial fractures
- Discuss spine, ICP, and sinus precautions associated with acute craniofacial and spinal trauma
- Discuss the implications of surgical wiring of the jaw in Le Fort fractures
- Highlight the utility in combining airway techniques in the management of difficult airways and the potential advantages and disadvantages of each

### Case Presentation

This case involves a 34 year old M with a PMHx of anxiety, alcohol and marijuana use who initially presented to the University of Colorado ED as a trauma activation (motorcycle vs. truck) with ejection suffering multiple traumatic injuries including: subdural hemorrhage, Le Fort III fractures, L rib fractures 3-5, and a complex T6 Chance fracture with instability. He was remarkably awake and mentating on arrival with C-collar in place and plan for staged repair of his injuries, starting with a T5-T9 percutaneous fusion and subsequent ORIF of bilateral midface fractures, possible orbital floor fractures, and mandibular fracture with maxillomandibular fixation.

Prior to intubation for the T5-T9 posterior instrumentation, CTs of the brain, face, cervical spine and neck were reviewed (Figure 1). Bedside airway exam was limited due to pain so the severity of any oropharyngeal trauma was unknown. Awake fiberoptic intubation was not considered due to patient's baseline anxiety level and intoxication. C-spine, T-spine and sinus precautions were maintained throughout given the patient's significant maxillofacial instability. We initially induced with ketamine alone to maintain spontaneous ventilation in case of failure to intubate and to facilitate "awake" insertion of a hyperangulated laryngoscope blade. Once a clear view of the epiglottis and glottic opening was quickly confirmed, we proceeded with an RSI with propofol and rocuronium given the risk of aspiration, inability to provide mask ventilation, and distorted facial anatomy. A Grade I view was obtained and the patient was intubated uneventfully. Considerations were made regarding fixating the patient's head in Mayfield pins vs. ProneView. After discussion with neurosurgery and ENT, decision was made that pinning may lead to excessive traction on unstable midface fractures and that positioning in a ProneView would minimize further damage, with the understanding of the risk of facial injury due to compression. The patient underwent a successful T5-T9 percutaneous fusion, was extubated and brought back to the surgical ICU for continued monitoring.

Three days later, the patient re-presented to the OR for repair of his Le Fort III and mandibular fractures. Due to the need for surgical access to the oropharynx and plan for wiring of the jaw pre-emergence, nasal intubation was indicated. Blind nasal intubation with McGill forceps was avoided due to the risk of basilar skull fracture and inadvertent intracranial advancement of ETT. CT imaging did not reveal any overt basilar skull fractures. However, nasal fiberoptic intubation was planned for better visualization and to identify any potential microfractures along the track from the nasopharynx to glottis. Given the rapid time to desaturation with a nasal fiberoptic technique and sinus precautions, which precluded the ability to provide any positive pressure ventilation via mask, we decided to induce and immediately place an LMA to allow for continuous oxygenation and ventilation during the careful advancement of the fiberoptic scope through the nasal passages, nasopharynx, and oropharynx. Once the LMA was visualized with the fiberoptic scope, the LMA was removed and a videolaryngoscopy blade was inserted to facilitate visualization and advancement of the fiberoptic scope through the glottis into the trachea. The tube was advanced successfully over the fiberoptic scope and position confirmed with ETCO2 monitoring and fiberoptic visualization. The patient underwent successful surgical fixation and jaw wires applied. The patient calmly emerged from anesthesia on dexmedetomidine and remifentanyl infusions and was extubated without issue. He was later discharged from the hospital on POD#3.



Figure 1: Demonstration of LMA-assisted nasal fiberoptic intubation



Figure 2: Demonstration of video-laryngoscopy-assisted nasal fiberoptic intubation

### Discussion

#### Spinal Precautions in Trauma:

Oftentimes, Le Fort fractures are merely one feature of a larger traumatic event. Spinal precautions in trauma often involve the utilization of a C-collar, log-rolling maneuvers, rigid backboard, and minimizing unnecessary and excessive movements of the head, neck and back to avoid secondary injury. With airway management a necessity in the acute perioperative setting, these procedures are often performed with C-spine precautions in place, restricting intubation options. Always perform an airway exam as able and review available imaging before formulating an airway plan with multiple contingency plans. Maxillofacial reconstruction and stabilization is often not emergent and can be delayed, so choice of intubation should be carefully selected.

#### Sinus Precautions in Trauma:

In the setting of basilar skull or midface fractures, sinus precautions are often instituted, which includes but is not limited to restriction of nose blowing, closed mouth sneezing, and use of positive pressure (PPV) via bag mask ventilation (BMV). PPV can potentially introduce foreign infectious material from the airway into the brain. Additionally, if a dural tear is present, BMV can lead to life-threatening tension pneumocephalus or infection (e.g. meningitis).

#### Intracranial Pressure (ICP) Considerations in Trauma:

Cranio-facial trauma raises the concern of elevated intracranial pressures due to acute hemorrhage from vascular injury. ICP status alters our anesthetic agent choices and should be carefully considered. This patient was found to have a small 5 mm subdural hematoma on head CT without evidence of midline shift. Additionally, there were no signs/symptoms of elevated ICP on physical exam (e.g. decreased level of consciousness, nausea/vomiting, pupillary changes, hemodynamic instability). Due to these findings, it was determined that use of ketamine for induction to maintain spontaneous ventilation during airway management could be used safely.

#### Maxillomandibular Fixation Considerations:

Surgical wiring of the jaw is often indicated in Le Fort fracture repairs. Once the jaw is wired, the mouth cannot be opened or easily manipulated. It is best practice to wake the patient up fully before extubation due to the limited available methods of reintubation should the patient require it. Wire cutters should be immediately available should the need arise to re-access the oropharynx for emergent reintubation. Suctioning of the oropharynx can be achieved by placing a soft suction catheter down the nares or by having the patient fully awake and swallowing to remove excess secretions. Extubation may be delayed if a patient does not meet criteria for safe extubation immediately after surgery.

### Conclusion

When formulating an airway management plan in the setting of complex maxillofacial and spinal trauma, combining airway devices/techniques should be considered. Advantages of multiple devices can be leveraged for safe manipulation and management of tenuous airways.

### Complications of Le Fort Fractures.

Acute Complications	Long Term Complications
<ul style="list-style-type: none"> <li>• Bone fragmentation compromising nerves, vessels and blood brain barrier (BBB)</li> <li>• Basilar skull and cribriform plate fractures contraindicating nasal intubation or NG tube placement</li> <li>• CSF leak and subsequent meningitis</li> <li>• Oropharyngeal bleeding and edema impairing visualization</li> <li>• Epistaxis, swelling, hematoma and nasal obstruction</li> <li>• Intracranial hemorrhage that may increase ICP or require emergent decompression</li> <li>• Associated cranial nerve (CN) injuries (e.g. V2 branch of the trigeminal nerve CN V and the olfactory nerve CN I are most likely to be injured, followed by CNs II, IV, VI and VII)</li> <li>• Altered dentition including loose teeth</li> </ul>	<ul style="list-style-type: none"> <li>• Retrobulbar hemorrhage and subsequent vision loss</li> <li>• Post-operative nasal deformity and nasal obstruction</li> <li>• Malocclusion and facial asymmetry</li> <li>• Tracheal stenosis, subcutaneous emphysema, laryngeal nerve damage</li> <li>• Trismus (lockjaw) and infraorbital nerve damage</li> <li>• Neurologic deficits resulting from concussion and brain trauma</li> <li>• Chronic pain</li> </ul>

### Intubation Techniques for Maxillofacial Fracture Surgery:

#### Videolaryngoscopy

- **Pros:** Rapid intubation time. Less cervical manipulation compared to DL. Possible awake assessment/intubation.
- **Cons:** Risk of oropharyngeal injury. May be hindered due to structural damage and distorted anatomy. Blood and secretions may obscure camera view. Despite view, may be difficult to advance ETT anteriorly. Expensive and still not widely available.

#### Fiberoptic Intubation

- **Pros:** Allows for navigation of distorted anatomy. Can be performed awake in spontaneously breathing patients. Can be advanced orally or nasally.
- **Cons:** Slower process. Risk of aspiration. Requires experienced operator. If awake, requires cooperative patient. Blood and secretions may obscure camera view. Nasal intubation contraindicated with basilar skull fracture. Contraindicated with impending or complete upper airway obstruction.

#### Submandibular or Submental Intubation

- **Pros:** Avoids complications associated with cricothyrotomy or tracheostomy. Useful when nasal intubation is contraindicated. Permits manipulation of maxilla and mandible and allows access to oropharynx. Does not interfere with maxillomandibular fixation.
- **Cons:** Potential for loss of airway or bleeding. Risk of damage to submandibular structures and the lingual nerve. Risk of oro-cutaneous fistula.

#### Retrograde Wire Intubation

- **Pros:** Useful when visualization from upper airway is obscured. Provides direct conduit between mouth and laryngeal inlet.
- **Cons:** Slow process. Requires experienced operator. Risk of catheter entering fractured pathways instead of direct path to oropharynx. Risk of esophageal perforation, laryngospasm, vocal cord damage or laryngeal damage. Contraindicated in patients with severe deformities, nonpalpable landmarks.

#### Surgical Cricothyrotomy or Tracheostomy

- **Pros:** Does not require access to oropharynx, nasopharynx, or maxillofacial structures. Durable, can be used for long-term airway, oxygenation, and ventilation needs.
- **Cons:** Potential loss of airway, hemorrhage, subcutaneous emphysema, recurrent laryngeal nerve damage, tracheal stenosis, trachea-esophageal fistula and scar. Requires experienced operator.

#### Combined LMA + Nasal Fiberoptic Intubation (Figure 1)

- **Pros:** Quick placement of LMA. Allows for continuous oxygenation and ventilation through fiberoptic process, reducing risk of desaturation. Fiberoptic allows for visual assessment of entire ETT track.
- **Cons:** Risk of aspiration. Potential for oropharyngeal trauma from LMA placement obscuring fiberoptic view. Requires experienced operator.

#### Combined Videolaryngoscopy + Nasal Fiberoptic Intubation (Figure 2)

- **Pros:** Improved visualization of oropharyngeal structures (2 cameras). Allows for anterior displacement of structures potentially obscuring fiberoptic view (e.g. tongue) with minimal footprint. Fiberoptic allows for visual assessment of entire ETT track.
- **Cons:** Requires at least two experienced operators. Slow process. No conduit for ventilation during fiberoptic advancement.

