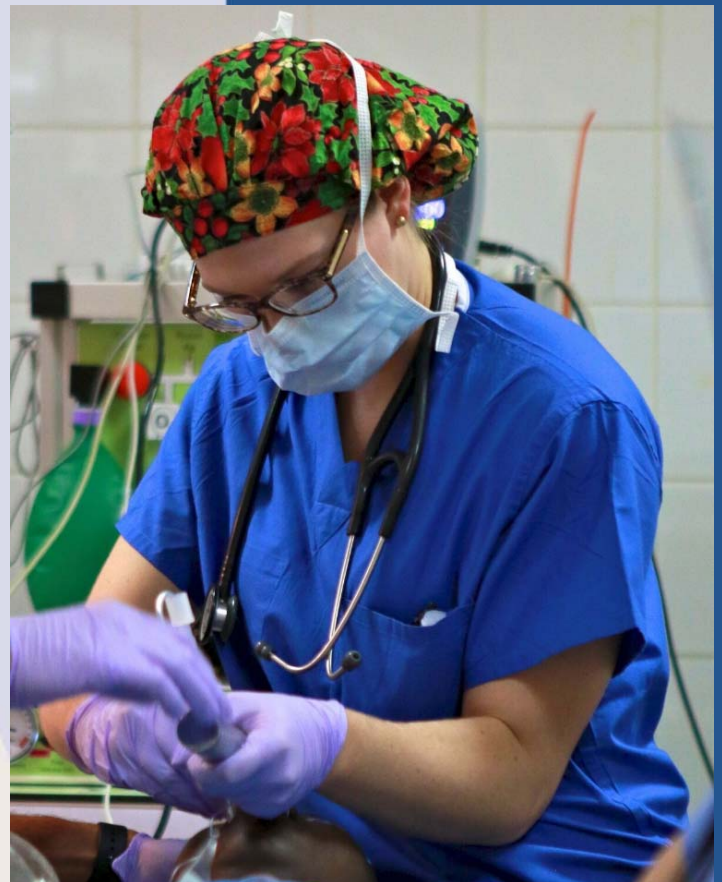


Volume 16 Issue 3 Fall 2017

The International Student Journal of Nurse Anesthesia

TOPICS IN THIS ISSUE

**Central Congenital Hypoventilation Syndrome
Transfusion in Developing Health Systems
Intraoperative Lidocaine Infusion
Pediatric Mitochondrial Disease
Goal Directed Fluid Therapy
Difficult Airway Workshop
Atrial Fibrillation Ablation
Tricuspid Regurgitation
Fiberoptic Intubation
Tracheal Bronchus
Dental Injury**



INTERNATIONAL STUDENT JOURNAL OF NURSE ANESTHESIA
Vol. 16 No. 3 FALL 2017

Editor

Vicki C. Coopmans, PhD, CRNA

Associate Editor

Julie A. Pearson, PhD, CRNA

Editorial Board

Laura Ardizzone, DNP, CRNA
LTC Sarah Bellenger, MSN, CRNA, ANC, USA

Laura S. Bonanno, DNP, CRNA
Carrie C. Bowman Dalley, PhD, CRNA
Greg Bozimowski, DNP, CRNA
Marianne Cosgrove, DNAP, CRNA
LTC Denise Cotton, DNAP, CRNA, ANC, USA

Janet A. Dewan, PhD, CRNA
Kären K. Embrey, EdD, CRNA
Rhonda Gee, DNSc, CRNA
Marjorie A. Geisz-Everson, PhD, CRNA
Johnnie Holmes, PhD, CRNA
Anne Marie Hranchook, DNP, CRNA
Donna Jasinski, PhD, CRNA

Ilene Klassy, MSN, CRNA
Connie L. Lorette, PhD, CRNA
Ann Miller, DNP, CRNA

Ryan L. Nations, PhD, CRNA
Johanna Newman, DNAP, CRNA
Teresa Norris, EdD, CRNA

Crystal Odle, DNAP, CRNA
Shannon Pecka, PhD, CRNA
Sarah Perez, MS, MSN, CRNA
Jo Ann Platko, PhD, CRNA, BC
J. Dru Riddle, PhD, DNP, CRNA
Michael Rieker, DNP, CRNA, FAAN
LTC Peter Strube, DNAP, MSNA, MBA(s) CRNA, APNP, ARNP

Bryan Tune, DNP, CRNA
Maria Van Pelt, PhD, CRNA
Tina Williams, MSN, CRNA
Kelly Wiltse Nicely, PhD, CRNA
Lori Ann Winner, MSN, CRNA
Kathleen R. Wren, PhD, CRNA

Memorial Sloan Kettering Cancer Center; NY, NY
Blanchfield Army Community Hospital;
Fort Campbell, KY

Louisiana State University Health Sciences Center
Georgetown University
University of Detroit Mercy

Yale New Haven Hospital School of Nurse Anesthesia
Ryder Trauma Center; Miami, FL
Northeastern University

University of Southern California
Millikin University and
University of Southern Mississippi

Naval Hospital Camp Lejeune
Oakland University-Beaumont
Georgetown University

University of Wisconsin Medical School
Northeastern University
Florida International University

Uniformed Services University
Anesco North Broward; Ft. Lauderdale, FL
University of Southern California

Lincoln Memorial University
Bryan College of Health Sciences

Washington University School of Medicine; St. Louis,
Commonwealth Health/Wilkes-Barre General Hospital
Texas Christian University

Wake Forest School of Medicine
Rosalind Franklin University
University of Wisconsin, Oshkosh
St. Mary's University

National University
Northeastern University

Carl R. Darnall Army Medical Center; Fort Hood, TX
Emory University
University of Pennsylvania
University of Wisconsin, Oshkosh

Contributing Editors for this Issue

Michele Gold, PhD, CRNA	University of Southern California
Ryan Johnson, MS, CRNA	University of Texas Health Science Center; Houston
Michael J. Kremer, PhD, CRNA, CHSE, FNAP, FAAN	Rush University
Paul Packard, DNAP, CRNA	Wake Forest School of Medicine
Molly Wright, DNP, CRNA	Union University

Reviewers for this Issue

Dawn Bent, DNP, CRNA	University of Pennsylvania
Shelli Collins, MSN, CRNA	Excel Anesthesia, PA; Dallas, TX
Michael Conti, PhD, CRNA	Emory University
Leah Stuart Feyh, DNAP, MSN, CRNA	East Carolina University
Jason Frantz, MS, CRNA	Washington University School of Medicine; St. Louis, MO
Shannon Hoy, DNP, CRNA, NNP	Children's Hospital and Medical Center
Terri D. Kane, DNAP, CRNA	Texas Wesleyan University
Brian Koonce, DNAP, CRNA	Texas Wesleyan University
Nina McLain, PhD, CRNA	University of Southern Mississippi
Keri Ortega, DNAP, CRNA	Wolford College
Susanne Owens MSN-A, CRNA	MAC Anesthesia Education Seminars
Bradley Wagner, MSNA, CRNA, APNP	University of Wisconsin Hospital and Clinics
David Wagner, MD	Catholic Medical Center; Manchester, NH
Mary Ellen Zerlan, DNP, CRNA	Washington University School of Medicine; St. Louis, MO

*The **opinions** contained in this journal are those of the authors and do not necessarily represent the opinions of the program or the University.*

Disclaimer for all articles authored by military personnel:

The views expressed in this journal are those of the authors and do not necessarily reflect the official policy or position of their respective Military Department, Department of Defense, nor the U.S. Government. The work was prepared as part of the official duties of the military service member. Title 17 U.S.C. 105 provides that 'Copyright protection under this title is not available for any work of the United States Government'. Title 17 U.S.C. 101 defines a United States Government work as a work prepared by a military service member or employee of the United States Government as part of that person's official duties.

Front Cover:

Leanne Brown, BSN, RN, a graduate student enrolled in the Northeastern University nurse anesthesia program performs laryngoscopy and intubation during induction of general anesthesia for a patient undergoing utero-vesicic fistula repair in Kigali, Rwanda. Senior nurse anesthesia students have the opportunity to gain experience delivering safe anesthesia in a low resource environment during a senior global health immersions elective. Ms. Brown also has a case report in this issue discussing her experience with blood product administration in this developing health system. The photographer was Frederick Van Pelt, MD, who accompanied Ms. Brown on the mission.

The Guide for Authors: can be found at www.aana.com by following this path:

Member Resources → Students → Scroll partway down, click on International Student Journal

Or, use this direct link: <http://www.aana.com/studentjournal>

Table of Contents

Case Reports

Anesthesia for Surgical and Catheter Ablation for Atrial Fibrillation	5
Paul Uzodinma, Northeastern University	
Finding of a Tracheal Bronchus Complicating One-Lung Ventilation	8
John K. Nguyen, Texas Christian University	
Goal Directed Fluid Therapy	11
Tracy McQueen, Wake Forest School of Medicine	
Central Congenital Hypoventilation Syndrome: Avoiding Hypoxemia	14
Jill Izzo, University of Southern California	
Anesthetic Management for Pediatric Mitochondrial Disease	18
Chadchadin Nonghin, University of Southern California	
Intraoperative Lidocaine Infusion utilization in Abdominal Hysterectomy	21
Tracy May, University of Southern California	
A Comprehensive Approach in Preventing Perioperative Dental Injury	25
Chelsea Cutaran, University of Southern California	
Anesthetic Management of Tricuspid Regurgitation for Non-Cardiac Surgery	28
Meredith Tatarzycki, Union University	
Awake Fiberoptic Intubation Using Dexmedetomidine and Nebulized Lidocaine.....	31
Sonja Sena-Cary, University of Southern California	
Unexpected Intraoperative Blood Loss in a Developing Health System.....	34
Leanne Brown, Northeastern University	

Research Abstracts

Difficult Airway Workshop with Emphasis on Emergency Surgical Cricothyrotomy	38
Brett R. McAllister, Rush University	
Editorial	40
Vicki Coopmans, PhD, CRNA	
Guide for Authors	41

Anesthesia for Surgical and Catheter Ablation for Atrial Fibrillation

Paul Uzodinma, MS
Northeastern University

Keywords: radiofrequency ablation, atrial fibrillation, supraventricular tachycardia, electrophysiology

The reported incidence of atrial fibrillation (AF) varies but it is generally acknowledged that the incidence and prevalence is expected to increase with continued rise in the aging population.^{1,2} Given the known medical complications from unmanaged AF, surgical and catheter ablation has increasingly become the recommended standard of treatment for patients with persistent and paroxysmal AF.³ Despite the successes of this therapy, there are serious potential complications whose anesthesia management requires robust preparation and meticulous perioperative management. Anesthesia practitioners must balance the demands of delivering optimal anesthesia care with the challenges presented in non-operating room environments.

Case Report

A 53-year-old, 79 kg, 187 cm male with history of persistent AF presented for radiofrequency (RF) ablation. His AF began approximately 4 years ago with infrequent episodes of paroxysmal AF that became persistent in the last year. He underwent 2 direct-current cardioversions, which briefly restored sinus rhythm. On exam, he reported frequent palpitations, at least twice daily, and occasional shortness of breath with increased activity. His other medical history was significant for hypertension and gastroesophageal reflux disease. His medication regimen included flecainide, apixaban, amlodipine, and omeprazole. His surgical history was only notable for a childhood tonsillectomy. All labs were within normal limits. A preoperative electrocardiogram (ECG) noted AF with ventricular heart rate at 68/min and a recent echocardiogram noted an ejection fraction of 60% with no valvular abnormalities. He was deemed in a good functional status as evaluated by his adherence of high intensity exercises 3 times weekly. He received midazolam 2 mg intravenously (IV) prior to transport to electrophysiology (EP) suite.

On arrival to the EP suite, standard multi-electrode mapping systems and monitors were applied by the EP nurse and technician. Standard anesthesia monitors were also applied. After pre-oxygenation, anesthesia was induced with propofol 200 mg, fentanyl 100 mcg, and rocuronium 30 mg IV. The trachea was intubated and respiration was controlled by a mechanical ventilator. A bispectral index (BIS) monitor was applied and anesthesia was maintained with sevoflurane 1.7 % inspired concentration in a mixture of oxygen 1 L/min and air 1 L/min and sufentanil infusion at a rate of 0.1 mg/kg/hr. A phenylephrine infusion was started at 20 mcg/min to maintain a mean arterial pressure of at least 65 mm Hg. The anesthesia practitioner inserted an esophageal temperature probe, placed a second peripheral intravenous catheter and padded and tucked both arms appropriately while the nursing staff placed an indwelling urinary catheter. At the start of the procedure, the interventional cardiologist (IC) cannulated the femoral vein, inserted venous sheaths and catheters and advanced them towards the right atrium under fluoroscopy. An initial bolus dose of heparin 3000 units was administered by the anesthesia

practitioner who also announced the return of 4 twitches. The IC then proceeded to make trans-septal punctures to access the left atrium (LA). The multi-electrode and mapping/ablation catheters used to record and deliver electrical signals were placed in the LA. Intra-operatively, the IC requested additional doses of heparin as indicated by the results of the activated clotting time (ACT).

After about 4 hours of procedural time, the IC successfully ablated the pulmonary vein foci. Isoproterenol infusion was administered when requested at a rate of 0.1 mcg/kg/min and titrated up to 0.8 mcg/kg/min, and was discontinued once the IC determined no return of arrhythmia. A final ACT level was determined and appropriate protamine dose was slowly administered. The patient emerged from anesthesia uneventfully and was transferred to the post anesthesia care unit (PACU) in sinus rhythm for continued 24-hour monitoring.

Discussion

The etiology of AF can be the result of electrophysiological and/or structural abnormalities that lead to atrial tissue remodeling, resulting in abnormal propagation of cardiac impulses or ectopic beats. These cardiac impulses are typically the result of cardiac tissue remodeling in the pulmonary vein-left atrium (PV-LA) junction.⁴ Valvular or atrial irregularities that contribute to a fibrotic and inflammatory state sustain abnormal cardiac impulses.^{2,5} The presence of unmanaged AF has been associated with several potential risks including stroke and major cardiac events requiring the need for therapeutic alternatives when conventional pharmacologic interventions prove insufficient.¹⁻³ Still, AF ablation therapy presents significant risk of complications that must be considered along with the underlying comorbidities of patients with AF. Consequently, a thorough preoperative evaluation is imperative. ECG, previous cardiac interventions, echocardiograms to rule out left atrial thrombus, coagulation status including INR, most recent anticoagulation therapy including when stopped, standard laboratory evaluation, functional status, and review of systems should be evaluated to inform the pre-anesthesia assessment and direct intra-operative management.

AF catheter ablation therapy is a minimally invasive procedure performed with a specially designed catheter which combines laser, cryothermic energy, and ultrasound or RF technology to create scar tissue to impede the aberrant conduction from previously mapped foci areas thought to be contributing to AF.^{4,5} The pulmonary vein (PV), muscular sleeves extending from the PV in the LA, lesions in the superior vena cava and cavotricuspid isthmus have all been identified as common foci sites amendable to RF ablation.^{4,5} The RF technology generates heat energy with temperatures as high as 50°C to form irreversibly non-conducting myocardial tissue at the foci site. The potential high temperatures can cause esophageal injury with atrioesophageal fistula a potentially life-threatening complication.⁵

The choice of anesthetic depends on the anticipated extent and type of ablation. Some ablation therapies can be performed under sedation or monitored anesthesia care (MAC) while general anesthesia is indicated for lengthy and technically difficult ablation procedures.⁶ For the case discussed in this report the choice of general anesthesia created an optimal surgical environment by ensuring patient comfort and immobility especially as RF energy application can be painful, while assuring smaller respiratory variations, making it less technically challenging for the IC.⁴

The use of sufentanil helped provide a balanced anesthetic with stable hemodynamics, while suppressing cough reflex particularly during periods when the IC asked for apnea.⁷ Additionally, given its relatively longer duration of action and elimination profile, sufentanil provided adequate analgesia in the immediate postoperative period, until the patient was able to tolerate oral analgesics as indicated. Intraoperative management also requires careful attention to signs of fluid overload especially with patients with pre-existing renal dysfunction who may be more vulnerable to overload from intravenous fluid in addition to irrigation fluid required for ablation.

Intraoperative anticoagulation with the administration of heparin as well as post-operative resumption of anticoagulation therapy is important given the elevated risks of thromboembolic events from the introduced sheaths and catheters during venous cannulation, the formation of scar tissues in the LA appendage, and creation of areas of impaired contractility, potentially resulting in decreased activity and stasis. Furthermore, the administration of other intraoperative drugs such as isoproterenol infusion—which induces arrhythmia to uncover non-PV foci—can induce marked tachycardia which can increase cardiac workload or induce ischemia in patients with coronary artery disease. Isoproterenol infusion has also been known to increase the level of awareness, even under general anesthesia.⁸ Therefore, the use of BIS monitoring—with readings in the range of 40 to 60—to allow for adequate titration of the level of anesthesia can be reassuring.

