Education of SRNAs on the Role of Vasopressin in Attenuating Hypotension: Cardiac and Non-Cardiac Anesthesia

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Abstract

The purpose of this project was to educate and assess the baseline knowledge of the 26 junior student registered nurse anesthetists (SRNAs) within Adventist University of Health Science's nurse anesthesia program regarding the use of vasopressin to attenuate hypotension among patients undergoing cardiac and non-cardiac surgery. The primary objective of this education and assessment was to increase the SRNAs knowledge base regarding vasopressin and to prepare them for their specialty clinical rotations. A literature review regarding specific situations in which vasopressin was successful in reducing hypotension was completed and an educational presentation was developed and presented to junior SRNAs currently enrolled in the nurse anesthesia program. A pretest and posttest was administered to assess whether or not the PowerPoint presentation education improved the students' current knowledge base regarding the use of vasopressin. A paired t-test in SPSS was performed on the resulting data, which indicated a statistically significant increase in mean scores between the pretest and post-test based on a p-value $< .001$ and a t-value of -7.528. It can be inferred from these results that the presentation was successful in increasing students' knowledge base regarding the use of vasopressin. The primary implication of these results is that the SRNAs upcoming practitioners that were educated will have a broader knowledge base of this alternate modality to treat hypotension.

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Introduction

Hypotension during the perioperative period is a common occurrence and often has multifactorial etiologies. Common treatments of hypotension include fluid administration, decreasing anesthetic depth, and/or pharmacologic vasopressor therapy. Commonly used pharmacologic modalities among anesthetists are phenylephrine, norepinephrine, ephedrine, and epinephrine. Although these medications are frequently successful at improving hypotension, certain situations, patient comorbidities, and/or procedures require the anesthetist to consider utilizing less common interventions which may be more patient specific and can lead to decreased morbidity and mortality. SRNAs entering their specialty rotations will be tasked with providing anesthetic care to complex patients that require these advanced interventions, and will benefit from expanding their knowledge on alternative treatment options. Vasopressin is a vasopressor that offers unique benefits to counteract hypotension, and has proven to benefit patients in specific situations. Adequate knowledge of how to utilize vasopressin is vital as SRNAs enter said specialty rotations and which highlights the need for this project.

Vasopressin is a less commonly used vasopressor that offers unique benefits to counteract hypotension, and has proven to benefit patients in specific situations. It is a hormone produced endogenously in the hypothalamus and secreted from the posterior pituitary in response to increases in serum osmolality as well as low blood pressure (Holt & Haspel, 2010). Exogenous vasopressin may be administered intravenously and acts on V1 vascular receptors, which stimulate phospholipase C and thus increase intracellular calcium resulting in vasoconstriction (Booth, Schinderle, & Welsby, 2002).

Expanding one's knowledge of vasopressin is important globally and locally, as research has highlighted several scenarios in which its use can improve clinical outcomes related to perioperative hypotension. Angiotensin-converting enzyme inhibitors (ACE inhibitors) and angiotensin receptor blockers (ARBs) are becoming more widely used in the setting of heart failure, and discontinuation of said medications preoperatively remains controversial (Hedman, Mann, Spulecki, & Castner, 2016). These medications contribute to hypotension secondary to both renin-angiotensin-system as well as sympathetic dysfunction, often making patients resistant to catecholamine treatment, yet responsive to vasopressin (Holt & Haspel, 2010). Vasoplegia, defined as low blood pressure with normal cardiac output, can occur after cardiac surgery and can contribute to severe, refractory hypotension. According to a study by Hajjar et al. (2017), vasopressin should be considered the first line defense in this situation. Studies have also shown that using vasopressin alone or as an adjunct to norepinephrine with anaphylactic, septic, or hemorrhagic shock raises blood pressure by blocking the effects of inflammatory mediators via cyclic-GMP channels and can decrease the dose of secondary vasopressor therapy necessary to maintain an adequate blood pressure (Holt & Haspel, 2010). Vasopressin has also been shown to be beneficial in situations where negative side effects of catecholamine infusions such as kidney hypoperfusion and increased pulmonary artery pressures may be detrimental. Studies show vasopressin does not increase pulmonary artery pressures (Elgebaly & Sabry, 2012) and increases glomerular filtration rate (Booth, Schinderle, & Welsby, 2002) making it a safer alternative to patients with pulmonary or renal comorbidities.

In regards to a specific clinical problem, this research project addressed the following question; in caring for patients during cardiac and non-cardiac surgeries, what is vasopressin's role in attenuating intraoperative hypotension? In regards to innovations geared towards answering this problem, this research project addressed the following question; among ADU junior SRNAs, will an educational PowerPoint presentation improve their knowledge base regarding the use of Vasopressin.