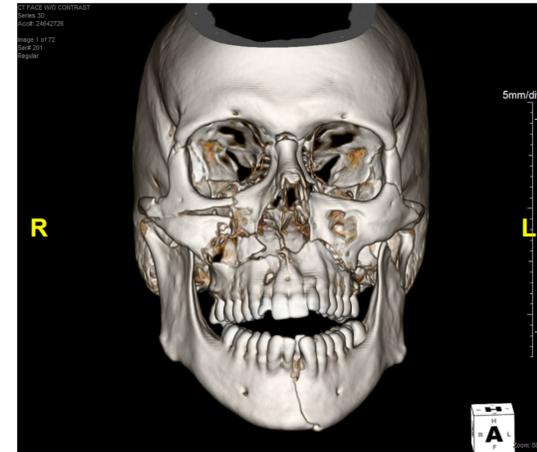


Figure 3: CT face 3D reconstruction demonstrating complex maxillofacial fractures

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# Anesthetic Considerations for Patients with Sickle Cell Disease

Sabrina Oh

Mentors: Ashlee Gourdine MD, Kenny Wise MD

## Introduction

Sickle cell disease (SCD) is an autosomal recessive disease prevalent in African, Middle Eastern, and Central Indian populations as it confers immunity against malaria.<sup>1,5</sup> Healthy red blood cells (RBCs) have a half-life of ~120 days, however this is reduced to 10-12 days in SCD causing chronic hemolytic anemia, hyper-proliferative bone marrow and hyperdynamic circulation, affecting all organ systems. Deoxygenation can cause a cascade of events leading to a sickle cell crisis. Some common triggers are pain, dehydration, and cold temperatures.<sup>1</sup>

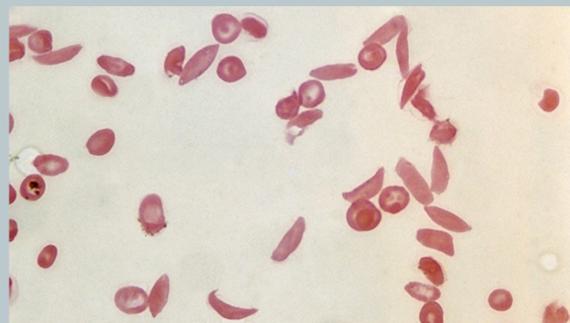


Figure 1. Microscope image of sickled RBCs

## Objectives

- Discuss challenges in intraoperative management of SCD patients
- Develop pain management approaches for postoperative pain and SCD crises
- Compare the benefits of general and regional anesthesia
- Evaluate the risks associated with different transfusion regimens

## Review of Literature

### Preoperative Care

A thorough preoperative evaluation is imperative for SCD patients and is aimed at identifying baseline Hgb and transfusion requirements, organ dysfunction, preventing crises, and postoperative complications. SCD patients are prone to cardiac and pulmonary complications and dysfunction, which may necessitate a TEE/ECHO. Difficult IV access due to chronic damage to endothelial lining, repeat blood draws and placement of catheters is common.<sup>2</sup> Incentive spirometry can decrease the incidence of atelectasis and ACS.<sup>1</sup>

### Fluid Management

It is imperative that patients are adequately hydrated. IV hydration at the standard maintenance rate is sufficient as fluid overload may lead to acute chest syndrome (ACS). NS is acidic and may increase blood viscosity and cause acidosis.<sup>1,2</sup> A pediatric study found NS bolused patients had poorer pain control compared to with other types of fluid. Isotonic fluids have not been thoroughly studied.<sup>2</sup> At this time, the official recommendation is still hypotonic fluid.

### Intraoperative Management

Goals: avoid hypoxemia, hypercapnia, acidosis, hypothermia, and hypovolemia. Oxygen supplementation is not usually necessary as oxygen toxicity is known to suppress the formation of new RBCs and cause lung injury. ABGS may provide more accurate information regarding oxygen saturation as pulse oximetry readings may not reflect arterial oxygen tension.<sup>1,5</sup>

### Regional Anesthesia

The benefits of RA are unclear. Research shows SCD complications are more frequent in patients receiving RA, however, these were sicker patients. RA theoretically causes regional hypoperfusion, venous stasis, redistribution of blood flow, oxygen tension and vasoconstriction of non-blocked areas.<sup>1</sup> It may aid in pain control, reduce length of stay, and decrease opioid consumption. It is recommended for local pain not adequately treated with opioids. Nerve catheters do not show decrease in reported pain scores.<sup>3</sup> Use of tourniquets are controversial because they create ideal conditions for sickling.<sup>1</sup>

## Review of Literature cont.

### Pain Control

Pain is treated aggressively and there is a large emphasis on multimodal pain management.<sup>5</sup> This includes opioids, NSAIDs, and ketamine. Ketamine may be useful for pain refractory to opioid therapy, but will not reduce for more than 3 days after initiation of therapy and does not decrease opioid consumption.<sup>4</sup> Opioid PCAs should be used with caution. Nonpharmacologic measures include music, heat and ice packs.<sup>1</sup>

### Transfusion Protocols

Preoperative blood transfusion is controversial. Transfusion can reduce HbS% and improving oxygen delivery, however, it will increase blood viscosity and the risk of alloimmunization. Net benefit if Hb  $\leq$  10 g/dL.<sup>1</sup> During acute events, transfusion may not be required in patients if Hb  $>$  9 and no hypoxemia.<sup>5</sup> Aggressive transfusion regimens aim for Hb  $\geq$  10 g/dL AND HbS%  $<$  30%. Conservative regimens do not have an HbS% goal. There is no difference in outcomes or blood loss in aggressive vs conservative transfusion regimens, however the aggressive regimen had increased report of alloimmunization.<sup>2,6</sup> Patients should receive preoperative transfusion as another study in which patients did not receive preoperative transfusions was terminated due to poor outcomes and increased risk of VOC and ACS. All patients undergoing GA  $>$  1 hour should receive transfusions. Simple transfusions are recommended for Hb  $<$  8.5 g/dL, with posttransfusion Hb goals  $<$  11 g/dL. Exchange transfusions should occur if Hb  $>$  8.5 g/dL. Autologous cell salvage has reported varying degrees of success and is not currently recommended.<sup>5</sup>

### Acute Chest Syndrome (ACS)

ACS is an acute lung injury characterized by respiratory symptoms, fever, and new radiodensity on chest imaging. Patients are at risk of ACS in the immediate post-operative phase and is the leading cause of death in patients presenting to the ED. Adults commonly present with chest pain, SOB, and neurologic findings. Pediatric patients present with fever and wheezing. VOC is the most common inciting cause along with respiratory illness.<sup>5</sup> This risk increases with the use of opioids and excessive IV fluids.<sup>5</sup>

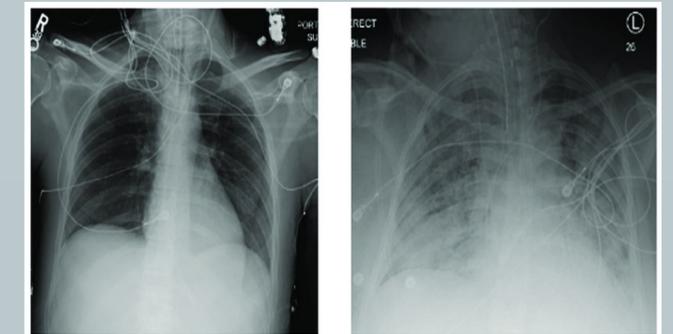


Figure 2. Chest x-ray of healthy lungs (left). Chest x-ray of acute chest syndrome (right).

Patients should be treated with adequate ventilation, transfusion, antibiotics, and bronchodilators.<sup>1</sup> ACS can cause worsening lung function due to fibrosis, and overtime can increase PHTN. Intercostal nerve blocks are recommended for patients with ACS and pain not adequately treated with opioids. Up to 21% of patients will experience respiratory failure within 24 hours of symptoms.<sup>5</sup>

## Conclusions

Most of these studies were conducted on otherwise healthy and optimized patients and undergoing elective procedures of low to moderate risk. The benefits of GA vs RA need more research as it is unclear if RA is actually beneficial. It was difficult to find reports regarding management of patients undergoing emergent procedures. More research is needed on different pain management techniques for patients undergoing SCD crises and optimal fluid choice for volume resuscitation.

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## Introduction

Osteogenesis Imperfecta (OI) is a brittle bone condition inherited genetically at birth. Gene variation can occur from spontaneous mutation, paternally, maternally, or both depending on the type of OI<sup>1</sup>. There are several different severities arising mainly from type 1 collagen defects that impact bone metabolism<sup>2</sup>. OI patient's bones are at an increased risk of fracture, and further complications include scoliosis, respiratory infections, heart problems (valvular malfunction), hearing loss, blue sclera, soft discolored teeth, CNS abnormalities, and vision loss<sup>3</sup>. Diagnosis can be confirmed through lab tests and x-ray. The main anesthetic goal is to prevent deformities and fractures during intubation and positioning.

Type	Inheritance	Severity	Fractures	Bone Deformity	Stature
I	AD	Mild	Few to 100	Uncommon	Normal or slightly short for family
II	AD	Perinatal lethal	Multiple fracture of ribs, minimal calvarial mineralization, platyspondyly, marked compression of long bones	Severe	Severely short stature
III	AD Rare recessive	Severe	Thin ribs, platyspondyly, thin gracile bones with many fractures, "popcorn" epiphyses common	Moderate to severe	Very short
IV	AD	Moderate to mild	Multiple	Mild to moderate	Variably short stature
V	AD	Moderate	Multiple with hypertrophic callus	Moderate	Variable
VI	Uncertain	Moderate	Multiple	Rhizomelic shortening	Mild short stature
VII	AR	Moderate	Multiple	Yes	Mild short stature

AD: Autosomal dominant, AR: Autosomal Recessive

Figure 1: Types of OI<sup>4</sup>

## Significance/Objectives of Case

It can be quite rare to provide anesthetic care to a patient with OI in the adult population because only a predicted 25,000-50,000 people in the U.S. have this disease<sup>4</sup>.

1. Increase awareness, knowledge, and expectations regarding patients with OI.
2. Review anesthetic considerations for the OI patient population.
3. Provide intraoperative care insight for OI management.

## Patient Description

A 36yo F with nephrolithiasis presented for right percutaneous nephrolithotomy and ureteral stent placement. A BMI of 27.71kg/m<sup>2</sup> and height of approximately 99cm (3'3") were recorded. Relevant medical history included OI, scoliosis, and PONV. The patient was unaware of which type of OI she was diagnosed with; however, based on clinical assessment and dependence on a motorized wheelchair for transportation, she most likely had type IV. The patient's only known allergy was latex. She did not take any notable medications. The patient reported daily recreational inhaled marijuana use, minimal alcohol consumption, and no tobacco use. Past surgical history included numerous orthopedic procedures for fractures, dental work, spinal fusion, and percutaneous nephrostomy. All her surgeries had been uneventful, with the last one being 4 years prior. Her anesthetic records indicated an easy mask, and she was successfully intubated with direct laryngoscopy using a MAC 3 blade and 7.0mm ETT.

