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Anesthetic Management for Brain-Dead Donors During Organ Procurement Procedures: Best Practice Recommendations

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ANESTHETIC MANAGEMENT FOR BRAIN-DEAD DONORS DURING ORGAN PROCUREMENT PROCEDURES: BEST PRACTICE RECOMMENDATIONS

by

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ABSTRACT

Americans today face an increased need for organ transplants as lifesaving measures. Regardless of patient circumstances or comorbidities, the need for a transplant is more significant than ever before, but it far exceeds the number of available transplantable organs. For this reason alone, each organ procurement case should be meticulously managed; therefore, the role of the CRNA during organ procurement cases of brain-dead donors (BDD) is crucial. Maintaining organ viability for transplant is essential in laying the foundation for the recipient's successful outcome. However, many organ procurement procedures often occur in rural hospitals or at odd hours so some anesthesia providers may be unfamiliar with common management guidelines due to the differences from routine general anesthesia. This DNP project aims to fill that void by the creation of best practice recommendations and cognitive aids for rapid referral and use in the operating room (OR).

The best practice recommendations and cognitive aid were developed through current evidence-based literature and survey analytics research. A survey to assess familiarity with BDD organ procurement cases was conducted from current anesthesia providers of all levels, students through licensed practitioners. The quick reference cognitive aid was created from compiling current literature and evaluated by survey participants. Based on the survey results and data, the author recommends that cognitive aid be incorporated into the USM NAP curriculum and made available for local hospitals.

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DEDICATION

I first want to thank the Lord, who has blessed me more than I deserve. I want to thank my husband for being my biggest cheerleader in life and throughout this program. Without his unwavering support, selflessness, and love, it would have been impossible. I also want to thank my parents for their support through this program, the values and morals they instilled in me, and the love they have shown me. I also want to thank my siblings for their prayers, immense support, and encouragement. To the many other family members and friends who have supported me in more ways than I can mention: Thank you. Without each of you standing behind me and seeing me through every endeavor, I would not be here today.

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LIST OF ABBREVIATIONS

AACN	American Association of Colleges of Nursing
AAN	American Academy of Neurology
ABA	American Bar Association
ABGs	Arterial blood gases
AMA	American Medical Association
ASA	American Society of Anesthesiologists
BDD	Brain-Dead Donor
CRNA	Certified Registered Nurse Anesthetist
DNP	Doctor of Nursing Practice
ECG	Electrocardiogram
HALO	High acuity low occurrence
HPA	Hypothalamic pituitary axis
ICU	Intensive Care Unit
IRB	Institutional Review Board
NOTA	The National Organ Transplant Act
NAP	Nurse Anesthesia Program
OPO	Organ Procurement Organization
OPTN	The Organ Procurement and Transplantation Network
OR	Operating room
PEEP	Positive end expiratory pressure
SRNA	Student Registered Nurse Anesthetist
SVR	Systemic vascular resistance

UDDA	Uniform Determination of Death Act
UNOS	United Network for Organ Sharing
USM	The University of Southern Mississippi
VQ	Ventilation-perfusion

CHAPTER I – INTRODUCTION

Organ transplants within the United States are becoming a greater need than ever before, but the number of organs needed far exceeds the number of donor organs available. Organ donation can be life-changing for those receiving organ transplants and their families. When the decision to organ donation of a brain-dead donor (BDD) is made, it is the responsibility of all healthcare team members to provide the donor with meticulous care to increase the chances that the organ, or graft, will survive the transplant in the recipient. Once the donation has been agreed upon, the anesthesia provider joins the multidisciplinary approach, with their role becoming essential even before entering the operating room (OR). "The perioperative role of the CRNA immediately before and during organ procurement is an important piece in the progression to a successful outcome" (Morse, 2017, p. 385). Since organ donation of a loved one is such a delicate subject, the anesthesia provider should have a significant understanding of the anesthetic management of the BDD so that the outcome honors the donor and increases the recipient's quality of life as intended. Because organ procurement surgeries may not be performed regularly by the certified registered nurse anesthetist (CRNA), they may not be exposed to enough of these surgeries to know what anesthetic plan is best suited for the recipient's health instead of the donor. Ultimately, having a best practice guideline targeted toward the anesthetic management of the brain-dead organ donor during organ procurement surgery will help the CRNA or other anesthesia providers make this possible.

