UND Nurse Anesthesia Program Student Presentations

2018 Fall Educational Meeting
North Dakota Association of Nurse Anesthetists
Bismarck, ND

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Intraoperative Ketamine to Reduce Postoperative Opioid Consumption in Chronic Pain Patients

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Introduction

- Chronic pain is an epidemic in the United States, resulting in an increased number of prescribed opioids. Medical professionals are being encouraged to decrease opioid prescriptions.
- Chronic pain patients who have a surgical procedure and are currently prescribed an opioid experience markedly higher postoperative pain.

(Chapman et al., 2011)

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Introduction continued

- NMDA receptors contribute to the pain felt after tissue injury and can cause increased pain perception.
- Ketamine binds to the NMDA receptors and blocks this effect reducing the patient's pain postoperatively
- Ketamine's usefulness in the perioperative setting is promising
  - It is an analgesic and an anesthetic
  - Decreases opioid requirements

(Nagelhout & Plaus, 2014)

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Case Information

- Diagnostic laparoscopy
- 29 year old female
- 99 kilogram – BMI 38.63
- ASA II
- Allergies to ketorolac and morphine

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Pre-operative Evaluation

- Past Medical History
  - ovarian cyst, chronic pelvic pain
- Surgical History
  - cholecystectomy, cervix biopsy, colposcopy, ovarian cystectomy
- Pre-op VS
  - BP: 126/82 HR: 83 RR: 18 T: 36.7C O2: 99% RA
- Pertinent labs
  - negative urine pregnancy
- Airway evaluation
  - Mallampati classification II, thyromental distance less than 3 fingerbreadths, full neck range of motion

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Anesthetic Course

- Pre-induction
  - 2 mg midazolam IV
- Induction
  - 100 mcg Fentanyl IV
  - 60 mg Lidocaine IV
  - 200 mg Propofol IV
  - 60 mg Rocuronium IV
  - 50 mg Ketamine (0.5mg/kg bolus) IV

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Anesthetic Course

- Maintenance
  - 1.8-2.4% Sevoflurane
  - 2 g Cefazolin IV
  - 6 mg Dexamethasone IV
  - 10 mcg/kg/min Ketamine IV infusion
  - 100 mcg Fentanyl IV with incision
- Emergence
  - 0.6 mg Glycopyrrolate IV
  - 3 mg Neostigmine IV
  - 4 mg Ondansetron IV

1200mL LR total EBL minimal

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PACU

- Patient complained of moderate pain and was given 75 mcg Fentanyl IV.
- Patient was discharged home with 1/10 abdominal pain.
- No adverse effects noted while in PACU.

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Chronic Pain

- Chronic pain is defined as pain that lasts longer than three months or beyond the normal healing time of an injury (Nagelhout & Plaus, 2014)
- Acute pain turns into chronic pain when peripheral damage and tissue inflammation switch to more prominent central nervous system mechanisms.
- Changes can also occur directly to nerve endings when nerve injury is present.
  - Regenerated and damaged nerves also have reduced thresholds, rendering them responsive to non-noxious stimuli
- Chronic pain is associated with chronic inflammation.
  - Causing hyperexcitability and sensitization of second-order neurons in the dorsal horn

(Reddi & Curran, 2014)

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Chronic Pain continued

- Central sensitization
  - Ongoing nociceptive input may cause an increase in excitability of neurons in the central nervous system
  - May manifest as hyperalgesia or allodynia
  - Wind-up occurs with repeated activation of C fibers and is due to the action of glutamate at NMDA receptors.

(Reddi & Curran, 2014)

- NMDA receptors also contribute to central sensitization and chronic pain
  - Due to up-regulation of second messengers causing hyperexcitability of NMDA receptors

(Steeds, 2015)

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NMDA Receptor

- N-methyl-D-aspartate (NMDA) receptors are glutamate-gated cation channels with high calcium permeability
- Found at most excitatory synapses in the post-synaptic membrane of a neuron
- Present on most cells of the central nervous system, especially those that participate in nociception

(Mion & Villevieille, 2013)

- Magnesium blocks NMDA receptor activation in a voltage-dependent manner
  - At resting membrane potential, the receptor remains blocked. With membrane depolarization, the magnesium block is relieved

(Nagelhout & Plaus, 2014)

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NMDA Receptor continued

- Glutamate is the major excitatory neurotransmitter in CNS
  - It activates NMDA receptors by occupying two binding sites of GluN2 subunits (Vytlicky et al., 2013)
  - NMDA receptor activation requires glutamate presence and binding along with depolarization of postsynaptic membrane to unseat the magnesium (Bennett, 2000)

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Ketamine

- Structurally related to phencyclidine
- Has two enantiomers: S(+)ketamine and R(-)ketamine.
- Ketamine is bioavailable by intravenous, intramuscular, transnasal, rectal, and oral routes
- Lipid soluble and not highly protein bound
  - Rapid uptake in highly perfused areas first
  - The onset of action after intravenous administration is 30 to 60 seconds and duration of 10 to 15 minutes
- Ketamine is metabolized by cytochrome P-450 enzymes by demethylation to norketamine (Barash et al., 2017)

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Ketamine continued

- Works on NMDA, opioid, noradrenergic, nicotinic and muscarinic receptors
- Binds to an intrachannel site on the NMDA receptor referred to as the phencyclidine site (this binding decreases channel opening time)
- It also works on a second site in the hydrophobic domain of the NMDA receptor to decrease the frequency of channel opening
  - By blocking these receptors, the medial thalamic nuclei, responsible for preventing afferent signals of pain perception to the thalamus and cortex, is depressed
  - NMDA-receptor antagonists suppress central sensitization (Miller et al., 2015)

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Ketamine continued

- Causes "dissociative anesthesia" due to a functional dissociation between thalamo-neocortical and limbic systems which allow sensory inputs to reach receiving areas but fail to be observed
  - It depresses neuronal function in the cerebral cortex and thalamus while simultaneously activating the limbic system
- Ketamine prevents "windup," especially if the NMDA receptor was already opened by glutamate (Mion & Villevieille, 2013)

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Perioperative Dosing

- Miller et al. (2015) states ketamine administration in small doses decreases postoperative analgesic consumption by 33 percent
  - Infusion rate of 0.15-0.25 mg/kg or a total dosage of 20-60 mg perioperatively is adequate to provide this analgesic effect.
- Remerand et al. (2009) conducted a randomized, double-blind, controlled clinical trial
  - Included 154 patients undergoing total hip arthroplasty
  - Given both a bolus and infusion of saline or ketamine.
  - Patients who received the ketamine bolus and infusion intra-operatively were found to have decreases in all of the following post-operatively: morphine consumption at 24 hours, walking assistance at 30 days, and hip pain while at rest at 180 days.

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Perioperative Dosing continued

- A literature review conducted by Jougelet-Lacoste, La Colla, Schilling and Chelly (2015) concluded
  - low-dose intravenous ketamine reduces opioid consumption by 40%
  - lowers pain scores following surgery
  - Low-dose intravenous ketamine was defined as a bolus of < 1 mg/kg and/or an infusion of 1.2 mg/kg/hr
  - These clinical trials included a total of 2,482 patients with 1,403 who received ketamine
  - did not find any major complications when the ketamine was administered at sub-anesthetic doses

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Perioperative Dosing continued

- Studies by Arikan, Aslan, Horasanh and But (2016) and Menigaux, Fletcher, Dupont, Guignard, Guerimund and Chauvin (2000)
  - small-dose intraoperative ketamine decreased the amount of morphine required in the PACU and 24 hours after surgery.
- Kaur, Saroa and Aggarwal (2015) conducted a randomized, double-blind, controlled clinical trail
  - Patients were given a 0.2 mg/kg ketamine bolus followed by an infusion of 0.1 mg/kg/hr for an open cholecystectomy.
  - intraoperative infusion of low-dose ketamine provided effective analgesia for the first 6 hours in the postoperative period.
  - the opioid-sparing effect of ketamine was observed to be useful for narcotic-tolerant patients.

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Perioperative Dosing continued

- Loftus et al. (2010) conducted a randomized, double-blind controlled study
  - Showed a decrease in opiate usage for 48 hours following surgery
  - Inclusion criteria required that the patients had a history of chronic pain with daily opiate use
  - Found that ketamine may reduce pain intensity
  - Given a 0.5 mg/kg ketamine bolus IV followed by a 10mcg/kg/min infusion

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Perioperative Dosing continued

- A systematic review completed by Himmelseher and Duriex (2005)
  - Examined the perioperative use of ketamine as an adjunct to general anesthesia and postoperative pain therapy.
  - Surgeries were described as being painful or less painful. A major visceral surgery was considered a painful surgery with a lumbar spine surgery being less painful.
  - Bolus ranged from 0.2-0.35 mg/kg depending on anticipated pain of surgery followed by infusion of 200-400 mcg/kg/hr infusion or 0.1-0.2 mg/kg bolus every 30 minutes
  - These doses were deemed sufficient as an analgesic adjunct

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Recommendations

- Ketamine should be used to supplement post-operative pain management in chronic pain patients
- More research needed to determine ideal dosing
  - There does seem to be consistency in the current literature with a Ketamine bolus of 0.2-0.5 mg/kg followed by an infusion or hourly dosing
    - Minimal or no side effects noted in literature at these doses

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Conclusion

- Case Study
  - 0.5 mg/kg bolus given at induction followed by 10mcg/kg/min infusion perioperatively
  - Within the ranges noted above
- Literature supports sub-anesthetic dosing beneficial for chronic pain patients in decreasing post-operative opioid requirements.