## Intervention/Anesthetic Method

- IV access was difficult due to patient's limited extremity movement and comfort. Ultimately, a 22g IV was placed in the patient's L forearm.
- Patient was moved to OR bed via undersheet ensuring whole body movement and no strain on her extremities.
- NIBP monitoring was doable with this patient on her forearm. Some patients can't even have a BP cuff on since the strain of the cuff squeeze can cause bone fractures. Arterial lines should be considered.
- Gentle BMV with no neck manipulation was performed to avert strain on cervical spine.
- Videoscope intubation (glidescope) with LoPro S3 blade, rigid stylet, and 6.0mm ETT, secured at 18cm after confirming bilateral breath sounds.
- Patient was carefully positioned in L lateral decubitus, with extra padding on pressure points.
- A 20g IV was placed in R forearm after positioning
- TIVA was performed to reduce PONV incidence.

## Images

Mouth Opening: 4-5 cm  
Mallampati: II  
TM distance: 4-5 cm  
C spine ROM: Limited Extension and Limited Flexion  
TMJ Jaw Protrusion: Incisors can meet  
Neck: Thick / Obese



Left, above, and below: Examples of bone deformities in OI<sup>5</sup>



## Discussion

Although the operation took longer than expected because of the patient's abnormal anatomy, anesthetic management was uneventful and successfully performed. BMV was easily attained. Intubation was more complicated as the patient's airway was slightly deviated to the right, which was corrected with gentle cricoid pressure. Vigilance was applied around the patient's teeth. BLBS were checked to ensure avoidance of mainstem intubation. TV was reduced to 280mL with less PEEP. The patient was carefully placed in L lateral decubitus with additional padding. A second IV was placed. PONV was not present postoperatively, and no damage was done.

## Conclusion

Depending on the severity of OI, changes to the anesthetic plan must be made. It is important to ensure that all those providing perioperative care to these patients are aware of the need for careful patient movement/positioning and ensuring adequate padding on all pressure points. Consider videoscope intubation to prevent cervical spine manipulation, and arterial line- especially if procedure is expected to take longer. Succinylcholine is also avoided, if possible, to avoid muscle fasciculations that could cause fractures. Encountering OI in clinical practice is rare. However, being aware of these patients and their special considerations will ensure safe and effective care.

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# Efficacy, Safety, and Routes of Dexmedetomidine as an Adjunct for Regional Anesthetic Peripheral Nerve Blocks: A Comprehensive Literature Review.

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## Introduction and Background

Effective pain management in the intraoperative and postoperative period is critical to patient outcomes. Administering upper extremity regional anesthesia allows for adequate analgesia, which leads to a reduction in opioid consumption, the general anesthesia requirement, and the possibility for chronic postoperative pain. The goal when completing regional anesthesia is to provide either sensory blockade or a combination of sensory and motor blockade while minimizing total opioid consumption. A reduction in opioid consumption reduces nausea and vomiting, respiratory depression, and pruritus<sup>3</sup>. Adjuncts can be used in regional anesthesia to prolong the effects of a block. This comprehensive literature review aims to assess the safety, efficacy, and routes of dexmedetomidine as an adjunct for regional nerve blocks.

### Dexmedetomidine

- Can be utilized as an adjunct systemically (IV) or perineural.
- Highly selective **α2-adrenoceptor agonist** used to decrease sympathetic tone, reduce anesthetic and opioid requirements, and to aid in sedation and analgesia while preserving psychomotor function<sup>4</sup>
- Side Effects: mild to moderate cardiovascular depression such as a decrease in heart rate and blood pressure.



## Discussion

From our research we recognize that additional adjuncts can be used to prolong the effects of a block such as:

- decadron
- clonidine
- buprenorphine
- tramadol
- sodium bicarbonate
- epinephrine
- magnesium

Additional research needs to be completed to determine which adjunct prolongs the effects of regional analgesia while minimizing side effects related to the use of certain adjuncts. The duration of prolongation for the adjuncts above varies significantly in literature, further complicating ASRAs recommendation of one over another.

## Conclusion

This comprehensive literature review reveals that the use of both systemic and perineural dexmedetomidine were observed to prolong sensory blockade and in some studies motor blockade.

- The extent of blockade prolongation was variable between perineural and systemic, with neither route showing superiority consistently.
- The adverse effects often seen in perioperative use of dexmedetomidine were only seen in one of the six studies.
- **The ASRA does not currently approve or recommend any adjunct in regional anesthesia prolongation due the inconsistent results of the low quality and clinical heterogeneity of published trials.**<sup>7</sup>

## Objective

Comprehensive review of current literature outlining efficacy, safety, and routes of dexmedetomidine when used as an adjunct to regional anesthesia peripheral nerve blocks prolongation in adults.

## Methods: Literature Search

**Search Terms:** (dexmedetomidine or precedex), (adjunct), (perineural), (systemic), and (regional anesthesia), filtered by 2013-2023.

**Data Sources:** PubMed Central, Cochrane, Google Scholar  
**Study Selection Criteria:** Randomized Controlled Trial (RCT), adult (18-65), ASA I-III, long-acting LA (levobupivacaine, bupivacaine or ropivacaine), upper extremity or intercostal nerve blocks using ultrasound guidance, sample size > 20.

**Variables:** Route of administration (perineural, systemic, control), duration of sensory and/or motor blockade, and dexmedetomidine related adverse effects.

Retrieved 32 articles, 6 Articles Included, 26 Excluded

## Results

Study	Sample Size	Route and Type of Block	Results on Duration	Adverse Events
Sane et al. 2021 <sup>1</sup>	N= 60	Perineural vs. Control Supraclavicular Block	<b>Perineural</b> Sensory: Y (+ 2.36 h) Motor: Y (+ 2.85 h)	None
Abdallah et al. 2016 <sup>2</sup>	N= 99	Perineural, Systemic, vs. Control Interscalene Block	<b>Perineural and Systemic</b> Sensory: Y (P: + 4.2 h) (IV: + 3.1 h) Motor: N Perineural = Systemic	None
Luan et al. 2023 <sup>3</sup>	N= 44	Perineural vs. Control Interscalene Block	<b>Perineural</b> Sensory: Y (+ 3.3 h) Motor: N	Not Included
Bao et al. 2022 <sup>4</sup>	N= 60	Perineural, Systemic, vs. Control Triple Nerve Mid Forearm Block.	<b>Perineural</b> Sensory: Y (+ 3.34 h) ; Motor: Y (+ 2.41 h) <b>Systemic</b> Sensory: N ; Motor: Y (+ 2.41 h) Perineural > Systemic	Perineural & Systemic: reduced blood pressure and heart rate.
Reddy et al. 2021 <sup>5</sup>	N=120	Perineural, Systemic, vs Control. Supraclavicular Block.	<b>Perineural &amp; Systemic</b> Sensory: Y (P: + 5.07 h) (IV: + 2.07 h) Motor: Y (P: +4.78 h) (IV: + 2.42 h) perineural > systemic	None
Yao et al. 2020 <sup>6</sup>	N=150	Perineural, Systemic, vs Control. Intercostal Nerve Block.	<b>Perineural &amp; Systemic</b> Sensory: Y (P: + 7.1 h) (IV: + 1.9 h) perineural > systemic	None

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# Are PENG Blocks Preferable to Fascia Iliaca Blocks Post-hip Procedure?

## A Review of Evidence Based Literature

Naomi Plack, SAA2 & Emma Sberna, SAA2

### Background

Pain management is a crucial aspect of perioperative care. In hip fracture patients, regional anesthesia has been shown to improve outcomes compared to general anesthesia [1]. Effective postoperative pain management is crucial for optimizing patient outcomes and facilitating early mobilization. Historically, femoral nerve blocks and fascia iliaca compartment blocks (FICB) have been used. However, both blocks have major unwanted side effects of quadriceps weakness and a high incidence of incomplete coverage, causing a delay in both post-surgical mobility and inadequate analgesia.

The Pericapsular Nerve Group, or PENG block is a relatively new regional anesthesia technique which has gained popularity in recent years. First described by L Girón-Arango et al. [2], PENG blocks claim to provide sensory only, superior dermatome coverage while completely sparing motor function. PENG blocks theoretically offer a promising alternative to traditional analgesic methods, such as opioids, by providing effective pain relief with reduced systemic side effects.

### Methods

A systemic literature search was conducted using electronic databases such as PubMed and Scopus to identify relevant studies published between 2018 and 2023. We used the following search terms to narrow down our research: pericapsular nerve group block, PENG block, fascia iliaca compartment block, hip and surgery:

- Population: Any type of hip surgery patients
- Intervention: PENG block
- Comparison: FICB
- Outcomes: Any one of the following- pain scores, total analgesic consumption, or time to first analgesic request after surgery
- Study type: Randomized controlled trials (RCTs)

We excluded studies analyzing the efficacy of PENG for patient positioning after hip fractures. We furthermore did not incorporate studies not meeting the inclusion criteria or lacking sufficient methodological details.

### About Fascia Iliaca Blocks

The fascia iliaca is a fibrous sheath enveloping the iliopsoas muscle, and it plays a crucial role in stabilizing the hip joint. Using Ultrasound (US), local anesthetic is deposited deep to the iliopsoas muscle, where it can spread underneath in a medial and lateral direction to reach the femoral nerve, and sometimes the LFCN. However, FICB's do not come without drawbacks. One of the main challenges of effective regional analgesia for hip pain is the complicated innervation of the hip joint by multiple nerves. The anterior hip capsule is shown to be supplied by articular branches of the femoral, accessory, and obturator nerves (Figure 3). This anterior capsule contains most of the sensory innervation of the joint and is the main source of postoperative hip pain. Novel anatomical studies have shown that the articular branches of the femoral and obturator nerve (both which innervate the anterior hip capsule) may not be optimally blocked by these techniques [3]. This block also causes a degree of motor blockade, delaying post-operative mobilization.

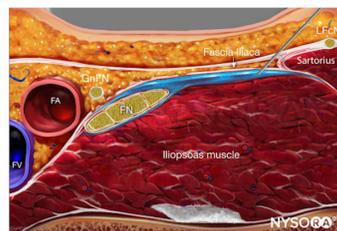


Figure 1. Drawing of a FICB. Source: NYSORAA©

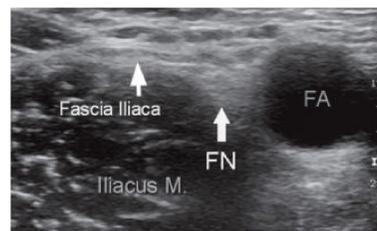


Figure 2. US image of a FICB. Source: NYSORAA©

### Significance/Aim

This poster aims to review the current evidence-based literature on the efficacy of PENG blocks compared to Fascia Iliaca Blocks for use in hip surgery. After analyzing five high quality randomized studies, we aim to provide a comprehensive overview of the effectiveness of these two techniques. By examining the time to first request of analgesia, overall opioid consumption, and the degree of motor block associated with each block (associated with time to discharge), we can gain insights into their relative effectiveness. The findings of the review will serve to better educate and inform anesthesia care professionals regarding pain management decision strategies.