Statement of the Problem

In the United States today, there are 106,158 people on the transplant waiting list, and sadly, 17 of those people die each day, waiting their turn for a second chance at life from an organ transplant (organdonor.gov). Through organ and tissue donation from a brain-dead organ donor, there is potential to save up to 8 lives and improve the lives of 50 or more people (organdonor.gov). Still, unfortunately, the number of people on the transplant waiting list far exceeds those who meet the criteria and wish to donate. While most available literature specifies the anesthetic implications of brain or cardiac death, organ procurement surgery may not be a day-to-day procedure for most anesthesia providers. Therefore, best practice guidelines for anesthetic management of the brain-dead donor (BDD) may not be readily available to all anesthesia providers. The role of the CRNA during organ procurement surgery is essential for maintaining allograft organ function and increasing the recipient's survival rate (Morse, 2017). It is necessary to bear in mind that the anesthetic management of the donor will affect the organ recipient's outcomes. In addition, the CRNA should strive to maintain the dignity of the BDD, the organ recipient, and their respective families during this difficult time. Hence, a clear understanding of expectations and high-quality care is crucial. This DNP project aims to develop the best practice guidelines for anesthetic management of the brain-dead organ donor during organ procurement procedures to enhance outcomes for organ transplant recipients.

Available Knowledge

An extensive online search was conducted to pursue evidence-based literature that supported a common foundation in the anesthetic management of heart-beating brain-

dead donors during organ procurement procedures. The following databases were utilized: CINAHL, EBSCOhost, Google Scholar, MEDLINE, and The Cochrane Library. Except for some literature containing foundational information on brain death, the search was limited to peer-reviewed articles published between 2017-2022 to identify the most recent findings. The following keywords were searched: anesthesia, anesthetic management, brain-death, brain-death criteria, organ donation, and organ procurement. This exploration resulted in several studies worldwide, all with common underpinning. These studies have been utilized in this DNP project to form best practice guidelines and are found listed in the evidence matrix.

Historical Background and Significance

The history behind organ procurement and transplant within the United States is significant. Years of trial and error regarding this topic allowed for the discovery of significant medical breakthroughs that continue to aid in the gift of life. While procurement and transplant surgeries can be complex, other considerations such as organ matching add to the level of complexity. The first successful kidney transplant from a living donor was performed in 1954 among 23-year-old twin brothers. By the 1960s, other organs such as the liver, heart, and pancreas obtained from BDDs were successfully transplanted, but the rejection rate rose dramatically and limited further transplants (UNOS, 2014). During this time, procurements and transplants were managed by local hospitals, so organs obtained could only be used if the donor and recipient were in close proximity. Unfortunately, no matching system existed to locate other compatible recipients elsewhere within the US before the organs were no longer viable and many organs could not be used (UNOS, 2014).

It was not until the early 1980s that the United States government became involved with organ procurement and transplant policy developments. By 1984, The National Organ Transplant Act (NOTA) was passed by Congress "to address the organ donation shortage and improve the organ matching process" (Organ Donation Legislation and Policy | Organdonor.gov, n.d.). The act led to the development of the Organ Procurement and Transplantation Network (OPTN), which regulates how new policies are developed, how organs are allocated, and how transplant data is collected (Organ Procurement and Transplantation Network Policies and Reports | Organdonor.gov, n.d.). Also, in 1984, UNOS became a non-profit member organization and continues to hold the federal contract to operate OPTN. UNOS provides the necessary technology, information, and data to make donor-to-recipient organ matches possible and remains a solid foundation in organ donation and transplant today.

Criteria of Brain Death Declaration

Brain-dead heart-beating donors contribute life to many transplant recipients, but specific criteria must be met for brain death to be declared before organ procurement can occur. In 1981 the Uniform Determination of Death Act (UDDA) was drafted and agreed upon by the American Medical Association (AMA) and the American Bar Association (ABA) to provide a more concrete definition of brain death for legal purposes. According to the literature, "Legal and medical brain death criteria differ from state to state, but all require cessation of both cerebral and brainstem functions" (Barash, 2017, p.1459). In the United States, a patient thought to have irreversible brain damage who may be a possible donor undergoes multiple examinations and testing to support brain death determination.

Although this patient still has a beating heart, the loss of function of the entire brain deems a patient dead by neurologic criteria.

The American Academy of Neurology (AAN) "endorses the UDDA's definition that brain death has occurred when the irreversible loss of all functions of the entire brain, including the brainstem, has been determined by the demonstration of complete loss of consciousness (coma), brainstem reflexes, and the independent capacity for ventilatory drive (apnea), in the absence of any factors that imply possible reversibility" (Russell et al., 2019, p.229). The academy utilizes a checklist to help determine brain death in adults. Its categories include multiple prerequisites such as an irreversible coma of a known cause, physical examinations such as nonreactive pupils to bright light and absent gag reflex, and varied apnea testing. The AAN suggests all boxes within each category are verified and checked before the legal time of death is pronounced. UNOS is contacted almost immediately once a patient is legally declared brain-dead, so the donor-to-recipient matching process can begin to safeguard organ viability.