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Thank You
Are There Any Questions?

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Regional Anesthesia and its Effects on Breast Cancer Recurrence and Metastasis

Jessica Hall, SRNA

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Introduction

- The use of regional anesthesia with paravertebral nerve blocks in mastectomies for breast cancer treatment has been thought to reduce the recurrence and metastasis of breast cancer by:
  - Reducing surgical stress response
  - Reducing immunosuppression
  - Reducing need for opioid and general anesthetics consumption
- I will discuss:
  - Case Report
  - Thoracic paravertebral nerve block
  - Cancer biology and promotion
  - Pharmacology
  - Review of Literature

(Sessler, Shamgar, Masch, Parat & Buggy, 2017)
(Barela & Welliver, 2017)

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Case Information

- Right modified radical mastectomy with axillary sentinel lymph node dissection for treatment of invasive ductal breast cancer
- 64 year-old
- 71 kg
- Female
- ASA 3
- Allergies: Prednisone, environmental factors

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Pre-operative Evaluation

- Past Medical History:
  - Asthma, fibromyalgia, hiatal hernia, hypokalemia, urinary tract infection, hypomagnesemia, invasive ductal carcinoma of the right breast, antineoplastic chemotherapy, chemotherapy-induced diarrhea, neutropenia, drug-induced pancytopenia, sepsis and neutropenic fever.
- Surgical History:
  - Sinus surgery, knee arthroscopy, colon polyp biopsy, venous access insertion, hysterectomy, carpal tunnel release and upper endoscopy
- Anesthetic History:
  - No complications

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Pre-operative evaluation continued

- Pre-op VS:
  - Blood pressure: 139/92 mmHg
  - Heart rate: 98/min
  - Respiratory rate: 18/min
  - Room air oxygen saturation (SpO2): 98%
  - Temperature: 97.7° Fahrenheit
- Mallampati class: 2

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Anesthetic Course

- Pre-induction:
  - Midazolam 2 mg IV
- Induction:
  - 2 puffs of albuterol inhaler, oxygen at 8L/min, IV induction with fentanyl 100 mcg, lidocaine 50 mg, propofol 150 mg, rocuronium 30 mg
- Airway:
  - 7.0 ETT, volume control ventilation: rate 12/min, TV 500 ml
- Sevoflurane ½ MAC, propofol infusion 80 mcg/kg/min
- After induction:
  - Fentanyl 50 mcg IV, phenylephrine 100 mcg X2 IV, cefazolin 2 gm IV, dexamethasone 10 mg IV
- Supine position

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Intraoperative & Postoperative Course

- Intra-op:
  - Hydromorphone 1 mg IV X2
  - Labetalol 10 mg IV
  - Uneventful
- Emergence
  - Extubation criteria met, 2 L O2 via nasal canula after ETT removed, VSS
- Post-op
  - Admitted to med/surg unit where she received IV morphine and PO acetaminophen/hydrocodone for pain control and was discharged later the next day.

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Paravertebral Block (PVB)

- Used for thoracic and breast surgeries
- Local anesthetic is injected in the paravertebral space, near the point where the thoracic spinal nerves emerge from the intervertebral foramina
- Benefits:
  - Reduce pain and opioid use
  - Lower chronic pain occurrence by > 30%
  - Decrease PONV
  - Shorten hospital stays
  - Attenuate perioperative immunosuppression

(Cali, Biffoli, Francesconi, Patrella, & Buonomo, 2017)
(Wardhan, 2015)

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PVB continued

- The use of ultrasound is associated with fewer complications compared to using landmark technique alone.
- Potential complications:
  - Pleural puncture
  - Symptomatic pneumothorax
  - Hypotension
  - Bradycardia
  - Local anesthetic toxicity
- Low rate of complications
  - Study involving 856 patients and reported 0.7% involved a complication, none of which were a pneumothorax

(Pace, Sharma, Anderson-Dam, Fleischmann, Warren, Stefanovich, 2016)

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Cancer Biology

- The microenvironment of a tumor is made up of cancer cells, inflammatory cells and mediators
- Inflammatory cells and mediators promote cancer formation and progression
- First step – “initiation” where DNA is damaged
- Second injury – “promotion”
  - Triggered by inflammation, injury or irritants
  - Increase of inflammatory cells, release of chemical mediators and oxidative damage make it hard for the body to destroy the cancerous cells resulting in cellular proliferation

(Tedore, 2015)

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Cancer Promotion

- **Surgical stress** affects the neuroendocrine response, suppresses the immune system, and lowers cell-mediated immunity (CMI) leading to overproduction of stress hormones and increased inflammatory response.
- **Pain** activates the stress response and suppresses CMI

(Barela & Welliver, 2017) (Tedore, 2015)

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Cancer Promotion

- Surgery inhibits T-cell, B-cell, and natural killer (NK) – cell function for days after the surgical insult
  - NK-cells are the body's primary defense against cancer cells
- During surgery there is a large release of inflammatory mediators (IL-6 and TNF-a) leading to suppression of CMI and NK-cells
- CMI doesn't eradicate the primary tumor, but it may eliminate minimal residual disease, preventing metastasis and recurrence

(Snyder & Greenburg, 2010), (Tedore, 2015)
(Xuan, Hankin, Zhao, Yao & Ma, 2015)

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Pharmacology

- Volatile anesthetics such as inhalational agents and IV anesthetics including ketamine and thiopental
  - Increase destruction of immune cells such as NK-cells and T-lymphocytes, leading to tumor progression

(Barela & Welliver, 2017)

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Pharmacology continued

- Propofol
  - Beneficial properties regarding spread of cancer
  - Inhibits enzyme matrix metalloproteinase (MMP)
    - Reduces cancer cell proliferation
  - Reduces inflammatory cytokines
    - Preserves NK-cell activity, inhibiting cancer spread
  - Inhibit cellular adhesion and migration, and has been looked at as a treatment for breast cancer

(Barela & Welliver, 2017) (Snyder & Greenburg, 2010) (Xuan et al., 2015)

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Pharmacology continued

- Local Anesthetics (LA)
  - At high concentrations, LA are cytotoxic to cancer cells via necrosis or apoptosis
  - Inhibit cancer cell proliferation, migration, and invasion along with anti-inflammatory properties
  - Beneficial in reducing spread and growth of cancer cells

(Barela & Welliver, 2017) (Xuan et al., 2015)

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Pharmacology continued

- Opioids
  - Chronic administration promotes angiogenesis and immunosuppression resulting in tumor cell proliferation
  - Fentanyl inhibits NK-cells
  - Other evidence suggests that at higher doses they may have tumor-suppressive effects due to blocking pain and surgical stress response

(Barela & Welliver, 2017) (Snyder & Greenburg, 2010) (Tedore, 2015)

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Research Trial Review

- Exadaktylos et al. conducted an initial retrospective trial in 2006
  - Hypothesized the use of regional anesthesia combined with general anesthesia (GA) would have lower rates of cancer recurrence and metastasis compared to GA with opioid use.
    - Group #1: PVB and GA
    - Group #2: GA and opioid use, postoperative morphine analgesia
  - Metastasis-free survival at 24 and 36 months
    - Group #1: 94%, 94%
    - Group #2: 82%, 77%
  - Results prompted further research

(Exadaktylos, Buggy, Moriarty, Mascha, and Sessler, 2006)

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Research Trial Review continued

- Retrospective Trials
  - Starnes-Ott, Goravanchi, and Meininger (2015)
  - Tsigonis et al. (2016)
  - Cata et al. (2016)
    - All studies compared regional anesthesia and use of PVB combined with GA to GA alone and post-operative opioid use, and its effects on breast cancer recurrence and/or metastasis
    - All studies showed no difference between the 2 groups
    - All studies showed those who received PVB had better pain control and less opioid use

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Research Trial Review continued

- Chen et al. (2015)
  - Used propofol-paravertebral anesthesia (PPA)
  - Hypothesized beneficial use of PPA to have lower chronic postsurgical pain, avoiding opioids and inhibiting surgical stress suppression of cellular immunity
  - PPA elevates NK-cells and T-cells to increase NK toxicity and augment cancer cell apoptosis.
  - Propofol reduces expression of MMP
  - Results showed no difference between the 2 groups

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Research Trial Review continued

- Karmakar et al. (2017) RCT
  - 3 anesthetic groups:
    - GA with total intravenous anesthesia (TIVA)
    - TIVA with a single injection TPVB and placebo infusion for 72 hours
    - TIVA with continuous TPVB for 72 hours
  - Showed no statistical difference

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Research Trial Review continued

- Buckley, McQuaid, Johnson, and Buggy (2014)
  - Compared blood samples from PPA to sevoflurane and opioid anesthesia group.
  - Serum samples were analyzed for NK-cells, NK activating receptors and cytokine production
  - PPA group maintained healthy donor NK anti-tumor cell activity
  - GA group showed a reduced expression of NK-cells

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Recommendations

- The literature does not support or refute the use of regional anesthesia for reduction of breast cancer recurrence or metastasis.
  - Low level of evidence, most studies are retrospective.
  - Many limitations within current research including: selection bias, different statistical analysis, heterogenicity in type of anesthetic technique, lack of information regarding tumor size, staging, presence of mutations, and additional treatments such as chemotherapy or radiation.

