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TOPICS IN THIS ISSUE

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Front Cover:

On the front cover, Lauren Gibbons, BSN, RN (left) and Emily Gonzalez, BSN, RN (right), doctoral students enrolled in the Cizik School of Nursing at UTHealth Houston Nurse Anesthesia Program, practice arterial line placement using a task trainer during a skills session in the simulation center.

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Airway Management for the Patient with Angioedema

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Keywords: Angioedema, anesthesia, airway management

Every year, over 100,000 Americans present to the emergency room with angioedema. Roughly half of these cases are caused by angiotensin converting enzyme inhibitors (ACEI).[1] ACEI-induced angioedema (ACEI-IA) presents as acute swelling targeting the submucosal and subcutaneous tissues.[1] Because the face, lips, tongue, and neck are typically affected, angioedema can place the patient at risk for an airway emergency. It is imperative for anesthesia practitioners to understand this ACEI-IA and provide thorough airway management plan, ensuring that the patient can be safely cared for.

Case Report

The patient was a 78-year-old female with a history of hypertension and gallstones presenting for an endoscopic retrograde cholangiopancreatography (ERCP). The case had an increased level of complication due to the patient having experienced an acute ACEI-IA episode from newly prescribed lisinopril less than 24-hours prior. The patient had diffuse swelling throughout the oropharynx and upper and lower lips with blisters beginning to form on the tongue. ERCPs are able to be completed in the supine or prone position, the proceduralist was requesting prone position during the ERCP. As this was a more complicated patient, the anesthesia team prepared a plan to safely administer general anesthesia and intubate the patient.

The anesthetic strategy involved use of the GlideScope (Verathon, Inc.) with blade size 3 and intubation with 6.0 mm endotracheal tube (ETT) with a fiberoptic scope was in the procedure room in event a fiberoptic intubation was necessary. In the event neither of these methods were effective, full reversal of rocuronium with a rescue dose of sugammadex and potential cricothyrotomy would be considered as emergent options. Additionally, the patient had been pretreated on the floor with antihistamines, and decadron. Preprepared epinephrine was also on hand in case swelling increased. After satisfactory denitrogenating with O_2 ? L/min via facemask to achieve an EtO_2 of 0.90, intravenous induction was achieved with lidocaine 100 mg and propofol 100 mg followed by a propofol infusion initiated at 50 mg/kg/min. Ventilation was achieved with 2 providers: one jaw thrusting and holding a 2-handed mask seal while the other gave breaths from the reservoir bag on the anesthesia machine.

After ventilation was confirmed, rocuronium 50 mg IV was administered. Prior to inserting the GlideScope, lubrication was placed on the patient's lips and tongue as well as on the blade and ETT to help prevent damage to the friable, swollen, mucosa and tongue. A Cormack-Lehane grade 2 view secondary to soft tissue swelling was obtained and the 6.0 mm ETT was successfully placed. Sevoflurane 2% inspired concentration was initiated.
Following confirmation of placement by auscultation of bilateral breath sounds, the ETT was secured and the patient was prepared to be positioned prone. Care was taken to ensure that the ETT did not migrate. After position change, proper placement of the ETT was confirmed by

auscultation for equal bilateral breath sounds again. Following ETT placement and prone positioning, cefazolin 2 g and dexamethasone 10 mg were given IV. The ERCP proceeded without complication. At the end of the procedure, the patient was repositioned supine, ensuring the ETT remained secured and did not migrate.

Once supine, the sevoflurane and propofol infusion were discontinued and acetaminophen 1000 mg IV and ondansetron 4 mg IV were given. The patient had 4/4 twitches following train of four monitoring and was given sugammadex 200 mg IV to antagonize muscle relaxation. Tidal volumes were > 400 mL and the patient was following commands; she was extubated without complication. The patient was transported on nasal cannula 4L/min to the post operative care unit (PACU) where she was monitored. She was subsequently transferred back to the floor to be observed overnight to confirm no delayed postoperative complications from airway manipulation.

Discussion

Angiotensin converting enzyme inhibitors are a class of drugs that target the angiotensin converting enzyme, preventing the conversion of angiotensin 1 to angiotensin 2.[3,4] This stops the renin angiotensin aldosterone system (RAAS) from increasing blood pressure.[3,4] However, ACEIs inhibit other factors in addition to angiotensin converting enzymes. Kininase II, an enzyme that inactivates bradykinin, has also been shown to be negatively affected by ACEI.[3] The inadvertent accumulation of bradykinin leads to increased vasodilation and vascular permeability, eventually causing angioedema.[2- 4]

Less than 0.5% of patients taking ACEI will ever experience ACEI-IA.[2] There are several risk factors that increase this risk including female gender, African descent, smoking, seasonal allergies, daily aspirin, age greater than 65, and history of a C1-inhibitor deficiency.[2,4] Patients are at highest risk for experiencing ACEI-IA within the first 30 days of starting an ACEI.[5] The patient in the above case report was at risk for ACEI-IA. They were female, of African descent, with seasonal allergies, and age greater than 65. They had no known history of C1-inhibitor deficiency and were not a current or former smoker. Additionally, they were newly prescribed lisinopril within the last 30 days prior to ACEI-IA.
Those who develop ACEI-IA should discontinue taking ACEIs immediately.[2,4] Patients who continue to take ACEI after an ACEI-IA episode can present with ACEI-IA within10 months of their last ACEI-IA event.[5] Less than 20% of patients with ACEI-IA require inpatient admission for observation.[5] However, the risk of severe airway obstruction is a possibility in patients with ACEI-IA, requiring the anesthetic practitioner to be well versed in the management of these patients.

When managing ACEI-IA, it is important to be aware that there are other causes of angioedema including hereditary angioedema (HAE). When treating angioedema, often antihistamines, steroids, and epinephrine have been found to have reduced efficacy or even be refractory in the patient with ACEI-IA.[4] Nonetheless, the anesthesia provider should still administer these medications as they may aid in acute ACEI-IA, preventing the progression of worsening edema.[4] Administering these medications will not cause further harm to the ACEI-IA patient.

Additionally, it can be a means to rule out if the patient is experiencing HAE or ACEI-IA. Unlike ACEI-IA, a patient with HAE will respond to antihistamines, steroids, and epinephrine. Interventions which target the increased bradykinin levels seen with ACEI-IA include bradykinin B2-receptor antagonists, kallikrein inhibitors, and complement-1 esterase inhibitors.[4] An example is icatibant, a bradykinin B2-receptor antagonist that resolves the acute episode of angioedema in 8 hours.[4] Most ACEI-IA episodes self-resolve in 24-72 hours.[4] Unfortunately, the small community hospital where the above case report took place did not have access to icatibant. Additionally, fresh frozen plasma (FFP) may be administered to patients suffering from ACEI-IA.[4] The FFP contains C1-INH and ACE which can help to reduce levels of bradykinin. Prior to administering FFP, risks vs. benefits should be evaluated for the potential complications that come with transfusing blood products.

All patients with ACEI-IA should be closely evaluated and monitored for progressing airway edema. A modality to assess airway patency is to have the patient phonate the letter "E."[5] In the event the patient is unable to do this, they are at a higher risk for having laryngeal edema.[5] Any signs of diffuse airway swelling including stridor, hoarseness, or dyspnea should be considered for advanced airway intervention. When confirming the extent of airway edema, it is important to remember that increased manipulation can lead to worsening angioedema. Use of oral airways or laryngeal mask airways should be avoided.[5,4] Fiberoptic technology can be used to evaluate the extent of airway edema.[4,5] When available, video laryngoscopy and fiberoptics are preferable to direct laryngoscopy as they allow the anesthetic provider to visualize the extent of airway edema while minimizing airway manipulation.[5] Depending on degree of airway severity and anesthetic provider comfort level, anesthetic practitioners can choose to perform an awake or sedated intubation.[5] The patient would need to be willing to participate in an awake intubation and risks and benefits for each technique be fully evaluated. In rare cases, the anesthetic practitioner may be required to perform a cricothyrotomy in order to secure the airway.[5, 4]

When caring for the ACEI-IA patient, anesthetic practitioners should take time to ensure a thorough airway management plan has been laid out with backup plans in the event of worsening airway edema. In this case report, the anesthesia practitioners took the time to create an anesthetic plan to secure the patient's airway safely and efficiently. Utilizing the GlideScope and avoiding the placement of oral airways or increased airway manipulation aided in successful intubation. In this case, it could have been been beneficial for the anesthesia team to consider delaying the case until the ACEI-IA had resolved. Additionally, an awake intubation or a fiberoptic airway evaluation prior to GlideScope intubation could have also proven helpful to get a better understanding for the degree of airway swelling. Lastly, the providers could have done a cuff-leak test prior to extubation to confirm if any subsequent airway swelling occurred. If the cuff-leak test was negative the providers could have confirmed swelling by a final assessment with the GlideScope or fiberoptic. Regarding the severity of airway compromise that can occur with ACE-IA, the anesthesia caregiver cannot be overprepared.

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Anesthetic Management of a Child with Sickle Cell Disease

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Keywords: Sickle cell disease, avascular necrosis, pediatric anesthesia, core decompression

Sickle cell disease (SCD) results when a person's genotype contains a set of homozygous sickle cell genes (HbSS), or one sickle cell gene paired with another hemoglobin gene mutation (HbSC). Through evolution, the mutated sickle cell gene (hemoglobin S) has expressed its highest incidence amongst Central Indians, Middle Easterners, and Africans.[1] Polymerization of hemoglobin S (HbS) creates sickle-shaped red blood cells that can cause microvascular occlusion and pain.[1] This polymerization process is activated by inflammation, vascular stasis, hypoxia, vasoconstriction, increased blood viscosity, hypotension, dehydration, hypothermia, acidosis, and stress.[1]

Case Report

An 11-year-old, BMI 33 kg/m^2, male with SCD (HbSC) and avascular necrosis presented for a left hip core decompression. The patient was admitted the night prior to the scheduled surgery for intravenous (IV) hydration and laboratory testing. Although this patient was admitted prior to the scheduled surgery date for hydration optimization, and his preoperative hemoglobin was 9.7 g/dl (with a goal of 10 – 11.5 g/dl per his hematology team), preoperative blood transfusions were not administered. Preoperatively, the patient received midazolam 2 mg IV and was transported to the operating room where standard non-invasive monitors were applied and O_2 8 L/min was administered via mask for 4 minutes. Induction included lidocaine 1% 40 mg and fentanyl 100 mcg, followed by propofol 200 mg IV. Once apneic and unconscious, adequate bag mask ventilation was confirmed, then rocuronium 50 mg IV was given. Mask ventilation continued for 3 minutes. The trachea was intubated with a 6 mm cuffed oral endotracheal tube

(ETT) and correct placement of the ETT was confirmed. Pressure control ventilation was initiated. Anesthesia was maintained with sevoflurane 2% in O_2 1 L/min and air 1 L/min.

After a timeout, anesthesia professionals who specialized in administering pediatric peripheral nerve blocks placed a single shot fascia iliaca block in the left lower extremity. The peripheral nerve block contained 0.35% ropivacaine 20 mL, 0.2% ropivacaine 15 mL, and clonidine 30 mcg. A second 20g IV catheter was placed in the left forearm. Dexamethasone 4 mg IV and cefazolin 1500 mg IV were administered. An upper body forced air warmer and warmed IV fluid were used. Additional analgesic management was administered in divided doses. A total of 0.6 mg hydromorphone IV, acetaminophen 1g IV and ketorolac 30 mg IV were given. Continuous IV fluids totaled 900 mL and blood loss was estimated to be 30 mL total. The duration of the procedure was approximately 4 hours.

Upon completion of the surgical procedure, the surgeon infiltrated bupivacaine into the incisional area. Sevoflurane was discontinued and O_2 8 L/min were administered. Ondansetron 4 mg IV was given. A train of four count of 4/4 was observed before administering sugammadex 150 mg IV. The trachea was then extubated with airway reflexes intact, and a facemask was placed with O_2 6 L/min. The patient was continuously monitored while transported to the post-anesthesia recovery area with stable vital signs and oxygen saturation. The patient did not express any signs of pain and was normothermic.