Literature Review

Vasopressin Therapy in Those Receiving ACE Inhibitors

In patients undergoing general anesthesia, pre-existing hypertension can be a primary cause of severe complications, namely intraoperative hypotension. These patients are often prescribed anti-hypertensives such as metoprolol, labetalol, lisinopril, and many others. While many classes of anti-hypertensives exist, it is the use of ACE inhibitors within 24 hours of surgery that can cause intraoperative hypotension that may or may not be responsive to catecholamine vasopressor therapy. Because ACE inhibitors are responsible for a decrease in the effectiveness of the renin-angiotensin-aldosterone system, they lower blood pressure via a mechanism that, compounded with the vasodilatory sympathetic-blocking effects of general anesthesia, can be catastrophic if not treated appropriately with medications whose action is situation-specific. Withholding ACE inhibitors before surgery is still debated in the literature; when they are taken within 24 hours of surgery, vasopressin has a much more direct clinical application (Hedman et al., 2016).

Because ACE inhibitors do not work directly on the vasculature, typical catecholamine-based vasopressor therapy may be ineffective. Additionally, if the patient

is beta blocked, catecholamines may be completely clinically ineffective. Holt and colleagues suggested, in 2010, that, in years of clinical experience, many instances of hypotension will not respond to catecholamines and, therefore, another method must be used. According to Hedman et al. in 2016, “The vasopressin system is the only endogenous vasopressor system that is not blocked during general anesthesia in patients receiving ACE inhibitors”. Holt and colleagues also found that studies in both humans and dogs, showed that those who experienced hypotension secondary to spinal anesthesia had an increase in endogenous vasopressin secretion (Holt & Haspel, 2016). Therefore, the conclusion can be drawn that if the body responds to hypotension with a secretion of vasopressin, exogenous administration should be beneficial as well. This makes vasopressin invaluable in treating hypotension that is not responding to catecholamines or fluid intraoperatively. Additionally, while vasopressin is very effective at constricting the peripheral vasculature, it is less effective at constricting coronary and cerebral vasculature, lessening potential cardiac or neurological complications of administration (Egelby & Sabry, 2012).

Hedman and colleagues conducted a systematic review of six vascular and coronary artery surgeries, and found that vasopressin was highly successful in treating ACE inhibitor- induced intraoperative hypotension. Vasopressin was used in these studies as small bolus doses, a method alternative to the typical provider-selected infusion. With this knowledge, it can be concluded that, in a case where an ACE inhibitor has been taken and hypotension occurs, giving a bolus of vasopressin should be considered and implemented to effectively raise the patient’s blood pressure either in

addition to or in the place of traditional catecholamine-directed therapy (Hedman et al, 2016).

Vasopressin Therapy for Cardiac Anesthesia

Frequently after cardiac surgical interventions, patients exhibit an adequate cardiac output, but a low blood pressure. This is deemed vasoplegia, and can be caused by a lack of systemic vascular resistance or lack of intravascular fluid. Either way, it is ideal to correct the blood pressure without increasing stress on the newly repaired cardiac tissues. If the blood pressure remains low, coronary perfusion will suffer and myocardial function may be impaired or completely non-functional. While typically a first-line cardiac drug, epinephrine carries adverse side effects that may increase risk in valve, coronary, or other cardiac surgeries. These risks include increased oxygen demand on the myocardium, induced arrhythmias, and decreased cardiac output due to a dramatic increase in systemic vascular resistance. Because of these side effects, vasopressin is a much gentler and effective vasopressor in the presence of adequate cardiac output after cardiac surgery (Holt & Haspel, 2010). Additionally, epinephrine can cause distal organ damage, such as kidney hypoperfusion. Not only does vasopressin lack this side effect, it actually increases the glomerular filtration rate, thereby increasing overall kidney function and lessening the chance of acute post-operative renal failure (Booth et al., 2002).

Research also shows that patients who have survived a myocardial infarction have higher levels of endogenous vasopressin than those who did not; it can be inferred from this research that exogenous vasopressin may increase survivability in these patients. In 2012, Egelby and Sabry discovered not only that vasopressin provides a necessary

increase in vascular tone after cardio-pulmonary bypass surgery, but that a lack of either endogenous or exogenous vasopressin can directly lead to vasodilatory shock. While some pertinent research is yet to be conducted, there has been no research that has shown vasopressin to be detrimental in cardiac patients. To even further encourage its use, the American Heart Association added vasopressin as an alternative to epinephrine in its 2005 revision of the AHA cardiac life support guidelines. Vasopressin has since been removed from the ACLS protocol to simplify the procedure for practitioners, but its merit has never been discredited (Holt & Haspel, 2010).

