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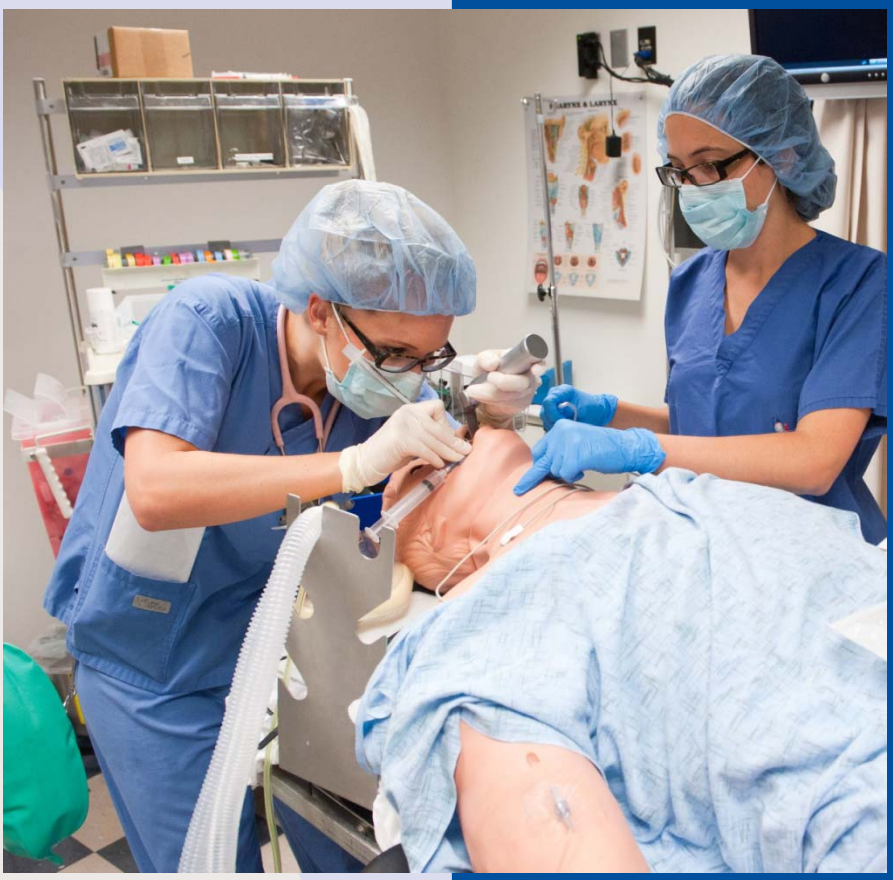

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Front Cover: Brittany Kolb, RN, BSN and Megan Bouwhuis, RN, BSN, graduate students in the Nurse Anesthesia Program at Georgetown University School of Nursing & Health Studies, practice clinical skills within the school's O'Neill Family Foundation Clinical Simulation Center. Photo courtesy of Phil Humnicky, Georgetown University.

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Marfan's Syndrome and the Bentall Procedure

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Keywords: Marfan's Syndrome, Bentall Procedure, Valve-Sparing Aortic Root Replacement

Marfan's syndrome (MFS) is an inheritable disorder of the connective tissue. This disorder is caused by gene mutations in the encoding of fibrillin-1, an extracellular matrix protein that aggregates to form extracellular microfibril.[1] MFS affects multiple organ systems to include ocular, skeletal and cardiovascular. A life threatening cardiovascular complication associated with MFS is thoracic aortic aneurysm leading to aortic dissection, rupture, or both. Prophylactic aortic repair is suggested to prevent aortic dissection and or aortic rupture. Two aortic root surgical techniques that are utilized include the Bentall procedure and a valve-sparing aortic root replacement (VSRR).[2]

Case Report

A 24 year old, 215 kg, 203 cm Caucasian male presented for a Bentall cardiovascular procedure. The patient was diagnosed with MFS at age 4 after noted eyesight failure and excessive growth. MFS was genetically inherited from his paternal father. Routine imaging revealed aortic aneurysm dilation and severe aortic valve regurgitation. The patient had been closely followed throughout his life with yearly subsequent imaging and β-adrenergic antagonist therapy.

His surgical history included ophthalmic surgery for lens correction. No other medical or social conditions and concerns were noted. This patient had no known drug allergies. Routine medications included a multivitamin once daily and 50 mg metoprolol twice daily. The patient continued his morning metoprolol dose on the day of surgery. Preoperative laboratory evaluation was found to be within normal value range.

The patient was prepared for surgery in the preoperative holding area where two 16 gauge intravenous catheters were initiated. Lactated Ringers solution was utilized for fluid management. During transport from the preoperative area to the operating room the patient received midazolam 2 mg. Once in the operating room, monitors were applied and an arterial line was placed in the left wrist. Pre-oxygenation was initiated and followed by intravenous anesthetic induction of fentanyl 250 mcg, rocuronium 5 mg, lidocaine 100 mg, propofol 200 mg and succinylcholine 200 mg. A size 9.0 cm endotracheal tube was placed in the trachea and secured. A pulmonary artery catheter (PAC) was successfully placed via the right internal jugular vein. Cardiac output was 6.3 L/min. Cardiac index was 3.4 L/min, and systemic vascular resistance was 720 (dyne*sec)/cm. Core body temperature was monitored via the PAC. With the goal of maintaining normothermia, an upper body warming blanket was applied and used during the procedure. Cefazolin 2 g was administered prior to the start of procedure.

General anesthesia was initiated and maintained with 0.8-1.0% Isoflurane in oxygen 1L/min and air 1 L/min and sufentanil 0.5-1.0 mcg/kg/hr. Additional intravenous medication was utilized throughout the procedure including

vecuronium 14 mg given for procedural paralysis. For cardiac dysrhythmia prevention, amiodarone 150 mg bolus with a continuous infusion of 1mg/hr and magnesium sulfate 2 gm were administered. Anticoagulation prior to the initiation of cardiopulmonary bypass was achieved with the administration of heparin sodium 67,000 units intravenous in conjunction with an antifibinrolytic of aminocaproic acid 10 gm that was administered twice, once before incision and then again while on cardiopulmonary bypass. Upon completion of the surgery, the heparin sulfate was reversed with protamine sulfate 350 mg. The surgery was uneventful and the patient remained hemodynamically stable and did not require any intravenous vasopressors support. The cardiopulmonary bypass time was 2 hours and 32 minutes. The patient received a total of 3600 ml of lactated ringers and 645 ml of cell saver blood transfusion. At the end of the procedure the patient remained sedated and intubated and was transported to the cardiac intensive care unit.

Discussion

MFS is predominately an autosomal dominate inherited disorder. It affects 1 in 3000 to 5000 individuals with 25% of patients having no family history of MFS, representing a new sporadic gene mutation.[1] When family history of MFS is identified, genetic analysis can confirm the genetic mutation. Even with advancements in modern technology, all genes that cause connective tissue disorder cannot be identified.[1]

Classic clinical symptoms of MFS are long tubular bones, high-arched palate, pectus excavatum, kyphoscoliosis, and hyperextension of joints, spontaneous pneumothorax, lens dislocation, myopia and retinal detachment.[3,4] This patient exhibited long and disproportionate stature, high arched palate and lens dislocation for which he underwent surgical correction and suffers with severe myopia. While there was potential for a difficult intubation with the high arch palate, no difficulty was encountered in this case. A Grade I view was achieved using a MAC 4 laryngoscope blade and a 9.0 mm endotracheal tube was placed on the first attempt.

Common cardiovascular complications associated with MFS include progressive aortic root enlargement starting at the sinus of Valsalva, valvular disease including mitral valve regurgitation, mitral valve prolapse, aortic valve regurgitation, left ventricular dilation, pulmonary artery dilation and heart failure, although, aortic root dilation is the most common cause of morbidity and mortality.[1,5] Due to dilation of the aortic root, aortic valve incompetence may arise, increasing the risk of aortic rupture when the diameter at the sinus Valsalva exceeds 5.5 cm.[1] MFS mortality from complications of aortic root dilatation has decreased from 70% in 1972 to 48% in 1995 and life expectancy has increased from age 32 (1978) to age 45 (1998).[5] Thoracic aortic aneurysm leading to aortic dissection, rupture or both is the most life threatening complication. Early detection and diagnosis of aortic root enlargement is important to allow for surgical intervention.

Treatment of MFS includes B-adrenergic antagonist therapy to decrease the risk of aortic dissection by reducing the systolic ejection impulse along with regular echocardiogram imaging to assess aortic root size. Imaging is recommended every 6 months to determine any rate of aortic root enlargement and then annually if unchanged aortic root size is noted. More frequent imaging should be considered when the

aorta is dilated > 4.5 cm. [1,5,6] Aortic root measurements may also be confirmed with computed tomography angiography (CTA) or magnetic resonance angiography (MRA). Surgical intervention is recommended when the aorta is >5.0 cm including rapid growth of the aortic diameter (<1 cm/year), a family history of premature aortic dissection (dissection >5 cm), and the presence of greater-than-mild aortic regurgitation.[1] Due to early diagnosis of MFS, this patient had been closely monitored throughout his life. Recent aortic root dilation of 5.6 cm and increasing aortic valve regurgitation prompted surgical intervention.

Two surgical techniques that have been utilized for aortic root repair with patients suffering from MFS include the Bentall procedure and a valve-sparing aortic valve replacement procedure (VSRR).[7] The Bentall procedure incorporates the replacement of the aortic valve with prosthesis and a Dacron graft replacing the aortic root. This procedure is favored when identification of leaflet asymmetry or fenestrations, significant stenosis, thickening, prolapsed of the aortic valve abnormalities are present. Complications associated with the Bentall Procedure include thromboembolic (TE) events from contributing factors of inadequate anticoagulation and prosthetic valve endocarditis. When there are no aortic valve abnormalities VSRR can be utilized. The aortic valves are "spared" and only the aortic root is replaced with Dacron graft. Reoperation was noted to be rare with VSRR and increased life expectancy was noted with both procedures.[5]

Managing care for a patient with MFS has many anesthetic considerations. Known skeletal muscle myotonia leads to increased joint laxity and hyper-extendibility in this population. Close attention must be paid to proper positioning to avoid injury and dislocations during anesthesia with special consideration to possible tempromandibular dislocation during intubation.[3]

Decreased pulmonary function resulting from pectus excavatum and kyphoscoliosis is attributed to airway closure due to the lack of small airway tissue support.[7] Pulmonary dysfunction may be further extended if emphysema, bronchogenic cysts and honeycombed lungs appear early in the developmental process.[8] Spontaneous pneumothorax is a frequent occurrence that anesthesia providers need to be cognizant of especially with volume-controlled ventilation.

Hemodynamic stability and avoidance of intraoperative aortic rupture through blood pressure control may be difficult. Diligence should be made to avoid sudden increases in myocardial contractility and the velocity of left ventricular contraction that would cause an increase in aortic wall tension.[2] Primary anesthetic technique includes inhalational agents such as Isoflurane with an adjunctive narcotic technique, continued beta blockade and caution utilized with vasodilators usage will help decrease fatal complications.

In conclusion, typically patients with MFS tolerate anesthesia and surgery well. Thorough preoperative assessment is imperative to recognize the severity of pre-existing cardiovascular disease and the acute cardiovascular and respiratory complications that may present intraoperatively. This assessment along combined with knowledgeable and skillful anesthesia providers and techniques will aid in the avoidance of potentially fatal complications.

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Anesthesia Management for Pseudocholinesterase Deficiency

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Keywords: pseudocholinesterase deficiency, succinylcholine, dibucaine number, prolonged ventilation

Pseudocholinesterase (PCE) is a glycoprotein enzyme produced in the liver that hydrolyzes choline esters in the plasma. PCE deficiency may be inherited, acquired, or iatrogenic.[1] In anesthesia management, PCE is important in the metabolism of succinylcholine, mivacurium, procaine, and cocaine.[1,2] Succinylcholine is a depolarizing neuromuscular blocker used for muscle relaxation with an approximate half-life of less than a minute.[1,3,4] Patients with PCE deficiency metabolize choline esters slower than patients with normal levels of PCE. In severe cases, paralysis may last 8 hours resulting in prolonged neuromuscular blockade and apnea.[1,5]

Case Report

A 79 year old, 72.5 kg, 168 cm Caucasian male was scheduled for esophagoscopy, laryngoscopy, and biopsy of a glottic mass. His medical history included chronic obstructive pulmonary disease, hypertension, gastroesophageal reflux disease, type II diabetes, and atrial fibrillation. Surgical history included a herniorraphy and laparoscopic appendectomy, both without anesthesia-related complications. Office laryngoscopy and preoperative CT imaging of the neck confirmed a nonobstructing glottic tumor. Preoperative laboratory values included; hemoglobin 12.8 g/dL, hematocrit 38.5%, platelet count 179x1000/mm^3, and glucose 272 mg/dL. Omeprazole 20 mg was taken the night before surgery and metoprolol 25

mg was taken on the morning of surgery. The patient was categorized as an American Society of Anesthesiology (ASA) class III due to cardiovascular and pulmonary restrictions on daily living.
The anesthetic plan was general anesthesia with an oral Ring-Adair-Elwyn tube. The patient was premedicated with 1 mg of midazolam and transported to the operating room. Following preoxygenation, intravenous induction medications were administered including: fentanyl 100 mcg, lidocaine 40 mg, etomidate 14 mg, and succinylcholine 100 mg. The 45 min procedure from induction to maintenance of anesthesia was uneventful. During emergence, the patient had no spontaneous respiratory effort and the peripheral nerve stimulator revealed no evoked response. After 15 minutes of manually assisted ventilation, the patient resumed minimal respiratory effort with tidal volumes were less than 50 mL. PCE deficiency was suspected. The endotracheal tube (ETT) was left in place and the patient was transported to the post anesthesia care unit with a propofol infusion for sedation (25 to 50 mcg/kg/min). One hour later, neuromuscular function returned, the ETT was removed, and the patient was admitted overnight for observation. Bilevel positive airway pressure support without sedation was used once during the night and the patient was discharged to home the next morning.