Discussion

Avascular necrosis occurs in up to 10% of people with SCD.[2] It is a consequence of bone ischemia that results from blood vessel occlusion.[2] Symptoms fall within a wide range from asymptomatic to bone necrosis and severe pain. Specifically, avascular necrosis involving the hip can cause pain in other areas such as the back, knee, and groin.[2] In these instances, treatment may include core decompression to remove the necrotic tissue in an effort to decrease pain and delay further joint damage.[2]

When caring for a surgical patient with SCD, caution must be taken to avoid exacerbating manifestations of the disease. Anesthetic management priorities include maintaining optimal hydration, normothermia, oxygenation, acid-base status and careful positioning.[1] The patient presented in this case study was admitted as an inpatient prior to the procedure to ensure optimal intravenous hydration, as dehydration supports polymerization and the sickling of cells.[3] Patients with SCD undergoing a surgical procedure are prone to vaso-occlusive crises, increased risk of peri-operative mortality, congestive heart failure and postoperative infection.[1]

Anesthetic management should prioritize preventing sickle cell crisis. A sickle cell crisis occurs when tissues are deprived of oxygen. It is characterized by recurring vaso-occlusive episodes, intense pain and, in extreme situations, end organ damage.[4] Causes of an acute sickle cell crisis are anxiety, hypoxemia, hypothermia, infection, venous stasis, dehydration, increased blood viscosity, and acidosis.[1] Hypoventilation leading to hypoxemia or acidosis may exacerbate SCD symptoms.[1] Hypothermia may contribute to sickle cell crisis through its hypothesized tendency to cause vasoconstriction, resulting in slowed capillary transit, and clustered red cell masses that can impede blood flow.[1]

Acute chest syndrome (ACS) is a serious complication of SCD that is characterized by radiodensity on a chest x-ray, respiratory distress, and fever. Common triggers of ACS in pediatric SCD patients are infection, vaso-occlusive pain and asthma.[5] ACS results when there is an impedance to flow within the pulmonary vasculature attributable to vaso-occlusion.[5] It can also result from respiratory depression that may occur from opioid use and fluid overload.[1] Treatment includes adequate pain management, bronchodilators, transfusions to increase oxygen carrying capacity, and antibiotics if there is suspected infection.[5]

Blood transfusions in the preoperative phase are sometimes administered to SCD patients to reduce the percentage of hemoglobin S, improving oxygen delivery to tissues and thereby reducing the incidence of ACS and vaso-occlusive pain episodes.[6] This predominantly pertains to patients with HbSS, as patients with HbSC show a less severe presentation of SCD and experience less complications.[7] Blood transfusions can lead to adverse events, as there is an increased risk of infection and increased blood viscosity, both of which can increase the risk of polymerization.[1] According to existing evidence, there is no significance in difference of perioperative complications between SCD patients who receive preoperative blood transfusions and those who do not.[1] Furthermore, when the hemoglobin is maintained at 10 g/dl, or just below, there is an overall benefit of improved blood flow and oxygen delivery to tissues, and the risk of increased viscosity related to transfusions is avoided.[1]

Because SCD patients may frequently require surgical procedures for secondary comorbidities, it is important that anesthesia practitioners are aware of the factors that can worsen SCD, as many of these are influenced by surgical conditions and anesthesia. Because hypoxia is a main trigger of sickle cell crisis, it is vital that accurate oxygen saturation measurements are obtained throughout the perioperative period. There have been reported discrepancies in oxygen saturation between pulse oximetry and arterial blood gas values in pediatric patients with SCD.[1] Anesthesia professionals must also consider the studies that suggest an overestimation of oxygen saturation when assessing the corresponding arterial blood gas values in patients with darker skin complexions that are common in SCD patients.[8] Although the patient presented in this case study was monitored solely with non-invasive monitoring, there could be benefit in placing an arterial line in SCD patients to confirm adequate oxygenation.

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Microvascular Decompression for Trigeminal Neuralgia

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Keywords: Trigeminal neuralgia, motor evoked potentials, somatosensory evoked potentials, brainstem-auditory evoked potentials, lumbar drain

Trigeminal neuralgia (TN) is a rare disorder affecting the trigeminal nerve. This disorder is associated with extreme bursts of pain in the region innervated by the trigeminal nerve, often causing impaired daily life.[1] Conservative treatment includes sodium channel blockers and anticonvulsants, while more progressive treatment includes surgical intervention.[1] This case report discusses the anesthetic management of a patient undergoing microvascular decompression of the trigeminal nerve root via suboccipital craniectomy.

Case Report

A 71-year-old 84 kg male presented for an elective suboccipital craniectomy with microvascular decompression of the right trigeminal nerve root for treatment of TN. The patient's medical history included hypertension, gastroesophageal reflux disease, hypothyroidism, and diabetes mellitus type 2. His surgical history included an appendectomy, knee arthroscopy, herniorrhaphy, and transurethral resection of the prostate. The patient was taking carbamazepine 200 mg four times daily and baclofen 10 mg two times daily. Despite both medications, the patient sought further treatment for unbearable pain in the maxillary nerve (V2) distribution of the right trigeminal nerve due to compression by the superior cerebellar artery, as seen on magnetic resonance imaging. On the morning of surgery, vital signs and lab values were within normal limits. The patient was neurologically intact, other than complaints of pain rated 5 out of 10 in the V2 distribution area.

Upon entering the operating room, the patient sat upright on the operating table, and standard noninvasive monitors were applied. A lumbar spinal drain was inserted between the L3 and L4 spinous processes with positive cerebrospinal fluid (CSF) drainage; the lumbar drain was clamped. The patient was repositioned supine, oxygen was administered via the anesthesia circuit at 10 L/min, and fentanyl 100 mcg, propofol 150 mg and succinylcholine 160 mg were given intravenously. The trachea was intubated with a 7.5 mm endotracheal tube, and mechanical ventilation was initiated. Bite blocks were placed between the jaws bilaterally. General anesthesia was maintained with sevoflurane at an expired concentration of 0.8-1.2% in O_2 2 L/min. An arterial line and a second intravenous catheter were placed, and an intravenous infusion of remifentanil was initiated at 0.15 mcg/kg/min. A Foley catheter was placed, the patient was positioned in the left lateral decubitus position, and the operating table was rotated 180 degrees. At this time, a neuromonitoring technician ensured that all somatosensory evoked potential (SSEP), motor evoked potential (MEP), and brainstem-auditory evoked potential (BAEP) monitors had strong signals with four out of four muscle twitches.

Before the surgeon secured the patient's head in Mayfield skull pins (Integra LifeSciences, Princeton, New Jersey), the remifentanil infusion was increased to a rate of 0.2 mcg/kg/min, and a bolus of propofol 80 mg was given. Throughout the case, the expired concentration of sevoflurane was maintained between 0.8-1.5%. The remifentanil infusion was titrated between 0.1-0.2 mcg/kg/min based on vital signs. Additional neuromuscular blockade was not administered. After the dura was opened, mannitol 50 g was administered. Additionally, the lumbar drain was opened intermittently to drain specified volumes of CSF. Fluid administration was limited to 700 mL of 0.9% sodium chloride throughout the two-hour surgical time, estimated blood loss was 100 mL, and urine output was 600 mL.

The patient remained hemodynamically stable throughout the case and the endotracheal tube was removed. The lumbar drain was removed, and he was initially sent to the post-anesthesia care unit, followed by the intensive care unit for close neurologic observation. On postoperative day one, the patient reported mild numbness around the right side of his mouth along the mandibular nerve (V3) distribution of the trigeminal nerve. Otherwise, he remained hemodynamically stable and neurologically intact. On postoperative day three, the patient was discharged from the hospital.

Discussion

Trigeminal neuralgia is a rare neurologic disorder presenting as brief, recurring episodes of sharp pain throughout the trigeminal nerve distribution of the face.[1] This disorder can be debilitating and lead to decreased quality of life and suicidal ideations in patients.[1] The pathophysiology of this disease is thought to be a result of nerve root compression and abnormal voltage-gated sodium channel expression.[1] Initial treatment includes sodium channel blockers and continued symptoms may be treated with anticonvulsants, botulinum toxin type A, muscle relaxants, and intravenous infusions of local anesthetics.[1] Patients who have exhausted multiple therapies may elect for surgical intervention, with the first choice being microvascular decompression of the trigeminal nerve root.[1] In this case, the patient had exhausted multiple pharmacological therapies and decided on surgical intervention.

Surgery involving the brain, spinal cord, or nerves presents a risk of sensory or motor dysfunction, and intraoperative neuromonitoring is helpful in detecting deficits early on. Evoked potentials monitor somatosensory, motor, auditory, and visual impulses and can be used to detect nerve damage during surgery.[2] Amplitude and latency are measured on evoked potential waveforms. Any increased latency or decreased amplitude may suggest ischemia.[2] Anesthetic agents can impact the amplitude and latency of evoked potentials.[2] Neuromonitoring technicians are responsible for monitoring evoked potentials, but anesthesia professionals must develop an anesthesia plan that promotes ideal monitoring conditions.

For this case, the surgeon requested monitoring of SSEPs, MEPs, and BAEPs due to the location of the trigeminal nerve in relation to other cranial nerves. The vestibulocochlear nerve, or cranial nerve VIII, is monitored with BAEPs, and changes in the amplitude and latency of these waveforms can predict hearing loss after surgery.[3] Unlike other evoked potentials, BAEPs are the most resistant to the effects of intravenous anesthetic agents but are affected by inhaled anesthetics in a dose-dependent fashion.[2] Monitoring of SSEP and MEP waveforms provides information regarding the sensory and motor function of the brain and spinal cord. Anesthetics play an important role in monitoring both SSEPs and MEPs as both are highly sensitive to inhaled anesthetics, particularly sevoflurane, mainly when used at exhaled concentrations greater than 0.7 minimum alveolar concentration (MAC).[4] While neuromuscular blockade does not affect SSEP monitoring, it does inhibit monitoring of MEPs as it eliminates motor action potentials and, therefore, should be avoided. Additionally, opioids have been shown to have no effect on SSEPs, MEPs, or BAEPs.[2] During this case, the exhaled concentration of sevoflurane was maintained at less than 0.7 MAC based on the patient's age, and neuromuscular blockade was avoided after the initial intubating dose of succinylcholine. Varying concentrations of volatile anesthetics have been used during neuromonitoring, with some research recommending concentrations as high as 0.7 MAC and others recommending less than 0.5 MAC or avoiding volatile anesthetics entirely.[2,4] A remifentanil infusion was utilized throughout the entirety of the case and titrated based on sympathetic response to stimulation. Communication was made between the neuromonitoring technician and anesthesia professionals to ensure that all evoked potential signals were strong while maintaining an adequate depth of general anesthesia.

A key component of nerve decompression is adequate surgical exposure, which may require relaxation of the brain. Intravenous osmotic diuretics, such as mannitol, can be given to shift fluid from the brain to the intravascular space to reduce the brain's volume.[5] Mannitol and other osmotic diuretics can result in adverse side effects such as hypovolemia, hyperkalemia, and renal insufficiency, therefore, careful monitoring of fluid status is necessary intraoperatively and postoperatively.[5] Lumbar drains can also be used to drain volumes of CSF, either continuously or intermittently, from the subarachnoid space, which helps to promote brain relaxation.[5] Draining CSF through a lumbar drain does not affect the body's blood volume and has been proven safe and effective; however, over-drainage of CSF can result in brain herniation and intracranial hemorrhage.[5] During this case, mannitol was given after the dura was opened, and as more brain relaxation was required, the surgeon requested that the anesthesia professionals drain specified volumes of CSF at various times.

Creating an anesthetic plan for patients undergoing neurosurgery utilizing neuromonitoring requires careful thought and consideration. The anesthetics chosen for this case were based on

current research that suggests which medications have the least effect on evoked potentials. A combination of sevoflurane and remifentanil worked together to provide a deep general anesthetic in which the patient would not move while avoiding paralytics. Mannitol was given to promote brain relaxation, but CSF drainage was also necessary. In retrospect, giving the mannitol earlier in the case may have helped reduce the need to drain CSF from the lumbar drain. Overall, the patient's neurologic outcome improved with seemingly decreased trigeminal neuralgia symptoms in the V2 distribution. He experienced numbness in the V3 distribution, but this could have been a temporary result of surgery.

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Transfusion Reaction Acute Lung Injuries

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Keywords: transfusion, lung injury, acute lung injury, transfusion-related injury, transfusion complication, treatment for lung injury, post-operative lung injury, TRALI

In 2019, over ten million units of RBC were transfused in the United States.[1] Transfusion-Related Acute Lung Injury (TRALI) is one of the leading causes of mortality following the transfusion of blood products.[2] Among the various transfusion reactions, TRALI has the highest mortality rate, estimated at approximately 43 percent.[2] Transfusion products containing plasma can trigger TRALI.[3] Due to the complexity of the disease process associated with TRALI, there are currently no specific diagnostic tools available; diagnosis relies solely on clinical presentation and disease progression.[3] TRALI highlights the critical importance for anesthesia practitioners to understand that the transfusion of blood products carries significant risks.

Case Report

A 29-year-old female presents to the operating room (OR) for an urgent exploratory laparoscopy. The suspected hemorrhage occurred following an emergent cesarean section performed under a subarachnoid block because of fetal distress the previous day. This 89.4 kg, 163 cm, G2P1 patient had no known drug allergies. Past medical history included essential hypertension, postpartum hemolysis/elevated liver enzymes/low platelet syndrome, asthma, migraines, and restless leg syndrome. The patient was on two separate blood pressure medications: nifedipine 30 mg once per day and labetalol 100 mg twice per day; however, the patient reported not taking them the day of surgery. Asthma was controlled by a ciclesonide inhaler and the leukotriene inhibitor montelukast. The estimated blood loss reported by the surgeon for the emergent cesarean section was approximately 495 mL. Her post-cesarean hemoglobin (Hgb) and hematocrit (Hct) were 12.3 g/dL and 40.1% respectively. All other laboratory values were within normal limits.