Effects of Brain Death on the Organ System

Brain death causes adverse physiological and metabolic effects within the multiorgan systems of the body. Maintaining homeostasis of the donor is crucial to sustaining organ perfusion and viability before and during arrival into the OR. It is of utmost importance that anesthesia providers understand the overall effects of brain death in the BDD.

- *Circulatory*. Brain death is associated with hemodynamic instability. Wide fluctuations in blood pressure and heart rate are due to sudden surges of endogenous adrenergic catecholamines as the brainstem deteriorates. Initially,

after cerebral death, hypertension, and bradycardia (Cushing's response) may manifest and lead to the further insult of ischemic injuries. Once the body's supply of catecholamines is depleted, profound hypotension ensues, resulting in hemodynamic collapse. Some literature suggests that if brain herniation occurs, tachycardia is more frequent than bradycardia until the sympathetic outflow terminates (Souter et al., 2017). Eventually, this phenomenon develops into bradycardia that is unresponsive to atropine. In addition, other electrocardiogram (ECG) events may appear, such as ST-segment and T-wave changes and dysrhythmias (Hines & Marschall, 2018).

- *Respiratory.* Due to the absence of brainstem function and ventilatory drive, brain death induces various pulmonary complications. The loss of gag and cough reflexes in the BDD leads to aspiration and atelectasis development. Other complications such as pulmonary edema and ventilation-perfusion (VQ) mismatch cause impaired gas exchange generating abnormal arterial blood gases (ABGs) that suggest hypoxemia, hypercarbia, and acidosis. Although most BDDs are intubated and receive ventilatory support before anesthesia's involvement, management must protect them from further harm such as barotrauma and decreased cardiac output from excessive positive end-expiratory pressure (PEEP). Pulmonary complications lead to detrimental effects on the BDD organs.
- *Endocrine*. Brain death often disrupts the hypothalamic-pituitary-adrenal (HPA) axis causing wide swings of certain hormones. Some literature states that "hypothalamic and posterior pituitary function is more likely affected than anterior pituitary, with up to 90% of patients exhibiting hormonal deficiency and

some loss of osmoregulation" (Souter et al., 2017, p. 213). Therefore, vasopressin deficiency in brain death leads to diabetes insipidus, where hypovolemia worsens and causes hyperosmolality and hypernatremia. Also, the stress of brain death and lack of insulin production produces a hyperglycemic state that exacerbates hypovolemia. Thyroid dysfunction may also be evident through abnormal triiodothyronine (T3) and thyroxine (T4) levels depending on the degree of damage to the anterior pituitary gland.

- *Temperature*. Temperature control is lost in brain death due to loss of temperature-regulatory mechanisms and injury to the hypothalamus. Braindead patients' body temperature fluctuates with the surrounding environment (Poikilothermic). While some mild hypothermia may provide some degree of organ protection, there is also a chance of "cardiac dysrhythmias, coagulopathy, and reduced oxygen delivery to tissues, thus potentially causing harm to the organs to be retrieved" (Hines & Marschall, 2018, p. 280). Active warming to maintain normothermia is a common foundation among studies.
- *Coagulopathy*. Coagulopathies are common among brain-dead patients. These issues typically occur secondary to the previously mentioned catecholamine depletion and hypothermia, therefore affecting platelet aggregation. The release of tissue thromboplastin and plasminogen into systemic circulation may lead to disseminated intravascular coagulation (DIC). Dilutional coagulopathy may also be present in BDDs who have been aggressively treated with intravenous fluids to stabilize hypovolemia.

Donation after Brain-Death: The CRNA's Role

Clinical management of the BDD requires a multidisciplinary approach that begins before transport to the OR for the organ procurement procedure. The role of the CRNA is crucial both preoperatively and intraoperatively for guiding the appropriate BDD treatment and "is essential for continuity of care in maintaining allograft survival" (Morse, 2017, p. 391). The CRNA should perform a thorough preoperative assessment, including reviewing past and current health records, lab work, and any information collected by the Organ Procurement Organization (OPO). Verifying blood type, crossmatch, and availability of blood products is essential should the need for transfusion arise during procurement to maintain organ viability. Confirmation of cause and time of death should also be noted. Finally, the preoperative period may present the CRNA with a window of opportunity to meet the donor's loved ones to provide the opportunity to address concerns. While the focus is mainly on the management of the donor, it is also important to consider the perspective of the donor's family. This procedure is a mournful time, so the CRNA should use this time to ensure the family that their loved one will be taken care of with dignity and respect.