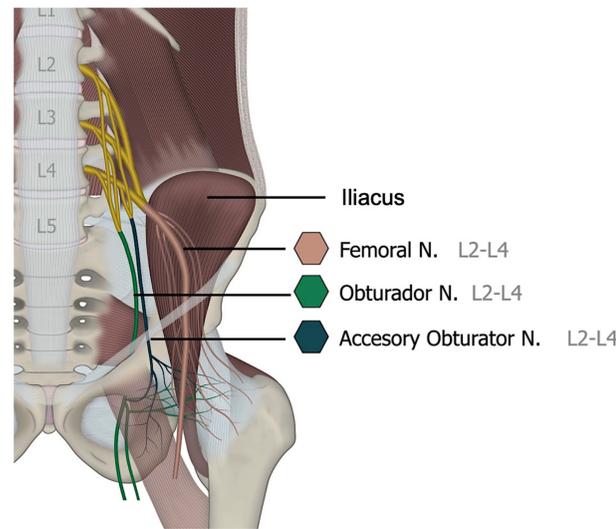


Figure 3. Anterior Innervation of Hip Capsule. Source: ASRA©

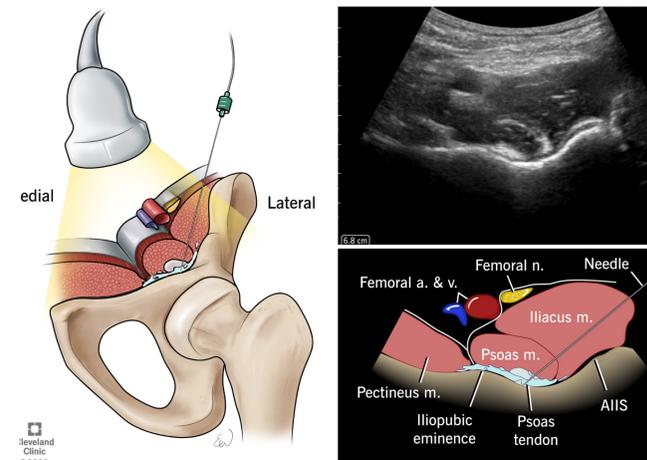


Figure 4. US image and drawings of a PENG Block. Source: Cleveland Clinic ©

### About PENG Blocks

Whereas FICB's provide analgesia to a couple nerves within the anterior hip capsule, PENG blocks involve almost the entire anterior capsule. When performing PENG blocks, a low frequency US probe is placed in a transverse plane over the anterior inferior iliac spine. The probe is then aligned with the pubic ramus by rotating the probe 45 degrees counterclockwise. The iliopsoas muscle tendon, iliopubic eminence, femoral artery, and femoral nerve should all be identified prior to needle insertion. A needle should be inserted from lateral to medial using an in-plane approach, ultimately guiding the tip to rest within the musculofascial plane between the psoas tendon anteriorly and the pubic ramus posteriorly. After negative aspiration, local anesthetic is injected, observing for displacement of the psoas muscle tendon secondary to fluid spread within this fascial plane. Specifically targeted nerves including the articular branches of the femoral nerve, the obturator nerve, and sometimes the accessory obturator nerve [4].

### Results

- Reddy, et al. (2022)** - 30ml of 0.25% Bupivacaine and 4mg of Dexamethasone for PENG/FICB. PENG significantly decreased pain scores, fentanyl consumption within 24 hours, and motor block.
- Duan, et al. (2023)** - 20ml of 0.25% ropivacaine for PENG block and 30 ml of 0.25% ropivacaine for FICB. Significantly decreased initial (30min) and final (24/48hr) pain scores, reduced opioid consumption, and earlier ambulation/muscle strength were seen with PENG blocks.
- Mosaffa, et al. (2022)** - double-blinded; 3mL/kg of 0.5% ropivacaine for FICB and PENG blocks. No difference between initial pain scores. Significant decrease in 12hr pain scores, longer time until request of initial post-surgical analgesia, and decreased 24hr morphine consumption in PENG block group.
- Lin, et al. (2022)** - double-blinded; 20mL 0.75% ropivacaine for both FICB and PENG blocks. PENG blocks had a significantly longer duration of action. They also exhibited a decreased period of muscle weakness, leading to significantly faster discharge.
- Aliste, et al. (2021)** - double-blinded; PENG group had 20 mL of adrenalized levobupivacaine 0.50%, FICB received 40 mL of adrenalized levobupivacaine 0.25%. PENG resulted in a significantly lower incidence of quadriceps motor block at 3 hours and 6 hours. PENG also provided better preservation of hip adduction at 3 hours, as well as decreased sensory block. No clinically significant differences were found in terms of postoperative pain scores, cumulative opioid consumption at 24 and 48 hours, ability to perform physiotherapy, opioid-related side effects, and length of hospital stay.

### Conclusion

Based on the reviewed literature for patients undergoing hip surgery, PENG block use appears to be loosely associated with a longer duration block, a decrease in opioid consumption {in other words, providing better pain management}, and increased motor function vs FICB. The significance of these results is further supported by Huda et al. [10], who conducted a statistical meta-analysis of some of our selected studies. Based on the available evidence, PENG blocks appear to offer significant advantages over FICB in terms of pain control, opioid consumption, and functional surgical outcomes. However, further research is needed to validate these findings and explore potential complications or adverse events associated with PENG blocks. Ultimately, the choice between performing a PENG block vs FICB should be based upon clinical judgment and all available clinical evidence.

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# Opioid Free Anesthetics in Anesthesia Care

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## Introduction

Historically, opioid drugs have been used as the standard of care for pain management in patients undergoing surgery. Opioid drugs are administered during the perioperative and postoperative periods of surgery in most cases to relieve pain. Their analgesic properties and history of use make opioid drugs an attractive choice for anesthesia providers when formulating an anesthetic plan.

While opioids are an appropriate choice for pain relief for many patients, the side effects and addictive properties make opioids dangerous to others (Bohringer et al. 2020). This creates a need to educate anesthesia providers on safe alternatives to these medications. Side effects of opioid drugs include post-operative nausea and vomiting, ileus, pruritis, and respiratory depression. These side effects can lengthen recovery times and lead to patient discomfort.

## Opioid Side Effects

Side Effect	Concerns/Patients Effected
Decrease respiratory drive	Patients at increased risk of respiratory failure including patients with COPD, asthma, morbidly obese
Postoperative ileus	Anastomotic leak in patients after bowel surgery can occur
Postoperative nausea and vomiting	Valsalva maneuver that occurs with vomiting can lead to CSF leaking, or bleeding

**Table 1:** Side effects of opioids and the patient populations that are affected.

## Opioid Epidemic

In the US, opioids were involved in 80,411 overdose deaths in 2021 (75.4% of all drug overdose deaths). The opioid crisis has been attributed to the rise of prescription use of opioids starting in the 1990s. Synthetic opioids such as fentanyl pose a significant risk for overdose because of the high potency and the ability to distribute these drugs illegally (CDC, 2023).

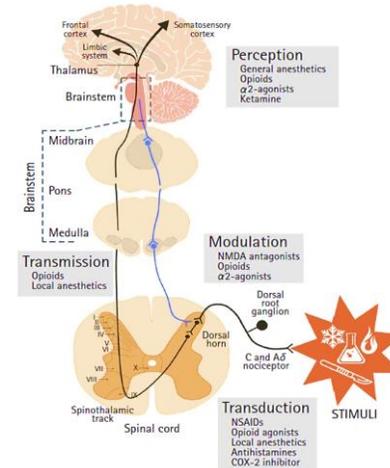
The opioid epidemic has affected the patient population seen by anesthetic providers. Chronic opioid users are Opioid-tolerant. Patients in recovery from opioid addiction may request an opioid free anesthesia plan.

## Opioid-Sparing Techniques

Opioid-sparing techniques utilize multimodal analgesia, including low doses of opioids. A multimodal approach allows each part of the pain transmission pathway to be blocked. The advantage is improved pain relief compared to OFA while reducing the side effects of opioids (Harsha et al. 2021).

## Recommendations/Conclusion

In current practice, it is not common to perform opioid-free anesthesia with general anesthesia. In pre-op, providers should manage expectations when using OFA. It is recommended to use multimodal analgesia (**Figure 1**) to avoid the overuse of opioids intraoperatively. Anesthesia providers serve a vital role in educating patients on the risks associated with opioids, including dependence, addiction, and overdose.



**Figure 1:** Pain transmission path

## Opioid Alternatives

Medication Name	Drug Type	Dosage
Dexmedetomidine (Precedex)	Alpha-2 agonist	0.25 mcg/kg boluses (0.5-mcg/kg/hr infusion)
IV Acetaminophen (Ofirmev)	Non-Specific COX inhibitor	15 mg/kg every 6 hours
Ketorolac (Toradol)	Non-steroidal anti-inflammatory drug	30 mg every 6 hours
Ketamine (Ketalar)	NMDA receptor antagonist	0.25 mg/kg boluses (0.1 mg/kg/hr infusion)
Lidocaine (Xylocaine)	Amide Local Anesthetic	1 mg/kg loading dose (1-2 mg/kg/hr infusion, Rate reduced by 50% every 6 hours)
Gabapentin	GABA Analogue	300 mg PO daily in pre-op
Magnesium	NMDA receptor antagonist	30 mg/kg loading dose (10 mg/kg/hr infusion)
Benadryl (Diphenhydramine)	Antihistamine	Typically give 25-50 mg PO or IV for sedation Pre-Op

**Table 2:** Opioid alternatives are listed with the appropriate dose in absence of anesthesia

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# Pharmacogenetics In Anesthesia Concerning Redheads: A Comprehensive Study

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## SIGNIFICANCE OF STUDY

- Study investigates increased anesthetic requirements in red-haired individuals, with implications in anesthesia field.
- Red hair phenotype linked to higher anesthetic needs, revealing potential genetic influence on drug response.
- Understanding individual variations in anesthetic requirements crucial for better patient care and anesthesia management.
- Anesthetic dosing should be tailored based on genetic characteristics, such as melanocortin-1 receptor gene mutations associated with red hair.
- Knowledge can improve anesthesia administration for red-haired patients, leading to better outcomes, enhanced safety, and reduced surgical risks.