Her laboratory values just prior to arrival in the OR were as follows: Hgb 5.9 g/dL, Hct 16.7%, and platelets 95 $x10^9$/L. An emergent airway assessment revealed a Mallampati score of 1, full range of neck motion, oral opening greater than three fingers, and thyromental distance greater than three fingers. The patient arrived at the OR with an 18-gauge peripheral intravenous (IV) access in the left forearm with a Lactated Ringers (LR) infusion running to gravity. She received oxygen support via a non-rebreather face mask with 15 L/min of oxygen, and standard non-invasive monitors were in place. Her vital signs were as follows: heart rate (HR) 115/min, respiratory rate (RR) 26/min, blood pressure (BP) 98/54 mm Hg, and SpO_2 of 100%. A second 18-gauge IV was placed in the patient's right forearm prior to the subarachnoid block ensuring adequate vascular access. In addition, the IV access provided a dedicated IV line for the infusion of blood products. A subarachnoid block was placed successfully at L3-L4 using fentanyl 15 mcg, morphine 0.1 mg, and 10 mg of 0.75% bupivacaine in the supine position. Pre-incision medications included midazolam 4 mg, metoclopramide 10 mg, tranexamic acid 1 g, and cefazolin 2 g.

The laparoscopy revealed two large blood clots at the rectus abdominis; blood was also noted on the right superior aspect of the rectus abdominis. The uterus inspection revealed good hemostasis. Topical thrombin was utilized to help with hemostasis at the rectus muscle. The patient received 1000 mL LR, four units of packed red blood cells (PRBC), two units of fresh frozen plasma (FFP), and one pack of platelets throughout the procedure. The patient's estimated blood loss was 2.2 L for this procedure.

Approximately onehour post-operation, the patient began to experience dyspnea with SpO2 75% on room air. A non-rebreathing face mask was placed on the patient, delivering O_2 at 15 L/min. Four actuations of albuterol 90 mcg/actuation were administered along with furosemide 20 mg IV. An additional dose of Furosemide 40 mg was administered IV. She was placed on bilevel-positive airway pressure and transferred to the intensive care unit (ICU).

A portable chest x-ray was completed upon arrival to the ICU, revealing hypo-inflation of the lungs and patchy infiltrates scattered bilaterally. A computed tomography (CT) scan showed bilateral patchy interstitial and airspace opacities throughout the lungs with more prominent

consolidation versus atelectasis in the lungs, possibly infection/inflammatory in nature. Labs retrieved on arrival at the ICU were as follows: Hgb 13 g/dL, Hct 37.5%, platelets 121 x 10^9 /L, fibrinogen 389 mg/dL, white blood cells 25.6x10^9 /L, and brain natriuretic peptide 64 pg/mL. The patient remained in the ICU for three days with no change in their labs. Blood cultures revealed negative MRSA, legionella, and positive for low levels of mycoplasma pneumonia. Her oxygenation improved over the three days, and she was moved to the medical-surgical unit post-operative day four.

Discussion

Transfusion-related acute lung injuries are rare, occurring approximately 1 in every 12,000 transfusions.[4] It is difficult to know the actual number of occurrences due to the inconsistent definitions and reporting requirements worldwide.[5] TRALI is difficult to define due to non-specific mechanisms, and transfusions are typically secondary to critical illnesses.[3] The Delphi Committee decided that TRALI is a clinical diagnosis and does not require specific labs for confirmation.[6] The Delphi committee also helped establish the two types of TRALI to help rid ambiguity of the definitions.[6]

Transfusion-related acute lung injury does not have definitive risk factors, but it is considered a "two-hit pathophysiology".[3,6] It is called a "two-hit" pathophysiology because the first hit is the patient's pro-inflammatory state, and the second hit is the transfusion.[3,6] However, TRALI is believed to be more common in patients with platelets that contain high amounts of human leukocyte antigens (HLA) or human neutrophil antigens (HNA).[3,4,6] Additional risks associated with TRALI are donor products from periparturients, old blood products, and AB products.[3]

Traditionally, patients who experience TRALI do not have any risk factors but experience damage to pulmonary vasculature due to an immune-mediated response.[5] However, there are medical institutions that recognize TRALI (Type I) and pTRALI (Type II).[6] Critically ill patients have a higher risk of having a reaction to the HNA and HLA secondary to the number of transfusions received and the neutrophil and inflammatory disease processes defined as pTRALI.[5] TRALI is estimated at one percent per blood product infused.[2] Approximately 30% of transfusion-related deaths can be attributed to TRALI.[5] Possible TRALI/TRALI Type II was designated for patients who had underlying acute respiratory distress syndrome (ARDS) symptoms, who received a transfusion, and had many other associated factors.[5]

Before the exploratory laparotomy, the patient displayed no respiratory symptoms or issues with shortness of breath. The only predisposing factor for pTRALI was a cesarean section.[2] However during her exploratory laparoscopy, she received multiple blood products, which increased her risk for TRALI. In the post anesthesia care unit, her presentation was indicative of pTRALI due to the acute onset of respiratory distress and hypoxia within an hour of finishing the blood products. The patient's SpO_2 on room air was 85%. The chest x-ray showed bilateral patchy infiltrates with hypoventilation and no evidence of circulatory overload. The patient received furosemide with no increased urinary output or ventilation improvement. The supportive care provided in the ICU improved her oxygenation. She no longer required supplemental oxygen. Unlike Acute Respiratory Distress Syndrome, the pulmonary injuries appear to be momentary

recovering in 80% of the cases in 48 to 96 hours.[7] If the treatment provided is unsuccessful in increasing the patient's oxygenation, a specialty center could be consulted for patient care.[3]

The most effective way to decrease patients possibly experiencing TRALI is to recognize that transfusions are not benign and they come with risks.[3] Because of these risks associated with transfusion products, blood management programs have been created to ensure products are not being transfused to satisfy a number.[2] Instead, transfusions should be carefully considered, and the risk of transfusion reactions should be weighed against the benefits of the transfusion.[3]

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Anesthetic Management for a Biventricular Assist Device Patient

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Keywords: Biventricular assist device, anesthetic management, intra-abdominal surgery, pneumoperitoneum

Noncardiac surgery for a patient with a biventricular assist device (BiVAD) requires interprofessional communication and planning by anesthesia professionals. Patients with BiVADs pose a unique subset of anesthetic considerations including anticoagulation and

alterations in hemodynamic monitoring that influence the anesthesia management plan. We present a BiVAD patient with complex history and co-morbidities undergoing diverting colostomy.

Case Report

A 62-year-old male with a history of hypertension, hyperlipidemia, and obstructive sleep apnea presented to the emergency department with chest pain 3 months prior. The patient's electrocardiogram demonstrated lateral ST elevations. He was transported to the cardiac catheterization lab. During transport the patient experienced a pulseless electrical activity arrest with return of spontaneous circulation (ROSC) following cardiopulmonary resuscitation (CPR). He subsequently experienced a ventricular tachycardia arrest and was cannulated with venoarterial extracorporeal membrane oxygenation (VA-ECMO). He underwent 42 minutes of CPR.

Twelve days after the cardiac arrest, the VA-ECMO oxygenator was removed, and the patient was supported on a CentriMag (Abbott) BiVAD. The patient underwent a tracheostomy creation several days later. His hospital course was complicated by a T10 level spinal cord infarct which produced paraplegia and subsequent sacral osteomyelitis. The patient became incontinent of stool and urine following the spinal cord infarct which exacerbated the sacral osteomyelitis and led to a non-healing sacral wound with cultures positive for extended spectrum beta lactamases (ESBL) and E. Coli. The patient was placed for heart transplant work up, and sacral wound healing was prioritized. He was scheduled for a diverting loop colostomy with pneumoperitoneum.

On preoperative exam in the intensive care unit (ICU), the right ventricular assist device (VAD) was flowing 5.1 L/min, and the left VAD was flowing 5.6 L/min. There was no chattering noted. The alarm history was notable for 4 left VAD suction alarms within the previous 6 hours. In response, the patient received 1 unit of packed red blood cells (PRBCs). The patient had a capped tracheostomy tube (TT), arterial line, and central line in situ. He was on room air. His pre-operative arterial blood gas (ABG) revealed a PaO_2 of 66 mm Hg. Other laboratory values included: hemoglobin 7.6 g/dL, hematocrit 22.9%, white blood cell 14 k/uL, and aPTT 54.9 seconds. The patient was maintained on a bivalirudin infusion at 0.02 mg/kg/hr for anticoagulation, which was discontinued 2 hours prior to surgery, and a norepinephrine infusion at 0.03 mcg/kg/min. He was receiving no sedation and was appropriately responsive prior to the procedure. He was medicated with midazolam 2 mg and transported to the operating room (OR), accompanied by anesthesia and perfusion team members.

Once in the OR, the patient was connected to standard non-invasive and arterial line monitoring. His TT was uncapped, and air was added to the cuff. There was a cuff leak noted, and the TT was exchanged prior to induction of anesthesia. The trach was connected to the ventilator and general anesthesia was induced with inspired sevoflurane 1.5% using fresh gas flows at O_2 4 L/min and a propofol infusion at 75 mcg/kg/min. The norepinephrine infusion was continued intraoperatively at 0.05 mcg/kg/min. Rocuronium 50 mg was administered for muscle relaxation prior to pneumoperitoneum, and fentanyl 100 mcg was administered prior to incision. Immediately following pneumoperitoneum, the patients hemodynamics remained unchanged. At

a later point during the intraoperative period, the patient experienced hypotension and LVAD suction alarms. The norepinephrine infusion was increased to 0.1 mcg/kg/min, and a unit of PRBCs was administered. Additionally, hydromorphone 0.4 mg was given for long acting pain relief. Following the procedure, neuromuscular block was antagonized with sugammadex 200 mg. The patient was transported with full monitoring back to the ICU, spontaneously breathing on O_2 via trach collar at 6 L/min.

Discussion

Mechanical assist devices, such as VADs, provide mechanical circulatory support. This enables perfusion of vital organs while offloading the failing ventricle. The device allows time for cardiac recovery and time to determine if the patient is a candidate for heart transplant or for long-term durable left VAD insetion.[1] Left and right VADs consist of an inflow cannula, a pump, and an outflow cannula. A left VAD pumps oxygenated blood through the inflow cannula in the left atrium or left ventricle into systemic circulation through the aorta or femoral artery. A right VAD pumps deoxygenated blood from the inflow cannula in the right atrium or right ventricle to the outflow cannula in the pulmonary artery.[2] CentriMag (Abbott) is a paracorporeal centrifugal pump. It can be used for left sided, right sided, or biventricular heart failure. The CentriMag (Abbott) offers up to 10L/minute of blood flow, and an oxygenator can be inserted if ECMO is needed.[2] Long term BiVAD use is associated with multiple device-related complications including multi-organ failure, septic shock, cerebral hemorrhage, bleeding, embolic events, malpositioning, and infection.[3,4]

Appropriate management of the BiVAD surgery patient begins with interdisciplinary collaboration for transportation of the patient and multiple essential devices from the intensive care unit (ICU) to the OR. Transporting these patients can be dangerous and may take several experienced individuals to assist in moving the bed, intravenous pole, and additional equipment associated with the VAD.[4] The patient in this case study was transported with appropriate personnel, including anesthesia and perfusion clinicians with monitoring, emergency medications, and backup airway equipment including an extra tracheostomy tube, bag valve mask, and a full oxygen tank.

Perioperative management of VADs in patients undergoing non-cardiac surgery is becoming more common.[3] There are a number of perioperative considerations for this subset of patients. Notably, VAD patients are at an increased risk of bleeding from the need for anticoagulants to prevent thromboembolic events from the device. Additionally, these patients are at an increased risk of platelet dysfunction and acquired von Willebrand Syndrome further increasing the risk of spontaneous hemorrhage.[3] The risk of hemorrhage should be weighed against the risk of thromboembolic events, and the decision surrounding anticoagulation should be made in a multidisciplinary manner.[4] The patient's bivalirudin infusion was discontinued two hours prior to surgery. Bivalirudin has a half-life of about 25 minutes which allows for fast reduction in anticoagulant effect following discontinuation of the infusion.[7] There is no reversal agent for bivalirudin.[7] There were 2 units of PRBCs on standby in the OR. One unit of PRBCs was administered intraoperatively not for blood loss but for volume repletion due to left VAD suction alarms. A suction alarm occurs when there is an acute drop in flow rates from reduced pump filling.[6]

Pneumoperitoneum should be induced slowly using the lowest possible pressure.[3] Laparoscopic procedures have not been shown to increase 30-day morbidity and mortality compared to open procedures and are felt to be safe in this patient population. [5] Through closed loop communication the surgical team communicated with the anesthesia team that they were initiating insufflation gradually. Our patient did not show hemodynamic compromise, and the anesthetist was prepared with emergency medications.