Discussion

Pseudocholinesterase deficiency is most often suspected when respiratory muscle relaxation unexpectedly persists for a prolonged period of time after a patient receives an appropriate dose of succinylcholine.[1,6] If the patient is not responsive to a train-of-four stimulation 15 minutes after administering succinylcholine, then the differential diagnosis should include PCE deficiency.[7] There is no cure or reversal for PCE deficiency. Treatment includes ventilatory support until passive diffusion of succinylcholine from the myoneural junction is complete, permitting return of neuromuscular function.[1,7-11] In addition, a multidisciplinary team approach involving the anesthetist, nurses, and respiratory therapists to evaluate the patient's progress for weaning and extubation is suggested by Leadingham.[8]

The patient in this case report was provided with ventilatory support until the neuromuscular blockade resolved. Administration of whole blood and fresh frozen plasma are reported in the literature to shorten recovery time. However, unnecessary exposure to transfusions is questionable when spontaneous recovery with ventilator support has been shown to be effective for the management of PCE deficiency.[7] Another possible treatment option includes cholinesterase inhibitors, but its use is controversial and has the risk of subsequent exaggerated neuromuscular blockade.[1]

Three proposed causes of PCE deficiency are hereditary, acquired, and iatrogenic. Genetic causes arise from one or more inherited abnormal alleles associated with the butyrylcholinesterase, a gene on the long arm of chromosome 3 (3q26.1-26.2).[1,7] Acquired PCE deficiency may be seen with neonates, elderly, pregnant women, patients with chronic infections or extensive burns injuries, liver disease, malignancy, malnutrition, and uremia.[1,7,8] Iatrogenic PCE deficiency may be induced by anticholinesterase inhibitors, chlorpromazine, oral contraceptives, esmolol, glucocorticoids, metoclopramide, pancuronium, monoamine oxidase inhibitors, bambuterol, cyclophosphamide, echothiophate ophthalmic drops,

hexafluorenium, phenelzine, and tetrahydoaminacrine.[1,7-9]

A quantitative diagnosis of PCE deficiency can be confirmed by plasma assays showing a decrease in plasma cholinesterase enzyme activity.[6,7,9] The standard assay is to determine the dibucaine number (DN). DN measures the percent inhibition of PCE activity by the local anesthetic, dibucaine.[1,6,8] This assay mixes the patient's plasma with a solution of phosphate buffer, benzoylcholine, quinidine sulfate, and 10 μM dibucaine.[6] The percent inhibition of plasma PCE is the DN.[6] A DN greater than 70 is normal or typical, a DN between 40 and 70 is intermediate or heterozygous for PCE deficiency, and a DN less than 20 is atypical or homozygous for PCE deficiency.[6,7,9] Individuals with a normal DN would be expected to hydrolyze succinylcholine in a normal fashion. A heterozygous patient has one normal gene and one mutated gene and would be expected to have a minimal prolonged response to succinylcholine. Finally, a homozygous patient has both abnormal genes and would have maximal post-succinylcholine muscle paralysis, sometimes lasting 2 to 8 hours.[1,6,7,9] The latter is the least common form.

Based on the literature presented, ideal management of the case presented would be to provide ventilator support until spontaneous recovery. All anesthesia professionals should utilize a peripheral nerve monitor when muscle relaxants such as succinylcholine are given.[6] If there is a period of prolonged neuromuscular blockade, PCE deficiency should be suspected and a multidisciplinary team approach should be employed for appropriate monitoring and ventilatory support. A diagnosis of PCE deficiency can be confirmed with a DN. In this case, the DN was not sent for diagnosis because the assay is not available in the facility and it would not alter management. However, the patient should have this laboratory confirmation prior to future surgeries so that the anesthesia team may better prepare for potential postoperative complications and the need for prolonged ventilatory support.

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The Pediatric Patient with Mastocytosis

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Keywords: mastocytosis, systemic, cutaneous, pediatric, anesthesia

Mastocytosis is a rare disorder in which there is an overproduction of mast cells. Anaphylaxis is mediated by these cells. Mast cell activation can be spontaneous (i.e., immunological) or be triggered by non-immunogical factors, such as drugs known to release histamine and physical or emotional stress.[1] Mast cell degranulation causes the release of histamine, heparin, prostaglandins, and various enzymes. Anaphylactoid symptoms such as urticaria, flushing, hypotension, and tachycardia are attributed to this release of mediators from the overabundant mast cells.[2] Because of this increased mast cell load, patients with mastocytosis are at an increased risk of adverse reactions while under anesthesia.

Case Report

A 12 year old, 41 kg female presented for an elective bone marrow aspiration and biopsy to rule out systemic mastocystosis. The patient's past medical history included cutaneous mastocytosis, four previous anaphylaxis reactions (one of which required cardiopulmonary support for 5 days), right lower extremity weakness secondary to a cerebral vascular accident, a resolved post anaphylaxis acute renal injury, intermittent myalgia, exercise induced asthma, and anxiety. Lab values included a negative urine human chorionic gonadotropin test and elevated serum tryptase levels with a range of 27 to 36 μg/L. Home medications consisted of melatonin, ceterizine, fexofenadine, famotidine, cromolyn sodium, and montelukast. Her drug allergy list consisted of aspirin, ibuprofen, morphine, and lidocaine. Previous surgical history included tonsillectomy and adenoidectomy, esophagogastroduodenoscopy, and dental extractions. The patient reported no issues with any previous anesthetics.

The patient was seen and evaluated preoperatively by an allergist who made the following recommendations: prednisone 1 mg/kg orally (PO), diphenhydramine 1 mg/kg PO, ranitidine 150 mg PO, and montelukast 10 mg PO. The medications were administered 12 hours prior to the

procedure and again 1 hour prior to the procedure. She was also instructed to take all additional daily medications not specified by the allergist with a sip of water.

The patient was examined in the pre-operative area by the anesthesia care team. She was pleasant, but lethargic. A topical anesthesia patch with lidocaine and tetracaine was applied to the right upper extremity and the bone marrow biopsy site. A 22 gauge peripheral intravenous (IV) line was placed. The patient was administered midazolam 2 mg and methylprednisone 40 mg IV. Once in the operating room, standard monitors were applied and the patient was pre-oxygenated via face mask for 3 minutes prior to IV induction with propofol 100 mg. A laryngeal mask airway (LMA) #3 was placed without difficulty and general anesthesia was maintained with sevoflurane 1% expired concentration in a mixture of oxygen 1 L/min and nitrous oxide 1 L/min. The patient received fentanyl 25 mcg, ondansetron 4 mg, and lactated ringer's solution 250 mL IV. The surgeon injected lidocaine 1% with epinephrine at the biopsy site. When the procedure was completed and the patient was breathing spontaneously, the LMA was removed and an oral airway was inserted. The patient remained on the operating room table until she removed the oral airway herself. She was then transferred to the post anesthesia care unit (PACU). Vital signs were stable upon arrival to the PACU and the patient was afebrile. The duration of the anesthetic was 52 minutes. She was subsequently admitted to the hospital for 23 hours of observation.

On post-operative day one the patient was hemodynamically stable and denied intraoperative recall, flushing, pruritis, pain, or nausea/vomiting/diarrhea. Oxygen saturation via oximetry was 100% on room air. She was later discharged home without further sequelae.

Discussion

Mastocytosis can occur in a cutaneous form, termed urticaria pigmentosa, or in a systemic form. Children are most affected with urticaria pigmentosa, a typically benign and asymptomatic malady.[2] These chiefly cutaneous pediatric cases will completely resolve in almost half of patients during puberty.[3] However, in the systemic form of mastocytosis, there is an increased risk of anaphylactoid reactions during anesthesia. This patient posed a particularly high risk, given her history of four previous anaphylaxis episodes, one of which resulting in severe cardiopulmonary compromise and multi-organ adverse events. Furthermore, serum tryptase levels in mastocytosis are normal in most cases of cutaneous mastocytosis, but are usually elevated (>20 μg/L) in systemic mastocytosis due to mast cell degranulation.[3] This patient's chronically elevated tryptase level reflected increased mast cell burden and prompted the need for further diagnostic testing.

Drugs listed as allergies by the patient and, in this case the patient's mother, should be discussed in order to ascertain specific reactions to the medication. For this patient, all allergies listed were precautionary, as they were all mast cell degranulators, and the patient had never actually experienced adverse drug reactions to any medication. Food allergies, specifically cashews and pistachios, were the cause of this patient's previous anaphylaxis episodes.

The selection of anesthetic and analgesic technique for the patient with mastocytosis is a daunting responsibility. This patient underwent preoperative consultation with an allergist who made several

recommendations for preventing mast cell degranulation on the day of the procedure. A combination of histamine blockers and steroids were administered prior to the procedure in order to antagonize histamine effects and provide temporary immunosuppression. While histamine blockers may decrease the symptoms of histamine release, they do not directly prevent mast cells from releasing histamine.[2] Cromolyn sodium, a medication regularly taken by this patient, is a mast cell stabilizer that may decrease the risk of bronchospasm.[2] Anxiety and emotional stress can also trigger mast cell degranulation. For this reason, anxiolytics were administered pre-operatively. In this case, inhalation agents were chosen because they do not release histamine and may prevent mast cell degranulation.[4] Despite the fact that stimulated mast cells release heparin, blood loss is unusual. However, bleeding, thrombocytopenia, and hemorrhage are associated with malignant aggressive systemic mastocytosis, a rare form of systemic mastocytosis. [2] That is why non-steroidal anti-inflammatory drugs like ketoralac and aspirin, which are both known to interfere with platelets, were not administered to this patient.[4]

Intraoperative care of the patient with systemic mastocytosis should prioritize interventions that avoid triggering agents and prevent mast cell degranulation.[4] Foremost, it is essential to avoid medications capable of non-immunologic histamine release. Certain antibiotics, basic compounds, hyperosmolar agents, opioids, muscle relaxants, and thiobarbituates release histamine and should be used with caution.[5] Having said that, if the administration of opioids and neuromuscular blockers would be helpful perioperatively, then their use is warranted. Instead of morphine, codeine, and meperidine, all of which are associated with higher levels of histamine release, it may benefit the patient to administer fentanyl or sufentanil.[1] Finally, newer aminosteroidal muscle relaxants such as rocuronium have minimal effects on histamine release and thus may be a better choice when compared to older relaxing agents like atracurium.[5]

Many anesthesia and analgesia agents have the potential to activate mast cell degranulation and cause anaphylactoid reactions. Additionally, the physical stress of the procedure can also stimulate mast cells. Therefore, it is imperative that resuscitation drugs are immediately available, and, especially in the pediatric patient, that drug doses are calculated according to the patient's weight prior to initiating the anesthetic. In the event of mast cell activation triggering extreme hypotension, hives, and/or wheezing, one should plan to administer methylprednisone, epinephrine, albuterol nebulization, and diphenhydramine.[2]

Even routine surgical procedures can pose significant risk to the patient with mastocytosis. However, concern for anaphylactoid reactions should not prevent the delivery of appropriate anesthesia in this surgical patient population. With an interdisciplinary approach that prioritizes vigilant premedication and a well-calculated anesthetic plan, surgery is safe and well tolerated in patients with mastocytosis.

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Anesthetic management of a patient with Eisenmenger syndrome

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Keywords: Eisenmenger syndrome, Down syndrome, trisomy 21, congenital heart defect, right-to-left cardiac shunt, anesthesia

Down syndrome is the most common chromosomal abnormality, occurring in an estimated 1 out of 691 live births.[1] Several characteristics associated with Down syndrome present challenges to the anesthesia practitioner including airway abnormalities, occipito-atlantoaxial instability, and predisposition to pulmonary complications.[2] One of the most concerning features of Down syndrome is the high incidence of associated congenital heart defects (CHD), found to be 43-44% in recent studies.[3,4] Left untreated, individuals with a CHD that causes a left-to-right shunt (systemic to pulmonary) develop progressive pulmonary hypertension, which can lead to reversal of this shunt accompanied by cyanosis, known as Eisenmenger syndrome.[5]

Case Report

A 35-year-old, 80 kg, 150 cm female was transferred to our institution after sustaining injuries to her lower extremities and abdomen in a motor vehicle accident. The patient had Down syndrome, but little else was known regarding her past medical history. Upon arrival to the emergency department, the patient was hypotensive and hypoxic. Erythrocytosis with hematocrit 55.4% was noted. Transthoracic echocardiography revealed a ventricular septal defect with significant right-to-left shunting and severe pulmonary hypertension consistent with Eisenmenger syndrome. The patient was taken late that night to the operating room (OR) for urgent surgical exploration, including small bowel, colon, and mesenteric repair and abdominal wound vac application. The patient was left intubated and transported to the surgical intensive care unit (SICU) for management. She returned to the OR the following day a for partial omentectomy, abdominal washout, and closure.

Prior to transfer to the OR, the patient remained in the SICU intubated on mechanical ventilation, receiving 500mL tidal volumes at 17 breaths per minute with 5 cm H_2O positive-end-expiratory-pressure

(PEEP) on 100% inspired oxygen with an SpO_2 of 76%. Norepinephrine at 10 mcg/min was infusing. A right internal jugular venous central line, radial arterial line, and two peripheral intravenous (IV) catheters were in place. The patient was transferred to the OR on a transport ventilator and monitor.