While vasopressin's primary role after cardiac surgery is to provide an increase in vascular tone, it has many other cardiac-specific beneficial qualities. Vasopressin increases the amount of calcium present in the myocardium, gently increasing myocardial contractility and, therefore, cardiac output. Calcium boluses are common in cardiac anesthesia and are used to increase blood pressure as well as the pumping capacity of the heart, and it can be concluded that the administration of vasopressin could potentially reduce the amount of exogenous calcium needed. Research has shown that administration of vasopressin has resulted in an increased ejection fraction in post-cardiac surgical patients, indicating the positive effect of vasopressin on cardiac output. Vasopressin also causes dilation in the coronary arteries, which is highly beneficial after a coronary artery bypass graft. Many times the coronaries that are repaired quickly become re-occluded, which can be a major cause of a "bring-back", or a surgical patient that has to be rushed back to surgery for a second coronary repair. Lastly, because of the dilation of the coronary arteries, blood flow to the myocardium increases. This can be invaluable because, however delicate a surgical technique is, myocardial damage and ischemia still

occurs. It can then be inferred that vasopressin administration may prevent symptomatic ischemia or simply prevent ischemia from worsening (Egelby & Sabry, 2012).

Vasopressin Therapy for Shock States

As previously discussed, vasopressin is a useful vasopressor in everyday situations, such as general and cardiac anesthesia. However, this research would be incomplete if vasopressin's role as an emergency vasopressor was not discussed. Vasopressin is highly effective in cardiac arrest, as previously discussed, but also in septic shock, anaphylactic shock, and hypovolemic shock caused by hemorrhage. While the SRNAs who will act as participants in this study are presumably familiar with these shock states, education on the perioperative recognition of shock and the appropriate use of vasopressin during these times could be the difference in significant morbidity and mortality.

Septic shock occurs typically from vasodilation triggered by a bacterial infection that leads to hypoperfusion, ultimately causing end-organ dysfunction. If the patient is unable to maintain an adequate mean arterial pressure, it is imperative for the anesthetist to supply vasopressor adjuncts to meat such a minimum. According to research by Holt and Haspel in 2010, endogenous vasopressin levels are inversely related to survivability of septic shock. Not only does vasopressin improve the systemic vascular resistance of septic patients, it increases kidney function and prevents end-organ damage to the kidneys that other vasopressors may not allow. While norepinephrine is a popular vasopressor in septic shock, vasopressin's vascular properties which make it kidney protective and therefor may be the superior choice in septic shock. When septic shock is suspected in the perioperative setting, end-organ damage should always be kept in mind,

and using a vasopressor like vasopressin that can prevent such damage may make long-term survivability more realistic (Holt & Haspel, 2010).

Severe anaphylaxis can occur intraoperatively, specifically in response to certain antibiotics or neuromuscular blocking agents. While identifying anaphylactic shock from other types of shock is important, epinephrine and IV fluids are almost immediately administered. Once the causative agent is identified and removed, typically the anaphylaxis subsides. However, in 2008, Schummer et al identified case studies showing that it was only after vasopressin was added to the treatment regimen that cardiovascular stability was achieved. Many surgical patients are beta blocked, making the beta agonist properties of epinephrine ineffective. Although high doses of epinephrine and fluid resuscitation are still adamantly recommended, vasopressin could be the adjunct that turns the situation from critical to manageable (Schummer et al, 2008).

Treatment of hemorrhagic shock protocol perioperatively resembles that of anaphylactic shock in that epinephrine and fluid or blood product resuscitation is the recommended treatment. However, the addition of vasopressin can be the element that cures refractory shock states secondary to hemorrhage. Naturally, the body secretes high levels of vasopressin when hemorrhage occurs. But, during prolonged hemorrhagic shock, the body has used its stores of vasopressin and needs exogenous replacement. When the patient has lost its compensatory mechanisms to maintain blood pressure, the effects of vasopressin are dramatically increased, and can be the diffnce in life-saving therapies directed at hemorrhagic patients. (Tsuneyoshi, 2005).

Contribution and Dissemination/Justification

This project contributed to the awareness of the need for improved understanding regarding the use of vasopressin in the perioperative period through the development of an educational presentation. The presentation also increased the knowledge base of the participants by providing extensive information regarding optimum usage of vasopressin including specific patients, comorbidities, and surgeries where vasopressin has been proven successful, dosage, routes of administration, contraindications, mechanism of action, and pharmacologic profile. This presentation was disseminated in the spring semester of 2018 per the project timeline; this timing was appropriately placed in the midst of the SRNA education on the complex client.

Project Aims

The goal of this project was to improve SRNA's knowledge base regarding the role of vasopressin in the treatment of intraoperative hypotension in cardiac and non-cardiac surgery. The principal aim was to meet this goal by the SRNAs' entrance into their senior year before participating in specialty rotations. Ultimately, the goal of this additional education was to give the SRNAs the appropriate knowledge base of vasopressin for hypotension so that they are comfortable using this drug in the clinical setting for complex cardiac and non-cardiac patients. The SRNAs' knowledge base should be inclusive of appropriate drug dosages and situations that specifically warrant the use of vasopressin over other vasoconstrictors. After completing this presentation, the SRNAs' mean test scores should increase between the pretest and posttest, which would confirm that the PowerPoint presentation was effective in increasing their knowledge base as it pertains to the use of Vasopressin.