Ventricular assist devices disable pulsatile blood flow, which complicates intraoperative monitoring of blood pressure. For most invasive procedures requiring general anesthesia, an arterial line is indicated.[4] Pulse pressure in these patients is narrow, and the MAP often correlates closely with systolic blood pressure. Similarly, pulse oximetry may be inaccurate. To adequately assess oxygenation, ABGs can be monitored. Furthermore, central access should be obtained if vasopressor support or an increased risk of bleeding is anticipated.[4] This patient had been monitored in the ICU for several months and had an arterial line and PICC line in situ which ameliorated any issues with non-invasive blood pressure and pulse oximeter monitoring.

Anesthetic management for BiVAD patients requires interdisciplinary communication and pre-operative preparation. It requires many individuals to care for these complex patients. Communication with both the surgical and perfusion team is essential in the noncardiac procedures to ensure patient safety.

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Awake Intubation for Osteophytectomy

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Keywords: osteophytectomy, diffuse idiopathic skeletal hyperostosis, awake intubation, difficult airway

Diffuse idiopathic skeletal hyperostosis (DISH) is a form of arthritis that causes calcium deposits that calcify into osteophytes. It affects soft tissues such as ligaments, joints, and tendons along the spine and axial skeleton.[1,2] Osteophytes may impact joint mobility and cause musculoskeletal pain, and compress nearby organs and nerves, leading to myelopathy, or even paralysis. In the neck, osteophytes may compress the esophagus or trachea, leading to dysphagia, breathing problems, or hoarseness. DISH is estimated to impact up to 28% of the population over 50 years of age, and is more common in males and those with metabolic abnormalities.[1-3]

Case Report

A 69-year-old male with years of progressive dysphagia and associated odynophagia, voice changes, and weight loss presented for C3-C4 osteophytectomy after videofluoroscopic swallow study showed a large C3-C4 osteophyte disc complex contributing to disease progression and narrowing of the pharynx. Height was documented as 165.1 cm, weight 62.1 kg, and BMI 22.8 kg/m^2. The patient had a documented allergy to nonsteroidal anti-inflammatory drugs. A thorough medical and anesthesia history was obtained from the patient and entered into the electronic medical record. A thorough airway exam was performed. Mallampati score was documented as 3. Thyromental distance was less than 6 cm. Past medical history was notable for gastroesophageal reflux disease, hypertension, type 2 diabetes mellitus, asthma, alcohol abuse, cervical spondylosis without myelopathy, and cervical stenosis. Previous anesthetic treatments were reported as uncomplicated. The patient had not required general anesthesia with an endotracheal tube (ETT) since the onset of dysphagia. After consultation with the multidisciplinary team, ENT used a fiberoptic scope to evaluate the patient's airway in the preoperative bay. Per discussion with the ENT and neurosurgery teams, awake intubation was selected for this patient.

Prior to entering the operating room (OR), the patient was placed in the sitting position, on a stretcher. The patient received 4% lidocaine 3 mL via nebulizer and 4% lidocaine 2 mL via atomizer to anesthetize the oral cavity and the posterior pharynx. In addition to local anesthesia, the patient received glycopyrrolate 0.2 mg, famotidine 20 mg, fentanyl 50 mcg, and midazolam 0.5 mg intravenously before transport. The patient was then transferred to the OR and standard noninvasive monitors were applied.

In the OR, O_2 10 L/min was administered via facemask for 5 minutes. Mask ventilation was not attempted. The patient remained sitting for the duration of intubation. Oxygen was delivered via a nasal cannula at 4 L/min during intubation attempts. Immediately prior to introducing the Glidescope (Verathon Inc.) S3 blade into the patient's mouth, an additional 0.5 mg midazolam was administered. We were able to obtain a view of the vocal cords but, despite patient

cooperation, were unable to pass an ETT through the vocal cords due to the large osteophyte burden. The ETT and blade were removed from the patient's mouth. A dexmedetomidine intravenous infusion at 0.6 mcg/kg was initiated at this time, and an additional 0.5 mg midazolam was administered. Oxygen continued to be administered via nasal cannula. The Glidescope blade was reintroduced into the patient's mouth and vocal cords were visualized again. A 6.0 ETT was introduced into the right side of the oropharynx and gently twisted to easily pass through the vocal cords. Following visual confirmation of the ETT passing through the vocal cords and positive $ETCO_2$ confirmation, induction of general anesthesia was initiated with propofol and rocuronium. A propofol intravenous infusion and a remifentanil intravenous infusion were initiated and an additional 0.5 mg midazolam and 50 mcg fentanyl were also administered. The dexmedetomidine intravenous infusion was discontinued and mechanical ventilation was initiated. The ETT was taped at 21 cm at the patient's lip. The patient's SpO_2 was maintained at greater than 95% throughout the duration of intubation.

General anesthesia was maintained utilizing propofol 100 mcg/kg/min and remifentanil 0.1 mcg/kg/min. The patient tolerated the anesthetic well, without any oxygen desaturation episodes and minimal hemodynamic changes. During the surgeons' closure, propofol and remifentanil intravenous infusions were incrementally decreased before being stopped, just after the surgical incision was closed. Sugammadex was administered to antagonize the neuromuscular blockade. The patient was extubated when awake and following commands.

Discussion

Diffuse idiopathic skeletal hyperostosis, also known as Forestier's disease, is characterized by ossification along the anterolateral aspects of at least 4 continuous vertebral bodies that maintain disc height.[1,2] To provide safe anesthetic care for a patient with DISH, one must understand how the pathophysiology of the disease creates the potential for difficult airway management and failed intubation. Due to the nature of osteophyte growth and compression of upper airway structures, including the trachea and soft tissue, awake intubation, in which the patient remains spontaneously breathing, is the safest choice for intubation. It is best to avoid actions that may cause soft tissue to obstruct the airway.

Though traditional airway assessment indicators do not always reliably correlate with difficult intubations, it is vital to perform a thorough airway assessment of your patient.[4] A mallampati score of 1 traditionally is associated with easy intubation, while a score of 4 is associated with difficult intubation. A short thyromental distance or small mouth opening are also considered predictors of a difficult intubation.[4] Utilizing all of this information as a whole is important in the preparation for airway management. Due to the variation in disease symptomology and the unique presentation of the patient's airway, no definitive guidelines for airway securement in the setting of DISH have been published. Individualized assessments and multidisciplinary team discussion guide airway management choices in a meaningful way.

Studies have shown that awake Glidescope intubation times are shorter than awake FOB times, though rates of first-attempt intubation success and patient satisfaction are comparable.[5,6] An awake Glidescope intubation was selected for this patient due to the ability to atraumatically mobilize airway soft tissue while reducing the risk of potentially catastrophic obstruction or

aspiration with induction of anesthesia. Though in previous case reports, fiberoptic bronchoscopy (FOB) was utilized to perform endotracheal intubation, discussion with the multidisciplinary team concluded that Glidescope intubation would be superior to FOB in this case.[3,7,8] Glidescope intubation was selected for its ability to displace the bulging soft tissue of the pharyngeal wall more easily than FOB could.

In addition to selecting awake Glidescope intubation for its ability to mobilize soft tissue, awake intubation was chosen to potentially avoid both compression and collapse of soft tissue during airway manipulation. Concerns related to neuromuscular blocking agents and induction dose hypnotic medications causing the collapse of soft tissue directed anesthesia professionals to select an awake method of intubation in which the patient was able to maintain a patent airway. Midazolam, fentanyl, and dexmedetomidine were administered judiciously, and patient response was evaluated. Medication doses were adjusted throughout the intubation process based on patient response and tolerance for awake intubation. Mahran and Hassan[6] discussed the use of glycopyrrolate to control airway secretions and the use of topical anesthesia in the oral and pharyngeal cavities to aid patient tolerance of airway instrumentation. In the case discussed above, glycopyrrolate was administered before intubation, and 4% Lidocaine was utilized via a nebulizer and an atomizer to anesthetize the oral cavity. The patient was able to tolerate two awake intubation attempts very well.

The management of this awake intubation was well-planned and performed. Although intubation was not successful on the first attempt, with minor adjustments, anesthesia professionals were able to secure the airway on the second attempt. The airway was secured while maintaining SpO_2 greater than 95%. Post-procedure discussions between the multidisciplinary team yielded a consensus that Glidescope intubation was the correct choice for this patient, though some team members believe that the addition of FOB during Glidescope intubation could be utilized in addition to the described airway management, for its ability to directly guide the ETT through the vocal cords.

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A Patient with Dexmedetomidine-Induced Diabetes Insipidus

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Keywords: dexmedetomidine, diabetes insipidus, polyuria, locus coeruleus

Evidence suggests that dexmedetomidine-induced diabetes results from noradrenergic inhibition between the locus coeruleus and the hypothalamus.[1,2] While this condition is usually associated with the long-term use of dexmedetomidine in intensive care units, recent studies have shown that dexmedetomidine-induced diabetes insipidus can also develop in the perioperative setting.[1,3] Characterized by polyuria-induced hypotension, general anesthesia can obscure the presentation of diabetes insipidus, leading to the development of potential neurological derangements, including seizures, myalgias, and coma.[3] Prompt detection of acute hemodynamic changes and use of point-of-care testing can reduce treatment delays for dexmedetomidine-induced diabetes insipidus and improve patient outcomes.

Case Report

An 18-year-old male with a medical history significant for depression and recreational marijuana use was scheduled for an emergent T7 - T12 spinal decompression and fusion following a motor vehicle accident. Spinal MRI imaging revealed edema around C1-C2, spinal cord compression between T9 and T10, and acute compression fractures of T3, T5, T8, and T11. Preoperative lab results indicated a positive marijuana and fentanyl urine toxicology, and a white blood cell count of 21.1 cells/μL. A limited airway assessment was conducted under cervical spine precautions, revealing a Mallampati class 2 airway with an inter-incisor gap greater than three fingerbreadths. Physical exam findings were significant for absent sensory sensation from the T12 dermatome level down and a loss of motor control of bilateral lower extremities.

The patient was transferred from the intensive care unit (ICU) to the operating room (OR) suite. Upon arrival in the OR, the patient remained in his bed while standard monitors were applied, and preoxygenation began. The anesthetic plan was total intravenous general anesthesia with endotracheal tube placement to allow for intraoperative neuromonitoring. The induction of anesthesia included midazolam 2 mg, fentanyl 100, lidocaine 80 mg, propofol 300 mg, and

succinylcholine 100 mg IV. While maintaining cervical spine precautions, the patient was intubated using video laryngoscopy. Once intubated, the patient's airway was secured, and mechanical ventilation was initiated. Maintenance of general anesthesia included continuous infusions of propofol and dexmedetomidine at 100-175 mcg/kg/min and 0.2-1.0 mcg/kg/min, respectively. Guided by the patient's hemodynamic profile and use of bispectral index monitoring, an acceptable anesthetic plane was achieved by titrating propofol by increments of 25 mcg/kg/min and dexmedetomidine by 0.2 mcg/kg/min.

Throughout the procedure, vital signs and fluid status were monitored by tracking hourly fluid administration, blood loss, and urine output. Initially, hourly urine output was 100 mL but abruptly increased to 700 mL at the fourth hour of the procedure, accompanied by hypotension. Despite administration of phenylephrine and ephedrine, the patient remained hypotensive, suggesting implementation of point-of-care testing to assess arterial blood gas, electrolyte, and hematocrit levels. Point-of-care testing results indicated normal levels for arterial blood gas, potassium, glucose, ionized calcium, and hematocrit; however, the serum sodium level rose significantly from 135 mEq/L preoperatively to 148 mEq/L. The anesthesia team decided to decrease the continuous dexmedetomidine infusion to 0.2 mcg/kg/min and administer single-unit vasopressin boluses to stabilize the patient's hypotension.

Following the administration of vasopressin and the reduction of the continuous dexmedetomidine infusion, hemodynamic stability was achieved. This was accompanied by a subsequent decrease in hourly urine output to 50 to 100 mL/hr for the remainder of the case.