In the OR, fentanyl, midazolam, and norepinephrine infusions were continued at 100 mcg/hr, 3 mg/hr, and 10 mcg/min, respectively. The patient's endotracheal tube was connected to the anesthesia machine and volume control ventilation (VCV) with 500 ml tidal volumes and 5 cmH_2O PEEP was initiated. Oxygen flows were delivered at 1 L/min throughout the case and anesthesia was induced with etomidate 12 mg IV. Vecuronium 8 mg IV, was administered for muscle relaxation. Continuous arterial blood pressure (BP), central venous pressure (CVP), electrocardiography, SpO_2, bispectral index, and arterial blood gas (ABG) values were monitored closely throughout the case. Anesthesia was maintained with inhaled desflurane at 3% in O_2 1L/min, dexmedetomidine at 0.5 mcg/kg/hr, and fentanyl and midazolam infusions as outlined previously. Pre-induction vital signs were BP 107/55 mmHg, heart rate 86/min, and SpO_2 just below 80%. The patient remained hemodynamically stable in normal sinus rhythm for the first half of the case with systolic blood pressures ranging from 100-120 mmHg.

Approximately 45 minutes after incision, at the time of abdominal closure, there was a noticeable increase in peak inspiratory pressures (PIP) from 28 mmHg to 40 mmHg. Concurrently, the arterial BP dropped to 80/55 mmHg and the SpO_2 decreased to 68%. The patient was switched to pressure control ventilation (PCV) and the norepinephrine infusion was titrated up to14 mcg/min. At the end of the case, the SpO_2 was 71-74% and arterial BP 107/61 mmHg. Total estimated blood loss was < 25mL. Neuromuscular blockade was antagonized. Desflurane and dexmedetomidine were discontinued. The patient was transported back to the SICU intubated on a transport ventilator and monitor.

Discussion

Eisenmenger syndrome is a rare condition, estimated to occur in 8% of individuals with CHDs.[5] However, critical discussion is warranted on this topic due to the unique challenge it presents to anesthesia practitioners, especially during emergency surgery. Eisenmenger syndrome develops gradually over many years, often diagnosed in the third or fourth decade of life. It initially arises from a left-to-right shunt, leading to an increase stroke volume of the right ventricle which causes increased pulmonary blood flow and ultimately damages to the pulmonary vasculature. The resultant increase in pulmonary vascular resistance (PVR) causes the direction of the shunt to reverse when it exceeds systemic vascular resistance (SVR). Deoxygenated blood in the right ventricle will then bypass the pulmonary vasculature, mixing with oxygenated blood in the left side of the heart, resulting in chronic hypoxemia.[5]

Although individuals with Eisenmenger syndrome may be able to compensate for chronic hypoxemia with adaptive mechanisms, such as proliferation of red blood cells and hyperventilation, so that they are able to maintain adequate functional status on a day-to-day basis, the stress of acute trauma or surgery poses a threat to this tenuous balance. Non-cardiac surgery is thought to be one of the most common causes of death in this population. [6] Reasons for this may include the drop in systemic BP

caused by most anesthetics, which will increase the right-to-left shunt, as well as the intraoperative arrhythmias and hemostatic abnormalities which are often seen in these patients.[6]

The goal of anesthetic management for patients with Eisenmenger syndrome is to avoid factors that decrease SVR or increase PVR.[7] Priorities of care for this patient during the perioperative period were discussed among the anesthesia, surgical, and critical care teams. Goals were to maintain CVP of 10 mmHg, mean arterial pressures >65 mmHg, PCO_2 of 35 mmHg, and a pH of 7.40-7.45 in order to reduce the right-to-left shunt and ultimately sustain systemic oxygenation. Sustaining both inotropy and SVR was crucial to successful hemodynamic management. Isotonic crystalloid (total 1.2 L) was administered throughout the case to maintain preload and sufficient right atrial pressures. Although some experts recommend ketamine as the induction agent of choice for its effects on SVR, our choice of etomidate for its minimal effect on cardiac output provided the hemodynamic stability that was desired. It is also speculated that desflurane may be more supportive of SVR than sevoflurane due to the mild sympathetic stimulation it produces.[5]

As mentioned earlier, serial blood gas values were followed during the perioperative period. The preoperative ABG result was: pH 7.34, $PaCO_2$ 35, PaO_2 52, SaO_2 85%. The focus of mechanical ventilation during the surgical procedure was to maintain a low $PaCO_2$ rather than a high arterial oxygen saturation because a high $PaCO_2$ will lead to acidosis and an increase in PVR. Additionally, the patient with ES has adapted to a chronically low SaO_2 so this value will be lower at baseline than that of the normal healthy adult.[5] Approximately halfway into the procedure an ABG was obtained with the following results: pH 7.34, $PaCO_2$ 36, PaO_2 48, SaO_2 81%. The ventilatory management up to this point in the case had maintained the patient near her preoperative values with only a slight increase in $PaCO_2$ and decreases in PaO_2 and SaO_2.

The major challenge to the hemodynamic and ventilatory management of this patient correlated with the time of the abdominal closure. This event likely caused an increase in intraabdominal pressure. While this increase in intraabdominal pressure may have augmented the SVR, the decrease in venous return as a result of compression on the inferior vena cava and possible decrease in ventricular compliance may have been responsible for an acute drop in cardiac output as seen in the decline in BP. The associated increase in intrathroacic pressure is known to increase the following parameters: PIP, mean airway pressure, intrapulmonary shunt, dead space ventilation, and $PaCO_2$, while causing a decrease in dynamic pulmonary compliance and PaO_2.[8] The acute fluctuations in these parameters were evident at the end of the surgical procedure. The anesthesia team sought to counteract the acute drop in BP by increasing the norepinephrine infusion rate to prevent a worsening of the right-to-left shunt and switched from VCV to PCV to maintain adequate alveolar ventilation. Despite the slight increase in tidal volume, these physiologic changes were apparent on the ABG results drawn postoperatively upon arrival to the SICU: pH 7.32, $PaCO_2$ 36, PaO_2 40, SaO_2 69%. Blood gases gradually improved postoperatively with hyperventilation in the SICU.

The patient with Eisenmenger syndrome presents a special challenge to the anesthesia practitioner who must carefully work to

maintain the tenuous balance of adequate circulation and oxygenation. Consideration of hemodynamic implications pertaining to specific surgical procedures must be an integral part of the anesthetic plan. Vigilance in monitoring and efforts to prevent worsening of the right-to-left shunt are keys to a safe and successful anesthetic in the patient with Eisenmenger syndrome.

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Hypertension during Emergence from Carotid Endarterectomy

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Keywords: carotid endarterectomy, hypertension, clevidipine

Cerebrovascular accidents are the third leading cause of death in the United States.[1] Carotid endarterectomy (CEA) is a surgical procedure performed in patients with atherosclerotic carotid artery disease to prevent and/ or decrease the incidence of stroke.[2] Many patients presenting for CEA suffer from a multitude of comorbidities such as hypertension (HTN), coronary artery disease (CAD) and pulmonary disease. These preexisting medical conditions coupled with the hemodynamic instability associated with the CEA procedure present a unique challenge to the anesthetist.

Case Report

A 66 year old, 70 kg, 69 cm Caucasian male with carotid atherosclerotic disease presented for a right CEA. His history of present illness included two transient ischemic attacks (TIA) with right permanent peripheral vision loss. No other neurological

deficits were noted. Past medical history included HTN, chronic obstructive pulmonary disease (COPD) as evidenced by chest radiograph and one pack per day smoker for 40 years. Current medication use included amlodipine, aspirin, hydrochlorothiazide, clopidogrel, tiotropium bromide and fluticasone and salmeterol twice daily. A computer tomography angiogram revealed 75% occlusion of the right internal carotid artery and 100% occlusion of the left internal carotid. Echocardiogram revealed a 45% ejection fraction. Electrocardiogram revealed a sinus rhythm of 68 beats per minute (bpm) with no other findings. No cardiac stress test was noted. Baseline vital signs were: heart rate (HR) 61 bpm, blood pressure (BP) 169/78 mmHg and oxygen saturation (SpO2) 96% breathing room air. Prior to entering the operating room a nebulizer treatment containing albuterol 0.5 mg and ipratropium bromide 3 mg was administered.

Upon entering the operating room the patient was positioned supine with arms tucked and standard monitors were applied. After a routine induction a 7.5 mm endotracheal tube (ETT) was placed with ease. A right radial arterial line was inserted and EEG monitoring was used to assess neurologic integrity. General anesthesia was maintained with 1.5% sevoflurane and oxygen. The patient remained hemodynamically stable throughout the procedure. Ten minutes prior to emergence 6 puffs of albuterol were administered via the ETT. Neuromuscular blockade was antagonized 18 min prior to emergence.

During emergence the patient's BP increased to 190-200/90-105 mmHg and the HR increased to 94 bpm. Nitroglycerin 60 mcg was administered IV in three divided doses followed by administration of metoprolol 1mg, hydralazine 2 mg, and labetolol 10 mg. After 30 min the BP was 142/63 mmHg and the ETT was removed. Post-extubation the patient started wheezing, exhibiting symptoms of bronchospasm. Successful bag-mask ventilation could not be achieved. The trachea was emergently re-intubated. Oxygen, sevoflurane and six more puffs of albuterol were administered. The patient was brought to the post-anesthesia care unit were two nebulizer treatments of racemic epinephrine were administered and the trachea was extubated 30 minutes later without further respiratory complications. No new neurologic deficits were noted and a 12 lead EKG revealed no new changes.

Discussion

Patients undergoing CEA commonly present with multiple comorbidities that increase the incidence of post operative complications. Current surgical practice dictates that 100% occlusion of an internal carotid artery is inoperable due to lack of evidence noting beneficial effects. According to the literature, perioperative protection of the brain from hypertension and hypotension while protecting the heart from myocardial ischemia are the two main goals of the anesthetist and they often conflict with each other.[4] Cigarette smoking and HTN have a 62% correlation with CAD.[1] The patient's presenting history of HTN and COPD when coupled with smoking and an echo revealing a 45% ejection fraction led us to assume that he may have had CAD and we treated him accordingly.

Anesthesia for a CEA may be carried out under regional or general anesthesia. A regional technique utilizing a superficial and deep cervical plexus block affords the surgeon and anesthesia providers the opportunity to monitor the patients neurological status via the patient which is ideal. However, phrenic nerve paralysis is

associated with deep cervical plexus blockade. Quiet surgical field, secured airway, and the ability to titrate medication to decrease cerebral metabolic demand are several advantages of a general anesthetic. The major disadvantage of the general anesthetic is that neurological monitoring via the patient is not possible, instead electroencephalograph monitoring, somatosensory evoked potential monitoring and transcranial doppler monitoring are used with less reliability. The possibility of phrenic nerve paralysis in a patient with COPD as well as patient preference for a general anesthetic ultimately guided our decision to perform a general anesthetic.

Hypertension is more common than hypotension associated with CEA and a systolic blood pressure greater than 180 mmHg is associated with an increased incidence of TIA, stroke and myocardial infarction. Hypertension associated with CEA is thought to be due to a loss of normal arterial carotid baroreceptor function as well as increased sympathetic nervous system activity related to increased catecholamine levels. Normally, arterial baroreceptors in the carotid bodies sense changes in arterial pressure and provide a reflex alteration in sympathetic and parasympathetic cardiovascular activity.[3] Factors such as increased age, chronic hypertension, recent TIA, stroke, diabetes, carotid body manipulation during surgery and surgical removal of plaque with associated stripping of sensory nerve endings from arterial walls, lead to hypertension and increased arterial pressure instability.[3] Patients with bilateral carotid atherosclerosis, such as the patient presented in this case study, often display significantly increased hypertensive episodes due to baroreceptor dysfunction of both carotid arteries. Hypertension may lead to cerebral edema, cerebral hemorrhage, neck hematoma and cardiac ischemia related to increased afterload.

Common medicines used by the anesthesia practitioner to attenuate increases in BP during a CEA include nitroglycerin (NTG), sodium nitroprusside (SNP), esmolol, metoprolol, labetolol, and hydralazine. Each of these drugs has the ability to treat HTN either alone or in combination with other antihypertensive agents; however, certain side effects limit their use. A new calcium channel blocker (CCB) clevidipine is a selective ultra short acting arterial vasodilator that has little if any effect on myocardial contractility or conduction and is not contraindicated in bronchospastic disease. Median time to target SBP was 5.3 minutes when the goal was to decrease BP by 15% or more, and in this case it may have been a useful drug to attenuate the BP increase that took 30 minutes to resolve. [4]

Sodium nitroprusside (SNP) is a nonselective peripheral vasodilator that has been associated with reflex tachycardia and intracoronary steal. At recommended doses, clevidipine does not exhibit this intracracoronary steal effect.[5] NTG is a weaker vasodilator than SNP that primarily dilates large venous vessels which decreases preload while simultaneously dilating large coronary arteries leading to an increase in blood flow to ischemic areas Both SNP and NTG exhibit their antihypertensive effects within minutes but are contraindicated in intracranial pathology. [6] Nonselective beta blockers such as labetolol are contraindicated in bronchospastic disease states. Although esmolol was available it was not given during this case. Instead a small dose of labetolol was given. Whether the labetolol played a part in this patient having a bronchospasm is unclear. The decision to administer labetolol to a patient with COPD was less than optimal. Instead

esmolol with its lack of beta-2 effects may have been a better choice for the treatment of mildly increased HR.
Based on a current review of literature I believe that clevidipine administered in conjunction with esmolol may have been a better choice for the rapid treatment of hypertension and increased HR associated with emergence during this CEA. Esmolol is easily titratable, of short action and would have decreased the HR adequately while clevidipine could have been administered to effectively and rapidly decreases blood pressure to protect the patient from many of the complications associated with CEA such as cerebral edema, cerebral hemorrhage, neck hematoma and cardiac ischemia.

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Emergent Treatment of Angioedema

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Keywords: angioedema, emergent intubation, fiberoptic intubation, facial swelling

Angioedema is a phenomenon that rapidly affects the tissues in the respiratory tract within minutes to hours of initial presentation. Characterizing features are sudden onset of laryngeal edema leading to airway compromise and asphyxiation. It has an asymmetric distribution with involvement of lips, larynx, and even bowel.[1] Ten percent of Americans can expect to have at least one episode of angioedema and of these, twenty percent require airway intervention.[2] As anesthesia practitioners, it is important to understand the identifying features of this phenomena so rapid treatment and airway management can be provided.