Primary anesthetic goals during organ procurement procedures are to promote donor organ perfusion and oxygenation. It is common practice for separate surgical teams to be present for each organ retrieved. In some instances, the CRNA may be asked to carry out special instructions from each procurement team, but ultimately, management focuses on optimizing the perfusion and oxygenation of donor organs. Hines and Marschall (2018, p. 280) suggest that "a good rule of thumb for the management of patients for organ donation is the rule of 100s: systolic blood pressure greater than 100

mm Hg, urine output greater than 100 ml/h, PaO2 greater than 100 mm Hg, and hemoglobin level greater than 100 g/L".

Labile blood pressure after brain death can lead to devastating effects on donor organs if not meticulously managed. Hypertension after brain death is poorly understood and does not commonly occur in the BDD. However, its occurrence is thought to be similar to autonomic dysreflexia that appears after spinal cord injuries of T6 or higher. Antihypertensives may be required to reduce the risk of ischemic injury to potential donor organs. Some studies suggest using volatile anesthetics for hypertensive episodes may also be helpful due to their ability to decrease systemic vascular resistance (SVR) and vasodilate. However, data is inconsistent among studies on volatile anesthetics to treat hypertension, suggesting its use depends on the specifics of each donor. While hypertension is less common and may only ensue for a brief time after brain death, hypotension typically dominates in the BDD from catecholamine depletion, loss of vasomotor tone due to brainstem death, and the onset of diabetes insipidus. Current strategies for hemodynamic maintenance of hypotension include replacing intravascular volume with crystalloids or colloid products. Excessive crystalloid solutions, however, may increase the risk of dilutional coagulopathy. In addition to plasma expansion, Vasopressin at a rate of 0.5 to 1.5 U/h is common practice due to its anti-diuretic and vasoconstrictor properties. Low-dose Dopamine is recommended to help increase renal perfusion. Indications of euvolemia and adequate perfusion in the donor are indicative by a systolic blood pressure greater than 100 mm Hg, mean arterial pressure greater than 70 mm Hg, and a central venous pressure of 12 mm Hg or higher. A urine output of 100 mL/h ensures renal perfusion.

Oxygenation and ventilation of the BDD are established through intubation, usually before the anesthesia provider's involvement in the case, but preservation must continue within the OR. Strategies to promote oxygenation and lung protection by the anesthesia provider include "maintaining tidal volumes of 6 to 8 mL/kg and PEEP adjusted to allow a minimal fraction of inspired oxygen (FiO2)," especially in lung donors (Barash, 2017, p. 1460). Literature suggests the same ventilator settings used in the ICU should continue within the OR to maintain the stability of the BDD. PEEP valves are often required for ventilation during transport to the procurement area. If the anesthesia machine is not equipped to provide the same ventilator settings, the ICU ventilator must be transported with the BDD to the surgical suite. Current studies suggest that arterial PCO2 is generally maintained at 30 to 35 mmHg (Barash, 2017) as a sign of adequate oxygenation and ventilation. Lastly, if lung donation occurs, a bronchoscopy may be performed, and additional medication administration such as glucocorticoids and prostaglandin E1 may be requested from the surgeon to help circulate the protective lung solution before retrieval (Barash, 2017).

Due to the effects of brain death and disruption of the pain pathway, volatile agents and analgesics are not necessary during organ procurement for unconsciousness, amnesia, and analgesia. Some literature argues that volatile agents may provide organ protection, but the data is conflicting. However, depending on the extent of their injuries, most BDDs have intact spinal reflexes and may require neuromuscular blockade during the organ procurement process. Due to the disrupted pathways from brain death, the BDD cannot perceive pain, so responses evoked from spinal reflexes do not signify pain.

Lastly, any active bleeding or coagulopathies may need to be corrected before and during organ procurement. Blood administration should be considered in the event of hypovolemia, dilutional coagulopathies, or refractory hypoxemia or hypoxia. A blood warmer should be used to avoid hypothermia in the BDD. In addition, glucose levels should be maintained between 120-180 mg/dL. An insulin infusion may be necessary as "recent studies support glucose control for maintaining donor kidney graft quality" (Barash, 2017, p. 1459). Also, the anesthesia provider should be ready to provide thromboprophylaxis by heparin or other means due to the high incidence of pulmonary emboli during organ procurement. Though many different anesthetic regimens may occur during organ procurement of the BDD, the common groundwork is the anesthesia provider must understand the effects that brain death has on organ systems to prepare and treat accordingly.

Commonly Accepted Guidelines: The Rule of 100s

Although abundant literature addresses guidelines for the ethical considerations of organ donation, there are currently no prominent or easily accessible specific treatment protocols for managing the BDD before and during procurement. Variations in management differ nationwide between hospital ICUs and state organ recovery agencies. However, the commonly accepted theme found in the literature is that applying the rule of 100s is best for monitoring oxygenation and perfusion regardless of variations in treatment.