Discussion

Dexmedetomidine, approved for procedural sedation by the FDA in 2003, has become widely utilized as an adjuvant due to its significant anxiolytic, amnestic, and analgesic effects in the perioperative setting.[1] Dexmedetomidine, an alpha-2 adrenergic agonist, exerts its greatest effect by inhibiting the nucleus of locus coeruleus located in the rostral pons, causing a reduction in a patient's level of arousal by decreasing sympathetic stimulation.[2]

The locus coeruleus plays a crucial role in regulating the sleep-wake cycle and maintaining the balance of the brain through its noradrenergic connection to various parts of the brain, such as the hypothalamus.[4] Effects of modulating communication between the locus coeruleus and hypothalamus influence the secretion of numerous hormones, including antidiuretic hormone (ADH), responsible for the reabsorption of water from the collecting ducts of the renal system.[2,5] Evidence finds that the use of dexmedetomidine can lead to decreased production of ADH due to noradrenergic inhibition, contributing to transient central diabetes insipidus.[2]

While rare, dexmedetomidine-induced diabetes insipidus is most commonly observed in patients who receive dexmedetomidine during prolonged stays in the intensive care unit. However, recent literature suggests that this condition can also develop acutely intraoperatively when dexmedetomidine is administered as a continuous infusion or as a single one mcg/kg loading dose.[3] The correlation between intraoperative dexmedetomidine administration and diabetes insipidus could potentially lead to postoperative complications if not promptly addressed.

Perioperative diabetes insipidus requires early identification and treatment to avoid volume and electrolyte abnormalities as well as neurological insult. Often concealed under anesthesia, early identification of diabetes insipidus is critical to prevent hemodynamic instability. Clinical presentation of diabetes insipidus involves sudden increased urine output, leading to hypotension due to significant fluid shifts. Diagnostic criteria include the presence of polyuria (urine output greater than 125 ml/hr), hypernatremia (serum sodium levels greater than 146 mmol/L), increased plasma osmolality (greater than 300 mOsm/kg), and decreased urine specific gravity (less than 1.003).[3] In the case report mentioned above, there was a high suspicion of diabetes insipidus based on sudden increases in urine output and a dramatic rise in serum sodium levels.

The intraoperative management of central diabetes insipidus should include discontinuing the triggering agent and concurrent correction of fluid losses while increasing available vasopressin. Using hypotonic solutions rather than isotonic solutions is recommended to treat deficits and prevent further increases in serum sodium levels. Desmopressin, a synthetic vasopressin analogue, is the preferred treatment for central diabetes insipidus due to its rapid antidiuretic effects, resulting in urine concentration within two hours.[6] Injectable administration of desmopressin is proven to have the most significant impact on reducing the polyuric effects of diabetes insipidus.[6] If desmopressin is unavailable, intravenous vasopressin can be used as an alternative.[2] Although its effects are similar to desmopressin, vasopressin shows stronger vasoconstrictive effects and potential adverse outcomes in individuals with existing cardiac dysfunction.[2,6] Although both agents promote potent antidiuretic effects, both exhibit significant risk for inadvertent hyponatremia and water intoxication.[2,6]

In this case, the differential diagnoses raised a high suspicion of intraoperative diabetes insipidus, prompting early identification and treatment of symptoms that led to a positive outcome during the perioperative period. While adjusting the continuous infusion of dexmedetomidine based on the patient's hemodynamic profile, the reduction in dosage and the administration of vasopressin dramatically improved polyuria. Following this case, a literature search revealed that dexmedetomidine-induced diabetes insipidus is a rare condition that is becoming more prominent in the perioperative setting. In summary, being highly vigilant about the patient's hourly urine output, conducting intraoperative point-of-care testing, and closely monitoring sudden changes in hemodynamics in patients receiving dexmedetomidine can be crucial in the early detection and treatment of dexmedetomidine-induced diabetes insipidus.

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Management of an Airway Obstruction During an Emergent Tracheostomy Exchange

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Keywords: Tracheostomy exchange; Airway emergency; Trauma; Fiberoptic bronchoscopy; Meconium aspirator (MA)

When ventilation through an endotracheal tube (ETT) becomes inadequate, several steps are required to address the issue. For example, suctioning the ETT if an occlusion is suspected.[1] However, what if the blockage cannot be cleared by a suction catheter or fiberoptic bronchoscope (FOB)? Airway obstructions that are unable to be suctioned due to copious blood, secretions or emesis have an increased risk of adverse events such as peri-intubation cardiac arrest.[2] This case report details a unique anesthetic management approach for a case in which an airway blood clot caused a critical obstruction that rendered ventilation ineffective.

Case Report

A 74-year-old male (121.8 kg, 180.3 cm, BMI 36.28 kg/m^2), presented for a tracheostomy tube exchange. He was initially hospitalized following a motor vehicle accident, where he sustained a C6-7 distraction injury, for which he underwent an anterior cervical disc fusion. Over the course of three weeks, his hospital course was complicated, necessitating a tracheostomy due to the inability to wean from mechanical ventilation. Additionally, he was placed on aspirin and clopidogrel after sustaining multiple cardiac events. His medical history was notable for hypertension, asthma, diabetes mellitus, and hypothyroidism.

On post-operative day one following the tracheostomy placement, the surgeon alerted the anesthesia team that the patient required an emergent neck exploration and tracheostomy tube exchange due to sudden hemorrhage from the stoma. Preoperatively, the patient's vital signs included an arterial blood pressure of 172/62 mm Hg, heart rate 97/min, respiratory rate 21/min, SpO_2 93%, and $EtCO_2$ 34 mm Hg. His hemoglobin was 7.2 g/dL and hematocrit 23.6%. The patient was mechanically ventilated with pressure support and had a peak inspiratory pressure (PIP) of 14 cm H_2O. His tidal volumes ranged from 200 to 300 mL, and propofol 40 mcg/kg/min was infusing continuously. Blood-soaked packing was noted around the tracheostomy site.

The patient was transferred to the operating room (OR) from the intensive care unit (ICU) on standard monitors with continuous invasive arterial blood pressure monitoring. Upon entry into the OR, pressure control ventilation was employed to maintain tidal volumes between 4-6 mL/kg of ideal body weight, respiratory rate was titrated to maintain an $EtCO_2$ of 35 to 45 mm Hg, and PEEP of 5 cm H_2O. His PIP ranged between 14 and 29 cm of H_2O. The patient received midazolam 2 mg and rocuronium 50 mg intravenously, and general anesthesia was maintained with propofol 50 mcg/kg/min. Fentanyl 100 mcg and cefazolin 3 gm were administered before surgical incision. Shortly after incision, the surgeon requested orotracheal intubation to facilitate the procedure. A 7.5 mm cuffed ETT was inserted in the patient's trachea under video laryngoscopy, with a Grade III Cormack-Lehane view. Once the ETT was confirmed with $EtCO_2$, the tracheostomy tube was removed, and the ETT was advanced past the stoma.

Post tracheal intubation, the patient's PIP increased to 41 cm H_2O. Manual ventilation attempts delivered tidal volumes of 25 to 44 mL. Suspecting an obstruction, the anesthesia providers used a GlideScope BFlex (Verathon, Inc.) 5.8 mm fiberoptic to examine and suction the ETT, only to discover a large clot in the lumen. The team attempted to clear the clot multiple times using vigorous saline lavage and suctioning, without success. The patient's SpO_2 decreased to 84% and $EtCO_2$ increased to 69 mm Hg. Ultimately, the anesthesia team requested a meconium aspirator (MA). After connecting the MA to the ETT and applying suction, a quarter-sized clot was aspirated, immediately improving ventilation. The patient's PIP returned to baseline, tidal volumes increased to 587 mL, SpO_2 rose to 100%, and $EtCO_2$ returned to the normal range of 35-45 mm Hg.

Once the patient was stabilized, the surgical team discovered and ligated the source of bleeding. Due to the patient's initial hemoglobin of 7.2 g/dL, the patient received two units of packed red blood cells, two units of thawed fresh frozen plasma, one platelet pack, and calcium chloride 1 gm. After securing the new tracheostomy, the ETT was removed, and the patient was transferred back to the intensive care unit. His post-operative vital signs were: blood pressure 118/39 mm Hg, heart rate 88/min, respiratory rate 23/min, SpO_2 98%, temperature 36.8°C, and PIP 14 to 20 cm H_2O. Neuromuscular relaxation was antagonized with sugammadex 300 mg, and care was handed over to the ICU team.

Discussion

Bleeding into the airway is a complication of newly placed tracheostomies and can warrant emergent surgical intervention. Patients on anticoagulants are at an increased risk of this complication.[3] This can result in an obstructed airway and can lead to an anesthesia emergency. It is the anesthesia professional's duty to ensure airway patency, oxygenation, and ventilation during surgery. Any disruption in these processes requires decisive action. One identifiable sign of a ventilatory compromise is high PIP, which is defined as greater than 40 cm H_2O. When this occurs, anesthesia practitioners should investigate and act before complications such as hypoxemia, barotrauma, and profound hypotension develop. Steps the anesthesia practitioner can take to manage a high PIP include placing the patient on high-flow O_2, switching to manual ventilation to assess pulmonary compliance, ruling out a mainstem intubation via auscultation, and attempting to detect an ETT obstruction by passing a suction catheter.[1] If the PIP is suggestive of an obstructed ETT due to a foreign body or secretion, the anesthesia provider can

then apply suction to the catheter. If this does not clear the obstruction, an FOB can be used to examine and lavage the ETT. If the practitioner is still unable to relieve the obstruction, one can consider replacing the ETT.[1]

In this case report, the first sign of an airway issue was an elevated PIP alarm on the anesthesia machine immediately following orotracheal intubation. At this time, the anesthesia team took the steps by placing the patient on 15 L of O_2, manually ventilating the patient, and placing a FOB down the ETT. Additionally, saline syringe lavages were employed, and the tube lumen was suctioned. The anesthesia team was able to quickly diagnose the obstruction as a large blood clot that failed to clear with suctioning using a FOB. Because the patient's vital signs were rapidly deteriorating, the decision was made to attempt one last method to clear the obstruction using an MA device. An MA is a plastic adapter designed to safely facilitate quick suctioning of the trachea when connected to an ETT as a continuous negative pressure source, a practice traditionally used in cases of suspected neonatal meconium aspiration.[4] While it was discussed among the anesthesia practitioners to exchange the ETT, the decision was ultimately made to continue to attempt to clear the obstruction based on the rationale that attempting to replace the ETT may be unsuccessful or lead to further migration of the clot down the patient's airway.

Novel uses of a MA with ETT as an alternative to oropharyngeal suction catheters, such as the Yankauer suction tip, have been documented in emergency medicine and anesthesia journals.[4-6] However, there are limited records of the use of a MA to clear an obstruction in an ETT that has already been placed in the anesthetized adult patient's trachea. Evans and Dodd[6] describe the use of a MA to relieve a clot obstructing an ETT in an ICU patient who was experiencing hemoptysis. After discovery of the clot, the intensivists extubated and reintubated the trachea, only to discover the clot had migrated to the carina and continued to occlude the new ETT. The clot they described, which was like the one mentioned in this case, caused a ball-valve obstruction that allowed only small tidal volumes to pass through as the clot rotated in the tube. In their report, an MA was then attached to the ETT and suctioned, thus clearing the ETT. However, parts of the clot had occluded the right mainstem bronchus, thus requiring later removal via bronchoscopy with cryotherapy.

This case report describes the use of a simple MA when faced with an inability to clear an obstructed ETT, thus avoiding clot migration and possibly preventing an anesthetic catastrophe. While some proprietary devices exist that are specifically designed for clearing large mucus burdens from an ETT, such as the CAM Rescue Cath (Omneotech), these devices may not be available in all facilities, nor as readily available as an MA. Therefore, every anesthesia practitioner should be familiar with the MA device and have readily available in the anesthesia workstation—especially when caring for critically ill trauma patients with bleeding diathesis.

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Opioid Sparing Techniques in Plastic Surgery

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Keywords: opioid sparing, opioid, anesthesia, plastic surgery, cosmetic surgery, opioid free, opioid analgesics

Introduction

The United States (U.S.) is combating an opioid crisis. The U.S. healthcare system is a major source of opioid prescription and distribution. A retrospective study by Kiang et al, determined the top 1% of total providers who prescribe opioids account for almost 50% of all opioid doses and 25% of opioid prescriptions written.[1] This top 1% of opioid prescribers included family medicine, physical or pain medicine and rehab, anesthesia, and internal medicine. Based on this study, anesthesia accounted for 14% of the opioid doses.[1] Anesthesia traditionally utilizes opioids for pain management in the intraoperative and post-operative periods.