## 01. Introduction

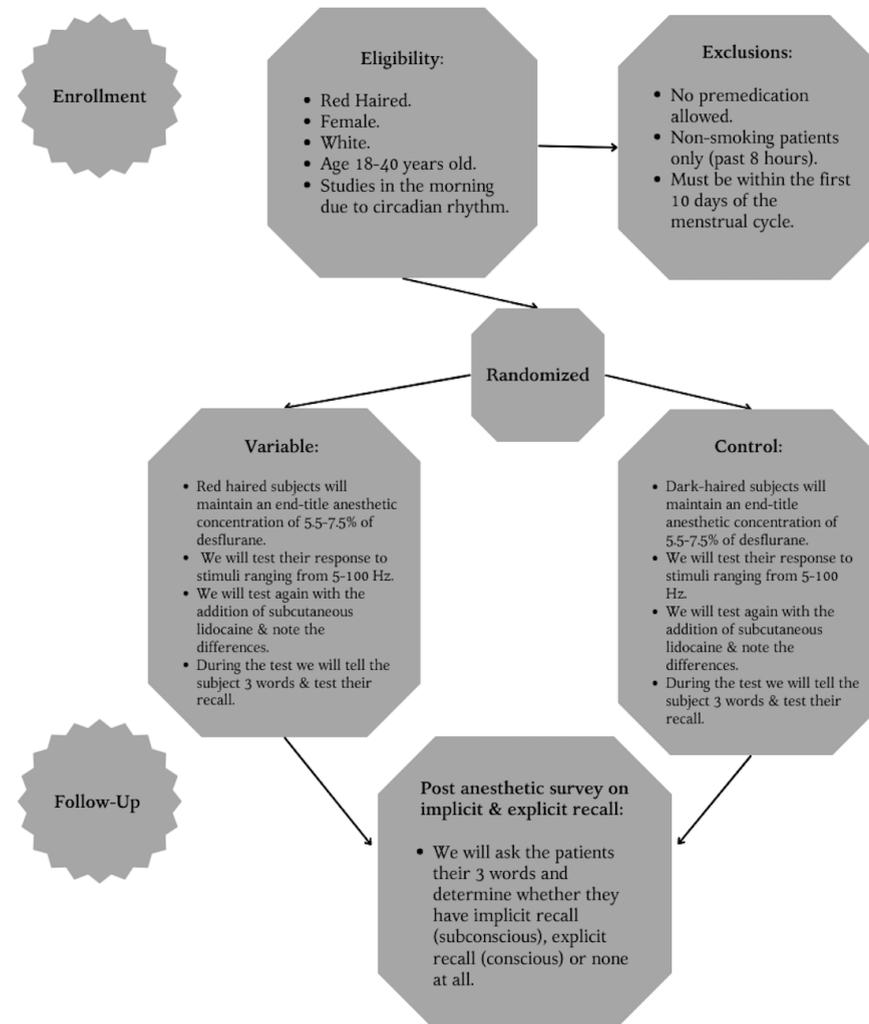
- This is a comprehensive study based on those conducted by Edwin Liem to explore the impact of natural red hair on anesthetic requirements and phenotypic associations.
- The study focuses on investigating the hypothesis of increased anesthetic requirements in individuals with red hair, specifically looking at the volatile agent desflurane while including sensitivity to thermal stimulation pain and the effectiveness of subcutaneous lidocaine, aiming to determine if the melanocortin-1 receptor gene mutation (redheads) affects anesthetic drug requirements for sedation and analgesia.



## 02. Materials

- Spectrophotometric hair analysis technology will be used to assess the integrity of the red hair, revealing a absorbance ratio of approximately 0.13 in red-haired patients compared to 0.3 in dark-haired participants, indicating differences in eumelanin and pheomelanin levels.
- Tetanic stimulus from percutaneous needles inserted into the anterior thigh with two electrodes (positive and negative) used to stimulate muscles directly with electrical current.
- Neurometer CPT/C is a diagnostic device for assessing nerve function and detecting peripheral neuropathy. It measures patient's perception of electrical frequencies and intensities on the skin, providing quantitative data on nerve sensitivity and identifying abnormalities in nerve function.
- Researchers employed the TSA-II Neurosensory Analyzer, a specialized computer-controlled device, to accurately measure baseline levels of thermal sensory perception, pain perception, and pain tolerance thresholds, making it ideal for the intended investigation.

## 03. Methodology



## 04. Predicted Results

- The red haired participants are expected to feel electrical stimulation at levels higher than the dark-haired participants.
- This should also apply and be heightened by the addition of subcutaneous lidocaine due to the subjects' expected resistance to local anesthetics concerning pain sensitivity.
- Overall, red haired subjects will require an increased anesthetic concentration as well as exhibit higher levels of implicit and explicit recall meaning they will have an increased likelihood of remembering the words that are given to them under anesthesia.

## 05. Conclusion/Discussion

- In conclusion, combining the findings from the studies conducted by Edwin Liem et al, and this study demonstrates a significant link between natural red hair and increased anesthetic requirements.
- This supports the hypothesis of higher anesthetic requirements in individuals with red hair due to melanocortin-1 receptor gene mutations.
- Research shows important implications for anesthetic management, emphasizing the need for personalized dosing based on genetic factors to improve patient outcomes and safety during surgical procedures.
- Red-haired individuals exhibit heightened sensitivity to thermal pain and reduced efficacy of subcutaneous lidocaine, further supporting the role of the melanocortin-1 receptor gene mutation in these phenotypic associations.

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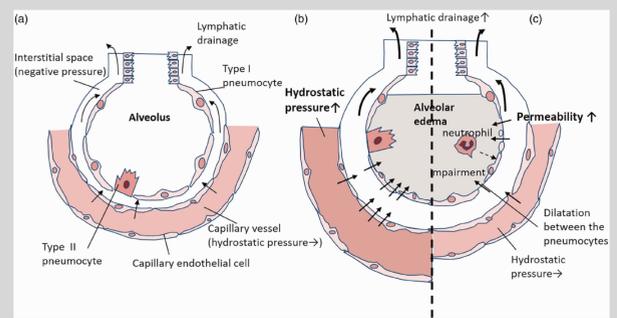
## Introduction

Pulmonary edema, characterized by the abnormal accumulation of fluid in the lungs, poses a significant threat to respiratory function. This particular case explores the aftermath of negative pressure pulmonary edema, shedding light on its clinical significance and the typical demographic of patients susceptible to this condition. Understanding the complexities of such cases is paramount for effective clinical management and underscores the need for heightened awareness within the medical community.

## Learning Objectives

- Review Basic Alveolar Anatomy
- Recognize signs and symptoms of Pulmonary Edema
- Identify treatment options for Negative Pressure Pulmonary Edema
- Differentiate between Cardiogenic Pulmonary Edema and Non-Cardiogenic Pulmonary Edema

## Pulmonary Anatomy



Oxygen-depleted blood from the pulmonary arteries is directed to the alveoli, where it undergoes gas exchange—carbon dioxide is released, and oxygen is absorbed. Oxygenated blood then returns to the heart through the pulmonary veins, facilitating systemic distribution of oxygen-rich blood throughout the body

## Types of Pulmonary Edema

- Cardiogenic Pulmonary Edema:**
- Heart Failure-Related Edema:** The most common cause of pulmonary edema is heart failure, where the heart's pumping ability is compromised. This can lead to increased pressure in the pulmonary veins, resulting in the leakage of fluid into the lung tissues.
  - Valvular Heart Disease:** Conditions such as mitral valve stenosis or regurgitation can contribute to increased pressure in the pulmonary vasculature, causing pulmonary edema.
  - Ischemic Heart Disease:** Myocardial infarction or coronary artery disease may weaken the heart muscle, leading to fluid accumulation in the lungs.
- Non-Cardiogenic Pulmonary Edema:**
- Acute Respiratory Distress Syndrome (ARDS):** Often caused by severe infections, trauma, or inhalation injuries, ARDS results in inflammation and increased permeability of the lung capillaries, leading to non-cardiogenic pulmonary edema.
  - High-Altitude Pulmonary Edema (HAPE):** Exposure to high altitudes can trigger HAPE, characterized by fluid accumulation in the lungs due to increased pulmonary artery pressure.
  - Neurogenic Pulmonary Edema:** Certain neurological events, such as seizures, head trauma, or brain hemorrhage, can induce sudden increases in sympathetic activity, resulting in non-cardiogenic pulmonary edema.
  - Negative Pressure Pulmonary Edema (NPPE):** Caused by upper airway obstruction or inspiratory effort against a closed glottis, NPPE results in a vacuum effect leading to fluid transudation into the pulmonary interstitium.

## Case: Total Shoulder Arthroplasty

Total Shoulder Arthroplasty  
Plan: General Anesthesia with Interscalene Block  
Case Proceeded unremarkably



- Height: 5 ft 11 in
- Weight: 98 kg
- BP: 145/95 HR 67bpm RR: 20
- Male
- Age: 36
- Medical history:
  - HTN
  - OSA
  - Red hair

## Emergence

- Patient prior to NMB reversal recorded ¾ TOF
- Patient was reversed with 5 mg Neostigmine and 1mg of Glycopyrrolate
- Post reversal patient recorded 4/4 TOF
- Tidal volumes: 400-500 ml
- Respiratory rate: 12 bpm
- HR: 65 bpm
- spO2: 100% at FiO2 of 100%
- etSEV: 0.1 MAC
- Patient able to open eyes and make movements on command
- Suction occurred and ETT removed
  - Small laryngospasm broken with positive pressure
- spO2: 95% at FiO2 via Simple Facemask at 100%, 8 L/min fresh gas flows

## Transport/PACU arrival

- Transport:**
- Patient SVing
  - Patient talking
- PACU**
- Difficulty holding saturation
  - Talking became labored as well as breathing
  - Saturation decreased to 85% from 92% on arrival to PACU
  - Saturation dropped to 70%
  - Lungs positive for crackles

## Treatment

- ETT intubation with 100 mg Propofol and 100 mg anectine
  - Foam emerged from tube
- Ambu Bag circuit with 10 L/min 100% O2
- 20mg Lasix IV
- Foley catheter Placed
- X-ray ordered

## Response to Treatment

- 10 minutes post intubation:
- spO2 90%
- Urine output: 40 mL
- X-ray: reveal fluid in lungs
- 120 minutes later patient was extubated
- 240 minutes later patient was discharged

## Discussion

Negative pressure pulmonary edema presents with a respiratory distress, pink frothy sputum, and audible inspiratory efforts. They can result after an episode of airway obstruction. Prompt recognition and treatment is essential for safe management of the patient.

In this case, the patient experience a brief laryngospasm post extubation. Though the spasm was treated the effects were profound as in their effort to breath during the spasm fluid entered the lungs decreasing the ability of the patient to properly exchange gases.

Treatment included re-intubation, increased fresh gas flows, and diuretics (Lasix). Chest X-ray confirmed our diagnosis. Patient's symptoms subsided and was safely discharged later that day.

Understanding the signs and symptoms allowed for the anesthesia team to act swiftly and appropriately.

## Take Away Points

- Laryngospasm can cause NPPE
- Cardiogenic and Non-cardiogenic PE have different etiologies
- Quick and appropriate management is important for positive outcomes

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## Contact

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## Foundations:

- An 8-year-old male, ASA (3) patient presented for a robotic thoracoscopic posterior mediastinal cyst excision combined with a flexible bronchoscopy & upper endoscopy.
- Chief complaint originated as an acute URI but morphed into a diagnostic finding of bronchogenic cyst on CT. Patient's medical history is solely remarkable for asthma.
- To facilitate exposure and removal of the mediastinal cyst, as well as, visualization of the great vessels, one-lung ventilation (OLV) was required.
  - Due to the patient's age and body habitus, the selection of appropriate lung isolation equipment posed a peculiar challenge.