Case Report

An 81 year old, 165 cm, 72 kg, African American female presented to the emergency department after being transferred from a rural hospital. Her past medical history included hypertension, reflux and hyperlipidemia. On her first arrival to the emergency department, she presented with complaints of airway swelling. She was transported to a second medical center, for further care, where she complained of increased facial swelling that began that morning and progressively got worse. The patient stated that she had not ingested any foreign substances or strayed from her usual diet. She denied any recent trauma or exposure to possible allergens. Her home medications included lisinopril, ranitidine and artorvastatin. The patient's vital signs were a heart rate of 95 beats/min, blood pressure of 165/102 mmHg, axillary temperature of 98.7 ^{o}C, and SpO_2 of 100% on room air.

On gross examination the patient had severe facial swelling involving the lower ocular orbits, mouth and tongue. She was drooling and unable to swallow oral secretions. Her mouth opening was greater than three finger breaths but a Mallampati classification of four was noted due to the extreme swelling of her oropharynx. An 18 gauge peripheral intravenous (IV) catheter was inserted. The emergency department paged anesthesia for assistance with emergent intubation and airway management. Upon arrival, the patient was evaluated by the anesthesia team for possible angioedema and given hydrocortisone 100 mg and diphenhydramine 25mg IV. An Ear nose and throat (ENT) specialist was consulted and the patient was transferred to the operating room (OR) emergently.

In the OR, the patient's airway was topicalized via nebulized lidocaine for evaluation through nasal video laryngoscopy which revealed an abnormal airway due to swelling of the tissues in the airway. The patient was given epinephrine 1 mg IV in divided doses of 0.5 mg, and ranitidine 150 mg IV. A fiberoptic nasal intubation was initiated. During the procedure the patient began to experience marked pharyngeal swelling with an SpO_2 of 95%. Placement of the endotracheal tube was verified with positive bilateral breath sounds, end tidal carbon dioxide and an increased SpO_2 of 100%. Additional epinephrine 1 mg and hydrocortisone 100 mg IV were administered. High blood pressure was never treated, as it never reached over 20% of patient's baseline. Once the ENT specialist arrived, facial swelling had decreased due to the administration of the medications noted above and the endtotracheal tube was removed from the nasopharynx. A diagnosis of angioedema was made and it was decided to keep patient under 24 hour observation postoperatively.

Discussion

The etiology of angioedema can be subdivided into two mechanisms that account for most cases: Mast cell-mediated and kinin-related. However, angioedema is also known to have a hereditary link in a small percentage of cases. Mast cell-mediated angioedema involves a release of mast cell-derived mediators that increase vascular permeability. This correlates with exposure to foods, drugs, latex or insect stings and is related to patients with allergic conditions, i.e. asthma, atropic dermatitis, and allergic rhinitis. Kinin-related angioedema results from the generation of bradykinin and complement-derived mediators that increase vascular permeability. This form of angioedema is

characterized by the absence of pruritis or urticaria.[3]

Angiotensin converting enzyme (ACE) inhibitors decrease angiotensin and increase bradykinin and may play a role as a risk factor for kinin-related angioedema.[4] Angioedema induced by ACE inhibitors is not drug specific and all ace inhibitors are equally as likely to cause this problem.[5] One half of angioedema cases related to ACE inhibitors occur within one week of beginning therapy, while the other half may occur up to several years later.[4] The patient in this case report was on lisinopril, an ace inhibitor, though the time span of how long she was on the drug was not noted. Other notable risk factors of strictly for ACE inhibitor angioedema include African American patients, females, as well as patients older than 65, all of which this patient incompassed.[2]

Treatment of angioedema depends upon the acuity, severity and mechanism of airway edema. A patient presenting with angioedema must first be assessed for signs of airway compromise if the swelling involves the tongue, uvula, soft palate or larynx. In this case, the patient did have these signs and treatment with IV steroids and antihistamines was initiated per the ED physician, who then consulted with anesthesia for further airway management. The main drug therapies used to treat angioedema include antihistamines, corticosteroids and catecholamines.[6] First generation antihistamines should be used as they have the quickest onset of action. According to Kaplan et al, initial therapy of antihistamines for the treatment of angioedema include diphenhydramine 25-50 mg IV or hydroxyzine 25-50 mg orally or intramuscularly.[6] In this case, diphenhyramine was used in 25mg IV doses.

In the case of severe angioedema, such as this one, catecholamines should be administered IV regardless of vasomotor compromise. If IV access cannot or has not been established, then subcutaneous epinephrine therapy should begin.[6] For this patient, epinephrine 1mg IV was administered when increased swelling was noted during attempted intubation. It is important for the anesthesia practitioner to be aware of any other chronic conditions the patient may have, such as coronary artery disease or history of stroke, when administering vasoactive medications. This patient did not have a history of any such disease; therefore, epinephrine was considered a good choice to halt the progression of severe swelling in this case. In the event that these disease states were present tighter blood pressure control may be needed and lower doses and/or slower adminestration of epinephrine may be considered to keep blood pressure within a less than twenty percent range of the patient's baseline blood pressure.

A compromised airway implies partial obstruction to airflow and the risk of total obstruction if further airway narrowing occurs. All compromised airways are potentially difficult intubations.[7] The airway compromise of an angioedema patient can be classified as mild, moderate, and severe. In the severe case, such as the one discussed above, intubation should occur as an awake tracheostomy or awake fiber-optic intubation.[8] Unless the airway is secured, then the patient with compromised airways must not be given general anesthesia or muscle relaxants.[7] Also, fiberoptic intubations can be a safe technique for the patient with a compromised airway.

Overall, the interventions chosen in this case report were the same as the suggested treatment of angioedema found in the

reviewed literature. The treatments chosen were also effective in reducing the swelling and obtaining an atraumatic successful intuabtion on first attempt. When assessing a patient with angioedema it is important to understand the different types of angioedema and their risk factors. Quick recognition is also important as the rapid progression of this phenomenon is life threatening. Understanding the pathology and distinguishing signs and symptoms can help the anesthesia practitioner deliver effective management and treatment. Once recognition of angioedema was made, appropriate treatment was effectively administered. The lesson learned here is that calm and quick interventions are key to resolving a critical situation.

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Anesthetic Management of Carcinoid Syndrome

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Keywords: anesthetic management, carcinoid tumors, carcinoid syndrome, somatostatin, catecholamines

Patients presenting with carcinoid tumor have the risk of developing carcinoid syndrome, which affords unique challenges to the anesthetist and should be anticipated throughout the perioperative period. Carcinoid syndrome can develop due to the secretion of hormones, mediators, and biogenic amines into the systemic circulation. This syndrome is potentially triggered by mechanical manipulation of the tumor, stress, exogenous administration of catecholamines, and histamine-releasing medications.[1] The most prominent manifestations are related to serotonin, histamine, and kinin peptides causing flushing, cardiac symptoms involving the tricuspid and pulmonary valves, bronchoconstriction, and intestinal

hypermotility.[2] Due to the infrequency of carcinoid syndrome, the treatment recommendations are limited. This case report discusses anesthetic management of carcinoid syndrome.

Case Report

A 63 year old, 175 cm, 79.5 kg male presented for a rigid bronchoscopy with laser ablation. The patient's past medical history was significant for a bronchial carcinoid tumor, chronic obstructive pulmonary disease, and tobacco use. The patient had no prior surgical history and was not on any medications. The chest x-ray revealed left hemithorax opacification and leftward mediastinal shift. A computed tomography scan indicated a left mainstem bronchus mass with complete lung collapse. On physical examination, chest auscultation revealed decreased breath sounds throughout the left lung, but no shortness of breath was noted. The patient's SpO_2 and PvO_2 on room air were 95% and 30 mmHg, respectively. Airway assessment revealed a Mallampati class 1, thyromental distance greater than 6 cm, and the ability to prognath. All other vital signs, laboratory values, electrocardiogram, and myocardial perfusion imaging study were unremarkable. The anesthetic plan included general anesthesia with total intravenous anesthesia and apneic technique.

Upon arrival to the operating room, standard monitors were applied, midazolam 2 mg intravenous (IV) was given, and the patient was pre-oxygenated with 100% oxygen via face mask for 10 minutes. An IV induction was achieved with lidocaine 80 mg, propofol 180 mg, and rocuronium 50 mg. The trachea was intubated under direct laryngoscopy without difficulty and respirations were controlled with manual ventilation. Propofol and remifentanil infusions were initiated and titrated along with intermittent boluses to maintain an adequate anesthetic depth throughout the procedure. Control of the patient's airway was then coordinated with the pulmonologist. The rigid bronchoscope was inserted simultaneously with endotracheal tube extubation. The patient was manually ventilated throughout the procedure on 100% oxygen through the bronchoscope with reintubation of the trachea when the oxygen saturation decreased below 93%.

With the initial laser ablation of the bronchial mass, the patient was noted to have flushing of the neck and upper thorax accompanied by a decreased blood pressure (BP) to 64/46 mmHg. The surgical procedure was paused. Lactated ringers (LR) 500 ml, ephedrine 10 mg, and phenylephrine 100 mcg were given with no change in blood pressure. Similarly, administration of epinephrine 20 mcg IV bolus led to minimal BP change. Finally, administration of octreotide 200 mcg IV increased the BP to greater than 100/56 mmHg. With regained hemodynamic stability, the surgery proceeded with no further sequelae.

At the conclusion of the surgical procedure, the patient's trachea was reintubated. Neuromuscular blockade was antagonized with glycopyrrolate 0.8 mg IV and neostigmine 4 mg IV and the patient met all criteria for extubation. Emergence and tracheal extubation were completed without complication. The patient was transferred to the post anesthesia care unit with 6 L/min of oxygen via face mask and no signs or symptoms of respiratory distress or hemodynamic instability were noted. Postoperative recovery was uneventful with no anesthetic complications.

Discussion

The majority of carcinoid tumors originate in the gastrointestional (GI) tract; however, they are also noted to occur in the head and neck, lungs, thymus, urinary tract, and gonads. These tumors are usually asymptomatic with only 7% of patients developing carcinoid syndrome.[2] For patients with carcinoid tumors, the most effective treatment is surgical management; however, simultaneous surgical manipulation of a carcinoid tumor and the administration of anesthesia can precipitate carcinoid syndrome.[2] Anesthetic management during the perioperative period must focus on preventing factors that trigger the release of bioactive mediators. Further, in the event that carcinoid syndrome does develop, it is essential to antagonize the effects of the bioactive mediators.[2] The primary goal for the anesthetic management of this patient was directed at avoiding catalysts that may precipitate carcinoid syndrome, such as stress, succinylcholine, morphine, and meperidine. A standard induction with midazolam, propofol, and rocuronium was utilized to prevent sympathetic nervous system stimulation and histamine release. Propofol and remifentanil infusions were chosen due to their rapid elimination and ease of titration to create optimal anesthetic conditions for bronchoscopy.

When this patient began to develop signs and symptoms of carcinoid syndrome with the onset of hypotension and facial flushing, interventions to antagonize the bioactive mediators' effects were initiated. A fluid challenge, ephedrine, phenylephrine, and epinephrine were administered. The symptoms continued and a synthetic somatostatin analogue, octreotide, 200 mcg IV bolus was administered ameliorating symptoms. The best evidence in the literature provides contradictory recommendations for the use of exogenous catecholamines for blood pressure management. Once thought to be a trigger for the release of bioactive mediators, current practice supports catecholamine use in conjunction with octreotide to improve hemodynamics.[2] A randomized, controlled study of 11 patients with carcinoid heart disease suggested the administration of exogenous catecholamines with octreotide was safe, and the historical recommendations to avoid these agents were questioned.[3] Although bolus doses of ephedrine and phenylephrine were not effective in reversing hypotension in this case, the concomitant administration of epinephrine and octreotide did result in improved hemodynamic stability. If hypotension is unresponsive to the sympathomimetic agents, vasopressin has been anecdotally suggested as an effective therapy, although no formal study exists.[2]

Due to the low incidence of carcinoid syndrome, prospective randomized clinical trials are not widely available. There is evidence suggesting steroids and histamine receptor blockers (H_1 and H_2) may be used to inhibit the release of bradykinin. However, the therapy of choice for perioperative management of carcinoid syndrome is the use of somatostatins, and octreotide.[2] Evaluation of the anesthetic management of 119 adult patients who underwent elective surgery for symptomatic carcinoid tumors found the use of octreotide intraoperatively was associated with a decreased frequency of intraoperative complications.[4] Furthermore, it has been demonstrated that the use of hydrocortisone and boluses of octreotide up to 1 mg IV can counteract "crisis"-induced hypotension.[5] In the above case report an effect with octreotide IV bolus was seen without the administration of hydrocortisone or

histamine receptor blockers. An alternative octreotide dosing option would have been to administer a continuous octreotide infusion of 50-100 mcg/hr in addition to the bolus to treat the intraoperative carcinoid crisis.[1] In a case report describing surgical intervention for three successive chemoembolization procedures of vasculature leading to a carcinoid tumor, prophylactic perioperative corticosteroids, along with histamine receptor blockers, and a somatostatin infusion did not prevent serotonin release and sudden hemodynamic instability due to massive mediator release.[6] It has been hypothesized that, despite somatostatin's ability to inhibit the release of serotonin, other mechanisms which may be a direct result of chemoembolization, such as tissue hypoxia with loss of functional cell membrane integrity or mechanically induced cell damage, may lead to mediator release that is not preventable by somatostatin.[6]

In addition to octreotide's utilization for intraoperative carcinoid crisis, preoperative prophylactic administration has also been suggested. Preoperative preparation for carcinoid syndrome can include octreotide 100 mcg subcutaneously three times daily two weeks prior to surgery or 10- 100 mcg IV administered slowly 1 hour prior to surgery.[1] Steroid and histamine blocker administration is also suggested as a preoperative treatment regimen.[1] Due to the urgency of this case, preoperative administration of steroids, histamine receptor blockers, and prophylactic octreotide was not feasible, but these medications could have been potentially beneficial to this patient. It is prudent to consider incorporating them into the carcinoid syndrome anesthetic regimen.