(Karmakar et al., 2015) (Perez-Gonzalez et al., 2017)

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Recommendations continued

- Benefits of PVB
  - Less severe chronic pain
  - Require less opioids
  - Experience less PONV
  - Fewer unplanned overnight admissions
  - Experience better physical and mental state

(Karmakar et al., 2015) (Tsigonis et al., 2016)

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Recommendations continued

- Further research required
  - Currently enrolling patients in a large, prospective randomized clinical trial
  - Patients assigned to a thoracic epidural or PVB group or a GA and morphine group.
  - Follow-up conducted over a 10 year period

(Perez-Gonzalez et al., 2017) (Starnes-Ott et al., 2015)

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Conclusion

- The data collected to date has been inconclusive
- PVB has shown no harm and are associated with a low risk of complications
- Anesthesia Professionals are always seeking ways to manage pain more effectively and improve patient satisfaction. The PVB may be a great option in the future, but more research is needed

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Thank You
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Pediatric Lung Isolation Techniques

Kasey Trontvet, SRNA

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Introduction

- Anesthetic care of children during thoracic surgery requires extensive knowledge of both pediatric and thoracic anesthetic techniques.
  - Specific techniques are required for smaller children less than 30 kilograms (kg)
- We must consider a variety of factors including:
  - Indication for lung isolation
  - Anatomy of the upper and lower airway,
  - Availability of airway and visualization equipment
  - Provider proficiency level with each technique

Case Information

- Pediatric patient undergoing left lower lung lobectomy
- 7 y.o.
- 27.9 kg
- Male
- ASA III

Pre-operative Evaluation

- Medical Hx: Recent acute lymphoblastic leukemia, encephalopathy, seizures, methotrexate toxicity, and acute renal failure (resolved)
- Surgical Hx: Previous abscess drainage (IR)
- Pre-op VS: BP 95/35, Pulse 115, Respirations 20, Temp 36.8° Celsius, and O2 Sat 98%.
- Labs: WNL
- CT scan: LLL fluid accumulation
- Airway Evaluation: Mallampati I

Anesthetic Course

- Inhalational induction => Sevoflurane (cooperative)
  - 18 gauge IV placed upon achieving adequate depth of anesthesia. Patient had tunneled port to right chest in place.
  - Fentanyl 30 mcg, Rocuronium 20 mg, and Decadron 2.5 mg prior to intubation
- Direct laryngoscopy was performed utilizing a Miller 2 blade and Size 6 mm endotracheal tube (ETT)
  - Grade I view => ETT advanced to 16 cm

Anesthetic Course

- A wire-guided Arndt blocker was advanced coaxially through the ETT, coupled with a small diameter fiberoptic bronchoscope (FOB)
  - Left lung auscultation => absence of air movement
  - An arterial line was placed in the right radial artery under sterile conditions
  - Patient then positioned into the right side lateral decubitus position, utilizing a positioning sand bag

Intraoperative Management

- Pressure Control Ventilation
  - Tidal volumes 6 - 8 mL/kg to the ventilated lung
- Peak Inspiratory Pressure (PIP) maintained less than 35 cmH2O
- Upon closing and request of the surgeon, the bronchial blocker was deflated and removed while actively re-inflating the left lung with positive pressure ventilation

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Intraoperative Issues

- Surgeon began with the VATS approach to wedge resection.
  - Inadequate visualization => Converted to open LLL lobectomy
- Patient became hypotensive and acidotic over the course of 240 minute procedure
- Patient received: 450 mL Lactated Ringers, 60 mL 5% Albumin and 2 units (700 mL) of packed red blood cells (PRBCs) in an attempt to replace 400 ml of blood loss and ongoing insensible loss.
  - Hypotension and acid/base balance improved => stability throughout the final minutes of the case
  - Ofirmev (330 mg) and additional Fentanyl (55 mcg) for pain management intraoperatively

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Closing / Transport

- Patient remained intubated throughout transport to PICU
- Weaned and extubated to room air approximately one hour following the procedure w/o complication

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Discussion

Pediatric Lung Isolation Techniques

- Lung isolation and one-lung ventilation (OLV) refer to the act of separating each lung into an individual unit through airway instrumentation and manipulation.
  - *Double Lumen Endobronchial Tubes (DLTs)*
  - *Endobronchial Blockers (EBBs)*
  - *The Univent Tube*
  - *Single Lumen Endobronchial Tubes (EBTs) and Endotracheal Tubes (ETTs)*

(Purohit et al., 2015)

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Pediatric Lung Isolation Techniques

- *Double Lumen Tubes (DLTs)*
  - Most commonly used method of lung isolation
  - Created side specific and have unique structural components based on typical airway anatomy
  - Adults: Left and right-sided versions => Sizes 30 to 41 Fr
  - Children (8 to 12 years old): Left-sided only option => Sizes 26 to 28 Fr

(Purohit et al., 2015)

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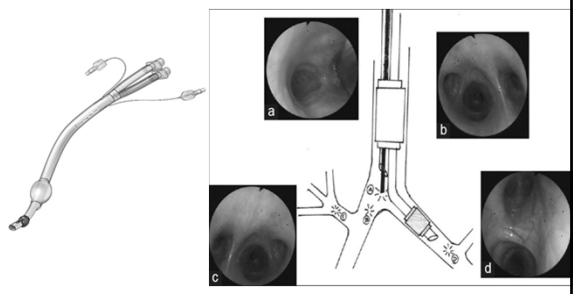
Pediatric Lung Isolation Techniques



(Purohit et al., 2015)

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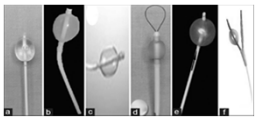
Pediatric Lung Isolation Techniques

- *Endobronchial blockers (EBBs)*
  - Isolate a lung through the inflation of a balloon at the distal end of a catheter
  - Common types
    - *Fogarty's vascular embolectomy catheter, wire-guided endobronchial blocker (Arndt blocker), and EZ-blocker*



(Purohit et al., 2015)

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Pediatric Lung Isolation Techniques

- *Fogarty's Vascular Embolectomy Catheter*
  - Sizes 6-8 Fr, with a length of 80 cm.
  - Guided into place with direct visualization via FOB, either coaxially or parallel to the ETT
- *Arndt blockers*
  - Sizes 5, 7, and 9 Fr
  - Smallest recommended single-lumen ETT (SLETT) for coaxial use 4.5, 7, and 8 mm
  - Guided via FOB through a Cook's multiport adapter to allow for uninterrupted ventilation throughout placement

(Purohit et al., 2015)

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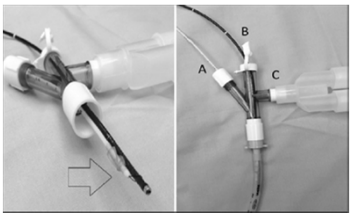
Pediatric Lung Isolation Techniques

- *Arndt blocker w/ Cooks adapter*



(Purohit et al., 2015)

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Pediatric Lung Isolation Techniques

- *EZ-blocker (EZB)*
  - Y-shaped bronchial blocker with dual balloons on each distal tip
  - One size (7 Fr)
  - Guided into the airway through a SLETT (coaxially) and is seated at the carina with no definitive need for direct visualization via FOB

(Purohit et al., 2015)

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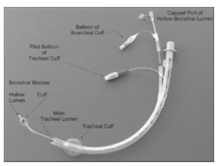
Pediatric Lung Isolation Techniques

- *The Univent Tube*
  - Preferred for patients between six to eight years old
    - Smallest size 3.5 mm ID
  - Tracheal tube including a bronchial blocker within an attached lumen.



(Purohit et al., 2015)

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Pediatric Lung Isolation Techniques

- *Single-lumen endobronchial tubes (EBTs)*
  - Similar to ETTs, however, longer in length to achieve the necessary distance to either mainstem bronchus.
  - Feature a relatively narrow bronchial cuff and a short distance from the proximal end of the cuff to the distal end of the EBT lumen to help avoid blockage of upper lobe conducting airways.
  - Placement can be assisted with FOB visualization either co- or paraxially to the EBT

(Hammer, Fitzmaurice, & Brodsky, 1999).