Healthcare Triple Aim

In 2010, the Affordable Healthcare Act was enacted to provide quality health care at a lower cost. As a result, The Institute for Healthcare Improvement (IHI) developed the

Triple Aim to optimize health system performance (Institute for Healthcare Improvement [IHI], 2023). The goals of the Triple Aim intertwine to improve patient experience, improve the overall population's health for better outcomes, and reduce per capita cost of care. This doctoral project meets all three components of Triple Aim by providing safe, effective, patient-centered care to the BDD so that the best outcome is possible for the organ recipient. The anesthesia provider's knowledge of current standards of practice during organ procurement of the BDD results in high-quality, effective care for the donor, ultimately providing an improved patient experience for the recipient.

Cognitive Aid

Aviation and anesthesia have long been compared similarly in maintaining high standards of practice to provide safe and optimal experiences for customers and patients. Adequate planning is required in both circumstances and is critical to ensure the accomplishment of objectives is safely carried out. The use of checklists and cognitive aids is utilized in aviation and is proven to be an effective means of safety during routine management and emergencies. Learning from these aviation techniques can develop safe and effective anesthesia practices. Developing a cognitive aid for this DNP project should guide the anesthesia provider through the organ procurement process by compiling critical points for quick reference.

HALO: High-Acuity Low Occurrence

Due to the low occurrence of organ procurements at certain facilities, anesthesia providers may have yet to participate in these procedures. However, the case of the BDD is high acuity and may present as challenging, complex, and unpredictable. Research shows that High Acuity Low Occurrence (HALO) programs and certifications concocted

to prepare those in emergency and high-stress situations help establish confidence and knowledge and improve the provider's skills. The development of a HALO curriculum and certification for anesthesia providers wishing to partake in organ procurement procedures could also be beneficial in addition to the cognitive aid for best practice guidelines created through this DNP project, although more research would be required.

DNP Essentials

The American Association of Colleges of Nursing (AACN) recognizes doctoral programs in nursing to be research-focused and practice-focused, earning either a Doctor of Philosophy degree (Ph.D.) or a Doctor of Nursing Practice (DNP), respectively. The nurse anesthesia program at USM is practice-focused, with graduates earning a DNP upon completion. This program "is designed to prepare experts in specialized advanced nursing practice" (American Association of Colleges of Nursing [AACN], 2006, p. 3). The DNP degree prepares nurses for leadership at the highest level while they simultaneously contribute to ever-evolving health care through innovative practice and evidence-based research. The AACN has deemed eight essentials necessary for advanced nursing practice and graduation from a DNP program.

Essential I: Underpinnings for Practice

This essential is met by creating best practice guidelines based on researching current evidence-based literature on the anesthetic management of the BDD during organ procurement procedures (AACN, 2006).

Essential II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking

Essential II was met by conducting peer-reviewed research for evidence-based literature that supported best practices of the anesthesia provider during organ procurement to encourage a better outcome for the transplant recipient (AACN, 2006).

Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice

This DNP project has been conducted through vast evidence-based literature research to include the best practice recommendations of the BDD during hospitalization in the intensive care unit (ICU) and the OR (AACN, 2006).

Essential V: Health Care Policy for Advocacy in Health Care

This DNP project aims to advocate for the BDD, the recipient, and their respective families by setting forth best practice guidelines during organ procurement procedures (AACN, 2006).

Essential VI: Interprofessional Collaboration for Improving Patient and Population Health Outcomes

Evidence-based literature shows the collaboration of the anesthesia provider with other healthcare team members before entering the OR is vital in the outcome of the organ allograft, and this DNP project aims to include that in the best practice guidelines (AACN, 2006).

Essential VII: Clinical Prevention and Population Health for Improving the Nation's Health

This essential is met by investigating evidence-based literature for best anesthetic practices and recommendations that improve the rate of organ allograft survival to improve the recipient survival rate (AACN, 2006).

Essential VIII: Advanced Nursing Practice

This DNP project aims to offer best practice guidelines for the anesthetic management of the BDD during organ procurement to improve organ allograft transplants for the recipient. This essential is met by collecting evidence-based literature, and data, and collaborating with anesthesia providers who are experienced in organ procurement procedures (AACN, 2006).

Rationale

The CRNA's goal while providing routine general anesthesia is to give patients the best surgical experience possible by managing amnesia, anxiolysis, analgesia, muscle relaxation, and hemodynamic stability. However, anesthetic management of the BDD differs significantly from routine general anesthesia due to the consequences of brain death on the body. A firm understanding of this concept by the CRNA is vital so that precise intraoperative management can be provided to maintain the viability of donor organs. For CRNAs who do not routinely perform anesthetic management of heart-beating brain-dead donors during organ procurement, clarification of best practice guidelines will provide guidance that optimizes donor and recipient outcomes.