## Learning Objectives:

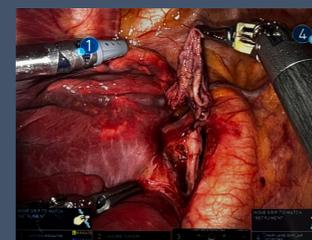
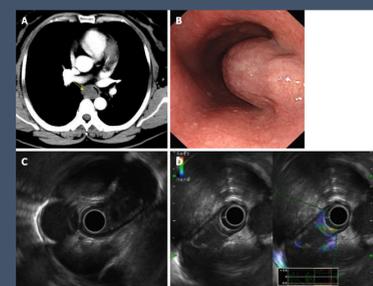
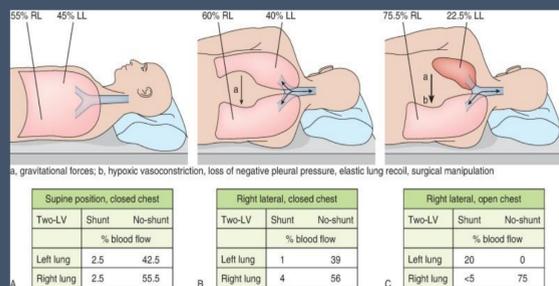
- Compare appropriate lung isolation techniques for pediatric patients.
- Discuss challenges & limitations of bronchial blockers.
- Describe anesthetic & physiologic relationship of lateral decubitus positioning, hypoxic pulmonary vasoconstriction (HPV), and one-lung ventilation (OLV).

## Background:

- The age of (8) is the branch point for lung isolation equipment determination, primarily between double-lumen tubes (DLT) & bronchial blockers.
- HPV is the intrinsic ability of the lungs to preserve ventilation/perfusion (V/Q) matching, even in the case of denervated & transplanted lungs.

## Case Flow:

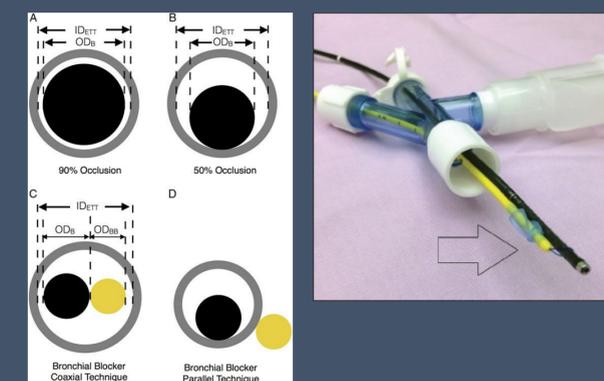
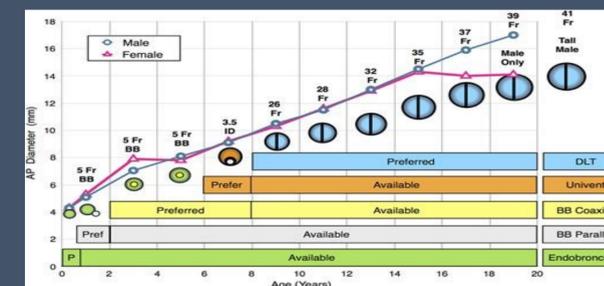
- The frontline therapy following the patient's initial emergency room encounter for acute URI was a combination of an albuterol nebulizer and decadron.
- Since this initial encounter was only (2) weeks prior to the operating date, a prophylactic albuterol breathing treatment was initiated on the morning of surgery as there were concerns for persistent airway hyper-reactivity.
- Upon entering the OR, ASA standard monitors were applied to the patient followed by an inhalational induction. As vital signs steadied, (2) peripheral IVs were placed. A "secondary" induction followed utilizing: lidocaine (numbing of airway reflexes), rocuronium, and fentanyl. A Phillips (1) provided a Cormack-Lehane Grade I view which facilitated placement of a (5.5) ETT.
- The (5.5) ETT was the perfect conduit to allow for the placement of a 5 Fr bronchial blocker, which had placement confirmed via a bronchoscope.
- While the primary objective of the bronchoscope was to initially confirm blocker placement, the secondary role was to assess the trachea for any potential communications with the cyst.
- Upon securing the bronchial blocker, the final assessment prior to excising the cyst was to perform the upper endoscopy.
- Again, this endoscopy served to assess the esophagus for any potential communications with the cyst. Since the degree of involvement concerning the cyst was unknown, esophageal temperature monitoring was avoided.
- Prior to docking the Da Vinci Robot, the patient was positioned in (R) lateral decubitus position.



## Discussion:

- Anteroposterior (AP) tracheal diameter is the driving force in choosing appropriate lung isolation equipment in pediatrics. Due to our patient's age (8), if a (DLT) was selected based on their height (4'7") this would have indicated a 37 Fr DLT. The external diameter of this tube would have totally occluded the child's airway. Thus, a 5 Fr bronchial blocker facilitates OLV in a much less traumatic manner.
- The 5 & 9 Fr Arndt Endobronchial blocker possess a removable internal lasso for suctioning and CPAP via the central lumen. However, only in the 9 Fr model is the lasso replaceable for additional repositioning.
  - The smallest recommended ETT for use with the 5 Fr model is a (4.5).

## Discussion: (cont.)



- Factors that attenuate HPV include nitric oxide, inhaled anesthetics, nitroprusside, nitroglycerin, and prostacyclin.
- If HPV is weakened to a degree that hypoxia ensues, treatment regimen goes as follows: 100% O<sub>2</sub>, verify placement of blocker, recruitment on dependent lung, PEEP on dependent lung, CPAP on non-dependent lung, (2) lung ventilation, clamping of non-dependent pulmonary artery.

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# Residual Neuromuscular Blockade, Antagonism & Quantitative Monitoring

Bianca Dal Porto SAA, Mary Mazzeo SAA & Victor Velazquez SAA

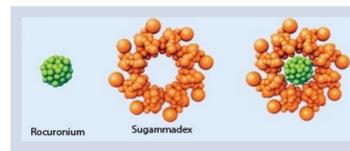
## Introduction

Residual neuromuscular blockade poses significant risks, with up to a 64% incidence rate at the end of surgery or in the PACU.<sup>1</sup> The American Society of Anesthesiologists (ASA) has taken a significant step by issuing guidelines that emphasize the critical importance of vigilant monitoring and the utilization of quantitative devices. These steps are an important direction in ensuring patient safety and better outcomes. While these guidelines offer valuable insights, recent research has uncovered additional nuances that clinicians should consider as improvements to practices will continue to evolve.

## Background

### Non-Depolarizing Neuromuscular Blocking Agent: Rocuronium

- Monoquaternary steroid analogue.
- Dosage: 0.6mg/kg for intubation. It can have a prolonged effect in elderly and liver disease patients.
- Onset like succinylcholine but with a much longer duration of action. It's also effective for precurarization before succinylcholine administration.<sup>2</sup>



### Reversal: Neostigmine

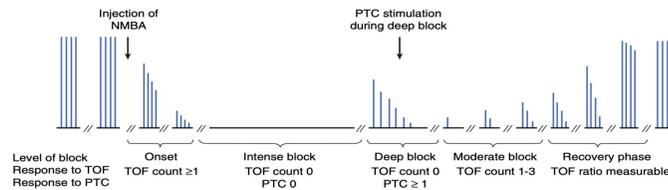
- Cholinesterase Inhibitor.
- Dosage: 0.02-0.05 mg/kg, max 5 mg.
- Side effects: salivation, lacrimation, bradycardia, bronchoconstriction.
- Side effect management: glycopyrrolate (antimuscarinic) at 0.2:1 ratio.
- Onset: 7-10 minutes, Duration: ~1 hour.<sup>2</sup>

### Reversal: Sugammadex

- $\gamma$ -cyclodextrin-based agent for reversing nondepolarizing neuromuscular blockade.
- It forms a 1:1 water-soluble complex with drugs like rocuronium, effectively terminating their neuromuscular blocking effects.
- Sugammadex may interfere with hormonal contraceptives, require caution in patients with severe kidney dysfunction, and is most effective against steroidal neuromuscular blockers like rocuronium.<sup>2</sup>

### Neuromuscular Monitoring (NMM) – Train of Four (TOF)

- TOF stimulation consists of four stimuli spaced at intervals of 0.5 seconds (equivalent to a frequency of 2 Hz) and is typically repeated every 10 to 20 seconds.
- When there are four responses to TOF stimulation, the **Train-of-Four Ratio (TOFR)** is determined by comparing the strength of the fourth response (T4) with the strength of the first response (T1).
- When the height of the fourth twitch equals or closely matches that of the first twitch (TOFR  $\geq$ 0.9 or no fade), it signifies full neuromuscular function recovery.
- Extubation should not occur until the TOFR is  $\geq$ 0.9 to prevent the risk of residual paralysis. In patients, a TOFR <0.9 is associated with increased morbidity and mortality.<sup>2</sup>



### Forms of Neuromuscular Monitoring

**Clinical Signs** – Clinicians use clinical signs to infer adequate return of neuromuscular function such as

- 5-second head lift
- Tidal Volume
- Grip Strength

**Qualitative Monitoring** – Clinicians use subjective visual or tactile assessments with a peripheral nerve stimulator (PNS) to estimate the strength of muscle contractions in response to TOF stimulation.



### Quantitative Monitoring

#### Mechanomyography (MMG)

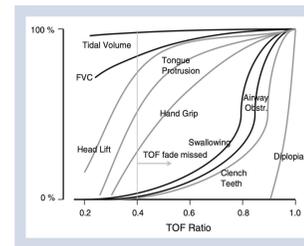
- MMG measures muscle contraction in response to nerve stimulation, but it has limitations such as bulky equipment and fixed arm position requirements.
- MMG is highly accurate, but there are no practical clinical devices available, and this is unlikely to change due to technical challenges.

#### Acceleromyography (AMG)

- AMG measures thumb acceleration in response to ulnar nerve stimulation using a piezo-electric ceramic wafer.
- Raw AMG data may display TOFR values above 1.00 (100%), requiring a mathematical correction for precise assessment. Most AMG units lack validation against MMG.