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Pediatric Lung Isolation Techniques

- **Pediatric Respiratory System**
  - Ventilation and perfusion should be well matched and are both highest in the dependent portion of the lung due to gravitational pull and pressure gradient.
  - During OLV => decrease in functional residual capacity and tidal volumes leads to an increase in V/Q mismatch
  - Hypoxic Pulmonary Vasoconstriction (HPV) => Self-regulated mechanism shunts blood away from an underventilated and atelectatic lung through an increase in pulmonary arterial pressure, redistributing pulmonary capillary blood flow to areas of high oxygen availability.

(Fabila & Menghraj, 2013; Sommer et al., 2008)

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Pediatric Lung Isolation Techniques

- **Pediatric Respiratory System cont.**
  - The physiologic impact of patient positioning differs between adults and infants
    - Adults => Positioned laterally with healthy lung in the dependent position allows for optimal oxygenation due to gravitational pull and increased hydrostatic pressure gradient
    - Small Peds / Infants => Smaller, softer, and more compressible lungs, leading to a decrease in the hydrostatic pressure gradient, decreased lung compliance, and increased airway closure

(Fabila & Menghraj, 2013)

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Pediatric Lung Isolation Techniques

- **Ventilation Strategies**
  - Ventilatory strategies to minimize lung injury while optimizing gas exchange and pulmonary function.
    - Lung protective V_T between 5 and 6 mL/kg
    - Prevention of atelectasis via maintenance of $FiO_2 < 1.0$.
    - Judicial use of PEEP and permissive hypercapnia

(Şentürk, Slinger, & Cohen, 2015)

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Pediatric Lung Isolation Techniques

- **Treatment of hypoxia / O2 desaturation**
  - 100% FiO2
  - Apply continuous positive airway pressure (CPAP) to the nonventilated lung when possible
  - Apply positive end expiratory pressure (PEEP) to ventilated lung.
  - Often, the application of PEEP occurs first as it avoids unwanted interference with surgical exposure.
  - Intermittent or continuous two lung ventilation
  - Clamp pulmonary artery (surgeon)

(Badner, Goure, Bennett, & Nicolaou, 2011)

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Recommendations

- ***Selective mainstem intubation*** for emergent situations or pediatric patients under 6 months old
  - Limited availability of appropriately sized airway tools in this age range
- ***EBBs*** are recommended as a safe and effective technique for patients between six months and six years of age,
  - Placed paraxially for children under two years old and coaxially for children two to six years old.
- ***The Univent tube*** is recommended for children ages six to eight,
  - Often limited in availability due to its narrow age range and current accessibility to other safe and effective airway tools.
- ***DLTs*** are suggested for patients over the age of eight and/or greater than 30 kg.
  - Many advantages: easy placement, an option to apply suction to either lung, and an ability to deliver CPAP to the operative lung and PEEP to the nonoperative lung.

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Conclusion

- In retrospect, the case report described previously was effectively managed through the use of a Single Lumen ETT placed in the trachea, paired coaxially with an EBB.
  - A Univent tube would have been an appropriate choice for the patient's age range, however, was not readily available.
  - Management of the patient through the case could have been optimized by lowering V_T to 6 mL/kg or below and maintaining set $FiO_2 < 1.0$.
- Lung isolation technique should ultimately be decided on a case to case basis, considering provider comfort and proficiency.
- Be prepared with alternative tools and methods to ensure patient safety while securing the airway.

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Thank You
Are There Any Questions?

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Dexmedetomidine for Prevention of Emergence Delirium in Pediatric Anesthesia

Kayla Henneberg, SRNA

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Introduction

- Emergence delirium (ED) in children was first discussed in the 1960s (Amorim et al., 2017).
- A specific cause and underlying mechanism of action for ED has not yet been identified, although several factors are thought to be involved (Nagelhout & Plaus, 2014).
- It is characterized by a dissociated state of consciousness where the child becomes inconsolable, uncooperative, agitated, and at times even aggressive (Amorim et al., 2017).
- The prevalence of ED in literature varies from 25%-85% depending on criteria chosen by authors.

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Complications of ED

- During an ED reaction, children risk injuring their surgical repair, themselves, and their caregivers (Sikich & Lerman, 2004).
- ED is self-limiting but can cause delayed recovery times, discharge times, and overall dissatisfaction from the parents and healthcare team (Kanaya, 2016).

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Pathophysiology of ED Cont'd

- Hypothesized that ED is due to different clearance rates of volatile agents from the CNS
- Varying recovery rates at different sites of brain function
- Cognitive function is slow to return compared to locomotion, sensibility, and audition, leading to confusion.

(Voepel-Lewis, Malviya, & Tait, 2003)

- Hypersensitivity to stimuli and hyperactive motor behavior (Sikich & Lerman, 2014).

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Assessment of ED

- Sixteen rating scales and two visual analog scales that measure agitation have been used to measure ED in young children
- The Pediatric Anesthesia Emergence Delirium Scale (PAED) is a validated tool for clinicians to assess ED in children.

(Sikich & Lerman, 2004)

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PAED Scale

- Behavior categories include: Eye contact, purposeful action, awareness of surroundings, restlessness, and if the child is consolable.
- Frequency of behavior is divided into five categories: Not at all, just a little, quite a bit, very much, and extremely.
- The total PAED is the sum of scores for the five behaviors indicated
- Score above 10 is indicative of ED (Sikich & Lerman, 2004)

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Dexmedetomidine (DEX)

- An alpha-2 adrenergic agonist
- Commonly used intraoperatively as an adjuvant for sedation and analgesia (Mason & Lerman).
- Binds with pre and postsynaptic alpha-2 receptors, causes a decrease in norepinephrine levels resulting in sedative and analgesic effects.
- Its sedative effect is similar to physiological sleep

(Cao, Pei, Wei, & Zhang, 2016)

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Dexmedetomidine Adverse Effects

- Cardiovascular effects of DEX have been well documented.
  - Hypertension
  - Hypotension
  - Bradycardia
- Despite substantial case reports of the safe use of DEX in pediatric anesthesia, DEX has not been approved for use in children by U.S. Food and Drug Administration (FDA)

(Mason & Lerman, 2011)

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Case Information

- Inguinal hernia repair
- 2 years old
- 84 cm
- 12 kg
- Male
- ASA 1

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Pre-operative Evaluation

- Past Medical History: Passive smoke exposure. NKA
- Surgical History: Negative
- Pre-op VS: BP 87/38 mm Hg, HR 112/min, RR 22/min, SpO2 100% on room air, Temp 99 degrees F
- No abnormal pre-op labs or studies
- Airway evaluation was unremarkable

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Anesthetic Course

- Patient did not receive pre-operative oral midazolam
- Escorted to OR with mother
- SpO2, BP, 3-lead EKG monitors applied
- Inhalation induction with 3L of O2 and 6L nitrous oxide, whilst titrating sevoflurane to desired effect
- 22-gauage IV placed in left hand
- NS fluids initiated with buretrol tubing
- Induced with 20 mg of propofol IV and 5 mcg fentanyl IV

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Anesthetic Course Cont'd

- Eyes taped
- Size 2 LMA placed and sealed with adequate TV, no leaks noted
- Nasopharyngeal temperature probe placed in right nare
- Dexamethasone 3mg IV, Ondansetron 1.8 mg IV were administered for prophylactic treatment of nausea and vomiting.

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Anesthetic Course Cont'd

- Supportive ventilation was administered until the spontaneous return of respirations occurred
- Adequate TV maintained throughout case
- A total of 10 mcg of fentanyl IV administered in increments of 5mcg for analgesia
- **Patient was given a slow 6 mcg (0.5mcg/kg) IV bolus of DEX near the end of the case.**
  - No negative hemodynamic side effects were noted.

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Anesthetic Course Cont'd

- The patient was extubated deep with a MAC of 1.3% sevoflurane
- Oral airway was placed
- Good airway exchange was noted without spasm, SpO2 was maintained at 98% or higher
- Blow by oxygen mask was placed near the child's airway

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Intraoperative Issues

- No intraoperative issues were noted.
- Patient remained stable throughout case.

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PACU

- Vital signs remained stable
  - No hypotension or bradycardia noted
  - BP: 90/55 mm Hg, HR 100/min , RR 22/min
- Patient woke up in PACU crying for mother
- Easily calmed and re-directed
- PACU stay was not delayed due to ED or increased sedation.