Project Methods

The design of the project was a single group quantitative study utilizing a convenience sample population that incorporated a pretest and posttest to determine whether or not a 30-minute educational presentation would improve the knowledge base of junior ADU SRNAs in the appropriate use of vasopressin. The presentation included a PowerPoint on basic information, case studies that showed appropriate indications for the drug, and interactive questions which engaged the target audience. Target participants were 26 junior ADU SRNAs who were currently enrolled in their fourth semester of the nurse anesthesia program.

Only after SRC/IRB approval or exemption did this study proceed. This research project was conducted during a regularly scheduled academic class for the SRNAs, in which they had already discussed the basics of cardiac anesthesia. Students were notified of the presentation at the beginning of the semester and were asked to participate the day of the presentation. Only students who signed the research consent participated in the pretest and posttest. The tests contained 10 multiple-choice questions that were appropriate to the graduate level.

Only students who were enrolled full time in the nurse anesthesia program were included in the research. In order to protect the privacy of the participants, each pretest and posttest was numerically assigned and passed out at random; no student was be allowed to place their name on a pretest or posttest. Additionally, any physical data or identifying information was be stored within a locked file, which was only to be accessed by the project authors, Lauren Heil and Sarah Price. Electronic data was input onto a computer and saved to a password protected Google Drive account for which only the

aforementioned authors had access to. At the completion of the project, physical paperwork was be shredded and discarded and the Google drive was deleted, along with all of the documents it was used to store.

Project Timeline

The timeline for this project was well defined and delineated among three academic semesters. The summer semester, May – August 2017, included the formulation of project topic and associated literature review, topic approval by NAP faculty, mentor identification scholarly project proposal, committee chair approval, IRB application and approval, development of the pretest and posttest, and CITI certifications. The fall semester, August – December 2017, included the development of the PowerPoint presentation. The spring semester, January – April 2018 included project implementation, data collection, and statistical data analysis.

Data Collection Plan

A pretest and posttest contained ten multiple-choice questions and was developed based on information that was provided to the SRNAs during the scholarly project presentation. Each participant received one pretest, which was completed prior to the presentation and turned in directly to the presenter without any identifiable data. Completed tests were counted and compared to the number of participants to ensure each participant took the test one time. The same test was administered immediately after the presentation using the same methods as described for the pretest. The presenters performed data collection and each test, both pre-test and post-test, was exchanged with the participants only one time.

Evaluation Plan

This scholarly project was evaluated using a paired t-test on the mean pretest and posttest scores. A ten-question pretest was administered prior to the presentation to determine the baseline scores and the same test was then administered immediately after the presentation. Both the pretest and posttest scores were collected and averaged among all of the participants and were then compared to determine whether or not the presentation was successful in improving the knowledge base of this topic. Dr. Lukman, the ADU statistician, performed a paired t-test to measure the results statistically and analysis was performed via the SPSS within Adventist University of Health Sciences.

Results/Findings

The researchers graded the pre-tests and posttests which yielded a mean pretest score of 4.7826 (47%), a mean posttest score of 7.6087 (76%), and a mean score improvement of 2.8261 points (28%). These results were sent to Dr. Roy Lukman for additional analysis. A paired t-test in SPSS was performed which indicated a statistically significant increase in mean scores between the pretest and post-test based on a p-value < 0.001 and a t-value of -7.528. It can be inferred from these results that the PowerPoint presentation was successful in increasing participant knowledge base regarding the use of Vasopressin. The statistical analysis in its entirety is summarized in the charts, which can be viewed in appendix D.

Conclusions/Limitations

In conclusion, this educational presentation was successful in improving the baseline knowledge of its participants regarding the use of Vasopressin. However, certain limitations do exist. The participants were junior ADU SRNAs in the class of 2019 who

had previous courses in pharmacology and complex clients, which may have provided education that impairs or artificially enhances the level of knowledge gained from the presentation. The educational presentation was delivered over 30 minutes in one sitting, therefore the knowledge increase in the observed population may have been inadequate in comparison to education that is delivered over time and clinically reinforced. The subjects were a small, convenience sampling, which may have dramatically shifted the results one way or another. Unfortunately, due to late arrival, three of the participants were unable to complete the pretest and which therefor decreased our sample size to only 23 students.

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Appendix A: Informed Consent

ADU NAP CAPSTONE PROJECT – INFORMED CONSENT

Our names are Lauren Heil and Sarah Price and we are MSNA students in the Nurse Anesthesia Program (NAP) at Adventist University of Health Sciences (ADU). We are doing a Capstone Project called *Education of SRNAs on the Role of Vasopressin in Attenuating Hypotension:*
Cardiac and Non-cardiac Anesthesia. This project is being supervised by Dr. Steven Fowler. We would like to invite you to participate in this project. The main purpose of this form is to provide information about the project so you can make a decision about whether you want to participate.