Specific Aims

This DNP project aims to provide a foundation of current evidence-based research that proposes best practice guidelines for the anesthetic management of the BDD during organ procurement. This DNP project also investigates the anesthesia providers' knowledge and awareness of current practices and management of the BDD. Implementation of this approach will inform and guide the anesthesia provider through organ procurement procedures to enhance the number and outcome of viable organs available for transplant recipients.

Summary

"Most BDD organ procurement procedures take place in community or rural hospitals, increasing the likelihood that the anesthesia provider will be asked to participate in the overall management of the potential of the BDD" (Morse, 2017, p. 386). Due to the nature and lack of routine organ procurement cases, the CRNA may be unfamiliar with this type of management. While several publications specify anesthetic implications of brain death, there is a void in how to provide anesthesia during organ procurement surgery. This DNP project seeks to fill that void and provide guidelines for best practices to enhance the viability of organs for transplant recipients.

CHAPTER II – METHODOLOGY

The purpose of this DNP project aimed to improve the anesthetic management of BDDs during organ procurement surgery by providing best practice recommendations. These developments were established through data found in thorough evidence-based research. Any practicing SRNA or CRNA unfamiliar with the organ procurement process can benefit by utilizing the recommendations outlined in this DNP project. By implementing these guidelines, organ perfusion and oxygenation can be improved with the risk of ischemic injury and hypoperfusion reduced. Overall, applying these recommendations should enhance the likelihood of allograft survival for the transplant recipient. Investigation and research for this DNP project were completed by assessing baseline knowledge and practices of current anesthesia providers at associated USM clinical affiliates.

Design

The design of this DNP project was to provide an assessment of the current practices and baseline knowledge of CRNAs and SRNAs who have or will participate in organ procurement procedures and carry out the anesthetic management of the BDD. Once approval was obtained from the Institutional Review Board (IRB), protocol number 23-0040, a questionnaire was mailed to currently practicing anesthesia providers at participating clinical sites to make an evidence-based assessment using publicly available email addresses or those who have previously indicated that they would like to participate in DNP project surveys. The email attachment included an IRB-approved email announcement, contact information, an online informed consent, a cognitive aid for best practice guidelines for BDD anesthetic management, and a link to an anonymous online

survey using the USM Qualtrics survey platform. No identifying information was asked. A period of two weeks was the amount of time allotted for participation in the survey before the data collection ceased. Participants were notified of their anonymity, and informed consent was obtained. At the end of two weeks, data from the survey was analyzed and best practice recommendations were made from survey results in conjunction with evidence-based literature.

Data Collection and Analysis

This DNP project deployed a survey assessment to determine anesthesia providers' baseline knowledge and current practices regarding the anesthetic management of BDDs during organ procurement procedures. The rationale for this particular DNP project was offered with the explanation that publications exist that specify the need for anesthesia's involvement in the BDD during organ procurement procedures. Still, there is a perceived general lack of knowledge of how to provide anesthesia because many facilities do not participate in organ procurement. A systemic literature search was completed using multiple databases that guided best practice recommendations and the creation of a survey questionnaire. The questionnaire addresses the baseline knowledge of currently practicing anesthesia providers who may or may not have participated in these procedures. It also addresses the practices of anesthetists who have provided anesthesia during organ procurement. Completed surveys help determine the best practice recommendations and aim to guide currently practicing anesthesia providers who have never had the opportunity to be part of the organ procurement team and those who wish to improve the quality of anesthesia provided. Included survey questions are a

combination of yes/no and short answer questions and a short section with room for narrative discussion.

1. Before proceeding, do you give informed consent to agree to participate by answering this questionnaire voluntarily? All participants will remain anonymous.
2. What is your title? CRNA or SRNA?
3. On a scale of 0 (unfamiliar) to 4 (very familiar), how aware are you of the current practices for the anesthetic management of brain-dead donors during organ procurement?
4. Have you ever been an anesthesia provider for a brain-dead donor during organ procurement? If you answer "no", please select not applicable for the following 3 questions.
5. If you answered "yes" to the previous question, please specify how many brain-dead donor organ procurement cases you have been involved in.
6. Did you use medications with analgesic or amnestic properties such as Fentanyl or Versed? If so, please specify which.
7. Did you use any inhalation agents during the procedure?
8. Do you believe this project brings awareness of the differences in routine general anesthesia and organ procurement procedures for brain-dead donors?
9. Did you find the cognitive aid for common goals and anticipations of these procedures clear and concise?
10. After participating in this project survey, do you believe implementing best practice recommendations for the anesthetic management of the brain-dead

donor will help increase the number of viable organs available for people awaiting transplants?