In summary, a review of the contemporary literature does not provide evidence for a standard approach to the anesthetic management of carcinoid syndrome. The primary goals continue to include avoidance of triggering agents and antagonizing the bioactive mediators' effects. It is imperative that an anesthetist's preparation for the management of a patient with a carcinoid tumor is thorough and multifaceted to prevent deleterious outcomes.

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Adrenalectomy for Pheochromocytoma

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Keywords: pheochromocytoma, laparoscopic adrenalectomy, anesthetic management, anesthetic implications

Pheochromocytoma is a catecholamine-secreting tumor of the adrenal glands. Composed of chromaffin cells of the adrenal medulla, it causes signs and symptoms of excessive circulating catecholamines.[1, 2] The main catecholamines secreted by this type of tumor are norepinephrine and epinephrine. Typical manifestations include hypertension, tachycardia, headaches, sweating, palpitations, pallor, and/or flushing.[1, 2] Pheochromocytoma is responsible for 0.1% of all hypertensive cases.[1] Surgical excision of pheochromocytoma tumors results in a greater than 90% cessation of symptoms. Undiagnosed cases are associated with a high mortality rate due to cardiovascular complications.[2] This case report discusses the anesthetic implications pertinent to the safe management of a laparoscopic adrenalectomy for pheochromocytoma.

Case Report

A 41 year-old, 71 kg, 170 cm male presented for a laparoscopic left adrenalectomy secondary to a 5.8 cm pheochromocytoma. The patient's chief complaint was left flank pain. Past medical history was positive for a 27 year history of smoking tobacco. The patient had orally taken phenoxybenzamine 10 mg daily for four weeks, which included the morning of surgery. This was the only medication regularly taken by the patient. Baseline blood pressure (BP) and heart rate (HR) were 124/84 mmHg and 54 beats per minute (BPM), respectively. The baseline electrocardiogram showed a rhythm of sinus bradycardia, with no abnormal findings. The patient's chest x-ray indicated no acute disease processes. A 24 hour urine sample, collected one month prior to surgery, confirmed the diagnosis of pheochromocytoma. The urine analysis was performed after noting a mass on the left adrenal gland via an abdominal computed tomography scan. The urine analysis indicated marked elevations in urinary vanillylmandelic acid, unconjugated norepinephrine and epinephrine, metanephrines, dopamine, and normetanephrines. Additionally, a complete blood count with differential and a comprehensive metabolic panel were analyzed, and no acute findings were noted.

Preoperatively, midazolam 5 mg intravenously (IV) was administered prior to the insertion of a right radial arterial catheter for continuous BP monitoring. General anesthesia was induced with fentanyl 250 mcg, lidocaine 100 mg, propofol 200mg, and rocuronium 50 mg IV. Following the insertion of an oral airway, the patient was ventilated with oxygen at 10 L/min and 2% sevoflurane for three minutes. Immediately prior to direct laryngoscopy, a bolus of nitroprusside 1 mcg/kg was administered IV. Nitroprusside was administered to prevent a hypertensive crisis during direct laryngoscopy and tracheal intubation. The patient was placed in right lateral decubitus position following tracheal intubation. The OR table was then set to the jackknife position for surgery. General anesthesia was maintained with oxygen at 2 L/min and with sevoflurane at 2.4 % (expired end-title %). Additionally, fentanyl 25-50 mcg boluses

were administered IV for a total of 500 mcg for the entire case. Fentanyl was administered to attenuate the sympathetic response to surgical stimulation and provide pain relief in the immediate post-operative period.

Prior to venous ligation of the tumor, the patient had multiple hypertensive episodes. Surgical manipulation of the tumor had to be temporarily halted twice during the procedure in order to treat hypertensive episodes. Nitroprusside was titrated within a dose range of 0.5-2.5 mcg/kg/min in order to maintain BP within 20% of baseline. Tachycardia was treated with esmolol 10 mg IV boluses (total of 100mg) as needed to maintain HR less than 110 BPM. Three liters of lactated ringers were infused IV prior to venous ligation of the tumor in order to prevent hypotension. Following venous ligation of the tumor, the patient's BP fell below 20% of baseline. An additional two liters of lactated ringers were administered IV to treat hypotension. Additionally, phenylephrine 100 IV mcg boluses (total of 3000 mcg) were used to maintain hemodynamic stability. After completion of the surgery, the patient was extubated awake and taken to the recovery room without incident. The patient remained hemodynamically stable and no additional vasoactive medications were required while in the recovery room.

Discussion

Preoperative preparation is critical to the reduction in morbidity and mortality associated with pheochromocytoma adrenalectomy. Perioperative mortality rates have decreased from approximately 45% to 0-3% with the administration of alpha-antagonists. Both selective and non-selective alpha-antagonists have been shown to be as equally effective.[2] Controversy surrounds the recommended duration of alpha blockade prior to surgery; however, most practitioners recommend the duration of alpha blockade to be 10-14 days prior to surgery.[2] Alpha blockade decreases peripheral vascular resistance and expands the intravascular fluid compartment. The intravascular fluid compartment is typically decreased due to chronic vasoconstriction.[1,2] In patients with pheochromocytoma, alpha-antagonists must be initiated prior to the administration of beta-antagonists. This order is critical due to the risk of unopposed alpha stimulation, which could lead to uncontrolled hypertension from alpha-mediated vasoconstriction if beta-antagonists were initiated first.[3] However, critics of pre-operative anti-hypertensive therapy question its effectiveness of reducing intraoperative hypertensive crises.[4]

Laparoscopic adrenalectomy for pheochromocytoma has been shown to be a safe and effective alternative to open adrenalectomy.[5-8] Specifically, patients undergoing laparoscopic adrenalectomy have less intraoperative blood loss and better outcomes than patients who have open procedures.[5,7] Although controversial, catecholamine-induced, intraoperative hypertensive crisis does not seem to be worsened by pneumoperitoneum.[5,7,8] In fact, laparoscopic adrenalectomy causes less catecholamine release than an open adrenalectomy.[7] Hypertensive crisis can be greatly reduced by careful surgical manipulation and early ligation of the adrenal vein.[4,5,7]

Pheochromocytoma patients should be adequately anesthetized to minimize any sympathetic response during painful stimulation. Prior to laryngoscopy, patients should be deeply anesthetized in order to block autonomic reflexes and prevent severe hypertension. Nitroprusside 1-2 mcg/kg can

be administered as an IV bolus prior to tracheal intubation to prevent hypertensive crisis.[1-2] Medications such as phentolamine, nicardipine, labetalol, magnesium sulfate, nitroglycerine, and fenoldopam have also been used to control intraoperative hypertension.[1-2]

Many medications commonly used by anesthesia practitioners are contraindicated for patients with pheochromocytoma. These contraindications arise from the possibility of profound hypertension and arrhythmias as a result of increased catecholamine release from the tumor. Succinylcholine-induced fasciculations and histamine releasing medications may worsen catecholamine release.[1] Sympatholytics and vagolytics should also be avoided due to the risk of hypertension.[1] Halothane can sensitize the myocardium to epinephrine-induced arrhythmias and therefore should be avoided.[2]

Intraoperative tumor manipulation can cause sudden, marked hypertension due to a surge of catecholamine release from the tumor.[1,2,4,5,7] Anesthesia practitioners should communicate with surgeons closely in the event of sudden hypertension. Surgical manipulation may need to be halted while vasodilators (e.g. nitroprusside, nitroglycerine) are titrated to decrease blood pressure. Tachycardia can be treated with the short-acting $beta_1$ antagonist, esmolol.[1] Following ligation of the adrenal vein, abrupt hypotension may occur.[1,2,5] Communication with the surgical team prior to venous ligation is essential to anticipate the hypotension that can follow. Initial treatment should be with IV fluid boluses, and if hypotension persists, adrenergic agonists (e.g. phenylephrine, norepinephrine) should be administered.[1,2] Persistent postoperative hypertension may indicate metastasis and further diagnostic testing may be required.[1,8]

In summary, preparation and communication are essential for providing a safe anesthetic to patients undergoing an adrenalectomy for pheochromocytoma. Anticipating acute hemodynamic changes improves anesthetic management and increases patient safety. Administering large volumes of IV crystalloid fluid, prior to the venous ligation of the tumor, may prevent the sudden onset of hypotension.[1,2] An understanding of which medications should be administered during this surgical procedure is monumentally important, and it underscores the importance of being prepared.

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A Proactive Approach to Pediatric Laryngospasm

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Keywords: pediatric, laryngospasm, extubation, burns, propofol, ketamine, magnesium

Laryngospasm is recognized as an anesthetic emergency. In pediatric patients there is an inverse correlation to age with a 1.74% incidence of laryngospasm in ages 0 to 9 years old, and 2.82% specifically in infants 1 to 3 months of age.[1] In an anesthetic culture where one is encouraged to be proactive rather than reactive, the maneuvers to prevent laryngospasm from occurring in the vulnerable pediatric population must be carefully considered. Burgoyne and Anghelescu concluded in the largest single-institution study to date that 47.6% of laryngospasm cases occurred during emergence from anesthesia.[2] Therefore, this case report will address possible pharmacologic methods to prevent the occurrence of laryngospasm, specifically during emergence from anesthesia.

Case Report

A 4 year-old, 119 cm, 19 kg female presented for debridement of a 19% total body surface area burn to the lower abdomen, genitalia, and bilateral inner thighs as well as harvesting of a skin autograft. The patient's surgical history was significant for an umbilical hernia repair at 8 months of age, without any anesthetic problems. All other physical findings, complete blood count, and basic chemistry panel were unremarkable. Preoperative vital signs included a heart rate of 120 beats/min and a blood pressure of 104/67 mm Hg. A plan for general anesthesia with an endotracheal tube (ETT) was discussed and agreed upon by the anesthesia team. The patient was crying and agitated and was therefore premedicated with midazolam 2 mg intravenous (IV) and ketamine 10 mg IV prior to transport to the operating room (OR). No preoperative antisialagogue was given.

Upon arrival to the OR, standard monitors were placed and the patient was preoxygenated with 1.0 FiO_2 for 5 minutes. An IV induction was achieved with fentanyl 25 mcg, lidocaine 20 mg, propofol 60 mg, and rocuronium 20 mg. The trachea was intubated under direct laryngoscopy without difficulty and a size 5.0 cuffed ETT was placed on the first attempt. The ETT placement was confirmed by the presence of end-tidal CO_2 ($EtCO_2$), bilateral breath

sounds, and equal chest excursion. General anesthesia was maintained with sevoflurane 3% added to the inhaled fresh gas mixture containing oxygen and air, each at 1 L/min. A total of fentanyl 120 mcg IV, morphine 2 mg IV, and ketamine 20 mg IV were given throughout the procedure.

At the conclusion of the case, residual muscle relaxation was antagonized, an oral airway was placed, and the oropharynx was thoroughly suctioned. Once extubation criteria were met, the sevoflurane was maintained at 2% and the ETT cuff was slowly deflated. The respiratory rate and pattern were regular and the patient did not react to the stimulation of cuff deflation; therefore, an extubation in a deep plane of anesthesia was performed. A lack of $EtCO_2$ and a still reservoir bag were immediately noted and a jaw-thrust maneuver, followed by a sustained positive-pressure breath, were performed. No respiratory effort against a closed glottis was noted at any point. Still unable to ventilate the patient, a two-person mask ventilation technique and additional positive-pressure breaths were attempted without breaking the laryngospasm. At that point, the patient's SpO2 decreased to 50% and propofol 60 mg IV and rocuronium 20 mg IV were administered in rapid succession. Within approximately 15 seconds, hand ventilation via the facemask was successful and the SpO2 promptly returned to 100%. The trachea was re-intubated without difficulty and the patient remained in the OR under direct observation for approximately two hours, with sevoflurane resumed at 2%, until we were able to antagonize the neuromuscular blockade using the train-of-four (TOF) monitor as a guide.

When extubation criteria were again met, the trachea was extubated with the patient awake. The patient showed no signs of respiratory distress or obstruction and was transferred to the post-anesthesia care unit with oxygen at 6 L/min via face mask. The child was observed for postoperative respiratory complications until she was transferred to the burn ward in stable condition.