In response to a growing understanding of the opioid epidemic many surgical disciplines have researched and identified standard practices in surgical analgesia and post-operative opioid use. Subsequently, societal guidelines have been created and consistent pain management strategies have been employed leading to reductions in both post-operative opioid use and duration. Currently, no guidelines exist for plastic surgery even though it is one of the surgical specialties, alongside general, orthopedic, cardiothoracic, vascular, colorectal, spinal, and neurologic, that prescribe opioids at a rate of 36.5% accounting for 10% of opioid prescriptions in the United States.[2]

Due to the nature of ambulatory plastic surgery, rapid recovery is a priority. Multimodal pain management approaches with reduced side effects and varying mechanisms of action compared

to opioids alone will provide better analgesic outcomes and aide in a faster recovery after surgery.[3] Ambulatory patients are discharged in the immediate post-operative period, they are at risk for opioid abuse due to the lack of monitoring and supervision while using opioids that have a strong medication profile and side effects.[4] A significant number of opioid pills prescribed for post-operative pain end up left over where they are accessible for nonprescription use by themselves and their family members.[3]

Another category of plastic surgery that requires consideration is patients undergoing more extensive reconstructive surgery, such as breast reconstruction that requires inpatient care. Crystal et al. stated that patients who undergo alloplastic breast reconstruction experience higher levels of post-operative pain than those who underwent mastectomy alone. This occurred despite high opioid use, which suggests that this patient population experiences poor opioid efficacy.[4] Current analgesia practices in plastic surgery are also subject to influences outside the patient's condition and type of surgery performed. According to Torabi et al., elective plastics procedures are associated with higher rates of prolonged opioid use, greater than 90 days after surgery, than trauma-related plastic surgeries.[2] Torabi et al. also noted plastic surgeons who only accept self-pay patients prescribe post-operative opioids 100% of the time; this is significantly higher than the surgeons who accept all forms of payment.[2]

The literature was analyzed to determine if opioid sparing anesthesia techniques in plastic surgery would provide equivalent analgesia as traditional opioid based anesthesia. The theoretical framework guiding this literature review and analysis was the Donabedian Model for Health Care Quality.[5] Donabedian Model focuses on the structure, organizational features and processes, and clinical management, in healthcare that ultimately result in patient outcomes. The goal was to have the necessary supplies and medications in place to support the opioid sparing anesthesia interventions that lead to positive patient outcomes such as adequate analgesia with prompt return to optimal function after surgery. [5]

Methods

The PICO question to guide this evidence-based practice change was, "do opioid sparing anesthesia techniques provide an equivalent level of effectiveness for post-operative pain management as traditional opioid based anesthesia techniques in adult patients undergoing plastic surgery?".

The two databases utilized for a comprehensive literature review included the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Ovid MEDLINE. Twenty-one articles were found within the CINAHL database, and 53 articles were retrieved from Ovid MEDLINE. The search terms included: opioid, plastic surgery, cosmetic surgery, opioid sparing, opioid free, and analgesics. Evidence levels I-III defined as systematic reviews, meta-analyses, randomized control trials, and cohort studies were accepted for analysis. The inclusion criteria consisted of peer-reviewed journal articles, articles written in English, articles published within the last 10 years, and articles regarding anesthesia techniques in plastic surgery. Criteria were established to exclude articles from the analysis. The exclusion criteria consisted of studies that included participants with pre-existing neuropathies, participants being treated for chronic pain disorders prior to plastic surgery, and participants that had burn injuries. In total, 15 articles were utilized in the review.

Literature Analysis

Effects of Preoperative Placement of Regional Nerve Blocks

Table 1 cites literature on the use of regional blocks as an opioid sparing method for adult patients undergoing breast surgeries and the influence the blocks have on opioid consumption and patient reported pain scores. All three studies included in the table were conducted with high levels of evidence suggesting strong recommendations for implementation into practice. Findings were consistent in that they were associated with a decrease in opioid consumption intraoperatively or postoperatively.[4,6,7] Crystal et al., reviewed studies that utilized various regional techniques that included intercostal blocks, paravertebral blocks, liposomal bupivacaine, and local anesthetic infusion pumps.[4] Momeni et al. focused strictly on transversus abdominus plane (TAP) blocks, while Yilmaz et al. utilized only pectoralis (PECS) I & II blocks. Therefore, it can be concluded that a variety of nerve blocks and regional techniques are effective as an opioid sparing technique.[6]

Methods by which opioid consumption was measured varied. Primary outcomes for Momeni et al. and Crystal et al. were measured in mean morphine equivalents (MME), while Yilmaz et al. used milliliters of remifentanil as a measurement.[6-8] Table 1 evaluates the overall opioid consumption and the use of different mechanisms of measurements does not seem to affect the strength of the synthesis.

Table 1: Effects of Preoperative Placement of Regional Nerve Blocks on Postoperative Opioid Consumption and Patient-reported Pain in Plastic Surgeries

Author(s), Design	**Sample size**	**Interventions**	**Significant Data/ Results**
Crystal et al.[4] (2021) Systematic Review	N = 14 articles5 RCTs 9 Cohort Studies	Opioid sparing techniques in alloplastic breast reconstruction: enhanced recovery after surgery (ERAS) protocols (2), intercostal nerve blocks (2), paravertebral nerve blocks (4), liposomal bupivacaine (3), diclofenac (1), and local anesthesia infusion pumps (2)	Patients treated with ERAS protocols demonstrated a reduction in opioid consumption and reported reduced pain scores, less postoperative nausea/vomiting, and improved sleep ($P < .05$) Patients that received paravertebral nerve blocks required less opioids and patients reported lower pain scores ($P < .05$) Liposomal bupivacaine (LB) field blocks resulted in a reduction in opioid consumption, benzodiazepine consumption, and hospital length of stay ($P < .05$) Patients who received LB field blocks demonstrated reduced opioid consumption in recovery when compared to those who received a paravertebral block ($P = 0.03$) and reported reduced numeric pain scores ($P = .05$) Other interventions did not demonstrate statistically significant reductions in either opioid use or patient reported pain scores

Momeni et al.[6] (2019) Mixed Prospective Retrospective Cohort Study	N = 46	Transversus Abdominis Plane (TAP) Block with liposomal bupivacaine for patients undergoing microsurgical breast reconstruction with free abdominal flaps	Of the patients who received a TAP block 91.3% did not require a PCA Mean time to first narcotic use after arrival on inpatient unit was 6 hours Mean total postoperative oral morphine equivalent (OME) use was 123.2 mg for patients who received a TAP block versus 194.3 mg for those who did not receive an opioid sparing technique TAP blocks resulted in reduced median patient-reported pain scores and hospital length of stay days
Yilmaz et al.[7] (2021) Randomized Controlled Trial	N = 60	Pectoralis Nerve (PECS) I and II blocks for breast surgeries	Reduced mean perioperative remifentanil (40mcg/ml) consumption: 1.73 mL for patients who received PECS I and II blocks versus 8.63 mL for the opioid based group ($P < .05$) Increased mean time for first analgesic demand after surgery for patients who received PECS I and II blocks: 35 minutes for opioid based group versus 124.5 minutes for PECS block group ($P < 0.05$) Increased patient and surgeon satisfaction scores reported ($P < .05$)

Impact of Enhanced Recovery After Surgery Protocol (ERAS)

Table 2 examines three studies that employed enhanced recovery after surgery protocols, also referred to as an ERAS protocol, and their effects on opioid consumption and patient reported pain scores. Bartlett et al. describe ERAS techniques as perioperative, multimodal, evidence-based interventions for surgical patients using a multidisciplinary approach to decrease the patient's stress response to surgery, increase post-operative function and decrease time to discharge and recovery.[9] The ERAS process starts in the preadmission period and continues until the moment the patient is discharged home. Components of an ERAS technique includes, but is not limited to, education, limiting the amount of time the patient is fasting, early nutrition, and a pain management plan that includes non-opioid adjuncts or regional techniques.[9]

The primary finding detailed in Table 2 was that ERAS techniques decreased opioid consumption in all three articles. Opioid use was measured using a variety of methods. Two of the articles consistently used MME as a primary outcome.[4,10] Bartlett et al., measured opioid use via fentanyl mean units and Tramadol, but the units for this drug are not specified.[9]

The second theme in Table 2 was patient reported pain. Bartlett et al. and Crystal et al. used a patient pain scale to measure post-operative pain. Patients from both studies reported decreased levels of pain when compared with patients who underwent traditional opioid based anesthesia.[4,9]

The synthesis table included studies that used a wide range of levels of evidence and may suggest the need for additional high-level studies.

Table 2: Impact of Enhanced Recovery After Surgery Protocol Use on Opioid Consumption and Patient Reported Pain in Plastic Surgeries

Author(s), Design	**Sample size**	**Interventions**	**Significant Data/ Results**
Bartlett et al.[9] (2017) Prospective Study	N = 22	ERAS protocol: Preop: celecoxib, gabapentin, ondansetron; Intraop: block with liposomal bupivacaine, IV acetaminophen; Postop: methylprednisolone, celecoxib, and gabapentin	Opioid use decreased in ERAS cohort ($P < .003$) Only 10% of ERAS patients used opioids in the postop period vs 100% in the control group Reduction in patient reported pain scores on POD 0, 1, 2, 3 in ERAS group ($P < .01$) 90% of ERAS cohort reported less pain than expected for the procedure while only 25% of the control group reported less pain than expected ERAS patients experienced less nausea, vomiting, fatigue, drowsiness, constipation, and hindrance of ambulation in comparison to the control group ($P < .05$)
Crystal et al.[4] (2021) Systematic Review	N = 14 articles 5 RCTs 9 Cohort Studies	Opioid sparing techniques in alloplastic breast reconstruction: enhanced recovery after surgery (ERAS) protocols (2), intercostal nerve blocks (2), paravertebral nerve blocks (4), liposomal bupivacaine (3), diclofenac (1), and local anesthesia infusion pumps (2)	Patients treated with ERAS protocols demonstrated a reduction in opioid consumption and reported reduced pain scores, less postoperative nausea/vomiting, and improved sleep ($P < .05$) Patients that received paravertebral nerve blocks required less opioids and patients reported lower pain scores ($P< .05$) Liposomal bupivacaine (LB) field blocks resulted in a reduction in opioid consumption, benzodiazepine consumption, and hospital length of stay ($P < .05$) Patients who received LB field blocks demonstrated reduced opioid consumption in recovery when compared to those who received a paravertebral block ($P = .03$) and reported reduced numeric pain scores ($P = .05$)

Straughan et al.[10] (2021) Retrospective Case Control Study	N = 359	ERAS protocol: Preop: acetaminophen, celecoxib, gabapentin; Intraop: block with liposomal bupivacaine, local infiltration with lidocaine or bupivacaine, ketorolac; Postop: acetaminophen, celecoxib, oxycodone prn.	Reduced opioid consumption in post-ERAS group compared to pre-ERAS cohort (100.3 versus 332.2 MME) ($P < .001$) Increased use of antiemetics in pre-ERAS group compared to post-ERAS group (664 mg per patient versus 16.3 mg of promethazine per patient) ($P < .001$) Reduced use of anti-spasmodic medication in post-ERAS group compared to pre- ERAS group (31.2 mg per patient versus 401.3 mg of cyclobenzaprine per patient) ($P < .001$) Post-ERAS patients demonstrated significant decreases in pain scores from postoperative days 1-3 in comparison to pre-ERAS patients ($P < .0001$)

Evaluation of the Anesthetic Techniques' Influence on Opioid Consumption in Retrospective Studies

Table 3 is a synthesis of retrospective studies that evaluated the use of opioids in plastic surgeries. A total of six articles were included in Synthesis Table 3. Four were observational only, indicating they did not employ the use of interventions.[10,11-15] The two remaining articles employed the use of opioid sparing techniques whether that be an ERAS technique or the use of local anesthetics via an infusion.[10,12] Table 3 compares the influence different anesthetic techniques have on opioid consumption in plastic surgery.

A major theme found was that each study that included an opioid sparing technique had a significant decrease in patient opioid consumption. Three studies did not employ the use of opioid sparing techniques and opioid consumption postoperatively was the primary method of analgesia utilized.[11,13,15] A subtheme noted was patient reported pain scores were only available for comparison between two studies.[10,15] Lacking the ability to assess and compare the patients' responses with decreased opioid consumption limits the utility of the evaluation of the anesthesia techniques utilized.

Strengths

A strength to this narrative review was the variety of studies found with levels of evidence, consisting of 1-3 within the last five years and their specificity. The findings among the studies were homogenous. Each study's intervention to implement an opioid sparing technique was shown to be effective. Results were exemplified by a reduction in postoperative opioid consumption and, when measured, showed an improvement in postoperative patient reported pain scores. A majority of the articles indicate that plastic surgery is overprescribing opioids and that there is a desire to improve postoperative opioid prescribing practices. This desire for change suggests there is an opportunity for more large-scale studies to be conducted in the future.