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DEX to Attenuate ED

- Reviewed Random Control Trials (RCT) & Meta-analysis
- Methods of each study were similar but there was variability among them
- Differences in studies included:
  - Dose of DEX
  - Time of DEX dose given
  - Route of administration of DEX
  - Surgical procedure
  - Patient populations and demographics
  - Evaluation tool to assess ED

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DEX to Attenuate ED Cont'd

- Hauber et al. (2015) conducted a randomized double-blind study
  - 400 patients ages 4 to 10 years
  - Tonsillectomy with or without adenoidectomy, with or without myringotomy, and/or insertion of ear tubes
  - All received a standardized anesthetic regimen
  - Divided into a DEX group and saline group

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DEX to Attenuate ED Cont'd

- 5 minutes prior to surgery ending
  - DEX group was administered 0.5mcg/kg IV bolus, saline group given equivalent dose at same time
  - ED evaluated using PAED
  - Results: ED was significantly lower in DEX group
  - Placebo group: required greater amount of rescue opioids, and experienced more adverse effects

(Hauber et al., 2015)

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DEX to Attenuate ED Cont'd

- Meta-analysis of 27 randomized trials involving 1882 children
  - DEX was largely adventitious and effective in reducing ED
  - DEX also decreased pain scores, PONV, opioid use, and occurrence of bucking during emergence.
  - DEX groups had longer discharge time due to sedation

(Jin-hui et al., 2013)

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DEX to Attenuate ED Cont'd

- Meta-analysis of RCT to determine the effectiveness of DEX on the occurrence of sevoflurane-related ED.
  - 15 RCT
  - DEX received by 518 children, 413 were given saline
  - Results demonstrated a significant decrease in the incidence and severity of ED in DEX groups

(Sun & Guo, 2014)

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DEX to Attenuate ED Cont'd

- Boku et al. (2016) conducted a prospective RCT
  - Evaluated sevoflurane based anesthesia in infants who underwent a palatoplasty
  - 70 patients, ages 10-24 months
  - Two group of 35 (DEX and saline)
  - DEX group received an infusion of DEX at 6mcg/kg/hr for about 10 minutes prior to the end of case, followed by 0.4mcg/kg/hr until 5 minutes following extubation.
  - Completed in same approach with saline group.
  - ED scores were significantly lower in the DEX groups.

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DEX to Attenuate ED Cont'd

- A randomized control trial by Makkar et al. (2016) compared the use of DEX to propofol and saline
  - 100 children undergoing infra-umbilical surgery
  - 3 groups (DEX, propofol, saline) 5 minutes before end of case:
    - DEX group: 0.3 mcg/kg IV DEX bolus diluted in 10 ml saline
    - Propofol group: 1mg/kg bolus of propofol
    - Saline group: 10 ml of saline
  - PAED scale used to assess ED
  - ED occurred in 9.4% of the DEX group, compared to 13.9% in propofol group, and 62.5% in the saline group

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Recommendations

- Additional, more uniform, studies should be conducted to to evaluate the efficacy and safety of using IV DEX in children to attenuate ED.
  - Same route, dosage, timing, evaluation, etc.
- A clear label use for DEX in children should be established by the FDA.
- A universal tool to uniformly measure ED should be implemented in all post-anesthesia care units (PAED)
- It can be recommended to administer DEX via IV bolus or continuous infusion to children to deter ED.
  - Safety profile
  - Potential to lessen postoperative ED which is associated with negative outcomes
  - Increase patient safety and satisfaction

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Conclusion

- The safety record of DEX suggests that it can be used effectively and safely in children, with appropriate monitoring and interventions.
- Anesthesia providers should evaluate appropriateness for each specific patient and case.
- DEX should be used as an adjuvant, in addition to other means to decrease ED.

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Thank You
Are There Any Questions?

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Intraoperative Lidocaine Infusion as an Analgesic

Joe Lennon, SRNA

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Introduction

- Opioids have long been the analgesic of choice for anesthesia providers
- Current trend is to avoid opioid use when possible
  - Opioid crisis and abuse potential
  - Respiratory depression
  - Decreased patient satisfaction
  - PONV
- When regional anesthesia is not an option, what do we do?

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Introduction

- Non-opioid analgesia
  - Ketamine
  - Dexmetetomidine
  - N2O
  - Acetaminophen
  - Gabapentin
  - IV Lidocaine??

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Case Information

- C5-6 anterior cervical discectomy/corpectomy, C4-6 fusion
- 71 years old
- 55 kg
- Female
- ASA 2
- Presents with numbness/pain to BUE

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Pre-operative Evaluation

- Past Medical History
  - COPD
  - Lumbar stenosis
  - DM2
  - Depression/anxiety
  - Everyday smoker
  - METS tolerance 2-3
- Surgical History
  - THA
  - Lumbar fusion
  - Appendectomy

- Pre-op VS
  - BP 134/72, SpO2 95%, HR 82, Temp 98.2F
- Labs/EKG/Imagining
  - WNL
- Airway
  - Mallampati 2 with adequate distances

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Anesthetic Course

- Induction
  - Ketamine 30 mg (20 mg given during A-line)
  - Propofol 70 mg
  - Rocuronium 30 mg
  - Esmolol 50 mg
- Infusions
  - Dexmedetomidine 0.5 mcg/kg bolus, 0.5 mcg/kg/hr
  - Lidocaine 2 mg/min
    - 2.18 mg/kg/hr
  - Phenylephrine titrated to keep MAP >90
- Video laryngoscopy
  - 7.0 ETT
  - BP 10% increase on intubation
- Maintenance
  - Volume-controlled ventilation
  - Sevo 0.5-0.7 MAC
  - 45% FiO2
- Incision
  - HR increased 10 BPM
  - Lidocaine 3 mg/min
    - 3.27 mg/kg/hr
  - HR returned 10 minutes later

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Wake up

- Lidocaine and dexmedetomidine stopped 13 minutes prior to extubation.
  - Smooth wake up
  - Minimal coughing
  - Minimal vital sign changes

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PACU

- Patient unable to rate pain immediately post-op
- 30 minutes post-op
  - Restful
  - Pain 3/10 (acceptable 5/10)

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Pain Pathway

- A-delta and C fibers
  - Sensitization by prostaglandins, cytokines, etc.
- Dorsal horn
  - Synapse to secondary afferent fibers
  - Modulation occurs
    - N-Methyl-D-aspartate (NMDA) receptors
    - Descending pathways
- Secondary afferent neuron
  - Transmission to brain

(Almeida, Roizenblatt, & Tufik, 2004)

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Systemic Lidocaine

- Amide local anesthetic
- 60% plasma protein bound
- 40% first pass via lungs
- Biphasic half life of infusion
  - 8-16 minutes followed by 1.5 hours
  - Hepatic metabolism
- Therapeutic index: 2-3.5 mcg/ml
- Toxicity: >5 mcg/ml (plasma concentration)

(Eipe, Gupta, & Penning, 2016; Oliveira, Issy, & Sakata, 2010)

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Systemic Lidocaine MOA

- Na channel blockade
- NMDA receptor blockade
  - Reduction in hyperactivity/hyperalgesia
- Anti-inflammatory
  - G protein-coupled receptors
    - Reduced free radicals, cytokines, neutrophils

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Literature Review

Farag et al. 2013 (RCT)

- 116 adults having spine surgery
  - Half lidocaine, half control
- 2 mg/kg/hr lidocaine infusion
  - No narcs
  - Beta blockers for HR/BP
- Morphine PCA in PACU
- Lidocaine group
  - Pain scores one point lower (0-10)
  - 20 mg less morphine on average

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Literature Review

Terkawi et al. 2015 control trial on chronic pain

- 61 females receiving mastectomies
- Lidocaine
  - Bolus 1.5 mg/kg, infusion 2 mg/kg/hr
  - Continued 2 hours into PACU
  - Narcs used
- 6 months post-op
  - Control: 8 had chronic pain
  - Lidocaine: 4 had chronic pain

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Literature Review

- Lidocaine in abdominal cases
  - Most studied population
  - C fiber visceral pain
- Dosing
  - Bolus: 1.5-2 mg/kg
  - Infusion rate: 1.5-3 mg/kg/hr or 2-3 mg/min
  - Duration of infusion: 20 min before emergence – 24 hours

(Yanxia et al., 2012; Kuo et al. 2006; Kim et al., 2013; Koppert et al., 2004)

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Lidocaine in Abdominal cont.

- Results (combined data)
  - Pain
    - Post-op: mild reduction
    - 6 hour: significant reduction
    - 24 hour: significant reduction
    - 72 hour: no reduction
  - Opioid use: significant decrease
  - Time to flatus and first BM: significant decrease

(Yanxia et al., 2012; Kuo et al. 2006; Kim et al., 2013; Koppert et al., 2004)

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Literature Review

Dose lidocaine work in all patient populations?

- RCT of 58 patient receiving THAs
- Lidocaine
  - 1.5 mg/kg bolus
  - 1.5 mg/kg/hr infusion
- Results
  - No difference in morphine use or pain

(Martine, Cherif, Gentili, Enel, & Abe, 2008)

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Literature Review

Cochrane Review

- 45 RTCS with 2,802 patients
  - Abd, spinal, breast, CABG, gyn
- Dosing: 1.5-3 mg/kg bolus, 1.5-5 mg/kg/hr infusion
- Duration: 30 min < closure – 48 hours
- Samples sizes: 20 – 241

(Kranke et al., 2015)

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Cochrane cont.