#### Electromyography (EMG)

- EMG measures muscle action potential intensity, with similarities to MMG.
- EMG can be utilized even when thumb movement is restricted or when the arms are tucked
- Accessibility is increasing due to commercial availability and advancements.<sup>2</sup>



### Notable TOFR, Physiological Markers

- At TOFR of  $\leq$  0.1 – Tidal volume while intubated possible.
- TOFR between 0.3–0.5 – Head lift and hand grip possible.
- At TOFR of 0.6 – Normal vital capacity achievable.
- Experienced clinicians employing peripheral nerve stimulation can identify fade when the TOF ratio is at or below 0.4, but they may not detect it when the TOF ratio falls between 0.5 and 0.9.<sup>3</sup>

### ASA Recommendations (published January 2023)

1. When neuromuscular blocking drugs are administered, we recommend against clinical assessment alone to avoid residual neuromuscular blockade, due to the insensitivity of the assessment
2. We recommend quantitative monitoring over qualitative assessment to avoid residual neuromuscular blockade.
3. When using quantitative monitoring, we recommend confirming a train-of-four ratio greater than or equal to 0.9 before extubation.
4. We recommend using the adductor pollicis muscle for neuromuscular monitoring.
5. We recommend against using eye muscles for neuromuscular monitoring.
6. We recommend sugammadex over neostigmine at deep, moderate, and shallow depths of neuromuscular blockade induced by rocuronium or vecuronium, to avoid residual neuromuscular blockade.
7. We suggest neostigmine as a reasonable alternative to sugammadex at minimal depth of neuromuscular blockade.
8. To avoid residual neuromuscular blockade when atracurium or cisatracurium are administered and qualitative assessment is used, we suggest antagonism with neostigmine at minimal neuromuscular blockade depth. In the absence of quantitative monitoring, at least 10 min should elapse from antagonism to extubation. When quantitative monitoring is utilized, extubation can be done as soon as a train-of-four ratio greater than or equal to 0.9 is confirmed before extubation.<sup>4</sup>

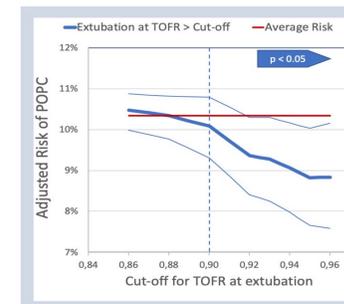
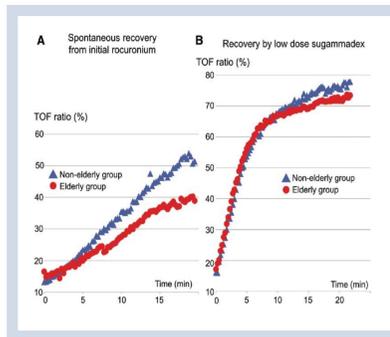
Strength of Recommendation	Strength of Evidence
Strong	Moderate
Conditional	Low
Conditional	Very Low



## Review of Literature

### Extubation at TOFR $\geq$ 0.95 Reduces Postoperative Pulmonary Complications (POPC)

The suggestion to aim for a TOFR greater than 0.95 is based on findings from a post hoc examination of the POPULAR trial. This analysis revealed a noteworthy reduction in the risk of postoperative pulmonary complications (POPC) when TOFR exceeded 0.95. Specifically, the adjusted absolute risk reduction for POPC was 3.5% in the complete case population and 3.4% in the propensity score matched population.<sup>5</sup>

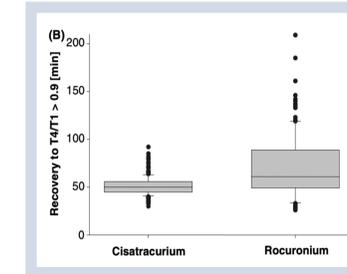


### Elderly at Greater Risk of POPC with Underdosed Sugammadex

Elderly patients face slower recovery and a higher risk of recurarization when sugammadex is underdosed for deep rocuronium-induced paralysis.<sup>6</sup>

### Faster Recovery in Morbidly Obese Patients with ABW-Dosed Sugammadex

The study found that dosing based on ideal body weight (IBW) caused a significant delay in the recovery of neuromuscular function compared to dosing based on actual body weight (ABW) in morbidly obese patients. While the median time to clinical recovery was 1.5 minutes faster with ABW dosing, the slowest 10% of patients took at least 3.7 minutes longer to recover when dosed by IBW compared to ABW dosing.<sup>7</sup>



### Rocuronium's Variable Duration of Action & Accumulation Effect

Rocuronium had a longer and more variable duration of action compared to cisatracurium after repeated administration, likely due to differences in their chemical structures. Rocuronium's duration of action increased with repeated doses, while cisatracurium remained consistent.<sup>8</sup>

### Variability in Sugammadex Dosing and the Importance of Quantitative Monitoring

Sugammadex dosing varies widely among patients, with doses ranging from 0.43mg/kg to 5.55mg/kg to achieve a train-of-four ratio of at least 0.9. This variability underscores the importance of quantitative twitch monitoring to assess Sugammadex's effectiveness, as a one-size-fits-all approach may not guarantee the desired outcome.<sup>9</sup>

## Conclusion

### Clinical Significance 1 – Quantitative Monitoring is Recommended

Reversal dosing varies widely among patient populations. Therefore, quantitative twitch monitoring is essential to confirm successful reversal.<sup>4</sup>

### Clinical Significance 2 – Clinical Budget Impacts

The reduced POPC events with the use of Sugammadex compared to Neostigmine (+/-Glycopyrrolate) overall leads to a savings by reduced OR time and faster recovery from NMBD in PACU. Therefore, appropriate dosing of Sugammadex for full reversal (TOFR of 0.95–1) will financially be beneficial as well as improved patient outcomes and satisfaction.<sup>10</sup>

### Clinical Significance 3 – Emergency NMBA Reversal

In a cannot ventilate cannot intubate airway emergency, where NMBA was used, reversal with Neostigmine takes approximately 7-10min (mild-to-light paralysis) and at least 1 twitch is needed. Whereas, with Sugammadex 16mL/kg, it takes 1.3-1.9 min to fully reverse NMBA and no return of muscle twitches are needed.<sup>2</sup>

### Clinical significance 4 – Generic Sugammadex Release in the Works

Merck, the producers of Bridion, has a patent that expires in January 2026. This allows a generic brand to be released on the market. Aspiro has been working on a generic, Sugammadex Sodium, that was approved on June 9th, 2023. The FDA tentatively approved a generic sugammadex, ANDA, from Syneos Health, LLC U.S. Agent for Gland Pharma Limited in 2021.<sup>11</sup>

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# Anesthesia Considerations for the Pediatric Cancer Patient

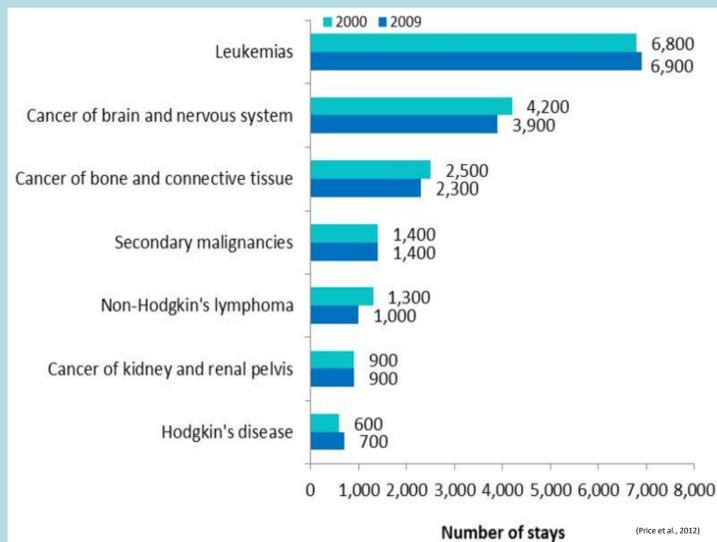


Ashton Warne, SAA  
 Advisor: Jason Kotun, CAA  
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## Introduction

Overall, childhood cancer is rare, accounting for only 1% of all cancer diagnoses. However, when these cases do arise, it is the responsibility of the AA to understand how to safely manage these patients. The aim of this analysis is to identify and discuss the most common considerations for anesthesia for the pediatric cancer patient in the current literature, which are as follows:

1. When this population requires anesthesia
2. The effect of anesthetic agents on cancer
3. The systemic effects of chemotherapy & radiation therapy
4. Airway concerns in this population



## Background

It is necessary to first understand the demographics of this patient population before considering anesthetic management. Leukemia is the most common childhood cancer type. Its highest incidence is seen in 2-3 year-old patients. 80% of these leukemias present as acute lymphoblastic leukemia (ALL). ALL is the #1 childhood cancer diagnosis. Fortunately, the survival rate is high, about 90%. Cancer of the brain & CNS is the second most common group after leukemia, making it the most common solid tumor. Lymphomas have high incidence in 10-14 year-olds, and include both Hodgkin's disease and non-Hodgkin's lymphoma, the latter being more difficult to treat. Nephroblastoma, or Wilm's Tumor, is the most common childhood renal tumor. Other possible malignancies include cancer of the bone & connective tissue.

## Review of Literature

### When Anesthesia is Needed

Pediatric cancer patients commonly require anesthesia for the following procedures: short procedures, central venous catheter insertion, radiation therapy, diagnostic MR & CT scans, and surgery. Short procedures include biopsies/diagnostic procedures, such as bone marrow aspiration and lumbar punctures, as well as intrathecal chemotherapy. The common anesthetic choice for these procedures is TIVA with propofol and either fentanyl or remifentanyl, as these patients often already have long-term IV access available and will only require analgesia for a short period. Radiation therapy and diagnostic scans are not painful procedures, but younger children may be unable to cooperate and often require anesthesia, commonly as a propofol infusion.

### Anesthetic Agents & Cancer

Some studies have observed the use of volatile agents and opioids to be associated with immune system inhibition and promotion of tumor growth. Meanwhile, studies have also observed propofol and local anesthetics to be associated with greater overall survival and lower cancer recurrence. These studies suggest propofol and local anesthetics may increase cancer cell sensitivity to chemotherapeutic agents. The current literature contains conflicting arguments on the effects of dexmedetomidine and ketamine in cancer patients.

### Systemic Effects of Chemotherapy

Cardiotoxicity has been associated with doxorubicin, daunorubicin, and idarubicin. Studies argue that these chemotherapeutic agents produce free radicals that may cause myocardial depression, ischemia, and conduction issues (namely SVT and heart block). Studies have observed various early pulmonary complications with methotrexate, vinblastine, paclitaxel, and bleomycin. Bleomycin was observed to cause toxicity (as bleomycin-induced pneumonitis) in up to 10% of patients. Furthermore, its toxicity increases with high FiO2 use after recent administration. In this event, studies recommend an intraop. FiO2 <25%. Myelosuppression may be caused by many chemotherapy agents and/or cancer itself, especially ALL. Many chemotherapy agents also cause nausea, vomiting, and/or diarrhea. Due to this prevalence, dexamethasone is used with many patients. Additional doses increase the risk of tumor lysis syndrome.

### Systemic Effects of Radiation Therapy

Children have a large portion of developing tissue more sensitive to radiation compared to adults. History of head and neck radiation may create a difficult airway via tissue stiffness limiting mouth opening and/or neck ROM or laryngeal stenosis and edema narrowing the airway. Cardiac complications may arise months to years following radiation, including pericarditis, pericardial or valvular fibrosis, and conduction issues. Radiation therapy may also result in restrictive lung function, with the most common complication being radiation-induced pneumonitis.

### Airway Concerns

Beyond radiation therapy, unique airway concerns in this population include patients with an anterior mediastinal mass, which may cause superior vena cava syndrome if sufficient SVC compression. Furthermore, lymphoma patients may present with enlarged lymph nodes, including tonsils and adenoids, which increase the risk of a difficult airway. These patients may present with OSA and/or stridor. A third unique airway concern is mucositis, caused by many chemotherapeutic agents, which may present with painful, ulcer-like lesions in the oral cavity, indicating the presence of friable tissue and possible subglottic edema.