Table 3: Retrospective Studies Evaluation of Anesthetic Techniques' Influence on Opioid Consumption in Plastic Surgeries

Author(s), Design	**Sample size/ characteristics**	**Interventions**	**Significant Data/ Results**
Crystal et al.[11] (2020) Retrospective Study	N= 28	Observation	No opioid sparing techniques were employed, all patients received opioids for analgesia A total of 15 patients (54%) had complications associated with opioid use: • 9 cases of immediate perioperative complications such as aspiration, hypoxia, or respiratory failure requiring rescue naloxone, oxygen supplementation, respiratory support, and/or reintubation • 4 patients had an opioid hypersensitivity of systemic hives or severe nausea and vomiting Three cases of opioid overdose and polypharmacy resulting in patient death
Henry & Barry[12] (2021) Retrospective Study	N = 8	Intervention**:** Local anesthetic infusion catheter protocol Control**:** Standard Opioid Technique	Intervention patients demonstrated a statistically significant reduction in daily opioid requirements ($P < .001$) for the first through third postoperative days
Marcusa et al.[13] (2017) Retrospective Study	N = 4,113	Observation	Opioid sparing techniques were not utilized Postoperative analgesia was managed with opioids Patients with comorbidities of anxiety or depression were more likely to continue to fill opioid prescriptions 90-120 days postoperatively than patients without those comorbidities ($P < .01$) Patients undergoing autologous free flap reconstruction were less likely to fill opioid prescriptions ($P < .001$)
Patel et al.[14] (2020) Retrospective Study	N = 4,084	Observation	Survey of breast surgeons revealed 23% reported using non-opioid regimens (NOR) in 2016 compared to 79% in 2019 ($P < .001$) NOR increased from 9% to 39% ($P < .001$) in breast operations from 2016 to 2019 Average morphine milligram equivalents

			(MME) per operation decreased significantly from 2016 to 2019 ($P < .001$) Fewer postoperative emergency room visits occurred in patients who received a NOR ($P < .001$)
Straughan et al.[10] (2021) Retrospective Case-Control Study	N= 359	Intervention: Perioperative ERAS protocol. Control: Standard Opioid Technique	MME increased in pre-ERAS group (332.2 MME) vs post-ERAS group (100.3 MME) ($P < .001$) More anti-nausea medications were required in pre-ERAS group (664 mg of promethazine/ patient) vs post-ERAS group (16.3 mg of promethazine/patient) ($P < .001$) Increased use of anti-spasmodic medications in pre-ERAS group (401.3 mg cyclobenzaprine/patient) vs post-ERAS group (31.2mg of cyclobenzaprine/patient) ($P < .001$) Reduced patient-reported numerical pain scores in post-ERAS group during postoperative days 1-3 ($P < .0001$)
Yan et al.[15] (2020) Retrospective Cohort Study	N = 328	Observation	Patients with bilateral breast reconstruction surgery required more MME than unilateral breast reconstruction ($P < .015$) Each additional hour of surgery increased postoperative MME by 9.4 postoperatively ($P < .01$) Patients with nonzero preoperative pain scores required increased MME (141 MME) postoperatively compared to patients with no preoperative pain (100.3 MME) ($P < .01$) Patients with postoperative index pain score ≤5/10 required less MME compared to patients with postoperative index pain scores >5/10 ($P < .01$) A dose of intravenous acetaminophen 1000 mg was found to decrease postoperative MME by 11.7 ($P = .024$) A dose of oral ibuprofen 600 mg was found to decrease postoperative MME by 8.3 ($P < .01$)

Limitations

Though there were many consistencies found between articles, there is a lack of uniformity in certain areas. While opioid sparing techniques demonstrated efficacy, there were many different types of opioid sparing protocols and interventions used, including nerve blocks, ERAS

protocols, the use of regional anesthesia, and nonopioid adjuncts employed at a variety of times during the perioperative period. The wide variety of interventions used makes it difficult to determine which strategies are best utilized. This may ultimately delay the development of recommendations for standardization among practitioners. Therefore, large-scale studies may be needed to narrow down which opioid sparing techniques are most effective.

Another limitation is that some studies did not assess patient-reported pain. A key indicator in the effectiveness of an intervention, whether opioid use or opioid sparing, is the experience of the patient who received the intervention. It is not enough to quantify opioid consumption before and after an intervention if the ability to measure the patient's experience associated with the intervention is lacking. Regularly assessing pain scores via numerical pain scales is standard protocol in most clinical settings so this measure should be discussed and incorporated routinely in future studies.

The last limitation is that a large portion of the studies evaluated were either observational or retrospective. The six retrospective studies included are at risk for biases such as selection bias because participants were selected after the outcome had occurred, and information bias because the data included for each patient would not be consistent and may be missing due to using preexisting records. Further, the two nationwide surveys conducted were limited by a response rate of approximately 13%. Although the response rates seem low, they were comparable to other nationwide studies. Only with well-designed prospective randomized controlled trials can assurance be given that the intervention being evaluated caused the outcome. It is evident, there is a need for more large-scale randomized controlled trials and subsequently systematic reviews to be able to make stronger generalizations and recommendations about the use of opioid sparing techniques in plastic surgery.

Conclusions

The evidence-based practice revealed there is a strong dependence on opioids as the primary technique for both surgical anesthesia and postoperative analgesia in plastic surgeries. Recognition of overuse of opioids by plastic surgery and anesthesia professions has led to a burgeoning interest in utilizing opioid sparing techniques for anesthesia. Opioid sparing techniques are widely varied but two that are gaining popularity in plastic surgery include preoperative placement of peripheral nerve blocks and perioperative ERAS protocols. The evidence shows that no matter which opioid sparing technique was implemented, the subsequent postoperative opioid consumption and, if it was measured, the patient reported pain scores declined in comparison to standard opioid based anesthetic techniques. Not only are opioid sparing techniques able to provide analgesia equally as effectively as traditional opioid based techniques, but they also improve pain scores with less opioid use.

The research supports the use of opioid sparing anesthesia techniques as a method to reduce opioid consumption and decrease acute surgical pain experienced by patients in the postoperative period. Both reductions prevent a sequela of negative events for patients that ultimately improve patient safety; therefore, use of opioid sparing techniques is suggested. It is also recommended to utilize a patient reported pain score in addition to measuring opioid consumption as a method to assess the effectiveness of the chosen analgesic technique.

One major drawback in the evidence is the prevalence of retrospective and observational studies. It would be beneficial to supplement the current research by conducting more large scale randomized controlled trials to provide further assurance that the interventions used for opioid sparing techniques are in fact producing these positive results and aid in determining which opioid sparing techniques are most efficient. Current interest from the plastic surgery community in reducing opioid use and subsequently reducing contributions to the opioid crisis make this an opportune time to both conduct further research and initiate implementation of opioid sparing techniques into their practices.

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Mentor: Haley DeLaGarza, DNP, CRNA

National Database Analysis to Reduce Adverse Respiratory Occurrences

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Keywords: thoracic surgery, pulmonary embolism, pneumonia, intubation

Introduction

Adverse postoperative respiratory occurrences (APROs) after thoracic surgery can result in prolonged lengths of stay, poor long and short-term outcomes, and increased healthcare costs for patients and healthcare organizations. The purpose of this project was to conduct a secondary data analysis using the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database to identify specific preoperative patient variables that may be predictors of APROs after thoracic surgery. These APROs include reintubation, pneumonia, pulmonary embolism, and failure to wean.

Methods

Preoperative predictors (independent variables) and APROs (dependent variables) were determined after an extensive literature review examining APROs in general surgery and availability in the ACS NSQIP database 2021 Participant Use File. Five preoperative predictors were identified and used for the predictive model for this study: sex, body mass index (BMI), serum creatinine (mg/dL), serum albumin (g/dL), and hematocrit (%). APRO cases were matched 1:1 with a control case (i.e., identical Current Procedural Terminology code and age [+/- five years]). Conditional logistic regression (i.e., based on matching each APRO case with a control case) was used to evaluate each APRO separately.

Results

All five preoperative patient variables had variance inflation factors (VIFs) less than five, indicating low correlations among the set of five preoperative patient variables. The predictive model containing the five preoperative patient variables was statistically significant for all

APROs. The model explained 19% of the variance in pulmonary embolism. Preoperative albumin (odds ratio [OR] = .25) and hematocrit (OR = 1.25) made statistically significant contributions to the model. The model explained 8% of the variance in unplanned intubation. Sex (OR = 1.89), preoperative creatinine (OR = 1.57), albumin (OR = .45), and hematocrit (OR = .95) made statistically significant contributions to the model. The model explained 7% of the variance in failure to wean. Preoperative albumin (OR = .59) and hematocrit (OR = .92) made statistically significant contributions to the model. The model explained 4% of the variance in pneumonia. Only preoperative albumin (OR = .56) made a statistically significant contribution to the model.

Discussion

The full model containing all five preoperative patient variables has a significant effect on the odds of observing all four APROs. Preoperative serum albumin was significantly associated with all four APROs. Every gram of change in serum albumin was directly associated with the occurrence of all four APROs. Preoperative hematocrit was significantly associated with three of four APROs. Every percentage change in hematocrit was directly associated with pulmonary embolism and inversely associated with unplanned intubation and failure to wean. Results from this study could be used in developing a preoperative checklist or risk assessment tool for patients undergoing thoracic surgery. Assessing the risk of developing an APRO can better guide preoperative stabilization, optimization, and prehabilitation. The primary limitation of this study is that only NSQIP data from 2021 was analyzed. Expanding the search criteria to additional years may yield additional findings.

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Mentor: Mark Gabot, DNP, CRNA, FAANA

Editorial

This publication is a labor of love for all involved. I do receive a lot of positive feedback about the value of the student journal. This comment was shared by a longtime editor – it stood out to me as it truly represents the mission of the ISJNA:

> Our first DNP class complained about having a writing assignment when they were all "writing" their DNP projects. We argued that as leaders prepared with a terminal degree, they needed to know multiple scholarship modalities that they can carry into their practice as clinical leaders . . . case reports are one example of the dissemination of clinical scholarship. Learning the publication peer review process is another benefit.
>
> And we all love reading case reports.

I wholeheartedly agree and hope all students who have participated in this process have benefited from it and continue to enjoy reading the ISJNA!

Sincerely,

Vicki Callan, PhD, CRNA, CHSE, FAANA
Editor

INTERNATIONAL STUDENT JOURNAL OF NURSE ANESTHESIA
GUIDE FOR AUTHORS

MISSION STATEMENT

The International Student Journal of Nurse Anesthesia (ISJNA) 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.

ITEM PREPARATION & SUBMISSION

Case reports, research abstracts, evidence-based practice (EBP) analysis reports, evidence-based practice project abstracts, 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). Case reports must be single-authored, while EBP analysis reports and abstracts may have multiple authors. Submissions may list only one mentor. **Mentors should take an active role** in reviewing the item to ensure appropriate content, writing style, and format prior to submission. 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. Authors and mentors should critically evaluate the topic and quality of the writing – multiple reviews of the item by the mentor, faculty, and peers (fellow graduate students) prior to submission is recommended. If the topic and 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.*

The journal is committed to publishing the work of nurse anesthesia students. The review process is always initiated with the following rare exceptions. We are conservative in accepting reports where the patient has expired, realizing that you can do everything right and still have a negative outcome. Submissions that report a case demonstrating failure to meet the standard of care (by any practitioner involved in the case) will not be accepted. Unfortunately, while the experiences in these cases can offer valuable insight, these submissions will not be accepted for review due to potential legal risks to the author, journal, and anyone else involved in evaluating the report.
It is the intent of this journal 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** (4-6 months recommended) to the author's date of graduation. 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 use the following format: ISJNA Submission_submission type_author last name_mentor last name. 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 PROCESS

Items submitted for publication are initially reviewed by the chief editor. If the chief editor does not acknowledge receipt of the item within two weeks, please inquire to ensure receipt. Upon receipt, the chief editor will review the submission for compliance with the Guide to Authors. If proper format has not been followed, 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 and author's responsibility to ensure formatting guidelines have been followed prior to submission.

All accepted submissions undergo a formal process of blind review by at least two reviewers. After review, items may be accepted without revision, accepted with revision, or rejected with comments. Once the item has been accepted for review the chief editor will assign a submission number and send a blinded copy to an editor, who will then coordinate a blinded review by two reviewers who are not affiliated with the originating program. Submissions are reviewed using the Track Changes function of Word. The editor will return the item to the chief editor, who will return it to the mentor for appropriate action. **The mentor should guide the author through the revision process. The revised copy must be returned clean (no comments or Track Changes) with the original submission number in the filename and subject line of the email.** Every effort is made to complete the process in an efficient, timely matter. Again, the goal is for all articles submitted by students to be published while the author is still a student. If an item is not ready for publication within 6 months after the student author has graduated it will no longer be eligible for publication. Mentors 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. Please contact the chief editor at intsjna@aol.com to submit photos for consideration. Only digital photos of high quality will be accepted. If the photo is accepted, consent forms must be completed and returned by all identifiable individuals in the photo, and the individual who took the photo.

ACADEMIC INTEGRITY

Issues of academic integrity are the responsibility of the author and mentor. Accurate and appropriate acknowledgement of sources is expected. The two most common breaches of academic integrity that have been identified in submissions to this journal are (AMA 11th ed., 5.4.2):

1. Direct plagiarism: verbatim lifting of passages without enclosing the borrowed material in quotation marks and crediting the original author.
2. Paraphrase: restating a phrase or passage, providing the same meaning but in a different form without attribution to the original author.