- Cochrane Review Cont'd
  - Results
    - Pain: most reduced immediate post-op
    - PONV: significantly reduced
    - Adverse effects: none reported

(Kranke et al., 2015)

Discussion

- What we did right:
  - Use lidocaine (chronic pain, COPD, smooth emergence)
- Improvements for future based on literature review:
  - No bolus dose
    - 4-5 hours to reach steady state

Recommendations

- Bolus 1.5 mg/kg, infusion 2-3 mg/kg/hr
- Use at provider discretion
  - Hepatic metabolism
  - Surgeon administered local
- Future research is needed
  - More uniform study design and dosing
  - Expand research to other patient populations

Conclusion

- Lidocaine is safe
- Mild to moderate analgesia
  - Potentially procedure dependent
- Reduction in chronic pain
- Lidocaine shows promise as a non-opioid analgesic in the operative setting

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Anesthesia for the Patient with Mast Cell Activation Disease

Chelsey G. Horner, SRNA

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Introduction

- Mast cell activation disease involves mast cell activation and degranulation with the enhanced release of chemical mediators
- Occurs unpredictably to a variety of triggering stimuli (allergic, microbial, nonimmune factors) making perioperative management difficult, as both anesthesia and surgery are responsible for triggers of rapid activation of mast cells in patients with mastocytosis
- Epidemiology: Estimated <200,000 people in the US are effected and occurs in both children and adults
- Mastocytosis: Umbrella term comprising of systemic mastocytosis (all forms), mast cell leukemia, and cutaneous mastocytosis
- Classification systems and diagnostic criteria for mastocytosis were first proposed in the 1980s

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Pathogenesis

- Mast cells are formed in the bone marrow. First as pluripotent stem cells, where they differentiate and mature into the adult form with the help of stem cell factor
- From the bone marrow, mast cell progenitor cells then migrate into the vessels, peripheral tissues, and nerves were growth and differentiation occur, as well as the binding of surface tyrosine kinase
- Differentiation is not complete until the cells reach peripheral tissues involving most solid tissues including the heart, lung, and central nervous system
- Mast cells have secretary granules that contain proteases, which are the major proteins that comprise them, with the major protease being tryptase

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Pathogenesis

- Surface tyrosine kinase receptors
  - mast cell markers
    - CD34, CD13, CD117 (C-KIT), and CD25
    - Point mutations can exit at the "C-KIT locus" (Asp816Val, or codon 816)
    - Codes for an abnormal cell membrane receptor protein for stem cell factor, producing clonal mast cell lines that lack normal growth and differentiation
- The mutated mast cells have granules that store and generate a number of vasoactive mediators
  - Histamine, tumor necrosis factor-α (TNFα), vascular endothelial growth factor (VEGF), leukotrienes, prostaglandin D_2, interleukins, proteases, heparin
- These mutations are able to be detected in the bone marrow where the C-KIT mutation can be found in 90% of adults with systemic mastocytosis

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Diagnosis of Systemic Mastocytosis

Systemic mastocytosis
Presence of at least 1 major and 1 minor criterion or 3 minor criteria in the bone marrow or other extracutaneous organ:
Major
Multifocal dense infiltrates of MCs (>15 MCs in aggregates)
Minor 1. MC infiltrates contain >25% spindle-shaped cells or other atypical morphologic features 2. C-KIT D816V mutation 3. Expression of CD2 and/or CD25 on CD117 + MCs 4. Serum tryptase levels >20 ng/mL (not valid if patient has concomitant hematologic disorder)

https://ezproxylr.med.und.edu:2261/#!/content/playContent/1-s2.0-S1081120609000076?returnurl=null&referrer=null

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Triggers

Category	Examples
Physical Stimuli	Heat, cold, friction, pressure, excessive sunlight, intense exercise
Emotional factors	Stress, anxiety
Drugs	Aspirin, NSAIDs, thiamine, alcohol, morphine, codeine, polymyxin-B, amphotericin B, quinine, dextromethorphan, anticholinergic preparations, vancomycin, α-adrenergic blockers
General Anesthesia	Succinylcholine, d -tubocurarine, metocurine, doxacurium, atracurium, mivacurium, rocuronium, etomidate, thiopental, enflurane, isoflurane, lidocaine
Venoms	Snakes, stinging insects
Polymers	Dextran
Miscellaneous	Radiocontrast media

https://ezproxylr.med.und.edu:2261/#!/content/playContent/1-s2.0-S1081120609000767returnurl=null&referrer=null

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Selected Mast Cell Mediators and Effects

- **Histamine**
  - Hypotension, shock, tachycardia, pruritis, urticaria, gastric hypersecretion, abdominal pain
- **Prostaglandin- D2**
  - Flushing and syncope
- **Heparin**
  - Hemorrhage (surgical and gastric)
- **Thromboxane**
  - Bronchoconstriction and vasoconstriction
- **Leukotrienes**
  - Vasoconstriction/vasodilation, increased capillary permeability
- **Tryptase**
  - Fibrinolysis

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Treatment

Symptom	Initial therapy
Pruritus	H_1 antihistamines
Flushing	H_1 antihistamines
Recurrent anaphylaxis	H_1 and H_2 antihistamines, self-injectable epinephrine
PUD	PPI
Diarrhea, nausea, vomiting, abdominal pain	H_2 antihistamines
Malabsorption	Cromolyn
Osteoporosis	Calcium and vitamin D
Bone pain	Non-NSAID analgesia
Neurologic symptoms	H_1 and H_2 antihistamines

https://ezproxylr.med.und.edu:2261/#!/content/playContent/1-s2.0-S1081120609000767returnurl=null&referrer=null

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Case Information

- Surgical Procedure
  - Hysterectomy, dilation and curettage, intrauterine device insertion for abnormal uterine bleeding
- Age: 40
- Gender: Female
- Weight: 112kg
- ASA: 2
- No known allergies

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Pre-operative Evaluation

- Past Medical History
  - history of mast cell activation syndrome, multiple past allergic shock states, hypertension, obstructive sleep apnea, morbid obesity, anxiety, hypermenorrhea, and left ovarian cyst
- Surgical History
  - None
- Home Medications: EpiPen (epinephrine injection USP), Zyrtec (cetirizine), Allegra (fexofenadine), Singular (montelukast), Zantac (ranitidine, Hcl), Requip (ropinirole Hcl), and labetalol.
- Pre-op VS
  - BP: 134/79, HR: 89, Resp Rate: 16, O2 sat: 98%, Temp: 36.9 degrees Celsius
- Pertinent Labs: all WNL
- Airway Evaluation: Mallampati 2, TMD adequate, incisor distance adequate

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Medications

- Drugs:
  - Premedicated
    - **2mg Versed**
    - **25mg Diphenhydramine**
    - **10mg Dexamethasone**
  - Induction
    - **150mg Fentanyl**
    - **14mg Etomidate**
    - **30mg Rocuronium**
  - Maintenance
    - **Sevoflurane 2%**
    - **Dexmedetomidine 0.5mcg/kg/hr**
  - Emergence
    - **Glycopyrrolate 0.6mg**
    - **Neostigmine 4mg**
- Drugs:
  - Intraoperative
    - **Albuterol**
    - **Solumedrol 125mg**
  - Emergency meds on hand
    - **Epinephrine diluted to 10mcg/ml**

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Intraoperative Issues

- Bronchospasm X2
  - #1) After intubation
    - Sats 70%, ↑ PIP, ↑ height & "shark-fin" appearance on capnography waveform, diminished breath sounds, wheezing.
    - Treatment: Positive pressure with fio2 100%, Increased sevoflurane gas, albuterol administered endotracheally (10 puffs), Solumedrol 125mg after spasm resolved
  - Maintenance:
    - Sevoflurane kept at 2.8%
  - Most likely caused from intubation stimulation
    - Possibly Etomidate or Rocuronium.

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Intraoperative Issues

- Bronchospasm #2
  - ↑ PIP, O2 sats declining, ↑ height on capnography waveform, no audible breath sounds.
  - Treatment:
    - Positive pressure with fio2 100%, Increased sevoflurane gas, albuterol administered endotracheally (10 puffs)
    - Resolved within one minute
  - No explainable cause except for current surgical stimulation

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Emergence & PACU

- Decision to extubate deep
  - Sevoflurane at 2.5%, full reversal per kg given, Dexmedetomidine infusion continued on
  - Spontaneously breathing (Vt & RR adequate)
  - TOF confirmed with strong tetany hold
  - Albuterol administered endotracheally
  - Oral airway placed
  - Suctioned while deep
  - Extubation on 10L oxygen simple mask

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PACU

- Notified of patient with highly irritable airway
- Referral for respiratory therapy, and CPAP therapy on standby
- No bronchospasm or respiratory issues
- Patient discharged home later that day

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Discussion

- Anaphylaxis due to a "massive mast cell mediator release is present in a significant portion of systemic mastocytosis (SM) patients (22–49%) and can be elicited by either known or unknown triggers through diverse mechanisms involving IgE- or non-IgE mediated pathways" (Matito et al., 2015).
- The severity of reactions that occur in the operating room depend on the "cardiovascular homeostasis disturbances, as profound vasodilatation following mast cell degranulation with subsequent histamine release may, at the extreme, result in life-threatening conditions" (Renauld et al., 2011).
- Suggested prophylaxis regimens found throughout the medical literature suggest that anti-histamines and steroids be taken, as well as acquiring a baseline tryptase level and identifying a patient with mast cell activation disease with a med alert bracelet (Klein & Misseldine, 2013).