Discussion

Laryngospasm is defined as a reflex closure of the upper airway caused by a spasm of the laryngeal musculature resulting in partial or complete glottic closure, impedance of respirations, hypoxemia, and hypercapnia. The exaggerated glottic closure reflex, mediated by stimulation of the superior laryngeal nerve, may occur secondary to abnormal excitation.[3,4] Laryngospasm can be clinically recognized by the presence of inspiratory stridor or airway obstruction, tracheal tug, paradoxical chest and/or abdominal movements, desaturation, bradycardia, and central cyanosis.[5]

Two key mechanisms that seem to play a role in laryngospasm are inadequate suppression of laryngeal reflexes and spasm of the laryngeal musculature. Therefore, it may be logical to consider measures that either suppress those reflexes or play a role in muscle relaxation. Two pilot studies suggest the administration of a sub-hypnotic dose of propofol to prevent stridor and/or laryngospasm. In a randomized study performed by Batra et al involving 120 subjects, propofol 0.5 mg/kg was given to pediatric patients once they began reacting to the ETT; the trachea was extubated one minute later. The results of the study showed that only 6.6% of the patients developed stridor or laryngospasm after propofol administration, compared to 20% in the control group. Of note, there were no hemodynamic changes in the group that received propofol, but 11.6% of the cases

did have a brief period of respiratory depression that necessitated mask ventilation.[6]

Propofol was also found to have a significant effect in decreasing stridor and cough at extubation in a randomized, double-blinded, pilot study performed by Pak et al involving 118 pediatric patients. The study subjects were given ketamine 0.25 mg/kg, propofol 0.25 mg/kg, or saline during emergence from general anesthesia once they had either resumed a regular breathing pattern or demonstrated purposeful movement. The ETT tube was removed one minute later. There was no laryngospasm in either the ketamine or propofol groups, compared to partial laryngospasm evidenced by stridor in 8.6% of the control group. Also, with regard to airway reflex suppression, 19% of patients in the propofol group had no coughing, whereas only 11% of the ketamine group and 6% of the saline groups were free from coughing. Based on the results, it was concluded that propofol 0.25 mg/kg had a significant effect in suppressing stridor and cough.[7] The exact mechanism to explain the efficacy of propofol is unclear, but one proposed mechanism is that it decreases airway reflexes.[8] Another explanation may be that propofol blocks the afferent pathway from the vocal cords and larynx to N-methyl-D-aspartate receptors in the brain stem that stimulate the vagal response of vocal cord closure.[6]

Magnesium sulfate ($MgSO_4$) has also been proposed to have beneficial effects in decreasing the incidence of laryngospasm.[9] In a prospective, randomized study performed on 40 patients, $MgSO_4$ 15 mg/kg IV was infused over 20 minutes following the induction of anesthesia. When compared to the control group, the 25% decrease in laryngospasm with extubation was attributed both to the central nervous system depressant effect of magnesium, as well as its calcium antagonistic effects that provide muscle relaxation.[9] The neuromuscular effect is of concern to many anesthesia providers since muscle relaxation must be reversed at the end of most surgical procedures. It is suggested that there is some presynaptic inhibition of neurotransmitter release when the plasma concentration of magnesium is greater than 2.5 $mmol \cdot l^{-1}$. However, after the administration of $MgSO_4$ 15 mg/kg the measured plasma levels of magnesium were lower than 2.5 $mmol \cdot l^{-1}$ and there were no purported episodes of excessive muscle relaxation. These results imply that this dose of $MgSO_4$ may be effective in preventing laryngospasm while avoiding the undesired neuromuscular effects.[9]

Two aspects of the management of this case could be discussed in greater detail. The decision to remove the ETT in a deep plane of anesthesia was made following a discussion regarding the patient's level of preoperative agitation. The surgical procedure did not necessitate a deep extubation; however this technique was utilized to avoid emergence agitation in this child. The patient was deemed to be at higher risk based on her preoperative agitation scale as well as study results showing that children less than 62 months of age are more prone to altered behavior on emergence.[10] Further explanation can also be provided regarding the rationale of using rocuronium instead of succinylcholine to treat the laryngospasm. The use of succinylcholine for patients with burn injuries can lead to a massive release of potassium from the extrajunctional acetylcholine receptors that presumably proliferate after burn injuries.[11] The increase in extracellular potassium as well as the proliferation of acetylcholine receptors can

increase the risk for bradycardia, ventricular arrhythmias, and cardiac arrest; therefore, succinylcholine is routinely avoided in this patient population.[11] If a rapid induction of anesthesia must be performed, the next fastest agent is rocuronium, with an onset of 45 to 120 seconds when given in a dose of 1 to 1.2 mg/kg.[11] Therefore, rocuronium was the agent of choice used in this case to promote rapid treatment of a complete laryngospasm.

The occurrence of laryngospasm is associated with an increase in morbidity due to factors such as oxygen desaturation, bradycardia, aspiration, negative pressure pulmonary edema, and cardiac arrest.[1,4,12] Therefore, the anesthetic implication of finding a successful prevention is clear. Based on the studies discussed, it does appear that either a subhypnotic dose of propofol or an infusion of $MgSO_4$ could potentially have been administered in this case, but the answer is not absolute. This review of current literature does not identify a sure method for laryngospasm prevention. However, it does highlight interventions that have been successful as well as identify an area for further research.

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Retrograde Wire Intubation for Angioedema of the Tongue

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Keywords: Retrograde wire intubation, angioedema, difficult airway

Retrograde intubation was initially defined by Butler and Cirillo in 1960, and over the past 50 years the use of retrograde intubation has been reported in several different cases.[1,2] Retrograde wire intubation is a technique that introduces a guidewire through the cricothyroid membrane which is blindly threaded upward into the larynx, ultimately emerging from the nose or mouth. This technique was added to the American Society of Anesthesiologists (ASA) Difficult Airway Algorithm in 1993.[3]

Case Report

A 56 year-old African American male presented to the emergency room with angioedema of the tongue. He was 170 cm tall and weighed 96 kg. His surgical history included a rotator cuff repair and an appendectomy. His past medical history included hypertension and tobacco use for 40 years. His medications included: lisinopril, amlodipine, and hydrochlorothiazide, and an allergy to clonidine. The patient was of large stature, and physical examination revealed a swollen face and lips with an engorged tongue. The patient was breathing spontaneously, although labored. Breath sounds were clear bilaterally. His vital signs revealed a heart rate of 120 beats per minute, blood pressure of 148/94 mmHg, and a SpO_2 of 99%. An arterial blood gas revealed a pH of 7.31, pCO_2 of 51 mmHg, pO_2 of 162 mmHg, base excess of -1.2 mEq/L, SpO_2 of 99%, and bicarbonate of 25.7 mEq/L. The patient was on a face mask with a FiO_2 of 60%. A Mallampatti score could not be assessed due to the patient's edematous tongue and lips obstructing the view of his airway. The patient was kept in a sitting position because he had difficulty breathing when laying flat. The patient was classified as American Society of Anesthesiologists IV-E physical status.

For a more controlled environment the patient was transferred to the operating room, and the surgeon was present in case an emergency tracheostomy became necessary. Aerosolized lidocaine was sprayed in mouth and nose to help numb the airway. Midazolam 2 mg IV and fentanyl 50 mcg IV was administered to help comfort the patient. Dexamethasone 12 mg IV and diphenhydramine 50 mcg IV was administered to help decrease swelling and relieve the allergic reaction. A nasal airway and an oral airway were successfully placed, and a suction catheter was placed down the oral airway to clear any secretions in the patient's airway. Glycopyrolate 0.2 mg IV was administered to decrease secretions. Awake fiberoptic intubation was attempted twice, and was unsuccessful. Propofol was then titrated in 10 mg increments with maintenance of spontaneous ventilation. A total of 160 mg was administered. Direct laryngoscopy was attempted three times using a Miller 3 blade. All attempts were

unsuccessful. A LMA Fastrach (LMA North America Inc., San Diego, CA) was placed, and ventilation was successful when lifting the LMA forward. However, ventilation was not possible when the Fastrach sat in the correct position. Sevoflurane was administered through the Fastrach, and fiberoptic intubation was attempted through the LMA. A 7.5 oral endotracheal tube was placed through the LMA; however, there were no breath sounds or end tidal CO_2 noted on auscultation. The endotracheal tube was removed, and ventilation was continued through the LMA. A 16 gauge intravenous catheter was placed through the cricothyroid membrane and a guidewire was threaded up through the LMA. The guidewire appeared through the nasal airway and a 6.0 endotracheal tube was passed over the guidewire and secured at the left nare at 25 centimeters. Bilateral breath sounds were equal and end tidal CO_2 was present. A chest x-ray was performed to confirm placement. No anesthesia complications were noted.

Discussion

While retrograde intubation is a rare procedure with several potential complications, in some cases of airway obstruction, it is the best option. In this particular situation, the reaction to an Angiotension converting enzyme (ACE) inhibitor was only a temporary airway obstruction with an acute duration; therefore, this less invasive technique was preferred over a tracheostomy. ACE inhibitors can cause an uncommon, but severe side effect known as angioedema. This can occur at different intervals of treatment. The skin and mucous membranes can become edematous, and can be characterized as firm, white, painful swelling. The edema typically affects the face; however, genitalia and extremities may also become edematous. Edema can become life threatening when it includes the tongue, pharynx, and larynx.[4] This particular patient had had been taking ACE inhibitors for approximately one year when the edema occurred.

Severe edema of the patient's tongue, larynx, and lips prevented normal oral tracheal intubation. Fiberoptic attempts failed because the edema was so severe that the airway anatomy was not recognizable. In addition, while the LMA allowed ventilation, it was unable to be secured properly. Traditional indications for retrograde intubation include: failed trials at laryngoscopy, laryngeal mask airway insertion, and fiberoptic intubation. Furthermore, this technique is appropriate if vocal cord visualization is blocked, and there is an immediate need to secure an airway. Other indicators for use of retrograde intubation include elective situations, such as maxillofacial trauma, an unstable cervical spine, and anatomic anamolies.[5] This case met the criteria to perform a retrograde intubation because there were multiple failed attempts at laryngoscopy and fiberoptic intubation, and visualization of the larynx was blocked due to his edematous tongue and larynx.

There are several contraindications to performing a retrograde intubation. One scenario is unfavorable anatomy. For example, if there is no way to gain access to the neck to perform this technique due to deformity. This can occur in patients who are obese, who have a large tumor or goiter, or just non-palpable landmarks.[5] Another contraindication is laryngeal stenosis, which could be increased by needle insertion or catheter placement.[5] A coagulopathy is a contraindication to the retrograde intubation, as is infection at the puncture site.[5] None of the contraindications were present in this patient.

Multiple complications can occur from performing a retrograde intubation. First, bleeding can occur. In order to keep this to a minimum, applying pressure to the site, placing a pressure dressing if necessary, and keeping the patient supine for a few hours after the procedure are all recommended.[5] Another common complication is subcutaneous emphysema around the puncture site. This is most often seen when a large bore needle is used, several needle punctures are made, or there is continuous intratracheal pressure on the puncture site.[5] In addition, pneumomediastinum can occur with needle puncture and increased pressure in the trachea, such as paroximal coughing and sneezing.[5] Other complications include esophageal perforation, laryngeal edema, laryngospasm, tracheitis, vocal cord damage, infection, tracheal fistula, epistasis, preitracheal hematoma, breath holding, caudad traveled catheter, trigeminal nerve trauma, incorrect placement, pretracheal abscess, pneumothorax, guidewire fracture, and loss of catheter hook.[5] In this case the patient's coagulation studies were within normal limits, only one puncture was performed, and the guidewire was easily threaded cephalad.

The LMA Fasttrach was critical to this case, it allowed for adequate oxygenation and ventilation while alternative intubation techniques were attempted. The LMA permitted administration of inhaled anesthesia while attempting to intubate the patient. Moreover, the LMA maintained airway patency while facilitating fiberoptic intubation attempts and, ultimately, a successful retrograde intubation. The guidewire is assumed to have traveled up through the vocal cords and around the LMA cuff and then up through the nare.

It is the role of the anesthesia provider to secure and manage the airway. This is usually accomplished in the standard way of laryngoscopy, which remains the technique of choice.[6] However, laryngoscopy is not always successful. There is no approach that is always effective, including the retrograde intubation[5] Hence, there should be multiple alternative approaches to securing an airway. The retrograde intubation with a guidewire should be considered as an alternative to laryngoscopy, especially in the presence of airway bleeding, whether caused from several failed intubation attempts or from facial trauma.[5] Furthermore, this technique is useful in patients who cannot open their mouths or have restricted neck mobility, and as demonstrated in this case, with angioedema of the tongue.[5] This case provided an ideal opportunity to utilize an effective, underused, life-saving technique of securing an airway.

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Anesthetic Management of a Patient with Prior Bleomycin Treatment

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Keywords: Bleomycin, chemotherapy, general anesthesia, pulmonary toxicity.

Bleomycin is a polypeptide antibiotic chemotherapeutic agent effective in the treatment of testicular carcinoma. The most serious complication of bleomycin is pulmonary toxicity resulting in pulmonary fibrosis and impaired lung function. Hyperoxia in patients previously treated with bleomycin may result in severe adult respiratory distress syndrome (ARDS) in the hours to days following surgery.[1,2] This case report presents the anesthetic management of a patient treated with bleomycin.

Case Report

A 17 year-old male with a history of testicular carcinoma was admitted for retroperitoneal germ cell tumor removal, retroperitoneal exploration, and retroperitoneal lymph node biopsy. He had completed four cycles of chemotherapy with bleomycin, etoposide, and cisplatin. Chemotherapy was administered over a four month period with the last dose given 45 days prior to surgery. His total bleomycin dose was 430mg.

The patient was 70 inches in height and 72 kilograms in weight. Other past medical history was significant for childhood asthma. The patient had been asymptomatic since age 6 with no prior hospitalization or intubations from asthma exacerbation. The patient was able to exercise without distress. Routine chemistry and hematology studies as well as electrocardiogram and chest x-ray were all within normal limits (WNL). Pulmonary function tests were obtained monthly during the patient's chemotherapy treatment and revealed normal FEV_1 and FVC values. Single breath carbon monoxide diffusion capacity (DLCO) values displayed a progressive decrease with monthly values of 32.8, 21.2, and 16.0 mL CO/min/mm Hg with a predicted value of 22.8.

His vital signs were stable with an oxygen saturation of 99% on room air. Breath sounds were clear to auscultation bilaterally.

The patient arrived in the preoperative area with an 18 gauge IV catheter and lactated ringers infusing. Midazolam 4mg was titrated for anxiolysis prior to entering the operating room. In the operating room with standard monitors in place, the patient was given oxygen by mask at 10L/min for 3 minutes. Induction of anesthesia was performed with 100mcg of fentanyl, 100mg of lidocaine, 140mg of propofol, and 50mg of rocuronium.