WHAT IS THE PROJECT ABOUT?

The purpose of this project is to improve the understanding of the role of vasopressin in the treatment of intraoperative hypotension in cardiac and non-cardiac surgery amongst MSNA students in the Nurse Anesthesia Program at Adventist University of Health Sciences.

WHAT DOES PARTICIPATION IN THIS PROJECT INVOLVE?

If you decide to participate in this project, you will be asked to complete an anonymous pre-assessment, attend a classroom presentation, and then complete an anonymous post-assessment. The assessment will address your knowledge of the utilization of vasopressin in the treatment of intraoperative hypotension prior to and after the presentation. Your participation by attendance at the presentation and completion of the survey is anticipated to take approximately one hour.

WHY ARE YOU BEING ASKED TO PARTICIPATE?

You have been invited to participate as part of a convenience sample of students currently enrolled in the ADU NAP. Participation in this project is voluntary. If you choose not to participate or to withdraw from the project, you may do so at any time.

WHAT ARE THE RISKS INVOLVED IN THIS PROJECT?

Although no project is completely risk-free, we don't anticipate that you will be harmed or distressed by participating in this project.

ARE THERE ANY BENEFITS TO PARTICIPATION?

We don't expect any direct benefits to you from participation in this project. The possible indirect benefit of participation in the project is the opportunity to gain additional knowledge about the utilization of vasopressin to treat hypotension during the intraoperative period.

HOW WILL THE INVESTIGATORS PROTECT PARTICIPANTS' CONFIDENTIALITY?

The results of the project will be published, but your name or identity will not be revealed. To maintain confidentiality of assessments, the investigators will conduct this project in such a way to ensure that information is submitted without participants'

identification. Any physical data will be stored temporarily in a locked file cabinet at the researcher's home. The data will be transferred to an electronic version in a timely matter and will then be stored in a password protected Google Drive account for which only the researchers, Lauren Heil and Sarah Price, will have the password for. All physical data will be destroyed using a paper shredder immediately after its transfer to an electric version. At the completion of the project, the Google Drive along with all uploaded documents will be permanently deleted. Thus, the investigators will not have access to any participants' identities.

WILL IT COST ANYTHING OR WILL I GET PAID TO PARTICIPATE IN THE PROJECT?

Your participation will cost approximately one hour of your time, but will require no monetary cost on your part. You will not be paid to participate.

VOLUNTARY CONSENT

By signing this form, you are saying that you have read this form, you understand the risks and benefits of this project, and you know what you are being asked to do. The investigators will be happy to answer any questions you have about the project. If you have any questions, please feel free to contact Lauren Heil at Lauren.Heil@my.adu.edu or Sarah Price at Sarah.Tooley@my.adu.edu. If you have concerns about the project process or the investigators, please contact the Nurse Anesthesia Program at (407) 303-9331.

_____ **Date** _____

Participant Signature

_____

Participant Name (PRINTED LEGIBLY)

Appendix B: Pre-Test and Post-Test Questionnaire

1. What is the most common antihypertensive drug class to cause refractory intraoperative hypotension?

a. Beta Blockers

b. ACE Inhibitors

c. Diuretics

d. Miscellaneous i.e. Hydralazine

2. Which of the following described Vasopressin?

a. Exogenous hormone that must be supplemented because it is not produced in the body

b. Endogenous hormone produced in the hypothalamus

c. Endogenous hormone secreted by the anterior pituitary

d. Exogenous hormone that only shows effects in shock states

3. Which of the following is a side effect of Vasopressin?

a. kidney hypoperfusion

b. increased PAP

c. high risk of end-organ damage

d. increased GFR

4. In clinical practice, what is most frequently the first line agent for critical hypotension?

a. Epinephrine

b. Vasopressin

c. Norepinephrine

d. Phenylephrine

5. By what regulatory mechanism does Vasopressin function?

a. Beta receptor agonism and resultant increase in cardiac output

b. Beta receptor agonism and resultant increase in SVR

c. Renin-Angiotensin-Aldosterone system activation

d. Alpha receptor agonism and resultant increase in SVR

6. What is the effect of Vasopressin on the coronary and cerebral vasculature?

a. Constricts coronaries and cerebral vasculature more than peripheral vasculature

b. Constricts coronaries and cerebral vasculature less than peripheral vasculature

c. Constricts coronaries and cerebral vasculature the same as peripheral vasculature

d. Constricts coronaries and cerebral vasculature with no effect on peripheral vasculature