The use of adenosine is sometimes indicated to uncover any dormant atrial foci and to examine for PV reconnection. While adenosine may unmask any remaining LA-PV conduction given its property of shortening atrial refractory period, it can nonetheless cause significant AV blockade resulting in bradycardia and hypotension.⁸

Undoubtedly, several factors contribute to a challenging environment for the anesthesia practitioner including anesthetizing the patient on the narrower fluoroscopy table without the ability to alter the head of the bed. Adequate patient positioning and padding is imperative to prevent nerve injury. Women of childbearing age require a negative pregnancy test, while all personnel should use appropriate protective radiation shields and monitoring to limit exposure to radioactive material.

Postoperatively, post anesthesia care staff also need to be aware of potential complications including femoral IV site pseudoaneurysm and hematoma formation, retroperitoneal bleeding, heart block, pulmonary vein stenosis, stroke, pericardial effusion, and cardiac tamponade. Consequently, adequate communication between the anesthesia, surgical team, and PACU staff remains invaluable. Pharmacological and mechanical means of intervention should be readily available as part of a robust perioperative anesthesia plan to optimize the safety and success of ablation therapy.

References

1. Colilla S, Crow A, Petkun W, Singer DE, Simon T, Liu X. Estimates of current and future incidence and prevalence of atrial fibrillation in the U.S. *Am J Cardiol.* 2013; 1128(8):1142-1147.

2. Panisello-Tafalla A, Clua-Espuny JL, Gil-Guillen VF, et al. Results from the Registry of Atrial Fibrillation (AFABE): Gap between undiagnosed and registered atrial fibrillation in adults—ineffectiveness of oral anticoagulation treatment with VKA. *Biomed Res Int*. 2015;134756. doi: 10.1155/2015/134756.
3. January CT, Wann LS, Alpert JS, et al. AHA/ACC/HRS Guideline for the management of patients with atrial fibrillation: A report of the American College of Cardiology/American Heart Association Task force on Practice Guideline and the Heart Rhythm Society. *J Am Coll Cardiol*. 2014;612(21):2246-2280.
4. Bunch TJ, Cutler MJ. Is pulmonary vein still the cornerstone in atrial fibrillation ablation? *J Thorac Dis*. 2015;7(2):132-141.
5. O'Neill MD, Wright M, Knecht S, et al. Long-term follow-up of persistent atrial fibrillation ablation using termination as a procedural endpoint. *Eur Heart J*. 2009;30(9):1105-1112. doi: 10.1093/eurheartj/ehp063.
6. Firme EB, Cavalcanti IL, Barrucand L, Assad AR, Figueiredo NV. Curative ablation of atrial ablation: comparison between deep sedation and general anesthesia. *Rev Col Bras Cir*. 2012;39(6):462-468.
7. Khaled R, Nadir T, Frederic S, et al. Conscious sedation with sufentanil and midazolam for epicardial VT ablation. *Journal of Innovations in Cardiac Rhythm Management*. 2013;3:849-853.
8. Elayi CS, Biasse L, Bai R, et al. Administration of isoproterenol and adenosine to guide supplemental ablation after pulmonary vein antrum isolation. *J Cardiovasc Electrophysiol*. 2013;24(11):1199-1206. doi: 10.1111/jce.12252.

Mentor: Janet Dewan, CRNA, PhD

Finding of a Tracheal Bronchus Complicating One-Lung Ventilation

John K. Nguyen, BSN
Texas Christian University

Keywords: tracheal bronchus, carina trifurcation, one-lung ventilation, double-lumen tube, bronchoscopy

Tracheobronchial abnormalities present unique challenges to the anesthesia practitioner, the most relevant being the finding of a tracheal bronchus (TB), which has a reported incidence ranging from 1-3% of the general population.^{1,2} A TB is any airway that originates from the tracheal wall within 2 to 6 cm of the carina. A TB more commonly supplies an upper lobe in the absence of normal bronchial anatomic branching and occur with much greater frequency on the right side. These tracheal bronchi are thus termed “displaced” as opposed to “supernumerary” in which the TB supplies an upper lobe in addition to the presence of normal bronchial anatomic supply.³

Case Report

The patient was a 76-year-old, 172 cm, 112 kg female who presented for left lower lobectomy for a 2 cm mass found on imaging consistent with non-small cell carcinoma on biopsy. She was

otherwise asymptomatic. Medical history included tobacco use, chronic obstructive pulmonary disease, multiple myeloma, hypertension, hyperlipidemia, gastroesophageal reflux disorder, thyromegaly, and obesity. Radiography confirmed the lung mass and pulmonary history without mention of any unusual anatomy. Airway examination was significant for Mallampati III classification, a thyromental distance of less than 6 cm, the appearance of a large neck circumference, and significant redundant soft tissue in the head and neck.

Monitoring included electrocardiogram, invasive arterial blood pressure monitoring, end-tidal carbon dioxide monitoring, and pulse oximetry. Vital signs before induction of general anesthesia were normal. The patient was pre-oxygenated at a flow of 10 L/min via mask while an arterial line was placed. Intravenous induction of general anesthesia with fentanyl 100 mcg, lidocaine 80 mg, propofol 80 mg, and rocuronium 40 mg proceeded without complication. The King Vision video laryngoscope (Ambu Inc., Ballerup, Denmark) was employed in anticipation of a difficult laryngoscopy view and a 37 French left double-lumen endotracheal tube (DLT) was selected based on anticipated airway size and anatomy. After DLT intubation and tracheal cuff inflation, bilateral apical breath sounds were auscultated. The first attempt at left lung isolation revealed positive bilateral upper lobe breath sounds both before and after bronchial cuff inflation and clamping maneuvers. Fiberoptic bronchoscopy (FOB) revealed the bronchial cuff to be below the carina, but upon deflation of both cuffs and slight retraction of the DLT, a carina trifurcation and the presence of a TB was revealed. The bronchial cuff had been placed in the bronchus intermedius. The FOB was then placed through the leftmost airway and the bronchial cuff was guided over it. Both cuffs were reinflated, visualization of the bronchial cuff was satisfactory, and correct placement was verified with successful isolation and deflation of left upper and lower lobes and satisfactory one-lung ventilation (OLV) of the right lung. Throughout these maneuvers, the patient's SpO₂ did not drop below 96% from a baseline of 99%.

The bronchial cuff was deflated for patient positioning in the right lateral decubitus position for surgical exposure and proper placement and reinflation of the bronchial cuff was confirmed with FOB. Adequate left lung isolation was achieved for the procedure and no other complications or events were encountered during the case. The patient recovered from general anesthesia and the DLT was removed without complications. A 24-hour postoperative visit found the patient recovering well without complaints.

Discussion

A TB is a congenital abnormality usually found incidentally during chest imaging or bronchoscopy for unrelated indications. Conacher's classification of tracheal bronchi distinguishes these aberrant findings via distance between the carina and the TB.⁴ Type I places the TB ≥ 2 cm above the carina with a narrowed distal trachea, Type II shows a TB ≥ 2 cm above the carina with a normal diameter distal trachea, and Type III shows a TB ≤ 2 cm above the carina. They are usually asymptomatic unless associated with other congenital abnormalities, such as vertebral abnormalities, abnormal pulmonary vasculature, congenital heart disease, or tracheal stenosis, the last of which was possibly encountered.^{1,3} Achieving adequate lung isolation for surgical exposure without occluding aberrant airways requires individualization for each patient's anatomy.

The patient presented with a potentially difficult laryngoscopy view and because OLV would be a high priority for this procedure, video laryngoscopy with a DLT was used for the first intubation attempt. The success and safety of video laryngoscopy has proposed changes to many difficult airway protocols and in this case the technique was valuable in maintaining view of the glottic opening while managing resistance encountered in passage of the DLT, presumed to be due to tracheal stenosis versus subglottic stenosis versus incorrect placement of the DLT.⁵ If passage of the DLT was found to be difficult or impossible, video laryngoscopy and a single-lumen endotracheal tube (ETT) with airway exchange catheter would be attempted and a bronchial blocker (BB) subsequently used to achieve lung isolation.

This presentation was a Type III tracheal bronchus with the bronchial cuff initially in the bronchus intermedius. The most common presentation of a TB is a displaced right apical segment aerating the right upper lobe, but it was also considered that this presentation could be a displaced left upper lobe segment.¹ The possibility of a tracheoesophageal fistula was excluded due to its origin being from the lateral wall of the trachea instead of the posterior wall. The diagnosis of whether the TB was displaced or supernumerary was not pursued at the time. The bronchial cuff was guided over FOB to the leftmost bronchus with visualization of the secondary carina and two bronchi, presumed to aerate the left upper and lower lobes. Left lung isolation was achieved. This finding of a displaced right apical segment was consistent with the incidence reported in the literature.^{1,2}

Many different approaches to difficult lung isolation are described in the literature and although the DLT is the most commonly used device, situational uses of the Univent tube (Teleflex Medical, Westmeath, Ireland), BBs, and Fogarty balloon catheters (Edwards Lifesciences, Irvine, California) have all been described.² A single-lumen ETT with a BB can be advantageous in difficult airways, however if a TB is undiagnosed as presented here, there have been cases describing inability to isolate the right lung with BBs; in these instances, BBs were abandoned and DLTs were used to achieve lung isolation.² Multiple reports state that prior knowledge of the TB would have significantly impacted their plan of care in favor of a DLT over BBs; they also recommend auscultation to accompany FOB in spite of seemingly satisfactory bronchoscopic findings.^{2,6} There is another reported case in which the angle of the TB at the carina was sufficiently acute to occlude the bronchial lumen of a left DLT, making lung isolation impossible. The surgical team in this case elected to proceed with the DLT despite inadequate OLV.⁶

In light of the reviewed literature, the use of video laryngoscopy in the management of an anticipated difficult view of the glottis, and the use of the DLT in the incidental finding of a TB were both supported. FOB allowed for confirmation of proper placement and avoidance of any inadvertent occlusion of a TB by the proximal tracheal cuff. Prior knowledge of the TB via chest radiography or computerized tomography (CT) would have precluded the use of a right-sided DLT, may have allowed for a more timely intubation and lung isolation, and may have allowed less airway manipulation and potential for tissue edema and injury.⁶ Patients who are asymptomatic with a tracheal bronchus should be managed conservatively, but incidental findings on radiography or CT would be helpful to the anesthesia practitioner.³ Multiple reports identified FOB as being the critical component to the identification and management of a TB and strongly advocated its presence and use in OLV. Inclusion of the tracheal bronchus in a

differential diagnosis and flexibility in the management of unconducive airway anatomies were also heavily emphasized.^{1,2,5,6} The presented case supports these recommendations as well as screening for tracheal bronchi on preoperative imaging if available.

References

1. Wisner SH, Hartigan PM. Challenging lung isolation secondary to aberrant tracheobronchial anatomy. *Anesth Analg*. 2011;112(3):688-692.
2. Lee DK, Kim YM, Kim HZ, Lim SH. Right upper lobe tracheal bronchus: anesthetic challenge in one-lung ventilated patients -a report of three cases-. *Korean J Anesthesiol*. 2013;64(5):448-450.
3. Mehta AC, Thaniyavarn T, Ghobrial M, Khemasuwan D. Common Congenital Anomalies of the Central Airways in Adults. *Chest*. 2015;148(1):274-287.
4. Conacher ID. Implications of a tracheal bronchus for adult anaesthetic practice. *Br J Anaesth*. 2000;85:317-321.
5. Brodsky JB. Lung separation and the difficult airway. *Br J Anaesth*. 2009;103 Suppl 1:i66-75.
6. Yoshimura T, Ueda K, Kakinuma A, Nakata Y. Difficulty in placement of a left-sided double-lumen tube due to aberrant tracheobronchial anatomy. *J Clin Anesth*. 2013;25(5):413-416.

Mentor: Ryan Johnson, CRNA

Goal Directed Fluid Therapy

Tracy McQueen, BSN
Wake Forest Baptist Health

Keywords: goal directed fluid therapy, GDFT, intraoperative fluid management, frank-starling principle

Goal directed fluid therapy (GDFT) is a patient specific technique of intraoperative parenteral fluid administration intended to reduce anesthetic morbidity and optimize recovery in high risk patients.¹ The standard parenteral fluid replacement protocol is based largely on patient weight, nothing by mouth (NPO) status and type of surgery. This approach has become the mainstay during anesthesia, leading to postoperative complications such as hypoperfusion injuries, respiratory compromise.¹ Research suggests that noninvasive monitoring, coupled with GDFT consisting of both crystalloids and inotropes reduces complications postoperatively.²

Case Report

A 74-year-old, 111 kg, 173 cm male presented for a percutaneous nephrostolithotomy. The patient's medical history consisted of systolic congestive heart failure, ischemic cardiomyopathy, coronary artery disease (CAD), diabetes mellitus, hypertension, asthma, and arrhythmias. His surgical history included an implantable cardioverter defibrillator (ICD) placement and a single

vessel coronary artery bypass. The patient's home medication regimen included metoprolol, aspirin, carvedilol, enoxaparin sodium, fosinopril, furosemide, dabigatran, tizanidine, glimepiride and sitagliptin. An electrocardiogram (ECG) demonstrated a paced rhythm at 80/min. Lab work completed during a preadmission assessment was within normal limits. Peripheral intravenous access (IV) and a normal saline infusion were established preoperatively.

Upon transfer to the operating room (OR) the patient was premedicated with midazolam 2 mg, fentanyl 100 mcg and ketamine 40 mg IV. Standard monitors including a noninvasive blood pressure cuff, pulse oximeter, and a 5-lead ECG were applied prior to induction.³ ICD tachyarrhythmia detection was disabled via magnet during the procedure. Preoxygenation commenced with O₂ at 10 L/min via facemask for 4 minutes immediately followed by induction of anesthesia with lidocaine 100 mg, etomidate 16 mg, metoprolol 2 mg and rocuronium 50 mg IV. Endotracheal intubation was performed via direct laryngoscopy with a Macintosh 3 laryngoscope and a 7.5 mm endotracheal tube. Immediately following induction of anesthesia, the patient required a total of phenylephrine 840 mcg IV to maintain a mean arterial pressure (MAP) of 70 mm Hg. Anesthesia was maintained with desflurane 4.1%, inspired concentration in O₂ 1 L/min and air 1 L/min. A right radial arterial line and additional IV access was established in the left external jugular vein.

Intraoperative IV infusions of phenylephrine and epinephrine were initiated to support systemic vascular resistance and cardiac inotropy. The phenylephrine infusion ranged from 25-40 mcg/min and the epinephrine infusion ranged from 5-10 mcg/min to maintain a MAP of 70 mm Hg, a systolic blood pressure greater than 110 mm Hg, and a heart rate (HR) less than 90/min, which the team agreed were optimal physiological parameters for this patient. Total intraoperative IV fluid was limited to 1200 mLs of normal saline in the interest of reducing further postanesthesia morbidity. Once the procedure was complete, neostigmine 5 mg and glycopyrrolate 0.8 mg was administered IV to antagonize any residual neuromuscular blocking agent effects. A transcutaneous nerve stimulator revealed four full twitches and no visible fade. Ondansetron 4mg IV was also administered for postoperative nausea and vomiting prophylaxis. The patient was extubated without incident. Epinephrine and phenylephrine infusions were no longer necessary for hemodynamic support and subsequently discontinued prior to leaving the OR. The patient was transported to the postanesthesia care unit and monitored for two hours. Vital signs remained within established parameters with no further requirements for phenylephrine or epinephrine infusions. Postanesthesia evaluation on day one revealed no anesthetic complications.

Discussion

The most significant risk factor of perioperative cardiac morbidity and mortality is existing heart failure.³ Arrhythmias, hypertension and CAD further compound perioperative risk of cardiac events in this patient population.³ Additionally, mismanagement of intraoperative IV fluid therapy leads to increased perianesthetic morbidity. Starling's Law best explains this principle. Oxford Dictionary of Sports Science & Medicine defines Starling's Law as an increase in stroke volume as a result of increased end diastolic volume in the heart.⁴ This volume increase results in a more forceful contraction by the ventricle wall due to myocardial stretch from the additional blood volume.⁴ Thus, stroke volume should also increase independently of end diastolic

volume.⁴ The Frank-Starling principle further explains that over a certain point, additional preload no longer enhances contraction, but in fact depresses and flattens the Frank-Starling curve, leading to myocardial overload and potential ventricle failure.⁵

Preoperatively, patients are dehydrated iatrogenically due to the practitioner instructions to be NPO immediately prior to the procedure. Many patients exhibit hypotension following anesthesia induction due to fluid volume deficit related to preoperative NPO status and the vasodilating effects of the medications utilized throughout this period. Standard protocol for IV fluid management suggests replacing NPO deficit utilizing a mathematical formula based on the patient's weight and the length of time they fasted. This formula recommends replacing the NPO fluid deficit within the first three hours of surgery, administer half of the calculated volume in the first hour followed by half over the next two hours.³ Additional IV fluid is administered for maintenance and for insensible fluid loss during surgery concurrently. While this does not seem unreasonable for healthy patients, this protocol lacks individualization associated with comorbidities.