11. Please add any comments or further recommendations you have that would make these recommendations more successful.

Using descriptive statistics and qualitative data coded as quantitative, along with content thematic analysis, the results were analyzed and evaluated. The data results are reported in Chapter III.

Ethical Considerations

Ethical considerations for anesthesia providers are plentiful. According to the American Society of Anesthesiologists (ASA), BDDs are classified as an ASA 6: a classification assigned to the declared brain-dead patient undergoing organ donation. Due to the nature of brain death, some healthcare ethical concerns are the use of analgesics and volatile anesthetics during organ procurement procedures. Some literature suggests that using these pharmacological agents may challenge the public's trust in healthcare causing them to question if their loved one still feels pain or if the brain death diagnosis was inconclusive. Although these concerns usually arise from the public's lack of understanding, the anesthesia provider is faced with these ethical considerations.

Other ethical considerations are the possibility of delivering two different standards of care in the preoperative and intraoperative periods. Evidence-based research supports the importance of a thorough preoperative assessment and managing the donor to promote the best perfusion and oxygenation of organs. Implementing this standard permits an increased chance of organ viability and successful transplant recipient outcomes while maintaining donor dignity. On the contrary, anesthesia providers who do

not utilize the standard of care allow for a higher risk of insulting injuries to organs, thus rendering them unfit for transplant.

Summary

In summary, the proposed evidence-based best practice recommendations aim to better understand the anesthetic management of the BDD that is necessary to maintain the viability of transplantable organs. A voluntary, anonymous survey was conducted via questionnaire to determine familiarity with the current anesthesia trends. The questionnaire was designed to elicit information from currently practicing anesthesia providers with regard to the selection of agents and medications, preferences, and knowledge of current standards of care for BDD patients. It also offered an opportunity to provide any additional information or recommendations. The author of this doctoral project collected the data from the survey and complied it with evidence-based literature to develop best practice recommendations. Next, this DNP project was presented in detail to a panel of anesthesia providers, who combined have over 100 years of combined experience, as well as to anesthesia providers with less than one year's experience. Upon presentation, the survey and collaboration provided valuable feedback, which helped further guide the development of best practice recommendations for the anesthetic management of the BDD during organ procurement procedures.

CHAPTER III – RESULTS

The doctoral-level education and advanced practice nursing skills learned through The University of Southern Mississippi's Nurse Anesthesia Program have helped create many resourceful projects for the SRNA and other anesthesia providers throughout the program's existence. While many topics have been meticulously researched and numerous resource tools have been constructed, no current information is available to anesthesia providers for the anesthetic management of brain-dead organ donors during organ procurement. If best practice recommendations for these types of procedures were combined into a quick access cognitive aid, it could enhance the anesthesia provider's knowledge of the situation to prepare for these high acuity low occurrence cases and ultimately improve outcomes for transplant recipients. Therefore, this DNP project focused on compiling best practice guidelines and creating a cognitive aid to help summarize expected events and outcomes of brain-dead organ donors and propose a resource tool for the past, present, and future USM SRNAs.

This DNP project was presented to and approved by the DNP chair and committee and then submitted to The Institutional Review Board (IRB) of The University of Southern Mississippi to ensure appropriate standards were met. An evidence-based cognitive aid for the common goals and anticipations for the anesthetic management of brain-dead donors during organ procurement was created. Upon approval from the IRB, an email containing informed consent, the cognitive aid, and the Qualtrics survey link was sent to all participants previously mentioned. Before survey completion, participants were informed that all answers would remain anonymous, and the information gathered would provide statistical information for this DNP project only. The survey questionnaire

asked ten multiple choice questions that aimed to provide data on the experience of the anesthesia provider, the familiarity with anesthetic management during organ donation procedures, the common practice and techniques of providers, and if the participant believed this DNP project was representative of doctoral work and was beneficial in providing insight for anesthesia providers. This survey also contained an open-ended section for comments and recommendations that would help improve this DNP project.

The survey questionnaire remained open to the invited participants for two weeks before quantitative and qualitative data were collected and analyzed. Of the 70 emails, 36 (51%) participants responded to the survey, including 1 CRNA and 35 SRNAs. One hundred percent of participants agree to online consent before proceeding. Table 1 below details the demographics of participants' awareness of the current practices of the anesthetic management of brain-dead donors during organ procurement based on a scale of 0 (unfamiliar) to 4 (very familiar).