7. What is the standard infusion dose for Vasopressin?

a. 1-6 units per hour

b. 0.01 mcg/kg/min

c. 10 mg/kg/min

d. 10-15 units per hour

8. Vasopressin acts as a(n) _____, leading to an increase in overall blood pressure.

a. anti-diuretic

b. beta agonist

c. alpha agonist

d. synthetic catecholamine

9. Which of the following patients may have adverse reactions to vasopressin?

a. A patient with intrinsic lung disease

b. A patient with low SVR

c. A patient with glaucoma

d. A patient with a coagulopathic disease

10. In which situation would vasopressin be an appropriate choice for cardiac anesthesia?

a. Adequate cardiac output, low SVR, CVP of 25

b. Adequate cardiac output, critical SVR, no other vasopressors started

c. Adequate cardiac output, low SVR, end organ damage concern

d. Adequate cardiac output, high SVR

*Correct answers are indicated with boldface font

Appendix C: PowerPoint Presentation

EDUCATION OF SRNAS ON THE ROLE OF VASOPRESSIN IN ATTENUATING HYPOTENSION:

CARDIAC AND NON-CARDIAC ANESTHESIA

Lauren Heil, BSN, SRNA
Sarah Price, BSN, SRNA
Project Mentor: Tiffany Benton, MSN, CRNA
Project Chair: Steven Fowler, DNP, CRNA
Adventist University of Health Sciences

OBJECTIVES

- Primary Aim: Improve SRNA's understanding of the role of vasopressin in the treatment of intraoperative hypotension in cardiac and non-cardiac surgery.
- Focus Questions
  - In caring for patients during cardiac and non-cardiac surgeries, what is vasopressin's role in attenuating intraoperative hypotension?
  - Among SRNA students, will an educational clinical presentation improve their knowledge base and ability to integrate vasopressin into clinical practice in caring for perioperative hypotension among complex patients in specialty rotations?

PROBLEM

- Hypotension during the perioperative period is a common occurrence
- Common early treatments:
  - IVF administration
  - Decreasing anesthetic depth
  - Vasopressor administration (Phenylephrine, Ephedrine)
- Certain patients and situations may require the anesthetist to provide a more tailored approach.

LATE TREATMENT OF HYPOTENSION

- Blood product administration
- Calcium chloride
- Initiation of vasopressor drips
  - Phenylephrine
  - Norepinephrine
  - Epinephrine
  - **Vasopressin**

BASICS OF ENDOGENOUS VASOPRESSIN

- Endogenously produced hormone in the hypothalamus
- Secreted from the posterior pituitary when:
  - Serum osmolality increases
  - Blood pressure decreases

Holt & Hassel, 2010

BASICS OF SYNTHETIC VASOPRESSIN

- Administered intravenously
- Mechanism of Action
  - Acts on V1 and V2 receptors
  - V1: Vascular smooth muscle
    - Stimulates phospholipase C → Increases 2nd messengers IP3 and DAG → Increases intracellular calcium → **vasoconstriction**
  - V2: Distal Convoluted Tubule
    - Stimulates adenylyl cyclase → Increases 2nd messengers cAMP → water retention (increased intravascular fluid volume)

Roach, Schroeder, & Wesley, 2002

CLINICAL CORRELATION

- While ACLS removed vasopressin from the ROSC algorithm for simplicity, its dosage is still appropriate in clinical use
- ACLS guideline: 40 units vasopressin replaced one IV push dose of epinephrine
  - This is HIGH DOSE vasopressin, and must be directly removed from a vial and given IV push
  - Vial is typically 20 units/mL, so 2mL would be the ACLS-guided dose

CLINICAL CORRELATION

- Standard Cardiac Drug Box Dose= 60 units/100mL
- Standard ICU Drip Dose= 50 units/250mL
- Making a push dose from an anesthesia drip bag will be a low concentration (10mL= 6 units), but is still clinically useful

WHEN:

YOUR PATEINT IS UNDERGOING CARDIAC SURGERY

VASOPLEGIA

- Vasoplegia defined: Hypotension with **adequate cardiac output**
  - Due to decreased SVR or inadequate intravascular fluid volume
  - Frequently occurs after comping off CPB
    - Volume depleted, metabolic washout
- Contributes to severe, refractory hypotension

Hallar 2017

VASOPLEGIA

- Key Point:
  - In instances where the patient's cardiac output is poor, epinephrine is the vasopressor of choice for the cardiac patient

VASOPLEGIA

- Epinephrine infusion as a first line treatment
  - Increased HR → increased MVO2
  - Arrhythmias
  - High doses may decrease cardiac output
  - Renal hypoperfusion
- Epinephrine does work, but is it really the best option for the patient with adequate cardiac output?

Hallar 2017

Clinical Question:

When is vasopressin an appropriate treatment for hypotension?

and

How do I use it?