Tachycardia during the perioperative period is another risk to patients with cardiac morbidity. Baroreceptor mediated tachycardia due to hypotension associated with a preload deficit is remedied by administering IV fluid boluses. Fluid boluses may further stress a compromised myocardium leading to increased morbidity and mortality. Experienced anesthesia practitioners should also anticipate stimulating surgical events, such as direct laryngoscopy and surgical incision. Sympathetic nervous system stimulation with its associated tachycardia and hypertension can be attenuated to avoid the negative myocardial impact of tachycardia. While transient tachycardia is tolerated in healthy patients, it can severely compromise coronary blood flow. This is due to a shortened diastolic filling time, which decreases myocardial oxygenation especially in a patient with CAD.³

In the case scenario, the patient has calculated fluid deficit of 1208 mL. Standard protocol fluid administration would have also included an additional 775 mL, at minimum, to be given for maintenance fluid replacement. For a healthy PS 1 or 2 patient, Starling's Law would suggest that additional IV fluid would improve stroke volume by increasing ventricular filling pressure. For a PS 4 patient that has comorbidities of CAD, systolic congestive heart failure and ischemic cardiomyopathy, additional IV fluid would only increase the workload of the ventricles. Upon induction, metoprolol 2mg was administered IV to prevent tachycardia. An increase in contractility, from the addition of inotropes, helped to maintain an adequate stroke volume. By early initiation of an inotrope, the anesthesia practitioner was able to avoid fluid boluses that are given to counteract the initial hypotensive effects of induction. While the use of transesophageal echocardiography and/or pulmonary artery catheters can be utilized to monitor fluid balance for cardiac compromised patients, their use may not be readily available in certain facilities. Intra-arterial pressure monitoring devices are more accessible and justified for use.³

Patients with cardiac compromise are at great risk for postoperative complications and mortality from major surgery.¹ Although current research varies research on noninvasive monitoring tools and techniques, GDFT has shown to shorten length of stay and reduce postoperative complications such as hypoperfusion injuries, infection, and respiratory compromise.⁶ Treatment measures of identifying patient comorbidities, early intervention with an inotrope, direct acting

vasoconstrictors, and GDFT can assist in preventing postoperative complications for patients that are at a high risk.

References

1. Arulkumaran N, Corredor C, Hamilton MA, et al. Cardiac complications associated with goal-directed therapy in high-risk surgical patients: a meta-analysis. *Br J Anaesth* 2014; 112:648-59. doi: 10.1093/bja/aet466
2. Benes J, Haidingerova L, Pouska J, et al. Fluid management guided by a continuous non-invasive arterial pressure device is associated with decreased postoperative morbidity after total knee and hip replacement. *BMC Anesthesiology*. 2015;15:148. doi:10.1186/s12871-015-0131-8
3. Barash P, Cullen B., Stoelting R. Commonly used monitoring techniques. In: *Clinical Anesthesia*. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2013.
4. Kent M. *The Oxford Dictionary of Sports Science & Medicine*. 3rd ed. Oxford University Press; 2006:526.
5. Marvin S. *Dictionary of Scientific Principles*. e-book. 2012. <http://WFU.ebib.com/patron.FullRecord.aspx?p=1120284>. Accessed 03 July 2016.
6. Mehta N, Fernandez-Bustamante A, Seres T. A review of intraoperative goal-directed therapy using arterial waveform analysis for assessment of cardiac output. *The Scientific World Journal*. 2014:2014 doi:10.1155/2014/702964

Mentor: Paul Packard, DNAP, MSNA, CRNA, NEA-BC, EMT-P

Central Congenital Hypoventilation Syndrome: Avoiding Hypoxemia

Jill Izzo, BSN
University of Southern California

Keywords: Autonomic nervous system dysfunction, alveolar hypoventilation, respiratory acidosis, Ondine's curse

Ondine's curse is a mystical reference to an alveolar hypoventilation syndrome of autonomic dysfunction which leaves newborns requiring lifelong ventilatory support.¹ In 1970, Mellins et al described cyanosis at birth as one of the hallmark features of central congenital hypoventilation syndrome (CCHS). Advances in research indicate that CCHS is no longer exclusively diagnosed in newborn populations, but rather may present throughout all stages of life.²⁻⁴ Knowledge of the syndrome and its pathophysiology can help guide anesthesia management and avert hypoxemic complications including respiratory failure and severe cardiac complications such as cardiac arrest.²⁻⁴

Case Report

A 3-year-old, 18 kg, 99 cm male presented for a magnetic resonance imaging scan (MRI) of the brain and orbits for headaches and seizures. The patient's medical history included obstructive

sleep apnea diagnosed at age 2 months, laryngomalacia, congenital central hypoventilation syndrome, sleep related hypoventilation/hypoxemia, headaches, and a history of maternal substance abuse. The patient's surgical history included bronchoscopy as a newborn and tonsillectomy/adenoidectomy at 2 years of age. The patient's initial sleep study diagnosed severe sleep apnea and resulted in prescription of supplemental oxygen at night. Following a tonsillectomy, the patient's condition improved and his need for supplemental oxygen decreased. Full assessment of the patient's CCHS history was confounded by lack of a reliable historian for past medical history. Abnormal findings included a chest x-ray revealing a moderately large cardiomeastinal silhouette and prominent pulmonary artery. However, the patient's echocardiogram was within normal limits.

A thorough review of systems was obtained including the patient's current activity level, sleep habits and supplemental oxygen use. A preoperative peripheral intravenous catheter was established. Pre-induction sedatives were withheld to avoid hypoventilation and the patient's mother was present for induction of anesthesia in the MRI suite. The patient was positioned supine with noninvasive monitors applied. Pre-oxygenation with O₂ 10 L/min was followed by an inhalation induction with progression of inspired concentration of sevoflurane up to 8%. A size 1.5 laryngeal mask airway (LMA, Teleflex Inc.) was placed without complications. After the reestablishment of spontaneous ventilation, the sevoflurane was terminated and maintenance of general anesthesia was achieved with a propofol infusion (200mcg/kg/min) without the use of additional anesthetic agents. Spontaneous ventilation was supported with continuous positive airway pressure (CPAP) via the ventilator circuit for the duration of the MRI.

On completion of the MRI, the propofol infusion was discontinued followed by uneventful removal of the LMA. Spontaneous ventilation was then supported by gentle positive pressure until the patient was fully awake. The patient was transported to the recovery room with O₂ 4 L/min via simple face mask, where noninvasive monitors were applied. Supplemental O₂ was titrated down as tolerated, maintaining SpO₂ greater than 94%. The patient was observed and monitored as a precaution in the recovery room, breathing room air, for an additional three hours.

Discussion

Congenital central hypoventilation syndrome is an autosomal dominant disorder mainly involving variations of the gene mutation of PHOX2B, which results in autonomic nervous system (ANS) dysfunction.²⁻⁵ The hallmark feature of this syndrome is impaired central nervous system ventilatory control. The syndrome predominates during sleep. However, in more severe cases, the symptoms persist during wakefulness as well.^{2,3,5} In healthy individuals, the presence of hypercapnia triggers the ANS to increase ventilation and reestablish normocapnia and adequate oxygenation. In contrast, in CCHS, hypercapnia and hypoventilation continue unchecked due to the lack of reflex ventilatory responses. Prolonged hypercapnia leads to respiratory acidosis and hypoxemia.^{1,2,3} Over time, the negative impact of the chronic lack of oxygen from continued episodes of hypoventilation results in multisystem involvement. The strain on the heart and pulmonary vasculature leads to abnormal physiologic changes such as hypertrophy of the heart and dilated pulmonary vasculature. In severe and untreated cases, CCHS will lead to cardiac and respiratory failure.¹⁻⁵

A common CCHS induced cardiopulmonary complication is reduction in cardiac contractility caused by increased plasma potassium concentration associated with respiratory/metabolic acidosis. This complication may result in arrhythmias, bradycardia, and transient asystole. Chronic episodes of even mild hypoxia associated with the syndrome lead to polycythemia, pulmonary hypertension, hypertrophy of the right atrium and ventricle, cardiomegaly, cor pulmonale and congestive heart failure.¹⁻⁶ Due to metabolic imbalances and suboptimal respiratory control, patients with this syndrome can be more sensitive to respiratory challenges such as feeding, exercise, anesthesia, and respiratory infections.¹⁻³

There are three categories of patients with CCHS to consider, each with varying degrees of central hypoventilation syndrome: 1) congenital, 2) late onset (acquired) after the newborn period and up through adulthood, and 3) the undiagnosed population.^{2,3,5,7} Mellins et al's criteria for CCHS in newborns defines a basic framework for understanding the disease process. A differential diagnosis of CCHS at birth should exclude any primary disease of the neuromuscular system, thoracic cage, and heart or lungs. Inclusion criteria for the syndrome are cyanosis at birth, cyanosis readily corrected with assisted ventilation and alveolar hypoventilation not responsive to elevated serum PaCO₂ and hydrogen ion concentration. This latter criterion highlights a possible CNS etiology for ventilatory dysfunction.¹⁻³

In late onset CCHS and in the undiagnosed population, the primary presentation of the syndrome could manifest after initial administration of anesthesia. These patients may be unable to regulate postoperative ventilation for a prolonged period of time and in some cases, they may require unanticipated postoperative mechanical ventilation.^{3,5}

Due to the under appreciation of this diagnosis and its various presentations, no controlled trials exploring the syndrome have been established.^{2,3} The current practice recommendations for management of CCHS have been derived from the culmination of case studies and collaborative systemic reviews by experts and scientists around the world.¹⁻³

Adequate knowledge of the disease process and its possible complications are essential for anesthesia management. To understand the patient's current health status a thorough review of systems must be completed. It is imperative to further investigate possible cardiopulmonary pathology by assessing for signs and symptoms of right-sided heart failure, sleep apnea, and the use of home oxygen or respiratory devices.¹⁻⁶ Diagnostic testing such as sleep studies, chest x-ray, electrocardiogram (ECG), transthoracic echocardiogram, vital signs/oxygen saturation, blood gas values, complete metabolic panel and blood count may facilitate a more comprehensive picture of the syndrome's sequelae. Depending on the extent of the planned procedure, it may be necessary to obtain additional testing and specialist consultations to further evaluate the patient.^{3,5,6}

The goal of the anesthetic plan should be to minimize perioperative respiratory depression, thereby avoiding hypercapnia, hypoxia and acidosis.^{1,3,6} Complications from pulmonary hypertension and right sided heart abnormalities can be mitigated by maintaining adequate ventilation and oxygenation.^{3,6,8} Adequate fluid balance and avoiding hypothermia help to reduce complications such as arrhythmias, heart failure and respiratory complications.^{3,6}

Choice of anesthetic technique depends on the surgery type and duration, as well as the patient's baseline functional status. The use of local anesthetics in lieu of general anesthesia may be appropriate for some procedures.^{1,3,6} There is no contraindication to the use of regional anesthesia, yet caution is warranted for neuraxial anesthesia due to the cardiac risks associated with sympathetic blockade in these patients.³ Since this population is unable to adequately regulate ventilation while receiving deep sedation or general anesthesia, the option of securing an artificial airway and controlling ventilation is a general recommendation.^{2,3,6}

When choosing anesthetic agents, short acting medications such as propofol and remifentanyl are recommended.^{3,6} Longer acting opiates and sedatives can cause drowsiness, altered mental status and respiratory depression and therefore should be avoided. Avoid or use low dose inhalation agents due to the need for respiratory clearance of these gases, and their side effects which include myocardial depression. Avoid the use of neuromuscular blocking agents wherever possible. If these agents are necessary, thorough antagonism of the neuromuscular blocking drug is imperative, as weakened respiratory muscles can lead to hypoventilation and failed extubation. The anesthetic plan for this patient addressed the known complications of hypoventilation for a patient with CCHS by avoiding reliance on the natural airway. The patient's airway and adequate ventilation and oxygenation were maintained during spontaneous ventilation by placing an LMA and by providing CPAP via the ventilator. An endotracheal intubation was also an option for this patient, despite the non-invasive nature of the procedure. Discontinuation of the inhalation agent following induction was aimed at preventing complications from postoperative hypoventilation associated with the characteristic blunted responses to hypercapnea in these patients. Continuous noninvasive monitoring, titration of supplemental O₂, and an augmented recovery time optimized the patient for postoperative discharge.

Congenital central hypoventilation syndrome results in ANS dysfunction which can affect all systems, especially those of ventilatory control. Awareness of CCHS and its pathophysiological manifestations is essential to providing appropriate anesthetic management in the perioperative period and in minimizing complications associated with the syndrome.

References

1. Mellins RB, Balfour HH Jr, Turino GM, Winters RW. Failure of automatic control of ventilation (Ondine's curse). Report of an infant born with this syndrome and review of the literature. *Medicine* (Baltimore). 1970;49:487–504.
2. Weese-Mayer DE, Berry-Kravis EM, Ceccherini I, et al. An official ATS clinical policy statement: congenital central hypoventilation syndrome. *Am J Respir Crit Care Med*. 2010;181:626-644.
3. Basu SM, Chung FF, AbdelHakim SF, Wong J. Anesthetic considerations for patients with congenital central hypoventilation syndrome: A systemic review of the literature. *Anesth Analg*. 2017;124(1):169-178.
4. Lee P, Su YN, Yu CJ, Yang PC, Wu HD. PHOX2B mutation-confirmed congenital central hypoventilation syndrome in a Chinese family: presentation from newborn to adulthood. *Chest*. 2009;135:537–544.
5. Fine-Goulden MR, Manna S, Durward A. Cor pulmonale due to congenital central hypoventilation syndrome presenting in adolescence. *Pediatr Crit Care Med*. 2009;10:41–42.

6. Niazi AU, Mocon A, Varadi RG, Chan VW, Okrainec A. Ondine's curse: anesthesia for laparoscopic implantation of a diaphragm pacing stimulation system. *Can J Anaesth.* 2011;58:1034–1038.
7. Kameyama Y, Wagatsuma T, Nakamura M, Kurosawa S, Saito K, Hoshi K. A case of congenital central hypoventilation syndrome. *J Anesth.* 2012; 26:922–924.
8. Salehi, A. Pulmonary hypertension: A review of pathophysiology and anesthetic management. *Amer J of Therap.* 2012;19:377-383.

Mentor: Kären Embrey, CRNA, EdD

Anesthetic Management for Pediatric Mitochondrial Disease

Chadchadin Nonghin, BSN
University of Southern California

Keywords: mitochondrial disease, mitochondrial dysfunction, MELAS, anesthetic considerations, propofol infusion syndrome

Mitochondrial disease (MD) encompasses multiple disorders caused by dysfunctional mitochondria.^{1,2} It most commonly affects young children and can result in devastating multi-organ dysfunction. Based on available data, 1 in 4,000 people inherit some form of MD and approximately 4,000 people are born with MD per year.¹ Manifestations of the disease can vary from mild symptoms to severely impaired cardiac and neurological functions.^{1,2} Due to the nature of the disease process, pediatric patients with MD invariably require surgeries early in life, giving rise to the need for current evidence-based anesthetic considerations to prevent deleterious outcomes.

Case Report

A 5-year-old, 105 cm, 16 kg, Caucasian male presented for a percutaneous endoscopic gastric tube exchange due to a new onset of purulent gastric tube site leakage. The patient was diagnosed 3 years prior with a rare form of MD known as mitochondrial encephalomyopathy, lactic acidosis, and stroke-like episodes (MELAS) and developed multiple associated chronic health problems. The patient's past medical history included mild developmental delay, seizures, respiratory insufficiency with nocturnal O₂ use (1 L/min), muscle weakness, and dysphagia with gastric tube feedings. The patient was allergic to vancomycin, and his medications included levetiracetam, baclofen, and coenzyme Q10.