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Discussion

Mast Cell Degranulation

- **Intraoperative crisis management:**
  - Epinephrine available and ready for use
  - Opposing the effects of mediators that have been released
  - Any reaction, from isolated flushing to anaphylaxis should be investigated in order to identify the mechanism of the reaction and performing an IgE specific assay is recommended to rule out if the reaction was from the disease process or drug/agent-induced IgE-mediated mechanism (Klein & Misseldine).
  - In patients with systemic mastocytosis, bronchospasm is said to usually not occur, although due to where mast cells populate with exposure to the external environment (skin, gastrointestinal, and respiratory tracts), risks are present for severe mast cell degranulation (Renauld et al., 2011).

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Recommendations

- **Preoperative:**
- Preoperative prophylaxis regimes as well as pretreatment for conditions of intraoperative stress (anesthesia and surgery) need to be conducted to prevent possible cardiovascular collapse with adult mastocytosis. Immediate reaction occurring in patients with mastocytosis should be highly investigated for future documentation of the mechanism of the reaction.
- Preparation for cardiovascular collapse is required, especially in a known mastocytosis patient undergoing anesthesia for a surgical case. It is important the practitioner is aware that patients with mastocytosis "experience both immune (IgE-related) and non-immune anaphylaxis, and the overall incidence of anaphylaxis in patients with mastocytosis has been reported to be higher than in the general population" (Klein & Misseldine, 2013).
- The most substantial mediator is histamine. The prophylactic use of H1-receptor and H2-receptor antagonists are given to prevent preformed histamine release.
- Glucocorticoids are used as mast cell stabilizers and have anti-inflammatory properties (Klein & Misseldine, 2013).

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Recommendations

- **Intraoperative:**
  - Maintain avoidance of triggers
    - Medications mentioned earlier
    - Deep anesthetic technique
  - Matito et al., (2014) reviewed 501 mastocytosis patients who underwent anesthetic techniques including general, regional, and local anesthetic techniques, and found that, in adult mastocytosis patients who "underwent anesthetic procedures the frequency of anaphylaxis was 0.6% and mast cell mediator release symptoms was 7% respectively and despite this, anesthetic procedures are considered high risk in mastocytosis since severe reactions (e.g. systemic hypotension/anaphylactic reactions and coagulopathy) resulting in death in individual patients have been recurrently reported" (Matito et al., 2015, p 53).
- **Postoperative:**
  - Continue treatment with antihistamines, leukotriene antagonists, steroids in postop period.

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Conclusion

- Mast cell degranulation in patients with mastocytosis is unpredictable, and does not occur consistently in any given patient. It is also unclear when drugs that elicit histamine release in normal patients or under study conditions will produce the same response in mastocytosis patients undergoing anesthesia
- There are currently no official guidelines for intraoperative management of mast cell activation disease and no known studies have been found to predict mast cell degranulation in this patient population. Extended research is needed for perioperative antidotes for the anaphylaxis-like incidences in mastocytosis patients.

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Recruitment Maneuvers and Positive End Expiratory Pressure for Obese Patients Undergoing Laparoscopic Procedures

Nathan McGee, SRNA

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Introduction

- One of the biggest responsibilities of anesthesia providers is to ensure our patients are properly oxygenated
- Many factors can alter oxygenation
- Both obesity and pneumoperitoneum used in laparoscopic procedures can create difficulty with oxygenation and ventilation
- When both factors are encountered, it is best to have a plan in place if troubles with oxygenation are encountered
- Recruitment maneuvers and PEEP prove to be an effective strategy to improve oxygenation in this population

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Case Information

- Emergent Laparoscopic Appendectomy
- 52 years old
- 165 kg
- Male
- ASA 2
- Arrived to ED with extreme LLQ abdominal pain

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Preoperative Evaluation

- Past Medical History: obesity, OSA, HTN, GERD, allergy to latex, no smoking, occasional alcohol use.
- Surgical History: toe amputation and Achilles tendon repair with no anesthetic complications.

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Preoperative Evaluation

- HR:129/min
- RR: 24/min
- BP: 169/91
- Temp: 37.4 °C
- SpO_2 : 98% on RA
- Pain rating: 9/10 in the RLQ of the abdomen
- All labs WDL
- Abdomen/pelvis CT scan: appendicitis with possible appendiceal rupture
- Airway evaluation: Mallampati III, TM Distance < 3cm

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Anesthetic Course

- RSI using Glidescope
- Drugs:
  - midazolam 2 mg
  - fentanyl 50 mcg
  - lidocaine 50 mg
  - fentanyl 100 mcg
  - propofol 200 mg
  - succinylcholine 140 mg

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Intraoperative Issues

- Following induction and intubation:
  - quickly desaturated to approximately an SpO_2 of 70%
  - 2 RMs were performed
    - pressure of about 30 cm H_2O held for 10-15 seconds each
  - manual ventilation was performed until the SpO_2 was above 90%
  - Ventilator was set to volume auto-control mode, Vt of 650 ml, RR of 16/min, FiO_2 at 100%, and PEEP of 5 cm H_2O

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Intraoperative Issues

- Trendelenburg position
  - Two more RMs were performed for SpO_2 of 91%
  - SpO_2 improved, and ventilator settings remained unchanged
- Vital signs remained stable throughout the remainder of the case

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PACU

- No anesthetic complications noted.
- Vital signs remained stable.
- Denied pain, nausea, or troubles breathing.
- Admitted to medical surgical unit and discharged home the next day.

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Discussion

Laparoscopic Procedures on Obese Patients

- According to the Center for Disease Control, from 2011 to 2014, the prevalence of obesity in American adults was 36.5% (2015).
- This specific population is at increased risk for:
  - Respiratory complications including reduced lung volumes, decreased lung compliance, and impaired oxygenation
  - Higher morbidity and mortality
  - Longer hospital stays
  - Higher healthcare costs

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Recruitment Maneuvers

- Also known as vital capacity maneuvers or sigh breaths.
- A RM is performed after a secure airway has been established and usually involves providing positive airway pressure around 40 cm H_2O for around 40 seconds.
- The RM recruits collapsed alveoli, caused by various factors.
- RM improves compliance, and alveolar ventilation / oxygenation
- RMs decrease elastance and airway resistance

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Positive End Expiratory Pressure

- PEEP is applied at around 10 cm H_2O.
- PEEP reduces the re-collapse of the recruited alveoli from the RM.

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Discussion Overview

- Evidence was evaluated using the Hierarchy of Evidence for Intervention Studies.
- Four systematic review/meta-analysis articles (Level I evidence)
  - RMs and PEEP improved oxygenation compared to multiple other ventilation strategies.
- Five of the six randomized controlled trials (Level II evidence), and one prospective study (Level IV evidence)
  - Found similar results to the systematic review/meta-analysis
- One RCT
  - No significant difference between using RMS and PEEP, to using PEEP alone in improving oxygenation.

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Best Ventilation Strategy

- Although the evidence was inconclusive on the specifics of how to apply a RM and PEEP, it overwhelmingly supported the use of RMs with the addition of PEEP in order to improve intraoperative oxygenation.
- Application of 30-40 cm H_2O held for 15-40 seconds should be used for a RM.
- PEEP of 10 cm H_2O should be applied throughout the intraoperative phase.

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Recommendations

- Using RMs with addition of PEEP to improving intraoperative oxygenation for this patient population is:
  - reasonable
  - cost effective
  - Supported by evidence of high quality
- Potential complications that would need to be considered and discussed with the operative team:
  - hemodynamic alterations
  - Barotrauma
  - specific patient conditions in which this intervention would be contraindicated

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Recommendations

- Future research focusing on:
  - which method for implementing RMs with addition of PEEP is the most effective in improving oxygenation
  - whether prophylactic use is warranted in this population
- Education on this intervention and discussion with:
  - Certified Registered Nurse Anesthetists
  - Anesthesiologists
  - Critical Care physicians taking over care of ventilated patients
  - Surgeons
  - Other members of the operative team

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Conclusion

- Sufficient, high quality evidence supporting the use of RMs with addition of PEEP to improve oxygenation.
- The use of this strategy proved to be effective in the case presented.
- This could ultimately lead to better patient outcomes and reduced hospital costs all with minimal risk of complications.