WHEN:

YOUR PATEINT HAS TAKEN THEIR ACE INHIBITIORS

SITUATIONAL VASOPRESSIN: ACE INHIBITORS

- **Ultimate issue:** Most common drug class to cause refractory hypotension intraoperatively.
- Who takes ACE Inhibitors?
  - Patient diagnosis: heart failure or chronic hypertension
- Controversial to continue or discontinue pre-operatively due to intraoperative hypotension (Hedman, Fletcher, Sjostedt, & Granath, 2016)
  - Problematic when taken within 24 hours of surgery

MOST COMMON ACE INHIBITORS

- Benazepril
- Captopril
- Enalapril (Vasotec, only IV ACEi available to anesthesia)
- Fosinopril
- Lisinopril
- Moexipril
- Peridopril
- Quinapril
- Ramipril
- Trandolapril

SITUATIONAL VASOPRESSIN: ACE INHIBITORS

- How do ACE inhibitors cause hypotension?
  - Decrease the effectiveness of renin-angiotensin-aldosterone system
  - Sympathetic dysfunction
- Because ACE inhibitors do not work directly on the vasculature, using a vasopressor that simply constricts the vasculature may be ineffective.
- How does Vasopressin counteract this?
  - V1 Receptors: Vasoconstriction
  - **V2: Receptors: Promotes water retention at distal convoluted tubule**

Holt & Hazzel, 2010

SITUATIONAL VASOPRESSIN: ACE INHIBITORS

- Literature: Systemic review by Hedman et al (2016) showed that in vascular and coronary surgeries, **intermittent vasopressin bolus**' were highly successful in treating ACE Inhibitor induced hypotension.

CARDIAC ANESTHESIA

- Vasopressin's main role is to manage vasoplegia
  - Increases intravascular volume by retaining water from the kidneys
  - Increases SVR
- Vasopressin has cardiac benefits that other vasopressors lack
  - Increases calcium in the myocardium = increased cardiac output
  - Leads to coronary artery vasodilation which ahs two direct benefits
    - Increased oxygen delivery to myocardium
    - Decreased risk of re-occlusion

CARDIAC ANESTHESIA

- Cardiaopulmonary Bypass
  - Egelby and Sabry (2012)
    - Vasopressin successfully increased SVR after cardiopulmonary bypass
    - Lack of vasopressin (endogenous or exogenous) lead to vasodilatory shock
- Patients with cardiac pathology require adequate diastolic blood pressure to maintain coronary perfusion pressure to avoid ischemia
  - Vasopressin accomplishes this without additional risk

CLINICAL CORRELATION

- Vasopressin for cardiac anesthesia is given as an infusion
  - Dose= 1-6 units/hour, titrated to goal blood pressure
  - Having the pump primed and hooked up is imperative for rapid vasopressin initiation
  - Bolus doses can be taken from the pump via the back priming function

WHEN:

YOUR PATEINT IS IN SHOCK

SEPTIC SHOCK

- Pathophysiology: systemic vasodilation triggered by bacterial infection which leads to hypo-perfusion (decreased MAP) and ultimate end-organ dysfunction.
- There is an inverse relationship between survivability and endogenous vasopressin levels.
  - Body naturally secretes high levels of endogenous vasopressin → depletion
  - Exogenous Vasopressin is required

Hoh & Hazel 2010

ANAPHYLACTIC SHOCK

- Pathophysiology: systemic vasodilation triggered by allergic which leads to hypoperfusion (decreased MAP) and ultimate end-organ dysfunction.
  - Common anesthetic medications: Antibiotic, Muscle relaxants
- Initial treatment
  - Removal of causative agent
  - Epinephrine
    - Effectiveness may be blunted in patients on beta blocker therapy
  - IV Fluids

EDUCATION OF SRNAS ON THE ROLE OF VASOPRESSIN IN ATTENUATING HYPOTENSION:

CARDIAC AND NON-CARDIAC ANESTHESIA

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OBJECTIVES

- Primary Aim: Improve SRNA's understanding of the role of vasopressin in the treatment of intraoperative hypotension in cardiac and non-cardiac surgery.
- Focus Questions
  - In caring for patients during cardiac and non-cardiac surgeries, what is vasopressin's role in attenuating intraoperative hypotension?
  - Among SRNA students, will an educational clinical presentation improve their knowledge base and ability to integrate vasopressin into clinical practice in caring for perioperative hypotension among complex patients in specialty rotations?

PROBLEM

- Hypotension during the perioperative period is a common occurrence
- Common early treatments:
  - IVF administration
  - Decreasing anesthetic depth
  - Vasopressor administration (Phenylephrine, Ephedrine)
- Certain patients and situations may require the anesthetist to provide a more tailored approach.