Significant laboratory values were within normal limits except a hemoglobin of 9.9 g/dL and hematocrit of 31%. A recent echocardiogram was unremarkable, and a sleep study showed desaturation to 86% without supplemental O₂. Preoperative vital signs included a blood pressure of 100/62 mm Hg, a heart rate of 95/min, and a SpO₂ of 95% on room air. A pre-anesthetic assessment revealed no significant findings except for the gastric tube leakage. The patient was alert and responding appropriately to commands. Last seizure activity was reported 3 months ago, and levetiracetam was last administered the night before surgery. The airway examination

was unremarkable. The patient had nothing by mouth for 10 hours and had 5% dextrose in normal saline (NS) infusing at 50 mL/hr via a 22-gauge intravenous (IV) catheter.

Midazolam 1 mg was administered IV prior to transferring the patient to the operating room (OR). Dexmedetomidine 16 mcg and ketamine 10 mg were given IV after noninvasive monitors were applied in the OR. A mask induction was initiated with sevoflurane 8% inspired concentration in a mixture of O₂ 4 L/min and N₂O 6 L/min. A second 22-gauge IV was inserted, and the IV fluid was switched to NS. No neuromuscular blockers were utilized. Direct laryngoscopy with a Macintosh size 2 blade provided a grade I glottic view, and the trachea was intubated with a 4.0 mm cuffed endotracheal tube (ETT). Proper placement was verified with positive end tidal CO₂ and bilateral breath sounds. A leak was present at 20 cm H₂O. The ETT was secured, and pressure control ventilation was initiated with a peak inspiratory pressure of 16 mm Hg and a respiratory rate of 20/min.

General anesthesia was maintained with sevoflurane 3.5% inspired concentration in a mixture of O₂ 1 L/min and air 1 L/min. A nasal temperature monitor was placed, and a forced-air warming device was utilized to maintain normothermia. The surgery proceeded without complications, and ondansetron 1.5 mg was administered IV 10 minutes before extubation. The ETT was removed with the patient fully awake. The patient was placed on O₂ 4L/min via a simple mask and transferred to recovery in stable condition. No opioids were required for pain management. The patient had no signs and symptoms of hemodynamic instability, pain, nausea, or respiratory depression throughout the recovery period.

Discussion

Mitochondrial disease is the result of mitochondrial DNA mutations and can either be inherited or acquired.^{1,2} Mitochondria are present in every body cell except red blood cells and play an essential role in the production of adenosine triphosphate, the energy source used to sustain life and promote growth.¹⁻³ Without proper functioning mitochondria, less energy is created and body functions shut down causing cells to die. This process can lead to failure of multiple body systems.^{1,2} Common manifestations of the disease include seizures, developmental delay, muscle weakness, dysphagia, cardiomyopathy, respiratory complications, vision and hearing impairment, diabetes, liver impairment, impaired wound healing, and delayed growth.^{1,2} In severe cases, significant morbidity and mortality may occur from cardiopulmonary arrest and intractable seizures leading to neurological coma.² There is no definitive treatment for MD, and therapy focuses on delaying progression and ameliorating side effects.¹

A literature review reveals various anesthetic agents have the potential to further inhibit mitochondrial function and lead to acute disease exacerbation.^{1,2,4} Data supports propofol should be avoided in this patient population because propofol inhibits mitochondrial function at multiple electron transport chain complexes and exaggerates the uncoupling of oxidative phosphorylation.¹⁻³ Mtaweh et al⁴ reported an incident where a single bolus of propofol administered to a pediatric patient with MELAS caused the patient to develop severe lactic acidosis, hemodynamic instability, and neurologic deterioration. Patients with MD are also at increased risk for developing propofol infusion syndrome (PRIS) after prolonged exposure due to its inhibition of long-chain fatty acid transport.¹⁻³ PRIS can lead to severe lactic acidosis,

rhabdomyolysis, fever, cardiogenic shock, and death.^{2,3} Dexmedetomidine may be a more desirable anesthetic agent for MD patients due to its ability to provide sedation and reduce post-operative pain without causing respiratory suppression.⁵ Research suggests dexmedetomidine reduces mitochondrial dysfunction and apoptosis in animal models.⁶ Inhalation anesthetics have been found to reduce oxidative phosphorylation in isolated mitochondria.³ These agents are rapidly eliminated via exhalation and minimally metabolized. As a result of this elimination mechanism, inhaled anesthetics provide superior anesthesia management for patients with MD when compared to IV anesthetic agents.²

Another important anesthetic implication is the use of muscle relaxants. Succinylcholine should be avoided due to the risk of developing myotonic crisis leading to an inability to adequately ventilate.¹ Recent research supports non-depolarizing muscle relaxants may be used cautiously if necessary.² Non-depolarizing muscle relaxants can elicit unpredictable responses in these patients, and the duration of action is usually prolonged. Patients with MD are at increased risk for postoperative respiratory insufficiency, and the use of muscle relaxants can worsen a preexisting respiratory dysfunction.² In addition, it is recommended to avoid using anticholinesterase medications for reversal of muscle relaxation because they can trigger acute myotonic crisis.¹ In this case, muscle relaxation was not necessary, and muscle relaxants were avoided.

Pain management is challenging in patients with MD. Local anesthetics should be used cautiously as most induce structural changes in mitochondria, causing concentration-dependent depolarization of the mitochondrial membrane and increasing cell apoptosis.^{1,3,7} Bupivacaine and ropivacaine inhibit complex 1 of the respiratory chain while many ester local anesthetics inhibit mitochondrial membrane potential.^{1,3} If needed, titrate local anesthetics and use the minimum amount required to elicit the desired effect.^{1,7} The use of long-acting narcotics is cautioned as they may increase the risk of postoperative respiratory insufficiency and necessitate postoperative mechanical ventilation.² Because there is no conclusive evidence showing that ketamine directly inhibits mitochondrial function, ketamine was used in this case for its potent analgesic properties and minimal respiratory depression.⁸

Fluid selection in patients with MD is crucial to ensure the patient has a favorable outcome. NS was used in this case, and lactated ringers (LR) was avoided since MD patients cannot adequately metabolize lactate.^{1,2} Especially in MELAS where lactate is chronically elevated, LR infusion could cause severe metabolic disturbances and lead to hemodynamic instability and lethal arrhythmias.¹ In addition, all fluids should be warmed because hypothermia depresses mitochondrial function, and even a small change in temperature can elicit dramatic effects.²

In the presented case, the anesthetic technique used followed many current research recommendations. In order to avoid the use of propofol, a mask induction was performed with sevoflurane. Dexmedetomidine and ketamine were given as adjuncts to inhalation induction. However, since both dexmedetomidine and ketamine were not necessary to achieve an adequate level of anesthesia for this case, it may have been safer to avoid these medications since there is inconclusive evidence supporting their usage in patients with MD. Avoiding LR helped to reduce lactate build up and maintain metabolic stability. Due to potential mitochondrial inhibition, local anesthetics and muscle relaxants were avoided completely. A forced-air warming device was

used to prevent hypothermia and subsequent mitochondrial inhibition. In conclusion, MD is a complex disease, and it is important that anesthesia practitioners are aware of the potential comorbidities to formulate a safe and effective anesthetic plan.

References

1. Rivera-Cruz B. Mitochondrial diseases and anesthesia: A literature review of current opinions. *AANA J.* 2013;81(3):237.
2. Niezgodna J, Morgan PG. Anesthetic considerations in patients with mitochondrial defects. *Paediatr Anaesth.* 2013;23(9):785-793. doi: 10.1111/pan.12158
3. La Monaca E, Fodale V. Effects of anesthetics on mitochondrial signaling and function. *Drug Saf.* 2012;7(2):126-139.
4. Mtaweh H, Bayir H, Kochanek P, Bell M. Effect of a single dose of propofol and lack of dextrose administration in a child with mitochondrial disease: A case report. *J Child Neurol.* 2014;29(8):40-46.
5. Peng K, Wu SR, Ji FH, Li J. Premedication with dexmedetomidine in pediatric patients: a systematic review and meta-analysis. *Clinics.* 2014;69(11):777-786.
6. Fu C, Dai X, Yang Y, Lin M, Cai Y, Cai S. Dexmedetomidine attenuates lipopolysaccharide-induced acute lung injury by inhibiting oxidative stress, mitochondrial dysfunction and apoptosis in rats. *Mol Med Rep.* 2017;15(1):131-138. doi: 10.3892/mmr.2016.6012
7. Nouette-Gaulain K, Jose C, Capdevila X, Rossignol R. From analgesia to myopathy: when local anesthetics impair the mitochondrion. *Int J Biochem Cell Biol.* 2011;43(1):14-19.
8. Morgan P, Sedensky M, Kayser E. Ketamine and mitochondrial function. *Anesth Analg.* 2016;122(3), 917-918. doi: 10.1213/ANE.0000000000000872

Mentor: Michele E. Gold, CRNA, PhD

Intraoperative Lidocaine Infusion utilization in Abdominal Hysterectomy

Tracy May, MSN
University of Southern California

Keywords: lidocaine, perioperative, gynecological surgery, abdominal surgery, anesthesia

Local anesthetics (LAs) possess unique properties which make them an effective pain adjuvant, particularly in abdominal surgeries. With an increased emphasis towards enhanced recovery after surgery, (ERAS), the utilization of multimodal therapy, including intraoperative lidocaine infusions, will help usher the patient through the peri-operative period while minimizing the necessity of high dose opioid analgesics.^{1,2} By reducing the use of opioids, practitioners can avoid the undesirable side effects such as constipation, sedation, nausea, vomiting, and respiratory depression which may prolong hospitalization.^{1,3} With the goal of balanced anesthesia, anesthesia professionals should aim to incorporate multimodal therapies, such as LAs, into their anesthetic plan.

Case Report

A 45-year-old, 158 cm, 83 kg female presented for a total abdominal hysterectomy, exploratory laparotomy, bilateral salpingo-oophorectomy, and cystoscopy due to leiomyoma of the uterus. Her medical history was pertinent for heavy menstrual bleeding, right adnexal mass measuring 4.2 cm, and a fundal fibroid measuring 13 cm, approximately the size of a 14 week gravid uterus. Her prior surgical history was pertinent for 3 caesarian sections without any anesthetic complications noted. She denied allergies. Her medication regimen included ibuprofen for pain management on an as needed basis. The pre-operative airway assessment identified a Mallampati classification II and pre-operative labs and diagnostic tests were unremarkable.

An 18 gauge intravenous (IV) catheter was started in the preoperative area and midazolam 2 mg IV was administered before transporting her to the operating room (OR). Upon arrival to the OR, standard monitors were applied to the patient including pulse oximetry, electrocardiogram, and a non-invasive blood pressure cuff. She was pre-oxygenated with O₂ 10 L/min for 5 minutes. For IV induction of general anesthesia, the patient received fentanyl 100 mcg, lidocaine 80 mg, and propofol 150 mg. Adequate mask ventilation was confirmed and rocuronium 50 mg IV was administered for muscle relaxation. Direct laryngoscopy was performed with a Mac 3 blade and the patient's trachea was intubated with a 7.0 mm endotracheal tube; placement was verified by auscultation, presence of end-tidal CO₂, and bilateral chest rise. Respirations were controlled with a combination of O₂ 1 L/min and air 1 L/min via volume controlled ventilation. An additional 18 gauge IV catheter was inserted.

Anesthesia was maintained throughout the case with sevoflurane at 1 minimum alveolar concentration. Neuromuscular blockade, measured with train-of-four monitoring, was maintained with intermittent boluses of rocuronium. Pain management was achieved with intermittent boluses of fentanyl 100 mcg and hydromorphone 0.2 mg, as well as a lidocaine infusion, 2 gm in 250 mL of 5% dextrose, at a rate of 2 mg/kg/hr. In total, the patient received fentanyl 200 mcg, hydromorphone 1 mg, and lidocaine 643 mg for pain control during the 4 hour case.

At the end of the surgery, the patient had received 2 L of lactated ringers IV and the estimated blood loss was 100 ml. Upon emergence, the patient was medicated with ondansetron 4 mg IV and the residual neuromuscular blockade was antagonized with neostigmine 3 mg IV and glycopyrrolate 0.6 mg IV. The patient was extubated after full muscle recovery as evidenced by a full train-of-four response to neuromuscular stimulation, sustained tetany greater than 5 seconds, head lift greater than 5 seconds, regular respiratory rate with adequate tidal volumes over 400 mL, and opening eyes to command. The patient was transported to the post-anesthesia care unit (PACU) receiving O₂ 8 L/min via face mask. The patient received two additional boluses of hydromorphone 0.2 mg IV in the PACU for pain management. The patient was admitted to an inpatient medical-surgical unit where her pain was controlled by oral opioids and ibuprofen before being discharged home 2 days later.

Discussion

Local anesthetics are composed of a lipophilic benzene ring linked via an intermediate ester or amide to a hydrophilic amine group.⁴ They work via inhibition of sodium-gated channels and NMDA channels which prevents cell depolarization, subsequently blocking action potential propagation.^{4,5} In addition, LAs exhibit anti-inflammatory properties via interactions between calcium signaling and g-protein coupled receptors.^{4,5} Surgery leads to inflammatory changes with the release of cytokines and activation of glial cells.⁵ Acute pain is subsequently linked to the inflammatory process; however, this process is suppressed by LA administration via both, IV and epidural routes.⁴

Local anesthetics can be administered throughout the peri-operative period. Lidocaine infusions maintain low plasma levels resulting in analgesia, suppression of peripheral neuronal firing, central sensitization of neurons in the dorsal horn of the spinal cord, and decreased production of cytokines and substance P.^{4,5} Sridhar et al conducted a randomized controlled trial looking at the stress response related to inflammatory mediators in patients undergoing elective open abdominal surgeries. The double-blind study compared a saline infusion with the use of a lidocaine infusion and the investigators measured leukocyte count, C-reactive protein (CRP), and interleukin (IL)-6 levels immediately and 24 hours after surgery.³ The results showed the lidocaine group had significantly lower leukocyte counts and IL-6 levels immediately and 24 hours following surgery. The results also showed lower CRP levels in the immediate postoperative period.

Utilization of lidocaine has been found to provide effective postoperative analgesia for patients undergoing abdominal surgeries. A 2010 meta-analysis reviewed 16 trials with 764 patients undergoing any surgical procedure that utilized perioperative IV lidocaine.⁶ Twelve studies focused on patients undergoing abdominal surgeries, with 8 trials focusing on open procedures. In patients undergoing open abdominal surgeries, 5 studies exhibited a profound reduction in postoperative pain scores.⁶ Five studies demonstrated lower total opioid administration. In comparison to the placebo groups, these studies indicated a 33-35% opioid reduction if the infusion continued one hour postoperatively and upwards of an 85% opioid reduction if the infusion continued for 24 hours.⁶ One additional study reported lower opioid doses in the intraoperative period with a 39% reduction in total fentanyl administered in the IV lidocaine group compared to the placebo group.⁶ According to the meta-analysis, IV lidocaine resulted in lower pain scores, total opioid dosage, and anesthetic requirements resulting in shorter hospitalization.

A study by Samimi, Taheri, and Tanha went further to compare the impact of IV lidocaine versus intraperitoneal (IP) lidocaine on pain management after abdominal hysterectomies.¹ They found both the IV and IP lidocaine groups had statistically significant lower postoperative pain scores, for up to 12 hours, when compared to the placebo group, which received IV and IP saline, in addition to lower total morphine consumption. However, there was no difference noted between the IV and IP lidocaine groups for either measure. An additional mode of postoperative pain management studied is LA via an epidural catheter compared to IV.² Patients either received a lidocaine infusion intraoperatively at 2-3 mg/min and postoperatively at 0.5-1 mg/min or a postoperative epidural infusion of bupivacaine 0.125% with hydromorphone 10 mcg/ml at 8

ml/hour. Patients receiving IV lidocaine reported similar pain scores on postoperative day 2 through day 4, with inconclusive results for postoperative day 1.² Consequently, this equivalent level of analgesia and pain rating came at the expense of higher overall opioid requirements for the patients in the IV lidocaine group. Therefore, IV lidocaine was not as effective as epidural LAs with opioid admixture.

One potential serious complication noted with the use of lidocaine infusions is LA systemic toxicity (LAST). During the initial delivery of IV lidocaine, up to 40% is eliminated through the lungs due to the pH differential.⁵ This results in a reduction of serum levels, and subsequently, the risk of LAST. The dose for continuous lidocaine 2% infusions is 2-5 mcg/kg/hr.^{1,3,6,7} This correlates to a serum level of 1-3 mcg/ml.⁷ Serum levels of lidocaine below 5 mcg/ml have been linked to increased levels of analgesia, while minimizing possible side effects. The most common side effect noted is sedation, with more severe signs associated with LAST, such as seizures or cardiovascular collapse, occurring at levels over 8 mcg/ml.⁷ Several studies have shown lidocaine at lower doses leads to minimal patients displaying signs or symptoms of toxicity.^{1-3,6} Lidocaine is contraindicated in patients with heart failure, coronary artery disease, and hepatic failure as it undergoes hepatic metabolism and patients may experience cardiac side effects such as bradycardia, collapse, or arrest.⁵

Multimodal therapy has been shown to be more effective in providing pain management while minimizing unwanted side effects. The goal in reducing opioid use is to decrease hospital length of stay and costs^{1,3,6} while promoting early ambulation, bowel motility, and patient satisfaction.^{1,3,5,6} The review of literature promotes the application of multimodal therapy in comparison to an opioid only technique.