After tracheal intubation, he was placed on volume control ventilation with oxygen, air and sevoflurane at 2%. The patient's

fraction of inspired oxygen (FiO_2) was reduced to 0.21-0.23, where it was maintained throughout the case. An arterial line was placed in the patient's right radial artery and a 14 gauge IV catheter was placed in his left forearm. An arterial blood gas assessment revealed pH of 7.37, CO_2 of 41 mmHg, HCO_3 of 24 mEq/L, and a PaO_2 of 129 mmHg with a SpO_2 of 99%.

The patient was given a total of 2,200 ml of crystalloid and remained hemodynamically stable throughout the remainder of the 4 hour and 35 minute case. His oxygen saturation did not decrease below 97%. The trachea was extubated without incident at the end of the case. The remainder of the patient's hospital stay was unremarkable. He was discharged home on post-operative day seven.

Discussion

Pulmonary toxicity is the most serious side effect of bleomycin administration potentially resulting in pulmonary fibrosis, impaired lung function, and ARDS. This complication was first identified many decades ago. This case study will review preventative treatments from past retrospective and quasi-experimental studies and reviews.

A report of post anesthetic complications following treatment with bleomycin by Goldiner et al suggested the use of minimal oxygen administration and judicious fluid management. The authors observed five patients who received bleomycin and died shortly after surgery. All of these patients suffered terminal pulmonary injury consistent with oxygen toxicity and fluid overload.[1] In response, a prospective study of twelve patients who received bleomycin within 1 year prior to surgery was designed. These patients were maintained with FiO_2 values between 0.22 – 0.25. Fluid management included proportionate distribution of crystalloid and colloid (3ml/kg/hr) based on capillary wedge pressures and cardiac output during anesthesia. These patients experienced no respiratory complications following their surgical procedures. Goldiner concluded that minimal oxygen concentration and careful monitoring of fluid replacement may play an important role in preventing pulmonary complication.[1]

In a laboratory investigation, Hay et al studied the mechanism by which intravenous administration of bleomycin caused acute pulmonary toxicity in rats. Following bleomycin administration, lung tissue was assessed by histologic examination and measurement of total pulmonary extravascular albumin space. It was found that bleomycin alone did not produce evidence of pulmonary damage however, exposure to hyperoxia with FiO_2 between 0.4 and 0.9 following bleomycin administration led to acute lung injury.[3] As a result, Hay suggested oxygen administration in patients treated with bleomycin be kept to a minimum.

In a review by Waid-Jones et al, this study recommended patients treated with bleomycin be managed with the lowest possible FiO_2 which allows for adequate oxygenation following 1-4 minutes of FiO_2 1.0 prior to induction of anesthesia.[4] Wuethrich et al examined the effects of minimal oxygen administration and pulmonary outcomes in patients presenting for retroperitoneal lymphadenectomy following treatment with bleomycin less than 6 months prior to surgery. These patients received 3 minutes of FiO_2 1.0 prior to induction of anesthesia. Following induction the FiO_2 was reduced to less than

0.3. No pulmonary complications were reported in these 22 patients.[5]

The overall risk of pulmonary lung toxicity in a patient receiving bleomycin is multifactorial. A review by Mathes of bleomycin and hyperoxia exposure identified preexisting bleomycin related pulmonary injury, as evidenced by decreased predicted FVC, FEV1, and DLCO values on pulmonary function tests, as a potential key factor for determining risk of pulmonary toxicity secondary to hyperoxia.[6] Of these measurements, DLCO has been found to be a more sensitive predictor of subclinical bleomycin-related pulmonary injury compared with standard volumetric measurements in young male patients treated for germ cell tumors.[7] A second major risk factor linked to pulmonary toxicity in patients treated with bleomycin is exposure 1 – 2 months prior to surgery.[6] Other factors thought to increase risk of bleomycin related pulmonary toxicity include total dose greater than 450mg, radiation therapy, age, and renal insufficiency.[6,8]

The patient in this case study presented with a relatively high cumulative bleomycin dose and recent treatment 45 days prior. Although he did not present with clinical signs of pulmonary damage, extensive decrease in DLCO values did indicate subclinical injury. As a result, this patient was maintained with FiO_2 0.21 during this case to prevent pulmonary injury related to oxygen toxicity as reported by Goldiner and others.[1,5] Prior to induction of anesthesia, we chose to administer 3 minutes of FiO_2 1.0 as recommended by Waid-Jones et al.[4] Judicious fluid management was key in preventing pulmonary edema; however, it was decided not to place central venous or pulmonary artery catheters given the patient's subclinical degree of injury, age, and overall state of good health preoperatively. In this, our management differed from that of Goldiner who described colloid administration based on capillary wedge pressures and cardiac output, the monitoring of which was deemed not necessary for this case.[1] We administered lactated ringer's (6ml/kg/hr) and only considered colloid administration if the patient became hypotensive. This is in accordance with Waid-Jones et al who found no reports identifying colloid administration to be superior in the treatment of these patients.[4]

The degree of intraoperative precaution necessary should be determined on a case by case basis when patients with a history of bleomycin treatment present for general anesthesia. Cumulative dose, time since last treatment, renal function, and degree of preexisting pulmonary damage must be considered when formulating an anesthetic plan. The presence of risk factors associated with pulmonary oxygen toxicity and ARDS warrants the use of the lowest FiO_2 necessary in order to maintain adequate oxygenation. In young otherwise healthy patients with limited degree of pulmonary injury, 1-4 minutes of pre-oxygenation with FiO_2 1.0 prior to induction of anesthesia is appropriate. Judicious fluid management of crystalloid or colloid replacement may also prevent pulmonary complications.

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Induced Hypothermia and Neurological Outcomes Following Resuscitation

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Keywords: AHA guidelines, cardiac arrest, implementation, neuroprotection, ROSC, therapeutic hypothermia, systematic review

Introduction

Anesthesia professionals, who are often first responders during cardiac arrest, have the opportunity to make a serious impact on improving neurological outcomes following the return of spontaneous circulation (ROSC). The purpose of this paper is to explore whether the anesthesia professional should advocate for post arrest hypothermia protocols, which may improve patients' neurological outcomes following ROSC. Cardiac arrest is the most common cause of global cerebral ischemia.[1] Many avenues have been explored to attenuate neurological injury post cardiac arrest. In the 1960's the role of hypothermia to improve post ischemic cerebral outcomes was abandoned due to poor cooling techniques that induced deep hypothermia (<30°C) causing adverse patient outcomes. Furthermore, the absence of fully developed intensive care units left the management of hypothermia treatment to the wards where nurses did not have adequate equipment, skill sets or personnel to sufficiently monitor and care for these patients. Subsequently, patient outcomes were poor and the institution of therapeutic hypothermia post ROSC to improve neurological outcomes ceased.[2,3]

In the 1980's there were several animal studies that demonstrated positive neuroprotective results following cooling, and interest in mild hypothermia (32-34°C) treatments for neuroprotection resurfaced.[2,3] Several large clinical studies involving humans were published in 2002 indicating that in a controlled setting when mild hypothermia (32-34°C) was induced during the first several hours following ROSC, a marked neuroprotective effect followed cardiac arrest.[1,3-12] The evidence these studies provided was compelling and in 2003, the International Liaison Committee on Resuscitation in Europe changed its guidelines to support the use of mild hypothermia post-ROSC.[1,3-6,10,11] The 2010 American Heart Association guidelines subsequently included recommendations for therapeutic hypothermia post-ROSC.[4]

While post arrest survival has improved following the induction of mild hypothermia after ROSC, the institution of post arrest cooling has not been widely embraced in the United States.[3,5,6] According to a 2006 survey of physicians in the US, which included emergency, critical care physicians and cardiologists, the use of mild hypothermia following ROSC had never been implemented by 74% of respondents.[5,6] In contrast, a survey performed in Finland in 2005, where the large Hypothermia After Cardiac Arrest (HACA) trial was completed, 19 of 20 ICUs implemented mild hypothermia techniques following ROSC.[5] According to Majersik et al, 2,298 patients a year could have better neurological prognoses following ROSC if all US physicians incorporated post-ROSC cooling techniques.[6]

There are several barriers to the institution of mild hypothermia following ROSC that anesthesia practitioners must overcome. The barriers are multifactorial and include the typical financial, technical, and logistical constraints that plague the health care arena.[5] However, specific barriers exist that are unique to post ROSC cooling. These include knowledge deficit on current scientific evidence of the benefits of cooling patients post ROSC, lack of compliance with the 2010 AHA guidelines, and the misconception that cooling patients is a difficult process.[5]

The current literature review was undertaken to address the question, "In adults who have experienced cardiac arrest, does the implementation of post-ROSC hypothermia protocols result in improved neurological outcomes when compared to patients in whom normothermia is maintained post-ROSC?" The specific assessments for improved neurological outcomes are defined below. Neurological outcomes in the US may improve following ROSC if anesthesia professionals have a better understanding of the benefits of employing therapeutic hypothermia post ROSC, AHA guidelines, and techniques to begin cooling measures,.

Methodology

The Iowa Model of Evidenced-based Practice to Promote Quality Care was utilized for the evidence search. All types of literature were considered and narrowed to relevant research in clinical practice. The PICO (Population, Intervention, Comparison, Outcome) format was used to construct an evidenced based question. In this review the population was defined as patients who were 18 years or older with return of spontaneous circulation following cardiac arrest. The intervention investigated was mild hypothermia following post-ROSC and the comparison was normothermia following post-ROSC. The outcome of interest was improved neurological outcomes as defined by cerebral

performance categories (see *critique of the evidence*).

The purpose of the review of evidence was to determine if the induction of therapeutic hypothermia post-ROSC leads to superior neurological outcomes. Two questions framed the clinical review of evidence. The first question was, "in adults who have experienced ROSC after cardiac arrest, does the implementation of post-ROSC hypothermia protocols result in improved neurological outcomes compared to those in similar patients maintained with normothermia?" The second question asked was, "do the adverse effects of mild hypothermia following cardiac arrest outweigh the beneficial effects of this therapy?"

A systematic key word search was conducted on Ovid, PubMed and Google Scholar, as well as a general internet search. Further, an article was selected from the reference list following the original search method. Search terms employed were AHA guidelines, cardiac arrest, implementation, neuroprotection, ROSC, therapeutic hypothermia and systematic review. The primary evidence cited in this review was obtained from three meta-analyses (Level 1), 1 prospective study (Level 1evidence), two cost-effective or cost-benefit analyses (Level I evidence), 2 randomized clinical studies (Level I evidence), a case report (Level II evidence), and three peer reviewed articles.

Literature Review

Pathophysiology of Cerebral Cellular Death and Protective Effects of Hypothermia

Excitatory neurotransmitter production, intracranial pressure, and oxygen free radical formation/accumulation lead to necrosis and apoptosis.[2,7-10] Cerebral cellular death may begin within minutes and continue for hours following initial injury. Cellular demise is thought to be the result of a series of mechanisms where insufficient adenosine triphosphate (ATP) production occurs leading to the failure of ion pumps.[2,7] The malfunction of these pumps results in an influx of sodium and calcium and an efflux of potassium.[7] Terminal depolarization, cellular edema, and finally, cellular death occurs. There is also an accumulation of oxygen free radicals which results in an increased level of glutamate that stimulates ion-channels. This excess of oxygen free radicals causes the activation of degrading enzymes that finalizes in cellular apoptosis.[2,8]

Hypothermia attenuates neuronal death by decreasing apoptosis through the reduction of free radicals, as well as toxic levels of catecholamines and neurotransmitters such as dopamine and glutamate.[11]The protection of ATP stores and the preservation of the blood brain barrier are both additional benefits of cooling. Hypothermia may also decrease intracranial pressure and increase cerebral blood flow.[11]Other significant benefits of therapeutic cooling include an attenuation of mitochondrial dysfunction and an improvement in cerebral metabolism. Therapeutic cooling diminishes acidosis, production of toxic metabolites, and vascular permeability, which in turn decrease formation of neuronal edema. This process also abates formation of micro-thrombi, activation of the immune response, and seizure activity. Cerebral metabolic rate decreases 50% to 65% when core temperature drops to 32°C, which in turn lowers oxygen consumption and CO_2 production.[7] Cooling lowers metabolism[3], and specifically cerebral metabolic rate, approximately 8% through each 1°C decrease in core temperature[2] and improves tolerance for ischemia.[2,3]

Pathophysiology of Hypothermia and Re-warming

Although therapeutic hypothermia is beneficial for improving neurological outcomes, possible adverse effects of cooling may alter many systems in the body. As cooling begins, vasoconstriction occurs and electrolytes begin to move from the intravascular to intracellular spaces effecting the genitourinary system. During the initial cooling process in patients with normal renal function, diuresis occurs which may deplete calcium, phosphorus, sodium, magnesium, and potassium. Conversely, hyperkalemia may result during the rewarming process due to the eventual efflux of potassium. Hyperkalemia can be avoided by gradual re-warming. Fortunately, if patients are monitored closely for ventricular arrhythmias and electrolytes are replaced the potential negative effects of electrolyte surges can be averted.