LATE TREATMENT OF HYPOTENSION

- Blood product administration
- Calcium chloride
- Initiation of vasopressor drips
  - Phenylephrine
  - Norepinephrine
  - Epinephrine
  - **Vasopressin**

BASICS OF ENDOGENOUS VASOPRESSIN

- Endogenously produced hormone in the hypothalamus
- Secreted from the posterior pituitary when:
  - Serum osmolality increases
  - Blood pressure decreases

Holt & Hassel, 2010

BASICS OF SYNTHETIC VASOPRESSIN

- Administered intravenously
- Mechanism of Action
  - Acts on V1 and V2 receptors
  - V1: Vascular smooth muscle
    - Stimulates phospholipase C → Increases 2nd messengers IP3 and DAG → Increases intracellular calcium → **vasoconstriction**
  - V2: Distal Convoluted Tubule
    - Stimulates adenylyl cyclase → Increases 2nd messengers cAMP → water retention (increased intravascular fluid volume)

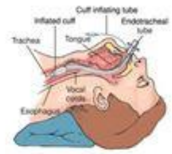
Roach, Schroeder, & Whitley, 2002

COMPARING VASOPRESSORS

- Vasopressin causes constriction of the peripheral vasculature
- Less effective at constricting coronary and cerebral vasculature
  - Decreases cardiac complications
  - Decreases neurological complications

Ezeiby & Sabry 2012

EMERGENCY ADMINISTRATION



[illegible]

- As well as being frequently administered IV, Vasopressin is one of few drugs that can be emergently administered via alternate routes:
- Endotracheal- double the IVP dose

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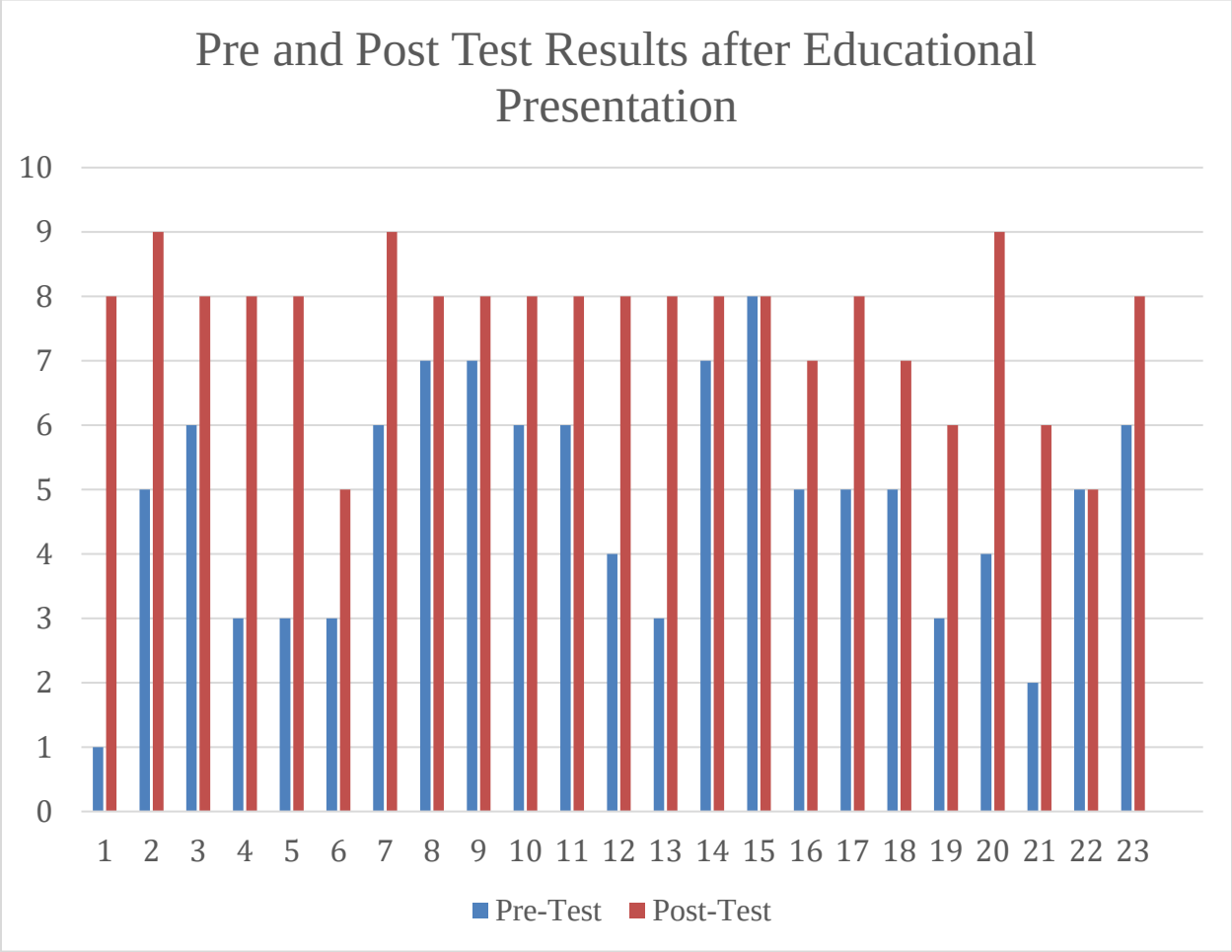
Appendix D: Results Analysis Chart



Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test	4.7826	23	1.80798	.37699
	Post-Test	7.6087	23	1.11759	.23303

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Test - Post-Test	-2.82609	1.80031	.37539	-3.60460	-2.04758	-7.528	22	.000