Please note that changing one or two words in a reference source passage (e.g. 'of' for 'in', or 'classified' for 'categorized') and then citing it as a paraphrase or summary is also not appropriate, and still falls within the definition of direct plagiarism. If plagiarism in any form is identified, review of the item will be suspended and it will be returned to the mentor. Repeated instances of plagiarism will result in rejection of the item.
Plagiarism detection software (Scribbr, TurnItIn, PlagScan, SafeAssign, etc . . .) can be used to analyze the document prior to submission to ensure proper citation and referencing, but is not required.
"Plagiarism is the presentation of someone else's ideas, writings, or statements as one's own. Plagiarism is a serious breach of academic integrity, and anyone who is found to have committed plagiarism will be subject to disciplinary action.

Paraphrase is the act of putting someone else's ideas into one's own words. The use of paraphrase can be an acceptable practice under some circumstances if it is used sparingly and if the original text is properly acknowledged. Unacknowledged paraphrase, like plagiarism, is a serious breach of academic integrity. Any improper use of sources may constitute plagiarism. Every quotation from another source, whether written, spoken, or electronic, must be bound by quotation marks and be properly cited. Mere citation alone is not sufficient when a scholar has used another person's words. Similarly, every paraphrase or summary (a more concise restatement of another's ideas) must be properly cited."
https://sites.google.com/a/georgetown.edu/gsas-graduate-bulletin/vi-academic-integrity-policies-procedures

GENERAL GUIDELINES

Items for publication **must adhere to the *American Medical Association Manual of Style*** (AMA 11th ed., the same guide utilized by the *AANA Journal* and such prominent textbooks as *Nurse Anesthesia* by Nagelhout and Elisha). Section numbers from the online version are provided for easy reference in the AMA Manual of Style throughout this document. The review process will not be initiated on items submitted with incorrect formatting and will be returned to the mentor for revision.

Reference: Christiansen S, Iverson C, Flanagin A, et al. *AMA Manual of Style: A Guide for Authors and Editors*. 11th ed. Oxford University Press; 2020.

Please note the following:

1. Use complete sentences.
2. Acronyms/Initialisms (2.1.5, 10.6, 13.9) - spell out with first use, do not capitalize the words from which the acronym/initialism is derived unless it is a proper noun or official name. If you are using the phrase only once, do not list the acronym/initialism at all. Avoid beginning sentences with acronym/initialisms.
3. Abbreviations (13.0)
4. Use *Index Medicus* journal title abbreviations (3.11.2, http://www.ncbi.nlm.nih.gov/nlmcatalog/journals)
5. Always provide units of measure (17.0). 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. Report height in cm, weight in kg, temperature in °C, pressure in mm Hg or cm H_2O. Report heart and respiratory rate as X/min (e.g. the patient's heart rate increased to 145/min). The manual includes a complete list of SI units (17.1 – 17.5).

6. 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, $EtCO_2$, N_2O. Please use SpO_2 for oxygen saturation as measured by pulse oximetry.
7. Use the nonproprietary (generic) name of drugs (2.1.3, 10.3.5) - avoid proprietary (brand) names. Type generic names in lowercase. When discussing dosages state the name of the drug, *then* the dosage (midazolam 2 mg).
8. 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 in parenthesis (e.g. a GlideScope (Verathon Inc.) was used) (14.5.1). Please note, TM and ® symbols are not used per the AMA manual.
9. Infusion rates and gas flow rates:
    a. Use mcg/kg/min or mg/kg/min for infusion rates. 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. Report gas flow of O_2, N_2O and Air in L/min (not %) and volatile agents in % as inspired or expired concentration (e.g. General anesthesia was maintained with sevoflurane 3% inspired concentration in a mixture of O_2 1 L/min and air 1 L/min.)
10. 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. 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.
11. If referencing software is used (Endnote, Zotero, etc.), any embedded <u>formatting must be removed</u> prior to submission.
12. Remove all hyperlinks within the text.
13. Avoid jargon and slang terms. Use professional, scholarly, scientific language.
    a. *'The patient was reversed'* - Did you physically turn the patient around and point him in the opposite direction? "Neuromuscular blockade was antagonized."
    b. *The patient was put on oxygen.* "Oxygen 2 L/min was administered via face mask."
    c. *The <u>patient</u> was intubated and put on a ventilator*. "The trachea was intubated and mechanical ventilation was initiated.
    d. *An IV drip was started.* "An intravenous infusion was initiated."
    e. Avoid the term "MAC" when referring to a sedation technique - the term sedation (light, moderate, heavy, unconscious) may be used. Since all anesthesia administration is monitored, pharmacologic, rather than reimbursement, terminology should be used.
14. Direct quotes are discouraged for reports of this length – please express in your own words.
15. Use the words "anesthesia professionals" or "anesthesia practitioners" when discussing all persons who administer anesthesia (avoid the reimbursement term "anesthesia providers").
16. Do not include ASA Physical Status unless it is germane to the report.
17. Do not use the phrase "ASA standard monitors were applied". Instead, "standard noninvasive monitors" is acceptable – additional monitoring can be detailed as needed.
18. References
    a. The **<u>AMA Manual of Style must be adhered to</u>** for reference formatting.
    b. All sources should be published within the past 8 years. Seminal works essential to the topic being presented will be considered.
    c. Primary sources are preferred.
    d. **A maximum of one textbook (must be most recent edition available) may be used as reference for case report submissions only**.
    e. All items cited must be from peer-reviewed sources – use of sources found on the internet must be carefully considered in this regard. URLs must be current and take the reader directly to the referenced source.

<u>Heading</u> – for all submission types (Case Report, Abstract, EBPA Report) use the following format.

1. **Title** is bolded, centered, 70 characters (including spaces) or less
2. Author name (academic credentials only) and NAP are centered, normal font
3. *Graduation date and email address* are centered, italicized, and will be removed prior to publication)
4. **Keywords** is left-justified, bolded – list keywords that can be used to identify the report in an internet search

Title

Author Name
Name of Nurse Anesthesia Program
Anticipated date of graduation
E-mail address

Keywords: keyword one, keyword two, etc.

Case Reports - The student author must have had a significant role in the conduct of the case. The total word count should be between 1200 – 1400 words (references not counted). 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 above)

A brief introductory paragraph of less than 100 words to focus the reader's attention and interest them to continue reading. 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.

Case Report (400-600 words)

This portion discusses the case performed 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. 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 heart of your paper which is the discussion and teaching/learning derived from the case.

- 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 of measure after the values (eg. Mmol/L or mg/dL).
- Physical examination/pre-anesthesia evaluation - **significant** findings only.
- Anesthetic management (patient preparation, induction, maintenance, emergence, post-operative recovery).

Discussion (600-800 words)

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.

References

A minimum of 5 references is recommended, with a maximum of 8 allowed. One textbook may be used as a reference – it must be the most recent edition. All references should be no older than 8 years, except for seminal works essential to the topic. This is also an exercise in searching for and evaluating current literature.

Mentor: mentor name, credentials

E-mail address: *(*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, population, and outcome. 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. Textbooks and non-peer reviewed internet sources may not be used, and sources of reference should be less than 8 years old unless they are seminal works specifically related to your topic of inquiry. A maximum of 16 references is allowed.

Heading

Introduction (bold)
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.
Methods (bold)
Include the format used for formulating the specific question you seek to answer, search terms and methods used, and levels of evidence.
Literature Analysis (bold)
Analyze and critique the literature relevant to your question, determining scientific credibility and limitations of studies reviewed. Your synthesis table is included in this section. Please follow AMA formatting guidelines for your table (4.1.2, 10.2.3). Your review and discussion of the literature should logically lead to support a practice recommendation. Subheadings may be used if desired.
Conclusions (bold)
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, 16 maximum)
Mentor: (bold, followed by mentor name and credentials in normal text)
E-mail address: (normal text, will be removed prior to publication)

Evidence Based Practice Project Abstracts - Evidence-based practice project abstracts are limited to 600 words. References do not impact the word count - a maximum of 5 are allowed. Note that the abstract is different from a project proposal. The following format should be used:

Heading

Introduction (bold)
A brief introductory paragraph including purpose (what change is intended) and rationale (why change is needed/evidence to support the change) here.
Design and Methods (bold)
Include population, intervention, and measures
Outcome (bold)
Present results from statistical analysis – do not justify or discuss here.
Conclusion (bold)
Discuss results (implications). Optionally include limitations, suggestions for future projects/research.
References (bold, 5 maximum)
Mentor: (bold, followed by mentor name and credentials in normal text)
E-mail address: (normal text, will be removed prior to publication)

Research Abstracts - Research abstracts are limited to 600 words. References do not impact the word count - a maximum of 5 are allowed. Note that the abstract is different from a research proposal. The following format should be used:

Heading

Introduction (bold)
A brief introductory paragraph including purpose and hypotheses.
Methods (bold)
Include sample and research design
Results (bold)
Present results from statistical analysis – do not justify or discuss here.
Discussion (bold)
Discuss results (implications, limitations, suggestions for future research)
References (bold, 5 maximum)
Mentor: (bold, followed by mentor name and credentials in normal text)
E-mail address: (normal text, will be removed prior to publication)

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. Journal names should be in italics and abbreviated according to the listing in the PubMed Journals Database. PubMed can also be used to perform a search: 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.

Journals (3.11) - A comma is placed 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). Page numbers are inclusive - **do not omit digits** (note - some online journals do not use page numbers). Some journals 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, 3.15.2) should be included (see examples below).

Journal, 6 or fewer authors:

Han B, Liu Y, Zhang X, Wang J. Three-dimensional printing as an aid to airway evaluation after tracheotomy in a patient with laryngeal carcinoma. *BMC Anesthesiol*. 2016;16(6). doi:10.1186/s12871-015-0170-1

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

Elayi CS, Biasse L, Bai R, et al. Administration of isoproterenol and adenosine to guide supplemental ablation after pulmonary vein antrum isolation. *J Cardiovasc Electrophysiol*. 2013;24(11):1199-1206. doi: 10.1111/jce.12252

Electronic references (3.15) - Only established, peer-reviewed sources may be referenced. Please do not reference brochures, fact sheets, or informational websites where a peer-review process cannot be confirmed. The accessed date may be the only date available. The URL must be functional and take the reader directly to the source of the information cited.

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

Examples:

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

Howlader N, Noone AM, Krapcho M, Garshell J, Miller D, et al. SEER Cancer statistics review, 1975-2012. National Cancer Institute. Published April 2015. Updated November 18, 2015. Accessed February 29, 2016. http://seer.cancer.gov/csr/1975_2012

Textbooks (3.12) - There are two types of books – 1) those that are fully authored by one or more individuals, and 2) those that are edited by one or more individuals, with chapters authored by different individuals. Edited textbooks give primary credit to the chapter authors, who are listed first, and the inclusive page numbers of the entire chapter are provided at the end. Textbooks that are authored do not have different chapter authors and the chapter titles are

not listed, but the inclusive page numbers where the information was found are provided, unless the entire book is cited.

Authored text:
Shubert D, Leyba J, Niemann S. *Chemistry and Physics for Nurse Anesthesia*. 3rd ed. Springer; 2017:405-430.

Chapter from an edited text (3.12.4)**:**
Pellegrini JE. Regional anesthesia. In Nagelhout JJ, Elisha S, eds. *Nurse Anesthesia*. 6th ed. Elsevier; 2017:1015-1041.

SUBMISSION CHECK LIST

Adheres to AMA Manual of Style and all other format instructions
___ Total word count not exceeded (1400 for case report, 600 for abstracts, 3000 for EBPA report)
___ The item is one continuous Word document without artificially created page breaks
___ All matters that are not common knowledge to the author are referenced appropriately
___ 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/slang is absent

Heading
___ Concise title less than 70 characters long (including spaces)
___ Author name, credentials, nurse anesthesia program, graduation date and email are included
___ Three to 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 400-600 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

Abstracts
___ The 600 word count maximum is not exceeded
___ Appropriate format used depending on type of abstract (research vs. EBP project)

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, population, and outcome is presented
___ A focused foreground question following either the PICO or SPICE format is used
___ Includes Introduction, Methodology, Literature Analysis (with synthesis table), and Conclusion sections

References
___ Adheres to AMA Style format
___ Reference numbers are sequenced beginning with 1 and superscripted
___ References are from anesthesia and other current (within past 8 years) primary source literature
___ Journal titles are abbreviated as they appear in the PubMed Journals Database
___ Number of references adheres to specific item guidelines (1 textbook allowed for case reports only)
___ Internet sources are currently accessible, reputable, and peer reviewed

Transmission
___ The article is sent as a Word document attachment to **INTSJNA@AOL.COM**
___ The file name is correctly formatted (e.g. PedsPain_Smyth_GU_Pearson_5.19.09)
___ Item is submitted by the mentor
___ Subject heading format - ISJNA Submission_submission type_author last name_mentor last name