References

1. Samimi S, Taheri A, Tanha FD. Comparison between intraperitoneal and intravenous lidocaine for postoperative analgesia after elective abdominal hysterectomy, a double-blind placebo controlled study. *JFPRHC*. 2015;9(4):193-198.
2. Terkawi AS, Tsang S, Kazemi A, et al. A clinical comparison of intravenous and epidural local anesthetic for major abdominal surgery. *Reg Anesth Pain Med*. 2016;41:28-36.
3. Sridhar P, Sistla SC, Ali SM, Karthikeyan VS, Badhe AS, Ananthanarayanan PH. Effect of intravenous lignocaine on perioperative stress response and post-surgical ileus in elective open abdominal surgeries: A double-blind randomized controlled trial. *ANZ J Surg*. 2015;85:425-429.
4. Salinas FV, Auyong DB. Local anesthetics. In: Evers AS, Maze M, Kharash EV, eds. *Anesthetic Pharmacology: Basic Principles and Clinical Practice*. 2nd ed. New York, NY: Cambridge University Press;2011:574-588.
5. Oliveira CMB, Issy AM, Sakata RK. Intraoperative intravenous lidocaine. *Rev Bras Anesthesiol*. 2010;60(3):325-333.
6. McCarthy, GC, Megalla SA, Habib AS. Impact of intravenous lidocaine infusion on postoperative analgesia and recovery from surgery: A systematic review of randomized controlled trials. *Drugs*. 2010;70(9):1149-1163.

7. Sharma S, Rajagopal MR, Palat G, Singh C, Haji AG, Jain D. A phase II pilot study to evaluate use of intravenous lidocaine for opioid-refractory pain in cancer patients. *JPSM*. 2009;37(1):85-93.

Mentor: Terrie Norris, CRNA, EdD

A Comprehensive Approach in Preventing Perioperative Dental Injury

Chelsea Cutaran, BSN
University of Southern California

Keywords: dental, perioperative, teeth, injury

Dental injuries represent one of the most common malpractice claims against the anesthesia provider.¹ Despite preoperative evaluation of a patient's dental status, dental damage during endotracheal intubation continues to occur. Dental injury has varying etiologies which can present perioperative challenges. This case report reviews several risk factors associated with dental injury and strategies for the anesthesia provider in the prevention of perioperative dental injury.

Case Report

A 56-year-old male (55 kg, 167 cm) presented with multiple fractures to the left foot. A closed reduction and percutaneous pinning of the third metatarsal joint and application of a lateral foot external fixator was planned.

A preoperative airway exam revealed poor dentition with periodontal disease. The patient denied having loose teeth and all teeth appeared stable in condition. Manual manipulation of the existing teeth was not performed. The preoperative assessment was completed with no pertinent medical history or allergies identified; NPO status confirmed.

On arrival in the preoperative area, an 18 gauge peripheral intravenous (IV) catheter was in place and midazolam 2 mg IV administered. Following transfer to the operating room, standard monitors were applied and oxygen at 10 L/min via anesthesia mask was administered. Induction of general anesthesia commenced with lidocaine 50 mg, propofol 120 mg, and fentanyl 100 mcg IV. Bag-mask ventilation was established and rocuronium 50 mg IV administered. A scissoring technique, utilizing the thumb and middle finger of the right hand, was performed with minimal force to open the mouth for planned direct laryngoscopy. Upon performing this standard maneuver, the lower anterior teeth (number 26 and 27), loosened but remained in place and in view. Avoiding the loose teeth, direct laryngoscopy was performed. A 7.5mm endotracheal tube was inserted into the trachea and placement confirmed by bilateral auscultation of breath sounds and positive end tidal CO₂. An intraoperative dental consult was called as the loosened teeth posed an aspiration risk. Mechanical ventilation was initiated with volume control, respiratory rate 12/min, and tidal volume 500 mL. Maintenance of anesthesia was obtained with an expired concentration of 2.2% of sevoflurane in a mixture of O₂ 1 L/min and air 1 L/min. Cefazolin 1 gm

IV and fentanyl 50 mcg IV were administered prior to incision. No additional medications were administered.

During surgery, the doctor of dental surgery (DDS) evaluated the patient's teeth. Teeth number 26 and 27 presented as non-restorable with Grade III mobility and an aspiration risk. The teeth were removed by the DDS without effort using a hemostat. Manual pressure with 4x4 gauze was applied to the extraction sites and caution advised against torqueing existing teeth with Grade II mobility.

At the end of surgery, the patient had received lactated ringers 1 L and, output included 5mL of estimated blood loss, and 300 mL of urine. Neuromuscular train of four was reassessed as 4/4 and neostigmine 3 mg and glycopyrrolate 0.6 mg IV were administered. Sevoflurane and air were discontinued, oxygen flow was increased to 15 L/min, and ondansetron 4 mg IV was administered. Spontaneous ventilations were observed as regular and unlabored at a rate of 12 to 16/min. Hydromorphone 0.4 mg IV was given. The case duration was three hours, after which the endotracheal tube was removed from the patient's trachea while fully awake with no additional injury to the remaining teeth. On postoperative day 1, reassessment of the patient's teeth showed no erythema or bleeding at the extraction sites.

Discussion

The most common dental injury occurs to the maxillary and mandibular anterior teeth.² The susceptibility of the anterior teeth to sustain a fracture can be attributed to its anatomy. The anterior teeth contains a single root and forward axis.³ When vertical and/or oblique movement is applied to the anterior teeth, a high susceptibility for damage arises.³ After induction of anesthesia, scissoring open the mouth for direct laryngoscopy with minimal or vertical forces is identified as a form of stress.³ It is recommended to subject only posterior, not anterior teeth to this force.³ Sometimes, anterior teeth can be used as a fulcrum with application of excessive force by a laryngoscope blade resulting in dental damage.³ A prospective observational study of 536 patients over a six month period at a university hospital was conducted by Mourão et al.⁴ to assess the frequency of and risk factors for dental damage after classic direct laryngoscopy for tracheal intubation. The results described 134 patients sustaining dental damage affecting 162 teeth, 147 maxillary and 15 mandibular teeth.⁴ The incidence as high as 25% of dental damage found by Mourão et al.⁴ could be due to the pre-existing dental condition of those involved in the study as already having missing or decayed teeth. Retrospective studies suggest a rate of dental damage following intubation of less than 1%.⁵

The comprehensive approach in preventing dental injury is preoperative identification of risk factors, risk avoidance, and a management plan if dental damage were to occur. In the preoperative period, it is imperative to document the patient's dental condition and to discuss the risks associated with potential dental injury.³ The dental mobility index, developed by Grace and Smales ranging from Grade 0 to Grade III, refers to the measurement of tooth mobility upon manual examination.⁶ Grade 0 is defined as no apparent mobility, while Grade III is mobility exceeding 2mm buccolingually or vertically.⁶ For suspiciously mobile teeth it is recommended the anesthesia provider apply a glove and slightly wiggle the teeth to assess mobility.³

Darawade et al.⁷ conducted a prospective, simple random sampling study involving 40 anesthetists who completed a questionnaire evaluating risk factors for dental trauma perioperatively. The investigators found that the maxillary left central incisor was most prone to dental injury compared to other teeth and recommended for extraction of Grade III mobile teeth prior to performing an elective surgery under general anesthesia.⁷ This patient presented with severe periodontal disease, which was identified as a risk factor. Clear documentation of his dental status was performed and a preoperative discussion regarding the potential for dental injury and a cautious approach was used while handling the patient's Grade II mobile teeth to prevent dental injury.

Recognizing vulnerable teeth is a key component of the dental preoperative evaluation. A retrospective study performed by Vogel et al.⁵ at a university hospital over eleven years involving 115,151 patients who received general anesthesia identified 130 cases involving tooth injury.⁵ The investigators found patients with pre-existing dental pathology were more likely to sustain dental injury during tracheal intubation in comparison to patients with no pre-existing dental pathology.⁵ Idrees and colleagues² noted the majority of dental injuries occur during tracheal intubation, and the anesthesia provider is frequently the first to recognize a dental injury and is responsible for requesting a dental consult and arranging appropriate treatment as necessary.²

If dental damage were to occur, the injury must be documented and evaluated by a dentist as soon as possible.³ If the tooth is avulsed or broken, it is necessary to retrieve the object, and if its location is unknown a chest radiograph is recommended to rule out aspiration.³ In this case, the loosened teeth were immediately noted. A dental consult was called intraoperatively and the DDS removed the patient's damaged teeth. It is also recommended to address the perioperative dental insult, when the patient is fully awake and to arrange for a dental consultation before the patient's discharge to ensure prompt attention and reduction of cost.³ In the post-anesthesia recovery room, the patient was informed of the intraoperative dental injury and prior to discharge, written information was provided for a follow-up appointment scheduled at the dental clinic.

Dental injury can be experienced by both the novice and expert anesthesia provider. A meticulous preoperative assessment of the severity of periodontal disease would be beneficial in future cases. Anesthesia professionals must document the preoperative condition of all teeth as unexpected difficulties can arise from various anesthetic techniques. It is equally imperative for patient notification of the possibility of dental damage. This discussion focused on the identification of risk factors associated with dental injury and strategies available to address one of the most common adverse events involving the anesthesia provider.

References

1. Rosa Maria G, Paolo F, Stefania B, et al. Traumatic dental injuries during anaesthesia: Part I: clinical evaluation. *Dental Traumatology*. 2010;26:459–465.
2. Idrees SR, Fujimara K, Bessho K. Dental trauma related to general anesthesia: should the Anesthesiologist perform a preanesthetic dental evaluation? *Oral Health Dent Manag*. 2014;13(2):271-4.

3. Yasny JS. Perioperative dental considerations for the anesthesiologist. *Anesth Analg*. 2009;108:1564–73.
4. Mourão J, Neto J, Luís C, Moreno C, Barbosa J, Carvalho J, et al. Dental injury after conventional direct laryngoscopy: a prospective observational study. *Anaesthesia*. 2013;68:1059-1065.
5. Vogel J, Stubinger S, Kaufmann M, Krastl G, Filippi A. Dental injuries resulting from tracheal intubation--a retrospective study. *Dental Traumatology*. 2009;25:73-77.
6. Marya CM. *A Textbook of Public Health Dentistry*. 1st ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2011:203.
7. Darawade DA, Dubey A, Gondhalekar R, Dahapute S, Deshmukh SB, Darawade AD. Assessment of the risk factors for oro-dental injuries to occur during general anesthesia and measures taken by anesthesiologist to prevent them. *J Int Oral Health*. 2015;7(7):77-79.

Mentor: Michele E. Gold, CRNA, PhD

Anesthetic Management of Tricuspid Regurgitation for Non-Cardiac Surgery

Meredith Tatarzycki, BSN
Union University

Keywords: Tricuspid valve, Tricuspid regurgitation, anesthesia, non-cardiac surgery, valve disease

The tricuspid valve is an atrioventricular valve located between the right atrium and the right ventricle of the heart that prevents the backward flow of blood from the right ventricle to the right atrium during systole.¹ Tricuspid regurgitation (TR) occurs when the tricuspid valve is insufficient to prevent this backward flow of blood during systole.² About 1.6 million people in the United States have moderate to severe TR.³ There are several anesthetic implications for the management of patients with this condition to prevent negative hemodynamic consequences that may occur.²

Case Report

A 55-year-old African American female presented for distal pancreatectomy splenectomy with a Roux-en-Y hepaticojejunostomy for chronic pancreatitis. History and physical assessment revealed a female 160 cm in height and 78 kg with a body mass index of 30.5 kg/m². Co-existing conditions included essential hypertension, coronary artery disease, trace mitral regurgitation, mild TR, sarcoidosis, sleep apnea, peptic ulcer, gastroparesis, irritable bowel syndrome, gastritis, diverticulosis, pancreatic stricture, hepatitis C, arthritis, type 2 diabetes mellitus, depression, and alcohol use. Home medications included gabapentin, insulin aspart, insulin glargine, and losartan. Allergy profile: aspirin, hydrocodone, acetaminophen, tramadol, nalbuphine, metoclopramide, and ketorolac. Significant laboratory results included: red blood cells 3.56 M/uL, hemoglobin 9.8 g/dL, hematocrit 31.1%, BUN 5 mg/dL, BUN/creatinine mass ratio 8.3, AST 87 U/L, albumin 2.5 g/dL, total bilirubin 1.1 mg/dL, ALT 78 U/L, and glucose 90 mg/dL.

The patient was transferred to the operating room via stretcher and was assisted onto the operating room table. Standard monitors for noninvasive blood pressure, electrocardiogram, and pulse oximetry were applied. The patient was preoxygenated with O₂ 10 L/min via facemask. Upon achieving an end-tidal O₂ of 90 mm Hg, smooth intravenous induction occurred with fentanyl 150 mcg, lidocaine 50 mg, propofol 200 mg, and vecuronium 8 mg. The trachea was intubated with a 7.5 mm cuffed endotracheal tube; placement was verified with direct visualization of the tube through the cords, tube fog, sustained EtCO₂, and equal and bilateral breath sounds upon auscultation. Respiration was controlled by a mechanical ventilator and general anesthesia was maintained with isoflurane 1.4% inspired concentration in a mixture of O₂ 1 L/min and air 1 L/min.

Throughout the maintenance phase of this case, neuromuscular blockade was maintained with additional doses of vecuronium. Hypotension after induction was treated with bolus doses of phenylephrine 100 mcg and then ephedrine 5 mg. Albumin 5% 750 mL and lactated ringers 800 mL were administered throughout the case. Opioid administration totaled fentanyl 250 mcg and hydromorphone 1 mg. Tachycardia up to 110/min was treated with metoprolol 5 mg. At the conclusion of surgery, neuromuscular blockade was antagonized with sugammadex 100 mg. Isoflurane was discontinued and O₂ was increased to 10 L/min. Hypertension and tachycardia on emergence were treated with labetalol 5 mg. After suctioning and return of spontaneous ventilation, the endotracheal tube was removed. The patient was transported to the post anesthesia care unit on O₂ 10 L/min via facemask.