Another potential adverse effect of hypothermia that occurs in the integumentary system is shivering. Shivering causes an increase in oxygen consumption. This increase in oxygen consumption may increase cerebral ischemia.[2,7] Administration of opioids, sedatives, anesthetic agents and neuromuscular blockaders will help alleviate these effects. Additionally, vasoconstriction may lead to poor tissue perfusion and stress ulcers.[2]

Another complication of cooling, which affects the endocrine system, is a reduction in insulin secretion. Hyperglycemia may occur and large doses of insulin must be administered to keep serum glucose within acceptable levels. Since the release of insulin is temperature dependent, insulin secretion will again increase when the patient is rewarmed and hypoglycemia may result. Therefore, glucose levels need to be monitored to avoid adverse fluctuations in blood sugar.[2,7]

Cardiovascular events may also occur with mild hypothermia. During hypothermia, a reduction in heart rate and cardiac output and an increase in myocardial contractility occur. Fortunately, the decrease in cerebral metabolic rate with the induction of hypothermia may obviate the reduction of cardiac output, resulting in a consistent or improved ratio of supply and demand.[2]

Other potential side effects of induced hypothermia include coagulopathies caused by platelet dysfunction and infections from a decreased synthesis of pro-inflammatory cytokines and inhibition of leukocyte migration.[2]One major concern associated with hypothermia induced platelet dysfunction is increased intracranial bleeding and intracranial hypertension in patients who suffer concomitant neurotrauma[2]. Fortunately, clinical studies have shown that severe bleeding and infections in patients who received cooling post-ROSC were no different compared to the control groups that received normothermia.[11]

Discussion

Although the International Liaison Committee on Resuscitation (ILCOR) in 2003 and the recent 2010 AHA guidelines support the use of cooling post-ROSC, the concept of therapeutic cooling for post arrest patients is fairly new.[11] The research states hypothermia greatly increases the chances of survival during an anoxic cerebral event.[11] For several years, certain surgical procedures, including neurosurgery, cardiac surgery and surgery requiring high aortic-cross clamping, have successfully employed hypothermic states for brain, spinal cord,

heart and kidney protection.[3] Experimental and clinical results describe the cerebral protective effect of cooling during as well as after ischemic insult[11] Two seminal studies published in 2002 about therapeutic hypothermia showed cooling post-ROSC improved neurological outcomes per the cerebral performance categories.[8,9] Numerous meta-analyses also demonstrate clear benefit to neurological outcomes with therapeutic cooling post-ROSC both short-term and long-term (survival up to six months).[6,10-12]

Critique of the Evidence

Five studies were included for analysis (see Table 1). Neurological outcomes were the primary outcome of interest in these studies. The trials included best neurological outcomes using a scale called the cerebral performance categories (CPC). The scale ranges from 1-5, with 1 indicating a good cerebral performance, 2 a moderate cerebral disability, 3 a severe cerebral disability, 4 a coma/vegetative state, and rating of 5 indicates certified brain death. A CPC score of 1or 2 indicates good neurological outcome. Secondary outcomes encompassed survival to discharge from the hospital, survival at six months, and survival at one year. The studies looked at the quality of life, ability to perform activities of daily living, and cost-effectiveness of the intervention.[11] Two studies were completed at multiple centers[12] and the other three were smaller, single-center trials.[10] Overall study results indicated that poor neurological outcomes were reduced, in hospital mortality decreased, and neurological outcomes improved in patients who received mild hypothermia treatments when compared to patients treated with normothermia after return of spontaneous circulation.[1,10-12]

The Hypothermia after Cardiac Arrest (HACA) study, which was undertaken by Holtzer et al, is the largest study to date in post arrest hypothermia and included 275 patients[9] from nine centers in five European countries.[11] This randomized, controlled study, which incorporated a blinded assessment outcome, included patients with a witnessed cardiac arrest. Comatose survivors presented with ventricular fibrillation as the initial cardiac rhythm and the presumed origin of arrest was cardiac dysrhythmia. Within 8 hours of arrest, bladder temperatures in the experimental patients were reduced to 32°C to 34°C and maintained at this level for 24 hours with a blanket that released cool air.[9,12] In the hypothermia group 75 of 136 (55%) patients had a favorable neurological outcome (CPC scores of 1 or 2) as opposed to 54 of 137 (39%) in those patients maintained at normothermia. Additionally, the rate of death six months after ROSC was 14% lower in the hypothermia group than the normothermia group. Although sepsis was slightly more prominent in the hypothermia group, P=0.70, this was not a statistically significant finding.[3,11,12]

The second largest study reviewed, included 77 patients who arrested following ventricular fibrillation at four hospitals in Australia.[3,8,12] Patients entering the study on odd days were randomized to a hypothermia protocol. Hypothermia was initiated with ice packs to the limbs, torso, head, and neck.

Normothermia was maintained in survivors who arrested on the even days.[12] In the patients where hypothermia was implemented, a core body temperature of 33°C was attained within two hours of ROSC and continued for 12 hours. Assessors of the patients' neurological outcomes were blinded to the post ROSC

Study	Number of Patients	Presenting Dysrhythmia	Target Temperature	Time to Target Temperature	Duration of Cooling	Method of Cooling	Favorable Neurological Outcome (CPC 1 & 2)	Poor Neurological Outcome (CPC 3 &4)	In hospital mortality	Risk Ratio 95% CI	p Value
HACA 2002	275	Ventricular Fibrillation or Pulseless Ventricular Tachycardia	32 – 34 °C	6 hours after initiation of cooling	24 hours	Cooling mattress (icepack PRN)	75/136 Hypothermia (55%) 54/137 Normothermia (39%)	61/136 Hypothermia (45%) 83/137 Normothermia (61%)	50/137 Hypothermia (36%) 69/138 Normothermia (50%)	1.51 (1.14-1.89)	.006
Bernard et al 2002	77	Ventricular Fibrillation	33 °C	2 hours after ROSC	12 hours	Icepacks	21/43 Hypothermia (49%) 9/34 Normothermia (26%)	22/43 Hypothermia (51%) 25/34 Normothermia (73%)	22/43 Hypothermia (51%) 23/43 Normothermia (53%)	1.75 (0.99-2.43)	.052
Hachimi -Idrissi et al 2001	30	Asystole or Pulseless Electrical Activity (PEA)	34 °C	3 hours after initial cooling	Until target temp reached	Cooling Helmet	Not reported	Not reported	13/16 Hypothermia (81%) 14/14 Normothermia (100%)	7.41 (0.83-infinite)	.15
Mori et al 2002	54	Not Reported	32 – 34 °C	Not Reported	72 hours	Not Reported	Not reported	18/36 Hypothermia (50%) 16/18 Normothermia (89%)	N/A	unknown	unknown
Petovic et al 2011	82	Any rhythm before cardiac arrest	32 – 34 °C	Within 3 hours of initiation of cooling	24 hours	Infusion of cooled IV fluids Ice-packs or cooling pads	24/45 Hypothermia (53%) 7/37 Normothermia (19%)	21/45 Hypothermia (47%) 30/37 Normothermia (86%)	20/45 Hypothermia (44%) 30/37 Normothermia (81%)	unknown	.003

Table 1: Review of the Current and Seminal Study Methods and Findings for Improved Neurological Outcomes Following Institution of Post ROSC Hypothermia

intervention. Twenty-one of forty-three patients (48.8%) in the hypothermia group had good neurological prognosis, which included patients that were discharged home or to a rehabilitation facility, as opposed to nine out of thirty-four (26.4%) in the normothermia group (P=0.046).[3,8]

Several meta-analyses looked at the HACA study, the Bernard et al trial, and a third study by Hachimi-Idrissi et al, which was a feasibility study using 33 patients, cooling half the patients with a helmet. In this additional study, comatose survivors presented with PEA or asystole. Overall results using the CPC score in four studies showed an increase in favorable neurological outcomes using the therapeutic hypothermia technique compared to the normothermia approach.[10-12] One study evaluated long-term outcomes examining mortality at six months and the presence of good neurological function. A higher incidence of survival and good neurological outcomes existed in the induced hypothermia group. There were no significant differences between the control groups using normothermia and the study groups using cooling post ROSC with regard to adverse events. Adverse events included sepsis, renal failure, severe bleeding, need for platelet transfusion, renal failure, pneumonia, pulmonary edema, pancreatitis, hemodialysis, cardiac complications, long lasting arrhythmias, hypophosphatemia, hypocalcemia, and pancreatitis.[11]

An additional study reviewed was a prospective study, which included 82 comatose patients who experienced ROSC following cardiac arrest. Intravascular cooling with external cooling or external cooling with cooling pads was used to induce hypothermia in 45 patients. In the control arm of this study 37 patients were treated with normothermia. A good neurological outcome, assigned with a CPC score of 1, was demonstrated in 46.7% of the therapeutic or mild hypothermia patients as opposed to 18.9% in the normothermia group, (P=0.006). Additionally, there was a 51.1% survival rate in the group treated with therapeutic hypothermia compared to only 18.9% in the normothermia group with a statistical significance (P=0.003). These results demonstrate congruence with the positive findings from the studies discussed above for the favorable neurological outcomes following induced hypothermia.[1]

Limitations of the literature review were that several of the studies utilized different cooling techniques and there were differences in time to initiation of cooling, and length of time the patients were cooled. Also, during the literature review no published trials were found that included statistically significant negative findings after post arrest cooling, although unpublished trials may exist. An additional limitation of the literature review was that neurological outcomes were only assessed with a single metric, the cerebral performance categories (CPC).[10]

Limitations of the current literature include the lack of specific guidelines for the institution of cooling measures. The AHA supports post ROSC induced mild hypothermia, but does not support one cooling method above others. There are many cooling techniques to reach a therapeutic temperature, including but not limited to the use of ice packs, cooling mattresses, placement of a cooling helmet, extracorporeal circulated blood cooling, administration of cold intravenous solutions and cold water immersion.[7] The reported times to goal temperature in the reviewed studies varied from 2 to 6 hours and duration of cooling varied from 0-24 hours.[10]As a consequence of variations in published

techniques, individual hospitals don't employ uniform practices. Adverse effects of cooling such as hemorrhagic complications, increased risk for infection, and immune deficiency may ensue, but with neurological demise and death as alternative outcomes, the overall positive effects of post arrest hypothermia suggested in the literature outweigh the complications of induced hypothermia.[12]

Table 1: Review of the Current and Seminal Study Methods and Findings for Improved Neurological Outcomes Following Institution of Post ROSC Hypothermia

The AHA recommends designation of cooling centers to ensure patients can be cared for at a center capable of inducing mild hypothermia safely. The requirement for hospitals to become established cooling centers has yet to be mandated. It has been suggested that each care center involve key professional nurses and physicians to formulate guidelines for the implementation of post ROSC mild hypothermia.[5] Inclusion and exclusion criteria for inducing post ROSC hypothermia has been suggested (see Table 2). The initiative to involve key professionals might be as effective as those surrounding the implementation of β-blockade to decrease myocardial infarction which were lead by medical professionals with strong leadership skills in the last decade.[5]

Inclusion Criteria: Witnessed arrest with less than 60 minutes of "down time"

Exclusion Criteria: [7]

- Existing do-not-resuscitate status
- Core temperature less than 35.0°C after cardiac arrest
- Age less than 18 years or greater than 85 years
- Chronic renal failure
- Severe bradycardia without a temporary pacemaker
- Sustained refractory ventricular arrhythmias
- Active bleeding, gastrointestinal bleeding
- Intracerebral hemorrhage
- Shock and traumatic full arrest
- Persistent hypotension despite the use of vasopressors and adequate intravenous fluid replacement
- Coma or severe neurologic dysfunction prior to arrest
- Platelet count less than 50 x $10^3/\mu L$ or known coagulopathy
- Drug intoxication

Table 2: Inclusion and Exclusion Criteria for Induction of post ROSC Hypothermia

Conclusion

A poor prognosis is associated with sudden cardiac arrest.[10] Current research demonstrates one out of five patients (20%) treated with mild hypothermia post ROSC will have a favorable neurological outcome, i.e. a CPC score of 1 or 2. Anesthesia practitioners involved in post arrest resuscitation may positively impact patient outcomes by advocating for the implementation of post ROSC hypothermia protocols in their institutions. While Finland and Norway have implemented therapeutic cooling guidelines nationwide, the United States has been slow to adopt similar initiatives.[3,5] Barriers to implementation cannot be fully explained by financial, technical, or logistical constraints alone.[5] Impediments to implementation appear to rest on lack of knowledge, opinions, organizational constraints, lack of advocacy, and lack of motivation.[5] The anesthesia practitioner must stay abreast of and advocate for hospital policies instituting cooling measures post arrest to increase positive neurological outcomes after ROSC. By understanding the benefits and risks of therapeutic cooling post-ROSC, and through patient advocacy, anesthesia practitioners in the United States can assist in the implementation of therapeutic hypothermia guidelines to improve patients' neurological outcomes.

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Mentor: Käryn K. Embrey, CRNA, EdD

Editorial

I am just returning from the AANA Annual Meeting that was held in San Francisco where I had the opportunity to speak with many of the volunteer editors and reviewers that continue to make this journal a reality. We shared new ideas and discussed the purpose of the student journal. Our goal is to provide student nurse anesthetists with an introduction to the process of peer-reviewed publication in the hopes of encouraging more advanced scholarly writing and dissemination in the future. Many students are producing great work that is often never published – we discussed the possibility of adding a 'literature review' option for submission. I would welcome any comments regarding this idea – the challenge is allowing for adequate coverage of the topic while maintaining a reasonable length for our reviewers.

I've also had some questions about accepting submissions from CRNAs who are pursuing doctoral degrees. At this time the journal will continue to accept submissions only from graduate students enrolled in their initial preparation to become nurse anesthetists (regardless of the degree awarded at graduation). As described earlier, this journal serves as primer for new writers and will continue to review and publish items of shorter length. This (hopefully) allows for a more rapid submission to publication timeframe, and a positive experience for the authors, editors, and reviewers!

Best,

Vicki C. Coopmans, CRNA, PhD
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.**"

To access prior issues of the ISJNA visit the following link:

www.aana.com/studentjournal

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 ^{o}C, pressure in mm Hg or cm H_20.
   c. In general, first use of pulmonary/respiratory abbreviations should be expanded, with the following exceptions: O_2, CO_2, PCO_2, $PaCO_2$, PO_2, PaO_2. Please use SpO_2 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 <u>one</u> 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 <u>patient</u> 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 <u>patient</u> 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.)

<u>Case Reports</u>

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. Diagrams 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 programs 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
Goldfarb School of Nursing at Barnes-Jewish College
4483 Duncan Ave., Mailstop 90-36-697
St. Louis, MO 63110

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.