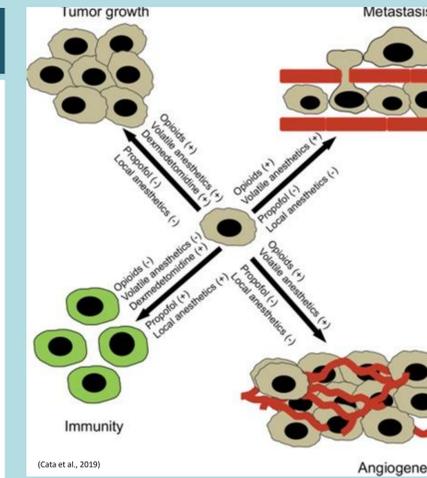


Table 2  
 List of traditional chemotherapeutic agents by class (17,20,38)

Alkylating agents	Antimetabolites	Natural products
Nitrogen mustards Methotrexate Cyclophosphamide Ifosfamide	Folic acid analogues Methotrexate Pyrimidine analogues Fluorouracil	Vinca alkaloids Vinblastine Vincristine Vinorelbine
Melphalan Chlorambucil Ethylenimines Thiotepa Alkyl sulfonates Busulfan Nitrosoureas Carmustine Lomustine Streptozotocin Platinum complexes Cisplatin Carboplatin Oxaliplatin Triazines Dacarbazine	Cytarabine Gemcitabine Purine analogues 6-Mercaptopurine 6-Thioguanine Pentostatin Cladribine Fludarabine Clofarabine	Vindesine Epidophyllotoxins Etoposide Teniposide Enzymes L-Asparaginase Antibiotics Actinomycin D Daunorubicin Dactinomycin Doxorubicin Idarubicin Bleomycin Mitomycin Plicamycin Camptothecin analogues Topotecan Irinotecan Taxanes Paclitaxel Docetaxel

(Latham and Greenberg, 2010)

- ♥ Cardiotoxicity
- ⊙ Pulmonary toxicity
- Myelosuppression
- Nephrotoxicity
- Neurotoxicity

## Discussion & Conclusion

The review of literature provides unique considerations that allow for safer management of this patient population. For example, patients on chemotherapy with known cardiotoxicity, a preop echo should be reviewed before receiving anesthesia. Fortunately, these patients may undergo frequent testing, and may already be dose-limited if cardiotoxic effects are present. For any pediatric cancer patient, a preop CBC should be conducted due to myelosuppression risk. Due to the GI effects of many chemotherapy agents, there should be a higher suspicion of aspiration risk in these patients as well. However, due to common administration, further doses of dexamethasone should be avoided. Finally, the literature identifies unique conditions in these patients' histories and airway exams that are not commonly considered in other populations, allowing for more accurate prediction and preparation for a possible difficult airway in this population.

Possible limitations in the current literature include the sparse & sometimes conflicting arguments on the effect of anesthetic agents on cancer. One explanation may be the methods chosen for these studies, which are largely in-vitro, not clinical. This discrepancy suggests that a cancer diagnosis is not currently an absolute contraindication of the use of a particular anesthetic agent.

In conclusion, the current literature suggests that anesthetic agent choice is of lesser importance in making anesthetic considerations for pediatric cancer patients. Instead, emphasis should be placed on understanding a patient's medical history, including their diagnosis, treatments, and possible airway exam findings, in order to identify and prepare for specific systemic effects and airway risks in these patients.

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# Management of Pierre Robin Sequence (PRS) in a Direct Laryngoscopy and Cleft Palate Repair

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Mentor: Brooke McDonald

## Objectives:

The learner will be able to define the characteristics of PRS and their implications.

The learner will be able to develop an anesthetic plan for a patient with PRS.

The learner will understand how to safely induce a patient with PRS.

## Introduction:

Pierre Robin Sequence (PRS) consists of triad of micrognathia, glossoptosis, and airway obstruction, as shown in figure 1.

Cleft palate is present in the majority of PRS cases. Malnutrition is common due to the abnormal anatomy of the oropharynx and often requires NG tubes for nutrition.

PRS can be associated with other congenital disorders such as stickler syndrome, velocardiofacial syndrome, hemifacial microsomia, and fetal alcohol syndrome.<sup>1,2</sup>

Methods for relieving airway obstruction in PRS include: prone or lateral positioning, CPAP, Lip-tongue adhesion - usually up until a year old, mandibular distraction, nasopharyngeal intubation, and tracheostomy is severe.<sup>3</sup>

## Case Report:

A 15 month old female, weighing 10 kg, presenting for direct laryngoscopy and bronchoscopy (DLB), bilateral myringotomy tubes (BMT) and cleft palate repair. PMH of Pierre Robin Sequence with cleft palate and OSA. Has an NG tube for nutrition. Normal ECHO.

## Plan:

Surgeon wanted to place the BMT first, then perform a DLB to examine the airway. Afterwards, ENT would intubate and perform the cleft palate repair.

## Evidence/Practice Based Guidelines:

### Pre-op Assessment

Obtain a detailed airway and cardiac assessment, evaluate for aspiration risk and any recent URI's. If the patient has other congenital syndromes, cardiology should be consulted due to potential for underlying cardiac abnormalities.<sup>3,5</sup>

### Induction/Intubation

In preparation, emergency airway equipment must be ready with ENT surgeons ready for emergency surgical airway.

Patients with PRS are at high risk of losing the ability to mask ventilate and intubate. Awake intubations can done with precedex and ketamine, however, this can be difficult in uncooperative children.

It also accepted that mask induction can be done as long as spontaneous ventilation is maintained. To relieve airway obstructions, two handed jaw thrust and airway adjuncts, such as an oral airway or LMA, can be used. A right paraglossal approach has been a common DL method for intubating patients with PRS, as shown in figure 2.<sup>3,5</sup>

### Emergence/Post-op

To decrease possible airway obstruction and post-op respiratory complications, consider limiting opioids by using non-opioid analgesics and local/regional blocks. Examination for airway edema and an air leak test should be done due to the surgical airway manipulation. Complete NMB reversal and an awake extubation is also essential. If obstruction occurs after extubation, the patient should be placed in the lateral position. If obstruction still occurs, CPAP or a tongue stitch can be used in the PACU.<sup>3,5</sup>

## Discussion of the Case:

After mask induction with sevoflurane, an oral airway was placed and the patient was spontaneously breathing. An IV was placed and a propofol infusion was started. The BMT was completed and moved to DL by turning the bed 90 degrees for ENT. ENT had a grade 4 view on their videoscope by resident and surgeon.

## Evaluating the Risks of Preceding:

After discussion between the parents and the anesthesia and surgical teams, it was decided to cancel the cleft palate repair.

ENT surgeries have an increased chance of accidental extubation. Surgical site bleeding and swelling could also make an intra-op reintubation or post op intubation very difficult. This was also an elective procedure with no improvement to the underlying issue. These factors paired with difficulties associated with PRS and the grade iv view lead to the cancellation of the cleft palate repair.

The agreed safer course of action would be to perform the mandibular distraction to extend the jaw and help open up the airway to create better conditions for elective intubations.

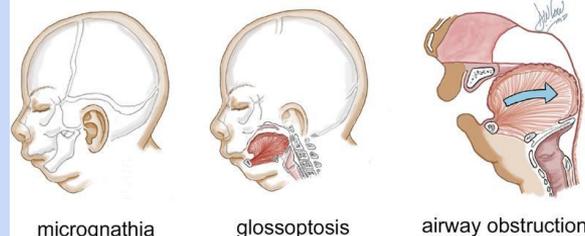


Fig 1: Pierre Robin Sequence triad: micrognathia, glossoptosis, upper airway obstruction<sup>6</sup>

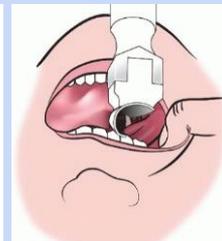


Fig 2: Paraglossal approach<sup>6</sup>

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# Does a ketamine bolus dose compared to a normal saline bolus dose during general anesthesia decrease the incidence and severity of postoperative depression symptoms in radical mastectomy breast cancer patients with mild to moderately severe depression?

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## Introduction

- Depression is a cause of morbidity in a wide variety of postoperative patients and can be associated with greater postoperative pain, infections, tumor progression, and poor quality of life. [1] Depression has also been associated with negative clinical surgical outcomes. [2]
- Not only has ketamine been found to have significant antidepressive effects, [3] perioperative administration of ketamine has also been found to significantly reduce postoperative depression scores and pain intensity. [4]
- Past research has shown that breast cancer mastectomy patients have an incidence of depressive symptoms, they can safely receive ketamine in an intraoperative setting, and S-ketamine is specifically effective in decreasing the severity of this patient population's postoperative depressive symptoms. [5]
- The goal of this research is to investigate whether an S-ketamine bolus compared to a normal saline bolus during general anesthesia significantly decreases the incidence and severity of postoperative depression symptoms in radical mastectomy breast cancer patients with mild to moderately severe depression.

## Methods

- Liu et. al in 2020 conducted a randomized and double-blinded research study investigating whether radical mastectomy breast cancer patients with mild to moderate depression had a lower incidence of postoperative depression due to intraoperative treatment with a bolus of S-ketamine after analgesic induction in comparison to their saline-treated counterparts.
- The Hamilton Depression Rating Scale for Depression (HAMD-17) was used to evaluate the severity of each patient's depression.
- Patients classified as American Society of Anesthesiologists (ASA) score of I-II, without additional mental diseases such as schizophrenia or mania, and without severe systemic diseases, were included in this study to limit comorbidity complications that may confound results. Patients were between the ages of 18 and 65.
- All patients underwent radical mastectomy with the same analgesic induction and anesthetic maintenance strategies. The analgesia and surgery procedures were completed by the same treatment blinded providers.
- The S-ketamine group included 101 patients who were given a bolus of 2mL of 0.125mg/kg, while the group that received normal saline included 100 patients who were given a bolus of 2mL of normal saline.

## Results

- The results were significantly lower ( $P < 0.05$ ) HAMD-17 scores in the S-ketamine treated group in comparison to the normal saline treated group at three days, one week, and one month after the radical mastectomy surgeries.

## Discussion

- Liu et. al (2020) confirm that breast cancer patients have an incidence of depressive symptoms, they can safely receive ketamine in an intraoperative setting, and S-ketamine is specifically effective in decreasing the severity of this patient population's postoperative depressive symptoms.
- These results and ongoing supportive research could indicate a change in the protocol of administration of S-ketamine in general anesthesia for radical mastectomy breast cancer patients with mild to moderately severe depression.
- Many more patients who struggle with postoperative depressive symptoms could find relief and likely heal better and quicker due to healthier postoperative behaviors and a decrease in stress and overall poor quality of life.

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