Discussion

The etiology of TR has been classified as primary or secondary. Primary TR accounts for 20% of cases and results from conditions that affect the tricuspid valve such as infective endocarditis, rheumatic fever, carcinoid syndrome, Ebstein anomaly, radiation, or injury.⁴ More commonly, secondary or functional TR results from right ventricle and tricuspid annulus dilatation in conditions such as ischemia, cardiomyopathy, atrial fibrillation, or pulmonary hypertension.^{4,5} Mitral regurgitation and TR often occur simultaneously.² The patient in this case report exemplified this feature. When more than one valvular disease is present, the lesion with greater severity and hemodynamic significance is considered to be dominant and the focus of anesthetic interventions.¹

The right atrium and vena cava have high compliance. Therefore, when regurgitation occurs at the tricuspid valve in secondary TR, only a small increase in right atrial pressure will occur even when large regurgitant volumes are present.² The resulting signs and symptoms are jugular venous distention, hepatomegaly, ascites, and peripheral edema.² Echocardiography is the primary diagnostic method and treatment includes targeting the underlying causative condition, annuloplasty, valvuloplasty, or valve replacement.²

TR has been described in the literature as a long neglected, ignored, and underestimated condition which is most likely from a false belief that TR is not clinically significant.^{5,6} Irreversible organ damage can occur before any measurable, objective or subjective clinical signs and symptoms. Further, if left untreated, TR can progress to refractory heart failure from right ventricular dysfunction resulting in rapid deterioration and death.⁶

There are several anesthetic implications for TR. The goals are to maintain an effective right ventricular stroke volume and left ventricular preload.² Maintaining central venous pressure in the high to normal range assists with right ventricular preload.² Hypoxia and acidosis should be avoided because they result in increased right ventricular afterload.² Interventions that considerably reduce venous return such as positive pressure ventilation and systemic vasodilating drugs may be detrimental.² Anesthetics that are pulmonary vasodilators and those that maintain venous return should be used. Nitrous oxide should be avoided because of the potential to increase pulmonary artery resistance which may increase the severity of TR.² Right atrial pressure monitoring during the intraoperative period can help to guide fluid replacement. When high atrial pressures are present, the possibility of a patent foramen ovale needs to be considered.² Systemic air embolism should be prevented by avoiding air entrainment through intravenous fluid systems.²

This patient's mild TR and trace mitral regurgitation were incidental findings during a transthoracic echocardiogram completed to rule out cardiac involvement during an admission for chest pain, nausea, and vomiting approximately one year prior to surgery. The source of the symptoms was determined to be her gastroparesis. Although the cause of this complex patient's TR was unknown, it could be due to undiagnosed pulmonary hypertension secondary to her sarcoidosis. Pulmonary hypertension occurs as a result of sarcoidosis in varying percentages but could be as high as 50 to 70%.¹ The patient had no known symptoms from the noted TR. Treatment prior to surgery was not needed as the severity was mild. The American Heart Association and the American College of Cardiology have a classification system for secondary TR that describes four stages: A, B, C, and D. The severity increases from Stage A to Stage D. This patient likely had Stage B secondary TR which is defined as asymptomatic TR with mild to moderate regurgitation. Diuretic therapy, pulmonary vasodilator therapy, and surgical interventions are recommended for the more advanced Stages C and D; however, in Stage B functional TR, tricuspid valve repair has been described as a reasonable option.⁴

During care for this patient, TR was determined to be the dominant valvular disease because the severity (moderate) was greater than that of the mitral regurgitation (trace) based on the transthoracic echocardiogram report. The amount of fluid replacement was carefully considered. The patient received lactated ringers 800 mL and albumin 5% 750 mL. Conservative fluid replacement was utilized per surgeon request; however, hypovolemia was avoided. Hypoxia and acidosis were also avoided which prevented increases in right ventricular afterload. Positive pressure ventilation could not be avoided because the duration of the procedure was five hours. Nitrous oxide was avoided. The recommendation from the literature to utilize agents that result in pulmonary vasodilation was observed through the use of isoflurane. Volatile agents are known to decrease pulmonary artery pressure.¹

Lessons learned from providing the anesthesia for this case include why TR has been a neglected valve pathology and how to deliver a balanced anesthetic to patients with this condition. If a similar case were to present itself in the future, many of the same techniques would be utilized perhaps with the addition of right atrial pressure monitoring or SVV monitoring to guide fluid replacement. In conclusion, anesthesia practitioners should not ignore TR because it is common

in adult surgical practice, can negatively affect clinical outcomes, and can threaten patient survival.⁶

References

1. Elisha S. Cardiovascular anatomy, physiology, pathophysiology, and anesthesia management; Rieker, M. Respiratory anatomy, physiology, pathophysiology, and anesthetic management; Kossick MA. Inhalation anesthetics. In Nagelhout JJ, Plaus KL. *Nurse Anesthesia*. 5th ed. St. Louis, MO: Elsevier Saunders; 2014:472, 649, 94.
2. Herrera A. Valvular heart disease. In Hines RL, Marschall KE. *Stoelting's Anesthesia and Co-Existing Disease*. 6th ed. Philadelphia, PA: Elsevier Saunders; 2012.
3. Taramasso M, Vanermen H, Maisano F, Guidotti A, Canna G L, Alfieri O. The growing clinical importance of secondary tricuspid regurgitation. *J Am Coll Cardiol*. 2012;59:703-710.
4. Ramakrishna H, Augoustides JGT, Gutsche JT, Stein E, Weiss SJ, Vernick WJ. Incidental tricuspid regurgitation in adult cardiac surgery: Focus on current evidence and management options for the perioperative echocardiographer. *J Cardiothorac Vasc Anesth*. 2014;28:1414-1420.
5. Mauro MD, Bezante GP, Baldassarre AD, et al. Functional tricuspid regurgitation: An underestimated issue. *Int J Cardiol*. 2013;168:707-715.
6. Kim H, Lee S, Kim Y, Sohn D. Tricuspid regurgitation: Clinical importance and its optimal surgical timing. *J Cardiovasc Ultrasound*. 2013;21:1-9.

Mentor: Molly Wright, CRNA, DNP

Awake Fiberoptic Intubation Using Dexmedetomidine and Nebulized Lidocaine

Sonja Sena-Cary, BSN
University of Southern California

Keywords: Awake fiberoptic intubation, dexmedetomidine, hand-held nebulizer, local anesthesia, airway management

A difficult airway is a clinical situation in which a skilled anesthesia professional encounters difficulty with facemask ventilation, endotracheal intubation, or both.¹ Adverse events associated with a difficult airway include damage to dentition, airway trauma, unnecessary surgical airway, brain injury, cardiopulmonary collapse, and death.¹ To avoid these adverse events, a preoperative history and physical exam should be conducted to determine the safest and least invasive airway management technique. This case report describes the measures used in preparation for an awake fiberoptic intubation when a difficult airway was identified preoperatively.

Case Report

A 59-year-old, 97.5 kg, 190 cm male presented for a total laryngectomy, neck dissection, thyroidectomy, and split thickness skin graft placement secondary to an invasive soft tissue mass

on his right vocal fold and thyroid cartilage. Pertinent past medical history included hypertension, osteoarthritis, gout, and an asymptomatic, stable 4.3 cm ascending aortic aneurysm. His past surgical history included a direct laryngoscopy with CO₂ laser 10 days prior, with anesthetic records indicating an awake fiberoptic intubation with no anesthetic complications. The preoperative physical exam revealed a Mallampati Class I airway, thyromental distance of 6 cm, interincisor distance of 5 cm, full range of motion of the atlanto-occipital joint, hoarse phonation, midline trachea with a 4.3 x 4.7 cm mass centered around the right larynx, and an abscess over the anterior midline neck extending over the thyroid cartilage. The patient denied any allergies. His drug regimen consisted of allopurinol, lisinopril, aspirin, and metoprolol.

In the pre-operative holding area, 4% lidocaine 2 mL was administered over 10 minutes using a hand-held nebulizer for oral, posterior pharynx and upper larynx topicalization. Midazolam 1 mg intravenous (IV) for anxiolysis and glycopyrrolate 0.2mg IV as an antisialogogue were administered. The patient gargled and expectorated 4% viscous lidocaine 4 mL. The patient was transferred to the operating room (OR), moved to the OR table, and placed in high fowler's position. Standard monitors were applied. Baseline vital signs were: SpO₂ 100%; BP 119/65 mm Hg; heart rate 100/min; respiratory rate 14/min. Lidocaine 40 mg was applied topically to the posterior pharynx using a laryngotracheal anesthesia (LTA) kit. The patient was instructed to signal how far the LTA kit catheter could comfortably be placed in his posterior pharynx. This process was repeated three times for a total topical dose of lidocaine 120 mg.

A dexmedetomidine 32 mcg IV bolus was administered over 10 minutes. A flexible fiberoptic scope, with a size 7.0 mm endotracheal tube (ETT) loaded and pre-positioned on the scope, was inserted into the oropharynx and advanced until the vocal cords were identified. The fiberoptic scope was passed through the glottic opening; tracheal rings and carina were visualized. The ETT was advanced over the scope and through the vocal cords. The ETT cuff was inflated and placement was confirmed by condensation in the ETT, presence of E_tCO₂, equal chest excursion, and bilateral breath sounds. Once the airway was secured, general anesthesia commenced with propofol 150 mg IV and rocuronium 50 mg IV.

The remainder of the case proceeded without incident. During the procedure, the surgeons created a tracheostomy. The oral endotracheal tube was removed and a size 8.0 armored ETT was placed into the tracheostomy and sutured into place by the surgeons. Residual neuromuscular blockade was antagonized with neostigmine 2 mg and glycopyrrolate 0.4 mg IV. After awakening, the armored endotracheal tube was removed and replaced with a laryngectomy tube. The patient was transferred to the post-anesthesia care unit with O₂ 6 L/min administered to the tracheostomy tube via facemask. The postoperative visit the next day revealed the patient was on room air and he denied any anesthetic complications. The patient was discharged home 14 days later.

Discussion

The preoperative evaluation and review of previous anesthetic records allowed the anesthesia team to determine this patient was at risk for a potentially difficult intubation and an awake fiberoptic intubation would be the safest and most efficient method of endotracheal intubation.

Many options are available for anesthetizing the airway for an awake fiberoptic intubation. Topical anesthesia, regional anesthesia, intravenous medications or any combination thereof may be used to blunt the airway reflexes and maintain spontaneous ventilation. While nerve blocks may be a suitable choice for anesthetizing the airway, they are often technically difficult to perform. Even in the hands of the most skilled professionals, nerve blocks carry the potential of complication or failure.² In this case study, the patient's anatomical neck landmarks were not easily discernible and the presence of an abscess contraindicated the use of a transtracheal block.

The local anesthetic used to anesthetize the airway was administered in a variety of methods. The topical anesthesia in this case was administered via hand-held nebulizer using lidocaine 80 mg, gargling lidocaine 160 mg, and lastly lidocaine 120 mg in divided doses via an LTA kit. When administering local anesthetics, it is prudent to calculate the maximum dose to avoid toxicity. For this patient, the maximum dose of lidocaine, at 5mg/kg, was 487.5mg; the total dose administered was 360 mg, well under the maximum.³ In a randomized control study by Kohli et al⁵, ultrasonic nebulization of 4% lidocaine 10 mL was compared to regional nerve blocks for awake fiberoptic intubation. The results of the study showed satisfactory intubating conditions with both methods. However, ease of intubation was shown to be lower in the nebulizer group than the block group.⁵ A hand-held nebulizer was selected in this case due to patient preference when presented the options for topicalization. The patient had experienced topicalization via hand-held nebulizer in the past and it provided satisfactory intubating conditions.

Patient tolerance, required for a successful awake fiberoptic intubation, depends on the effectiveness of topical anesthesia and blunting of pharyngeal, laryngeal, and tracheobronchial reflexes.³ Intravenous sedation can be used as a primary or secondary method of preparing a patient for an awake fiberoptic intubation. In this case, intravenous midazolam and dexmedetomidine were administered as the secondary method. Dexmedetomidine is a selective alpha-2 adrenergic receptor agonist that exerts anxiolysis and analgesia without respiratory depression.⁴ A randomized, double-blind study by Ryu et al⁴ compared the use of remifentanyl and dexmedetomidine for flexible bronchoscopy. The level of sedation between the two groups was comparable.⁴ The study subject's willingness to undergo repeat bronchoscopy was also comparable between the two groups.⁴ Sedation along with willingness to undergo repeat bronchoscopies as needed aid in the success of awake fiberoptic intubations. The incidence of hypotension, hypertension, tachycardia and arrhythmia were higher in the remifentanyl group.⁴ The use of dexmedetomidine resulted in fewer incidents of oxygen desaturation and reduced need for oral cavity suctioning.⁴ Dexmedetomidine was utilized as an adjunct in this case due to the decreased risk of hypoxia and respiratory depression compared to remifentanyl while having comparable level of sedation. An LTA kit was used to administer lidocaine to suppress coughing which is similar to the administration of lidocaine via bronchoscope in the Ryu et al⁴ study.

Fiberoptic intubation is the gold standard for intubating a difficult airway. In patients who have a suspected difficult airway, suitable preparation allows for successful intubation. Multiple methods are available for anesthetizing the airway for an awake fiberoptic intubation. The anesthesia professional must consider the risks and benefits of each technique, along with his or her own skill level, when determining the best method to perform for their patients.

References

1. Apfelbaum JL, Hagberg CA, Caplan RA, et al. Practice guidelines for management of the difficult airway. *Anesthesiol.* 2013;118(2):251-270. doi:10.1097/aln.0b013e31827773b2.
2. Pani N, Kumar Rath S. Regional & topical anaesthesia of upper airways. *Indian J Anaesth.* 2009;53(6):641-648.
3. Heiner, JS, Gabot, M.H. Airway management. In Nagelhout JJ, Plaus KL: *Nurse anesthesia.* 5th ed. St. Louis, MO: Elsevier; 2014:445-448.
4. Ryu JH, Lee SW, Lee JH, Lee EH, Do SH, Kim CS. Randomized double-blind study of remifentanyl and dexmedetomidine for flexible bronchoscopy. *Br J of Anaesth.* 2011;108(3):503-511. doi:10.1093/bja/aer400.
5. Kohli S, Farooque K, Jalwal G, et al. Topical airway anesthesia for awake fiberoptic intubation: Comparison between airway nerve blocks and nebulized lignocaine by ultrasonic nebulizer. *Saudi J Anaesth.* 2014;8(5):15. doi:10.4103/1658-354x.144056.

Mentor: Terrie Norris, CRNA, EdD

Unexpected Intraoperative Blood Loss in a Developing Health System

Leanne Brown, BSN
Northeastern University

Keywords: Global healthcare, uterine fibroid, blood loss, resource limitation

Health system infrastructures vary with regard to the availability and administration of safe blood products. While anesthesia professionals in the United States practice judicious administration of blood products when clinically indicated, the same treatment options may not be achievable in developing systems with resource limitations. A case report of a patient undergoing a total abdominal hysterectomy for uterine fibroid removal at a district hospital in Sub Saharan Africa (SSA) reveals the challenges and barriers to safe blood product administration in developing health systems.

Case Report

A 41-year-old female with uterine fibroids presented for total abdominal hysterectomy at a district hospital in SSA. Pre-anesthetic exam revealed a weight of 57 kg, blood pressure (BP) of 138/99 mm Hg and heart rate (HR) of 88/min. A complete blood count (CBC) showed a hemoglobin of 12.7g/dL and hematocrit of (hct) 39.2%. The patient's blood type was B-negative. Her medical history was significant for uterine fibroids and human immunodeficiency virus (HIV) managed with anti-retroviral medications.

A 20 gauge peripheral intravenous (IV) catheter was inserted. Pre-operative preparation included oral gabapentin 300 mg and acetaminophen 1 g, and chlorhexidine 4% abdominal wash. The patient was brought to the operating room (OR) and assisted to the supine position by the anesthesia professionals, surgical team, and operating room nurse.

Following preoxygenation, induction of anesthesia was accomplished with fentanyl 50 mcg IV and propofol 200 mg IV. Neuromuscular blockade was established with cisatracurium 10 mg IV, and the trachea was successfully intubated. Pressure points were padded and bilateral upper extremities were tucked. General anesthesia was maintained with isoflurane 1.5% inspired concentration in a mixture of O₂ 1 L/min and air 1 L/min via a draw-over ventilation system with an integrated O₂ concentrator. Neuromuscular blockade was maintained with intermittent boluses of cisatracurium IV, as indicated by train of four monitoring using a peripheral nerve stimulator.

As the uterus was dissected, the estimated blood loss (EBL) reached 800 mL. The anesthesia practitioners initiated a 500 mL crystalloid bolus and requested that two units of packed red blood cells (PRBCs) be crossmatched. The patient's left arm was un-tucked and an 18 gauge peripheral IV catheter was inserted. A repeat CBC was sent to the laboratory, revealing a hct of 29%. B-negative blood was unavailable, and O-negative blood was requested after discussion with the surgical team.

Within the following hour, the EBL reached 2,000 mL. Two units of uncrossmatched O-negative PRBCs were brought to the OR. The patient's blood pressure, heart rate, and oxygen saturation (SpO₂) remained within normal parameters, and the uncrossmatched PRBCs were returned to the blood bank. A surgeon with type B-negative blood offered to donate her own blood, but the hospital declined.

Within 30 minutes after the blood had been returned, the patient's BP decreased to 61/30 mm Hg, her HR approached 120/min, and SpO₂ decreased to 80%. Gelatin polysuccinate 4% 500 mL was administered rapidly, and phenylephrine was obtained and administered in 50-100mcg IV boluses to maintain mean arterial blood pressure greater than 60 mm Hg. Improvement in BP and SpO₂ followed. At skin approximation, EBL was 2,700 mL and the patient had received a total of 3,000 mL crystalloid and 500 mL gelatin polysuccinate 4%. A repeat hct was 19% and vital signs were BP 95/45 mm Hg, HR 95/min, and SpO₂ 98%. Neuromuscular blockade was antagonized with glycopyrrolate 0.4 mg IV and neostigmine 2 mg IV. The trachea was extubated when the patient was fully conscious and responsive to commands.

The patient was transported to the post-anesthesia care unit (PACU) and oxygen was administered by face mask via an oxygen concentrator. Her vital signs were BP 81/29 mm Hg, heart rate 88/min, and SpO₂ 95%. Three units of type-specific cross-matched PRBCs arrived in the PACU from another hospital. After administration of the first unit of PRBCs, the patient's BP increased to 88/55 mm Hg, and SpO₂ was 99%. The remaining two units of PRBCs were administered over 1.5 hours. The patient experienced an uneventful recovery.