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Anesthesia Considerations for Intrathecal Narcotic Utilization for a Cesarean Section

Tanner Robberstad, SRNA

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Introduction

- Subarachnoid block (SAB) has been utilized for cesarean section cases for decades
- 2016, US registered 3,945,875 births
  - 32% via cesarean section
- Advantages over general anesthesia include
  - Relatively quick/easy performance with rapid onset
  - Decreased mortality
  - More alert neonate with sooner mother-neonate bonding
  - Better post-operative pain control
- Intrathecal narcotic additive primary agent to provide analgesia
  - ASA only offers up recommendation for use, but no specifics
  - Results in highly variable practice routines amongst providers
    - Morphine and fentanyl primary focus of this project

(Martin et al. 2018, Butterworth et al. 2013, Apfelbaum et al. 2015)

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Case Information

- G2P1, 35 y/o female measuring 37 weeks 4 days
- 114kg, 167 cm, BMI 41
- Elective cesarean section due to malposition of baby
- ASA classification 2

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Pre-operative Evaluation

- Medical Hx: HTN, gestational diabetes, headaches
- Surgical Hx: negative, uncomplicated vaginal delivery with epidural
- Medications: methyldopa, metformin, prenatal vitamins
- Airway evaluation: Mallampati II, TM distance >3, full neck mobility, normal dental exam
- Pre-op VS: BP 135/86, HR 88, RR 20, SpO_2 94%
- Denied any lower back surgery history, spinal abnormalities, or bleeding disorders

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Anesthetic Course

- Consented for spinal anesthetic with addition of intrathecal narcotic
- Arrived to OR with LR infusing, positioned in sitting position, & prepped in normal sterile fashion
- Subarachnoid space obtained at L3-4 level with 25g, 3.5 inch pencil point Pencan needle
- Injected 0.75% hyperbaric bupivacaine 12 mg, fentanyl 10 mcg and duramorph 0.15 mg
- Positioned in left uterine tilt and BP monitored every 2.5 minutes
- Complaints of pruritus to face and neck 5 minutes post med injection
- Decreased temperature sensation correlating with T4 dermatome
- Denied feeling abdominal pinch by surgeon with subsequent incision

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Intraoperative Issues

- Uneventful phase
- No drop in BP or feelings of N/V
- Healthy baby delivered with Apgar scores 8/8 at 1 and 5 minutes respectively
- Post placenta delivery
  - 20 units oxytocin in hanging LR liter bag
  - Ondansetron 4 mg, diphenhydramine 12.5 mg, dexamethasone 4 mg, ketorolac 30 mg
- Total 1,200 ml IVF, EBL 700 ml, UOP 50 ml

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PACU

- Transported to OB floor in stable condition
- One mild episode of hypoglycemia 73 mg/dL
  - Given apple juice with recheck 142 mg/dL
- Per facility protocol placed on ketorolac 30 mg every 6 hours
- Required no additional opioids during stay
- Discharged home on POD 2

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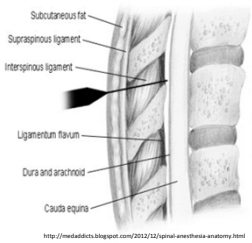
Anatomy Review

- Spinal cord terminates at L1 level in adults
- SAB at L3 or lower preferred
- Spinal cord meninges
  - Dura mater
  - Arachnoid mater
  - Pia mater
- Spinal ligaments include
  - Supraspinous ligament
  - Interspinous ligament
  - Ligamentum flavum



http://medaddicts.blogspot.com/2012/12/spinal-anesthesia-anatomy.html

(Butterworth, et al. 2013)

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Spinal Anesthesia

- Nerve root principal site of action for SAB
  - Small dose and volume can achieve dense sensory and motor block
  - Sensory blockade associated with posterior nerve roots
  - Motor blockade associated with anterior nerve roots
- Sympathetic nerve fibers exit between T1-L2
  - Blockade results in unopposed parasympathetic activity
    - Results in hypotension

(Butterworth et al. 2013, Catterall & Mackie 2018)

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Differential Blockade

- Nerves separated into 3 groups
  - A, B, and C fibers
  - A fibers have four subcategories: alpha, beta, gamma, delta
  - Diameter and myelination differentiating characteristics
- Order of blockade progression
  - B > C & A-delta/gamma/beta > A-alpha
  - Sympathetic blockade 2-6 dermatomes above sensory block
  - Sensory block 2-3 dermatomes above motor block

(Nagelhout & Plaus 2014)

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Intrathecal Analgesia

- 1st pain processing synapses occur in dorsal horn of spinal cord
- Opiate receptor review
  - Mu 1 & 2, kappa, and delta
  - Primarily located in the substantia gelatinosa, laminae II of dorsal horn
- First intrathecal opioid study occurred in 1979 with 2mg morphine
- Able to use significant less medication compared to other routes
- Advantage of prolonging sensory block without affecting motor or sympathetic function & reducing visceral pain

(Yaksh & Wallace 2018, Nagelhout & Plaus 2014, Gomez & Garzon 2015)

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Intrathecal Medications

- All should be preservative free agents
- Morphine
  - Hydrophilic➢ slow onset, prolonged duration
  - Greater cephalocaudal spread➢ respiratory depression
  - Higher rates of adverse effects (pruritis, N/V)
- Fentanyl
  - Lipophilic➢ quick onset, short duration
  - Associated with less adverse effects

(Yaksh & Wallace 2018)

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SAB technique

- Pure local anesthetic agent
- Benefit: avoid narcotic side effects
- Disadvantage:
  - Venkata et al. (2015) found ↑ intraoperative hypotension, prolonged period to reach T6 sensory block, reduced postoperative analgesia
  - Onishi et al. (2017) discovered higher doses of 0.5% bupivacaine resulted in a significant increase trend in phenylephrine use and incidence of N/V

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SAB Technique Cont.

- Morphine additive
  - Highly used adjunct
  - Decreases post-operative pain & improves patient satisfaction
  - Side effect profile creates hesitancy
- Alone or in combination with fentanyl?
  - Siti Salmah & Choy (2009) found morphine superior to fentanyl based on lower post-op visual analogue scores (VAS) & less cumulative morphine PCA use
  - Thorton et al. (2015) found no need for fentanyl as the VAS at 4 hours post-op not significantly different and side effects more common
  - Karaman et al. (2010) also support only a morphine/bupivacaine SAB based on similar block height, time for block onset, similar intraoperative pain scores, and occurrence of side effects

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SAB Technique Cont.

- Morphine dose
  - Highly variable in practice and numerous research articles investigating
  - Carvalho & Tenorio (2013) found no statistical difference in moderate/severe post-op pain scores between morphine 50 mcg and morphine 100 mcg
  - Wong et al. (2013) in comparison found patients receiving morphine 200 mcg had better post-op analgesia and consumed less rescue opioids when compared to morphine 100 mcg
    - However, nausea and anti-emetic use also greater
  - Sultan et al. (2016) found insignificant difference in post-op pain scores between low dose (50-100 mcg) morphine and high dose (>100-250 mcg) morphine
    - HD group had 4.5 hour longer duration before first analgesic request
    - HD also had increased pruritus, N/V, & antiemetic use

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SAB Technique Cont.

- Morphine & Respiratory Depression
  - Lack of universal definition regarding respiratory depression makes exact incidence difficult to compute
    - Reported as low as 0-0.26%
    - Ladha et al. (2017) found significant higher rates however
  - Increasing dose, increases risk
  - Progesterone theoretically combats by stimulating respiratory system, ↑ minute ventilation, ↓ $PaCO_2$, & causing mild respiratory alkalosis (Gomez & Garzon 2015)

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SAB Technique Cont.

- Fentanyl additive
  - Intraoperative and immediate post-op analgesia
  - Weigl et al. (2016) discovered lower intraoperative pain scores and less rescue medication need in the first 12 hours post-op with fentanyl use
    - Pain scores similar between 12-24 hour period
    - Fentanyl 25 mcg can prolong analgesia averaging between 3 to 5 hour post-operatively
    - Doses 10 mcg and greater abolish intraoperative visceral pain in almost all cases

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SAB Technique Cont.

- Combination of morphine/fentanyl
  - Ideal characteristics with fast onset fentanyl producing intraoperative analgesia and long lasting morphine providing post-op analgesia
  - Side effect rates slightly increased
  - Weigl et al. (2017) found morphine/fentanyl group required less intraoperative opioids, but more than double the amount in the first 1-12 hours post-op
    - Spinal opioid tolerance
    - Receptor availability theory

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Recommendations

- Intrathecal narcotic utilization for cesarean section is beneficial
- Would recommend against sole fentanyl addition
- Morphine at a dose between 100-150 mcg alone or in combination with fentanyl 10-25 mcg provides adequate analgesia
- Need proper staff education and monitoring protocols when morphine is used
- Thorough discussion with each patient regarding potential benefits and possible adverse effects should be held prior to SAB "cocktail"

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Conclusion

- The use of intrathecal morphine & fentanyl in combination with 0.75% hyperbaric bupivacaine in this case is supported by the literature
  - Patient required no additional narcotics during stay
  - Had one episode of intraoperative pruritus
    - Masked by anti-emetic "cocktail"?
- Intrathecal narcotics in combination with local anesthetics provide adequate analgesia for cesarean section cases, which benefits both mother and neonate and should be incorporated into practice by anesthesia providers

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Thank You
Are There Any Questions?

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