Discussion

This case report describes the potential and unexpected challenges that may be encountered by anesthesia professionals when caring for patients with clinical indication for blood product administration in developing health systems. As the patient continued to experience rapid blood loss, almost 4 hours elapsed between request and actual administration of type-specific PRBCs. This time period was marked by several barriers that threatened the ability of the anesthesia

practitioners to provide adequate hemodynamic support. A discussion regarding the availability and demand for safe blood products in low resource areas provides insight into the current status and future goals of blood administration in developing health systems.

The World Health Organization (WHO) explains that access to safe blood and blood products and their appropriate use remains a major challenge throughout the world.¹ Demand for blood products in developed nations is met by supply from low-risk, voluntary donors. Blood supplies in developing nations, including those in SSA, are rarely sufficient to meet existing requirements.² While 80% of the world's population lives in developing nations, only 45% of the 80 million units of blood donated annually are collected in developing countries.² A lack of voluntary, low-risk donors, inadequate screening of donated blood, and unnecessary administration of blood products impact blood supply and its safe use.² Although supply falls short, demand remains robust. While wealthy countries predominantly utilize blood transfusions in support of advanced medical and surgical procedures, the SSA population more frequently requires blood transfusion in cases of obstetrical hemorrhage, trauma, and malaria-related anemia in infants and children.²⁻⁴ Patients in low resource countries may present late in the course of their disease, and the urgent need for transfusion coupled with an inadequate or inaccessible blood supply can result in morbidity and mortality before a blood transfusion can be initiated.⁴ A 2015 study of three East African countries revealed that, among children with severe anemia, 52% died within 8 hours if they were not transfused.⁵

In addition to limited access, the safety of blood product administration in developing systems is also a concern. The WHO explains, “particularly in the developing world... unsafe transfusion contributes significantly to the global burden of disease, especially among women and children.”¹ While the rate of transfusion transmitted infections (TTIs) is at a quantifiable low in wealthy nations, the risk of TTIs in SSA is difficult to estimate due to a lack of data, but is thought to be substantial. HIV prevalence in SSA ranges between 0.5% and 16%. Among blood donors, HIV prevalence typically remains less than 5% in West Africa, less than 10% in East and Central Africa, and more than 10% in southern Africa.⁴ Countries with endemic proportions of malaria find plasmodium species in 16-55% of donor blood.⁴ A 2010 study aimed to quantify the risk of TTIs among blood recipients in SSA and found that, per 1000 units of blood, the risk of acquiring HIV, hepatitis C, or hepatitis B were 1, 2.5, and 4.3, respectively.⁶

The WHO has made recommendations regarding improving access to safe blood products in developing countries. These include (1) establish a national blood transfusion service that can provide adequate and timely blood supply for all patients in need; (2) collect blood only from voluntary and non-remunerated donors from low-risk populations; (3) screen all blood for transfusion-transmissible infections and standardize procedures for grouping and compatibility testing; and (4) reduce unnecessary transfusions through the appropriate use of clinical blood.⁴ In recent decades, modest strides have been made toward reaching these goals. In 2002, the WHO estimated that among the 46 African member states, only 15 had a national blood policy and just 6 had a policy to specifically encourage and develop a system of non-remunerated donation.⁴ The most recent survey in 2007 revealed that 40 of 41 of the African states surveyed had a national blood policy, but only 56% had implemented their policies.⁴ The U.S. President's Emergency Plan for AIDS Relief (PEPFAR), initiated in 2003, appears to be making headway as increases have been seen in both the number of units of blood donated and number of countries

screening at least 95% of donated blood for hepatitis B and C.⁴ The majority of donated blood in SSA continues to come from family members rather than voluntary, low-risk donors.^{3,4}

While goals for a safer and more accessible blood transfusion system have been set, barriers to change remain as a result of the high cost of blood management and administration in relation to health care budget, limited supply of voluntary, low-risk donors, and unnecessary administration of blood products when equally effective alternatives exist. Future solutions may turn towards preventative medicine, as laboratories around the world are working to develop a vaccine against malaria, a major cause of anemia.³ Obstetrical patients with postpartum hemorrhage might benefit from receiving low-cost antifibrinolytic medications such as tranexamic acid (TXA). The World Maternal Antifibrinolytic Trial (WOMAN) is currently underway, aiming to quantify the effect of TXA on death, hysterectomy, and blood transfusion in 15,000 women with postpartum hemorrhage.⁷ Blood administration currently remains a life-saving intervention for obstetrical hemorrhage and malaria related anemia, as well as trauma and sickle-cell crisis.

When teams from high resource systems assemble to perform surgery in low resource settings, communication and cultural factors play a role in care delivery. Although in this case large volume blood loss was not expected, the patient had a type and screen pre-operatively. Supply issues were unexpected when PRBCs were requested. While O-negative blood was brought after type-specific blood was found to be unavailable, the PRBCs were uncrossmatched and the patient's vital signs remained within 20% of baseline. When the patient became hypotensive and tachycardic, safer alternatives were utilized to quickly stabilize the patient as the team waited for crossmatched blood. The plasma expander, gelatin polysuccinate, provided an unfamiliar bridge to transfusion, as did intermittent boluses of phenylephrine.

Anesthesia professionals must be well informed about the availability of and access to blood products and the process by which safe blood products are obtained when practicing in developing health systems. In the case presented, determining on site availability of the patient's blood type and an earlier request for blood products could have reduced the time between significant blood loss and transfusion. When confronted with unexpected blood loss, recognizing the need for blood products is an initial step, but having a firm grasp on the surrounding health care delivery system is equally important. The judicious use of blood products will save lives, and knowing how and when to acquire these are essential elements of anesthetic care, whether practicing at home or abroad.

References

1. Durand G. Good policy process for blood safety and availability. *Cap-aux-Diamants*. 2008(95):57. http://www.who.int/bloodsafety/publications/who_eht_08_02_en.pdf?ua=1
2. World Health Organization Department of Essential Health Technologies Blood Transfusion Safety Unit. Universal access to safe blood transfusion. *World Health Organization*. 2008. <http://www.who.int/bloodsafety/publications/UniversalAccessToSafeBT.pdf?ua=1>.
3. Lund TC, Hume H, Allain JP, McCullough J, Dzik W. The blood supply in sub-saharan africa: Needs, challenges, and solutions. *Transfus Apher Sci*. 2013;49(3):416. doi: 10.1016/j.transci.2013.06.014.

4. Roberts DJ, Field S, Delaney M, Bates I. Problems and approaches for blood transfusion in the developing countries. *Hematol Oncol Clin North Am.* 2016;30(2):477-495.
5. Kiguli S, Maitland K, George EC, et al. Anaemia and blood transfusion in african children presenting to hospital with severe febrile illness. *BMC medicine.*2015;13(1):21. doi: 10.1186/s12916-014-0246-7.
6. Jayaraman S, Chalabi Z, Perel P, Guerriero C, Roberts I. The risk of transfusion-transmitted infections in sub-saharan africa. *Transfusion.* 2010;50(2):433-442. doi: 10.1111/j.1537-2995.2009.002402.x.
7. Shakur H, Elbourne D, Gülmezoglu M, et al. The WOMAN trial (world maternal antifibrinolytic trial): Tranexamic acid for the treatment of postpartum haemorrhage: An international randomised, double blind placebo controlled trial. *Trials.* 2010;11(1):40. doi: 10.1186/1745-6215-11-40

Mentor: Janet A. Dewan, PhD, CRNA

Difficult Airway Workshop with Emphasis on Emergency Surgical Cricothyrotomy

Brett R. McAllister, BSN
Rush University

Keywords: cricothyrotomy, emergency cricothyrotomy, difficult airway, CICV

Introduction

While in training, the majority of student registered nurse anesthetists (SRNAs) acquire the requisite knowledge to successfully manage “cannot intubate, cannot ventilate” (CICV) situations, or perform an emergency surgical cricothyrotomy. However, hands-on experience with the required skills for CICV scenarios vary depending on cases in which students participate. Recent literature indicates that CICV situations requiring emergency surgical airway access are seen in 2.5 per 10,000 surgical cases. Closed claims analysis indicates adverse events associated with airway management remain one of the leading causes of anesthesia-related morbidity and mortality, with CICV situations accounting for up to 25% of anesthesia-related deaths. As a result of the lack of experience and the infrequency with which this procedure is performed clinically, SRNAs may lack the necessary confidence and experience to successfully navigate CICV situations.

Methods

After submission to the Institutional Review Board, this was deemed a quality improvement project. To enhance training among SRNAs regarding CICV situations, a difficult airway workshop was created to provide senior-level SRNAs with didactic and hands-on training with the American Society of Anesthesiologists (ASA) Difficult Airway Algorithm and emergency surgical cricothyrotomy. The evaluation method consisted of a quasi-experimental, quantitative design with a pre-test/post-test. Workshop participants completed an evaluation immediately prior to and immediately following the workshop to determine whether or not there was an

increase in participant knowledge, ability, and comfort with CICV situations and emergency surgical cricothyrotomy. Statistical analysis of the data derived from this design, performed in coordination with a university statistician, allowed for evaluation of the degree to which the intervention influenced the results of the program.

Results

Greater than 90% of participants (n = 31) demonstrated an increase in knowledge, skill, and comfort with CICV situations and emergency surgical cricothyrotomy. The mean participant score on a 12 question pre-workshop knowledge-based assessment was 39%, while the mean participant score of 70% on the post-workshop assessment demonstrated improvement in knowledge regarding difficult airway management, the ASA Difficult Airway Algorithm, and emergency surgical cricothyrotomy. A binomial test was used to analyze individual items, which indicated that the improvement was statistically significant for 75% of assessment items, ($p < 0.05$). Participants also rated their comfort with the knowledge, skills and abilities required to implement the ASA Difficult Airway Algorithm on pre- and post-tests. Participant comfort and knowledge regarding the management of difficult airways, including CICV situations, between the pre-workshop and post-workshop periods. A binominal test revealed a statistically significant increase for each of the 12 items in the assessment ($p < 0.001$). These probability statements indicate that the increase in scores was not the result of chance, and can be exclusively attributed to participation in the project intervention.

Discussion

This project intervention yielded a statistically significant improvement in SRNA knowledge, skill, and comfort with CICV situations and emergency surgical cricothyrotomy. Due to the fact that significant improvements seen among workshop participants for all objectives are a direct result of the workshop, integration of this program into the curriculum would thus be in the best interest of program administrators and students alike. The recommendation can be made to incorporate this didactic and hands-on educational program into the nurse anesthesia curriculum.

Mentor: Michael J. Kremer, PhD, CRNA, CHSE, FNAP, FAAN

Editorial

I have a few updates I would like to share with you. With the redesign of the AANA website, there is a new path to the ISJNA:

Member Resources → Students → Scroll partway down, click on International Student Journal

The direct link, www.aana.com/studentjournal is still active and will take you directly to our page. I am working on an update to the Guide for Authors, which I hope to have posted prior to the next issue.

Based on feedback from editorial board members, mentors, and reviewers I have revised the ordering of post nominals in the ISJNA. From its inception until now, the CRNA licensure/certification was listed first, followed by the highest academic degree and other certifications. I was also taught to list my credentials in that manner as a new registered nurse (RN, BSN). While this may still be in practice, the more formally accepted ordering of post nominals is as follows:

1. Religious orders
2. Theological degrees
3. Academic degrees
4. Honorary degrees, honors, decorations
5. Professional licenses
6. Professional certifications
7. Fellowships and professional associations/affiliations

Hickey, Robert. "How to use post-nominal abbreviations". Honor & Respect: The Official Guide to Names, Title, & Forms of Address. http://www.formsofaddress.info/post_nominals.html#378. Updated December 6, 2017. Retrieved January 10, 2018.

Just another example of how learning is a lifelong process! I would also like to point out that the graduate student on the cover also has a case report published in this issue – both are from her mission trip experience in Kigali, Rwanda.

Sincerely,



Vicki C. Coopmans, PhD, CRNA
Editor

“The International Student Journal of Nurse Anesthesia is produced exclusively for publishing the work of nurse anesthesia students. It is intended to be basic and introductory in its content. Its goal is to introduce the student to the world of writing for publication; to improve the practice of nurse anesthesia and the safety of the patients entrusted to our care.”

INTERNATIONAL STUDENT JOURNAL OF NURSE ANESTHESIA GUIDE FOR AUTHORS

MISSION STATEMENT

The International Student Journal of Nurse Anesthesia *is produced exclusively for publishing the work of nurse anesthesia students*. It is intended to be basic and introductory in its content. Its goal is to introduce the student to the world of writing for publication; to improve the practice of nurse anesthesia and the safety of the patients entrusted to our care.

ITEMS ACCEPTED FOR PUBLICATION

Case reports, research abstracts, evidence-based practice (EBP) analysis reports, and letters to the editor may be submitted. These items must be authored by a student under the guidance of an anesthesia practitioner mentor (CRNA or physician). The mentor must submit the item for the student and serve as the contact person during the review process. Items submitted to this journal should not be under consideration with another journal. We encourage authors and mentors to critically evaluate the topic and the quality of the writing. If the topic and the written presentation are beyond the introductory publication level we strongly suggest that the article be submitted to a more prestigious publication such as the *AANA Journal*.

ITEM PREPARATION & SUBMISSION

Student authors prepare case reports, abstracts, EBP analysis reports, and letters to the editor with the guidance of a mentor. Only students may be authors. Case and EBP analysis reports must be single-authored. Abstracts may have multiple authors. **Mentors should take an active role** in reviewing the item to ensure appropriate content, writing style, and format prior to submission.

The original intent of this journal was to publish items while the author is still a student. In order to consistently meet this goal, all submissions must be received by the editor at least **3 months prior** to the author's date of graduation.

PEER REVIEW

Items submitted for publication are initially reviewed by the editor. Items may be rejected, or returned to the mentor with instructions for the author to revise and resubmit prior to initiation of the formal review process. All accepted submissions undergo a formal process of blind review by at least two ISJNA reviewers. After review, items may be accepted without revision, accepted with revision, or rejected with comments.

General guidelines

1. Items for publication must adhere to the *American Medical Association Manual of Style* (AMA, the same guide utilized by the *AANA Journal* and such prominent textbooks as *Nurse Anesthesia* by Nagelhout and Plaus). The review process will not be initiated on reports submitted with incorrect formatting and will be returned to the mentor for revision. Please note the following:
 - a. Use of abbreviations is detailed in Section 14. Spell out acronyms/initialisms when first used. If you are using the phrase once, do not list the acronym/initialism at all.
 - b. Instructions regarding units of measure can be found in Section 18. In most cases The International System of Units (SI) is used. Abbreviations for units of measure do not need to be spelled out with first use. Some examples: height/length should be reported in cm, weight in kg, temperature in °C, pressure in mm Hg or cm H₂O.
 - c. In general, first use of pulmonary/respiratory abbreviations should be expanded, with the following exceptions: O₂, CO₂, PCO₂, PaCO₂, PO₂, PaO₂. Please use SpO₂ for oxygen saturation as measured by pulse oximetry.
 - d. Use the nonproprietary (generic) name of drugs - avoid proprietary (brand) names. Type generic names in lowercase. When discussing dosages state the name of the drug, *then* the dosage (midazolam 2 mg).
 - e. Use of descriptive terms for equipment and devices is preferred. If the use of a proprietary name is necessary (for clarity, or if more than one type is being discussed), give the name followed by the manufacturer and location in parenthesis:

“A GlideScope (Verathon Inc., Bothell, WA) was used to”

Please note, TM and ® symbols are not used per the AMA manual.

- f. Examples of referencing are included later in this guide.
2. Report appropriate infusion rates and gas flow rates:
 - a. When reporting infusion rates report them as mcg/kg/min or mg/kg/min. In some cases it may be appropriate to report dose or quantity/hr (i.e. insulin, hyperalimentation). If a mixture of drugs is being infused give the concentration of each drug and *report the infusion rate in mL/min*.
 - b. Keep the gas laws in mind when reporting flow rates. Report the liter flows of oxygen and nitrous oxide and the percent of the volatile agent added to the gas mixture. Statements such as “40% oxygen, 60% nitrous oxide and 3% sevoflurane” do not = 100% and are thus incorrect. For example, “General anesthesia was maintained with sevoflurane 3% inspired concentration in a mixture of oxygen 1 L/min and air 1 L/min”.
3. Only Microsoft Word file formats will be accepted with the following criteria:
 - a. Font - 12 point, Times New Roman
 - b. Single-spacing (except where indicated), paragraphs separated with a double space (do not indent)
 - c. One-inch margins
 - d. Place one space after the last punctuation of sentences. End the sentence with the period before placing the superscript number for the reference.
 - e. Do not use columns, bolds (except where indicated), or unconventional lettering styles or fonts.
 - f. Do not use endnote/footnote formats.
4. Do not use Endnotes or similar referencing software. Please remove all hyperlinks within the text.
5. Avoid jargon.
 - a. *‘The patient was reversed’* - Did you physically turn the patient around and point him in the opposite direction? “Neuromuscular blockade was antagonized.”
 - b. *The patient was put on oxygen.* "Oxygen was administered by face mask."
 - c. *The patient was intubated and put on a ventilator.* “The trachea was intubated and respiration was controlled by a mechanical ventilator.
 - d. *The patient had been on Motrin for three days.* “The patient had taken ibuprofen for three days.”
 - e. Avoid the term “MAC” when referring to a sedation technique - the term sedation (light, moderate, heavy, unconscious) sedation may be used. Since all anesthesia administration is monitored, the editors prefer to use specific pharmacology terminology rather than reimbursement terminology.
6. Use the words “anesthesia professionals” or “anesthesia practitioners” when discussing all persons who administer anesthesia (avoid the reimbursement term “anesthesia providers”)
7. References
 - a. Again, the **AMA Manual of Style** must be adhered to for reference formatting.
 - b. All should be within the past 8 years, except for seminal works essential to the topic being presented.
 - c. Primary sources are preferred.
 - d. All items cited must be from peer-reviewed sources – use of internet sources must be carefully considered in this regard.
 - e. Numbering should be positioned at the one-inch margin – text should begin at 1.25”.
8. See each item for additional information.
9. **Heading** for each item (Case Report, Abstract, EBPA Report) must adhere to the following format:

Title (bold, centered, 70 characters or less)

[space]

Author Name (centered, include academic credentials only)

Name of Nurse Anesthesia Program (centered)

[space]

Anticipated date of graduation (italics, centered, will be removed prior to publication)

E-mail address (italics, centered, will be removed prior to publication)

[space, left-justify from this point forward]

Keywords: (‘Keywords:’ in bold, followed by keywords (normal font) that can be used to identify the report in an internet search.)

Case Reports

The student author must have had a significant role in the conduct of the case. The total word count should be between 1200 – 1400 words. References do not count against the word count. Case reports with greater than 1400 words will be returned to the mentor for revision prior to initiation of the review process. The following template demonstrates the required format for case report submission.

Heading (see #9 above in General Guidelines)

[space]

A brief introductory paragraph of less than 100 words to focus the reader's attention. This may include historical background, demographics or epidemiology (with appropriate references) of the problem about to be discussed. It is written in the *present tense*. Although it is introductory, the heading word '**Introduction**' is not used. Be certain to cite references in this section, especially statistics and demographics pertaining to your topic.

[space]

Case Report (bold, 400-500 words)

[space]

This portion discusses the case performed in *400 words or less*, and is written in the *past tense*. Do not justify actions or behaviors in this section; simply report the events as they unfolded. Present the case in an orderly sequence. Some aspects need considerable elaboration and others only a cursory mention.

Patient description: height, weight, age, gender.

History of present illness

Statement of co-existing conditions/diseases

Mention the current medications, **generic names only**. (Give dosage and schedule only if that information is pertinent to the consequences of the case.)

Significant laboratory values, x-rays or other diagnostic testing pertinent to the case. Give the units after the values (eg. Mmol/L or mg/dL).

Physical examination/Pre-anesthesia evaluation - **significant** findings only. Include the ASA Physical Status and Mallampati Classification **only** if pertinent to the case.

Anesthetic management (patient preparation, induction, maintenance, emergence, post-operative recovery).

Despite the detail presented here it is only to help the author organize the structure of the report. Under most circumstances if findings/actions are normal or not contributory to the case then they should not be described.

Events significant to the focus of the report should be discussed in greater detail. The purpose of the case report is to set the stage (and 'hook' the reader) for the real point of your paper which is the discussion and teaching/learning derived from the case.

[space]

Discussion (bold, 600-800 words)

[space]

Describe the **anesthesia** implications of the focus of the case report citing current literature. Describe the rationale for your actions and risk/benefits of any options you may have had. This section is not merely a pathophysiology review that can be found in textbooks. *Relate the anesthesia literature with the conduct of your case noting how and why your case was the same or different from what is known in the literature.* Photographs are discouraged unless they are essential to the article. Photos with identifiable persons must have a signed consent by the person photographed forwarded to the editor via first class mail. Diag must have permission from original author. This is the most important part of the article. In terms of space and word count this should be longer than the case presentation. End the discussion with a summary lesson you learned from the case, perhaps what you would do differently if you had it to do over again.

[space]

References (bold)

[space]

A minimum of 5 references is recommended, with a maximum of 8 allowed. No more than 2 textbooks may be included in the reference list, and all references should be no older than 8 years, except for seminal works essential to the topic. This is also an exercise in evaluating and using current literature.

[space]

Mentor: (bold, followed by mentor name and credentials in normal text)

E-mail address (italics, will be removed prior to publication)

Research Abstracts

Research abstracts are limited to 500 words. References are not desired but may be included if considered essential. Note that this abstract is different from a research proposal. This abstract reports the *outcome* of your study. Use the same format described for the case report with the exception of the section headings:

Heading (see #9 above in General Guidelines)

[space]

Introduction (bold)

[space]

A brief introductory paragraph including purpose and hypotheses.

[space]

Methods (bold)

[space]

Include research design and statistical analyses used

[space]

Results (bold)

[space]

Present results – do not justify or discuss here.

[space]

Discussion (bold)

[space]

Discuss results

[space]

References (bold)

[space]

Not required, but a maximum of 5 references is allowed.

[space]

Mentor: (bold, followed by mentor name and credentials in normal text)

E-mail address (italics, will be removed prior to publication)

EBP Analysis Reports

Evidence-based practice analysis reports are limited to 3000 words. Please do not include an abstract. The report should provide a critical evaluation of a practice pattern in the form of a clinical question about a specific intervention and population. The manuscript should:

1. Articulate the practice issue and generate a concise question for evidence-based analysis. A focused foreground question following either the PICO or SPICE format should be used.
2. Describe the methods of inquiry used in compiling the data.
3. Critically analyze the quality of research reviewed and applicability to different practice settings.
4. Draw logical conclusions regarding appropriate translation of research into practice.

The same general format guidelines apply with the exception of the section headings as below. Please note that text books and non-peer reviewed internet sources should be avoided, and sources of reference should be less than 8 years old unless they are seminal works specifically related to your topic of inquiry:

Heading (see #9 above in General Guidelines)

[space]

Introduction (bold)

[space]

Briefly introduce the reader to the practice issue or controversy, describe the scope or significance or problem, and identify the purpose of your analysis. Describe the theoretical, conceptual, or scientific framework that supports your inquiry.

[space]

Methodology (bold)

[space]

Include the format used for formulating the specific question you seek to answer, search terms and methods used, and levels of evidence.

[space]

Literature Analysis (bold)

[space]

Review and critique the pertinent and current literature, determining scientific credibility and limitations of studies reviewed. Your synthesis table would be included in this section. Your review and discussion of the literature should logically lead to support a practice recommendation. Subheadings may be used if desired.

[space]

Conclusions (bold)

[space]

Summarize the salient points that support the practice recommendation and make research-supported recommendations that should improve the practice issue, while also acknowledging any limitations or weaknesses

[space]

References [bold]

[space]

A minimum of 8 references is recommended, with a maximum of 12 allowed.

Letters to the Editor

Students may write letters to the editor topics of interest to other students. Topics may include comments on previously published articles in this journal. Personally offensive, degrading or insulting letters will not be accepted. Suggested alternative approaches to anesthesia management and constructive criticisms are welcome. The length of the letters should not exceed 100 words and must identify the student author and anesthesia program.

AMA MANUAL OF STYLE

The following is brief introduction to the *AMA Manual of Style* reference format along with some links to basic, helpful guides on the internet. The website for the text is <http://www.amamanualofstyle.com/oso/public/index.html>. It is likely your institution's library has a copy on reserve.

<http://www.docstyles.com/amastat.htm#Top>

<http://healthlinks.washington.edu/hsl/styleguides/ama.html>

Journal names should be in *italics* and abbreviated according to the listing in the PubMed Journals Database. The first URL below provides a tutorial on looking up correct abbreviations for journal titles; the second is a link to the PubMed where you can perform a search.

<http://www.nlm.nih.gov/bsd/viewlet/search/journal/journal.html>

<http://www.ncbi.nlm.nih.gov/pubmed>

The International Student Journal of Nurse Anesthesia (ISJNA) is not listed in the PubMed Database. For the purpose of citing the ISJNA *in this Journal* use “**Int Student J Nurse Anesth**” as the abbreviation. The titles of text books are also printed in *italics*. Please pay close attention to ensure correct punctuation.

Journals

Note there is a comma after the first initials until the last author, which has a period. If there are six or less authors **cite all six**. If there are more than six authors **cite only the first three** followed by “et al.” Only the first word of the title of the article is capitalized. The first letters of the major words of the journal title are capitalized. There is no space between the year, volume number, issue number, and page numbers. If there is no volume or issue number, use the month. If there is an issue number but no volume number use only the issue number (in parentheses). The pages are inclusive - **do not omit digits**.

Some journals (and books) may be available both as hard copies and online. When referencing a journal that has been accessed online, the DOI (digital object identifier) or PMID (PubMed identification number) should be included (see example below).

Journal, 6 or fewer authors:

Hamdan A, Sibai A, Rameh C, Kanazeh G. Short-term effects of endotracheal intubation on voice. *J Voice*. 2007;21(6):762-768.

Journal, more than 6 authors:

Chen C, Nguyen MD, Bar-Meir E, et al. Effects of vasopressor administration on the outcomes of microsurgical breast reconstruction. *Ann Plast Surg*. 2010;65(1):28-31. PMID: 20548236.

Texts

There is a difference in citing a text with one or more *authors* from a text with one or more *editors*. Texts that are *edited* give credit to the authors of the chapters. They must be annotated and the **inclusive** pages of the chapter are noted. Texts that are *authored* do not have different chapter authors, the chapter is not cited by heading **but the inclusive pages where the information was found are cited**, unless the entire book is cited.

Text:

Stoelting R, Dierdorf S. *Anesthesia and Co-Existing Disease*. 3rd ed. Philadelphia: Churchill Livingstone; 1993:351-354.

Chapter from a text:

Burkard J, Olson RL, Vacchiano CA. *Regional anesthesia*. In Nagelhout JJ, Plaus KL, eds. *Nurse Anesthesia*. 4th ed. St. Louis:Elsevier; 2010:977-1030

Each chapter was written by a different author. Note the chapter's author gets the prominent location. The chapter title is cited; "editor" is abbreviated in a lowercase. The word "edition" is also abbreviated and in lower case. The inclusive pages of the chapter are cited.

Electronic references

Only established, peer-reviewed sources may be referenced. Please do not reference brochures or informational websites where a peer-review process cannot be confirmed. Authors are cautioned to not copy and paste from these without full credit and quotation marks where appropriate. Electronic references are cited using the following format:

Author (or if no author, the name of the organization responsible for the site). Title. *Name of journal or website*. Year;vol(issue no.):inclusive pages. doi: or URL. Published [date]. Updated [date]. Accessed [date].

For online journals, the accessed date may be the only date available, and in some cases no page numbers.

Examples:

Kamangar N, McDonnell MS. Pulmonary embolism. *eMedicine*. <http://www.emedicine.com/med/topic1958.htm>. Updated August 25, 2009. Accessed September 9, 2009.

Gupta A, Aggarwal N, Sharma D. Ultrasound guided ilioinguinal block. *The Internet Journal of Anesthesiology*. 2011;29(1). http://www.ispub.com/journal/the_internet_journal_of_anesthesiology/volume_29_number_1/article/ultrasound-guided-ilioinguinal-block.html. Accessed August 1, 2011.

ACADEMIC INTEGRITY

Issues of academic integrity are the primary responsibility of the author and mentor. Accurate and appropriate acknowledgement of sources is expected. **Any violation will be cause for rejection of the article.**

"Plagiarism is defined as the act of passing off as one's own the ideas, writings, or statements of another. Any act of plagiarism is a serious breach of academic standards, and is considered an offense against the University subject to disciplinary action. Any quotation from another source, whether written, spoken, or electronic, must be bound by quotation marks and properly cited. Any paraphrase (a recapitulation of another source's statement or idea in one's

own words) or summary (a more concise restatement of another's ideas) must be properly cited.”
http://grad.georgetown.edu/pages/reg_7.cfm

HOW TO SUBMIT AN ITEM

Manuscripts must be submitted by the mentor of the student author via e-mail to **INTSJNA@aol.com** as an attachment. The subject line of the e-mail should be “Submission to Student Journal”. The item should be saved in the following format – two-three word descriptor of the article_ author’s last name_ school abbreviation_ mentor’s last name_ date (e.g. PedsPain_Smyth_GU_Pearson_5.19.09)

REVIEW AND PUBLICATION

If the editor does not acknowledge receipt of the item within one week, assume that it was not received and please inquire. Upon receipt, the Editor will review the submission for compliance with the Guide to Authors. If proper format has not been following the item will be returned to the mentor for correction. This is very important as all reviewers serve on a volunteer basis. Their time should be spent ensuring appropriate content, not making format corrections. It is the mentor’s responsibility to ensure formatting guidelines have been followed prior to submission.

Once the item has been accepted for review the Editor will send a blinded copy to a Section Editor, who will then coordinate a blinded review by two reviewers who are not affiliated with the originating program. The reviewers recommend publication to the Section Editor or make recommendations for changes to be addressed by the author. The Section Editor will return the item to the Editor, who will return it to the mentor for appropriate action (revision, approval to print). If the article is returned to the author for repair it is usually to answer a specific question related to the case that was not clear in the narrative or it asks the author to provide a reference for a statement. Every effort is made to place the returned article in the earliest next issue.

The goal is for all articles submitted by students to be published while the author is still a student. Therefore, deadlines must be met and the entire process must be efficient. If an item is not ready for publication within 3 months after the student author has graduated it will no longer be eligible for publication. For this reason it is recommended that case reports be submitted at least 4-6 months prior to the student author’s anticipated graduation date.

Mentors of the papers may be asked to serve as reviewers of case reports by student authors from other prog and will be listed as contributing editors for the issue in which the item is published.

PHOTOS

Photos of students for the front cover of the Journal are welcome. Include a legend describing the activity and who is in the photo and identify the photographer. Only digital photos of high quality will be accepted via email to **INTSJNA@aol.com**. There must be a follow up hard copy signed by all present in the photo, as well as the photographer/ owner of the original photo, giving consent to publish the photo. Mail that consent to:

Vicki C. Coopmans, CRNA, PhD
Webster University
470 E. Lockwood Ave. Suite 15
St. Louis, MO 63119

SUBMISSION CHECK LIST

AMA Manual of Style and other format instructions are adhered to.

- Total word count not exceeded (1400 for case report, 500 for abstract, 3000 for EBPA).
- The item is one continuous Word document without artificially created page breaks.
- Verbatim phrases and sentences are quoted and referenced.
- All matters that are not common knowledge to the author are referenced.
- Generic names for drugs and products are used throughout and spelled correctly in lower-case.
- Units are designated for all dosages, physical findings, and laboratory results.
- Endnotes, footnotes not used.
- Jargon is absent.

Heading

- Concise title less than 70 characters long
- Author name, credentials, nurse anesthesia program, graduation date and email are included.
- Five **Keywords** are provided

Case Report

- Introduction is less than 100 words.
- Case Report section states only those facts vital to the account (no opinions or rationale)
- Case report section is 400-500 words and not longer than the discussion.
- Discussion section is 600-800 words.
- Discussion of the case management is based on a review of current literature
- Discussion concludes with lessons learned and how the case might be better managed in the future.

Abstract

- The 500 word count maximum is not exceeded.
- Abstract reports the *outcome* of your study.
- Includes Introduction, Methods, Results, and Conclusion sections.

EBPA Report

- The 3000 word count maximum is not exceeded.
- A critical evaluation of a practice pattern in the form of a precise clinical question about a specific intervention and population is presented.
- A focused foreground question following either the PICO or SPICE format is used.
- Includes Introduction, Methodology, Literature Analysis, and Conclusion sections.

References

- AMA Style for referencing is used correctly.
- Reference numbers are sequenced beginning with one and superscripted.
- References are from anesthesia and other current primary source literature.
- All inclusive pages are cited, texts as well as journals.
- Journal titles are abbreviated as they appear in the PubMed Journals Database.
- Number of references adheres to specific item guidelines.
- Internet sources are currently accessible, reputable, and peer reviewed.

Transmission

- The article is sent as a attachment to **INTSJNA@AOL.COM**
- The file name is correctly formatted (e.g. PedsPain_Smyth_GU_Pearson_5.19.09)
- It is submitted by the mentor with cc to the student author
- The words "Submission to Student Journal" are in the subject heading.