Table 1

Participant Demographics of Awareness of Current Practices During BDD Organ Procurement

Choice #	Answer	Percentage	Count
1	0 (Unfamiliar)	44.44%	16
2	1	19.44%	7
3	2	25.00%	9
4	3	11.11%	4
5	4 (Very familiar)	0.00%	0
	Total	100%	36

In addition, the data exhibited that four (11%) survey participants have been a provider in BDD organ procurement, while the remaining 89% have not. Of the four providers who answered “yes”, 100% have been in five or fewer organ procurement surgeries. Figure 1 below details feedback when asked about the use of medications with analgesic or amnestic properties during organ procurement. Two (5.7%) providers said they used Versed, one (2.86%) provider stated they used other medications with the same properties, and one provider did not answer. The remaining 32 participants were instructed to answer "not applicable" to these questions.

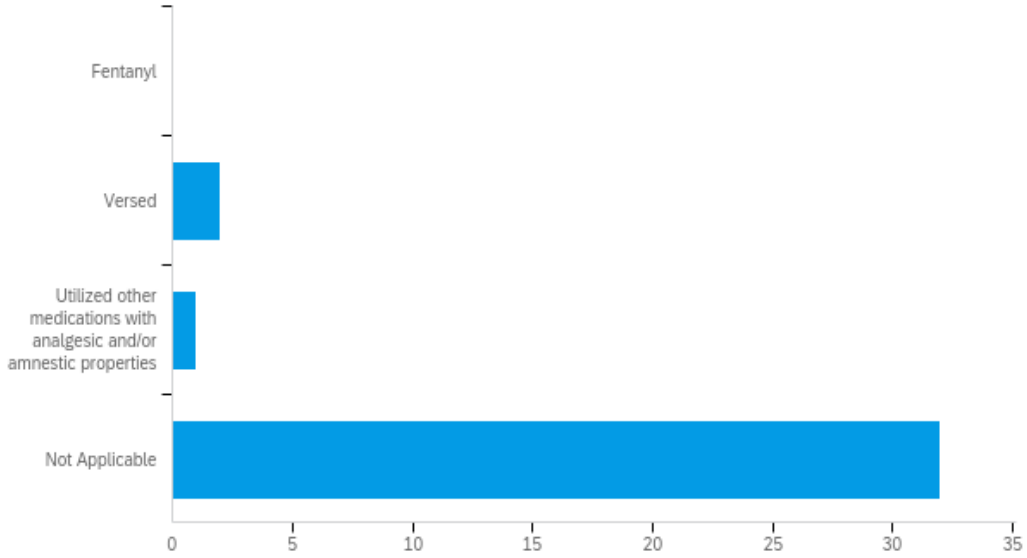


Figure 1. Responses to the Use of Medications With Analgesic or Amnestic Properties During BDD Organ Procurement

Survey participants were also asked if they utilized inhalation agents during the procedure. Of the four providers with previous experience, three (8.57%) answered they did not utilize inhalation agents, with the remaining provider (2.86%) answering they did

use inhalation agents during one or more cases. As instructed, 31 participants answered "not applicable" to this question, and one did not respond.

This survey needed to inquire if doctoral-level work was reflected in this DNP project. When asked if they believed implementing best practice recommendations for the anesthetic management of brain-dead donors would help increase the number of viable organs available for people awaiting transplants, 89% of participants strongly agreed, 9% somewhat agreed, and 2% remained neutral. No participants disagreed. 100% of participants agreed this DNP project brings awareness to the differences between routine general anesthesia and BDD organ procurement practices. 100% of participants also found the cognitive aid created for this DNP project to be clear and concise.

Lastly, qualitative data for this doctoral project was collected through an open-ended comment section provided in the anonymous survey. This section allowed participants to give feedback and any further recommendations on the DNP project that they felt could make it more successful. Table 2 shows several responses received in the comment section.

Table 2

Free-Text Responses to Comment Section in Qualtrics Survey

Participant	**Comments or Suggestions**
4	One of the best projects I've seen. I will be using this as a future resource for any brain-dead donor cases I do!
5	Very informative!
11	Great project. Great job!

Table 2 (continued).

26	This project is very intriguing as I've always wanted to see organ procurement surgery. Prior to entering anesthesia school, I cared for both populations of brain-dead donors and transplant recipients. I am excited to learn more about your findings.
30	Great project for raising awareness about proper anticipation and interventions to maintain organ viability

Summary

This DNP project provided evidence-based best practice recommendations for managing the brain-dead organ donor during procurement. The survey regarding the awareness of current practices revealed that knowledge on this topic needs to be improved for some anesthesia students and providers. Implementing the information gained from this DNP project and utilizing the cognitive aid could enhance their performance in the clinical setting.

CHAPTER IV – DISCUSSION

This doctoral project was created with the purpose of providing USM SRNAs and other anesthesia providers with the current best practice recommendations for anesthetic management of BDD during organ procurement procedures. Once the evidence-based literature and data were thoroughly researched, it was compiled into a quick-access cognitive aid that addresses common goals and anticipated outcomes for these procedures. The cognitive aid serves as an adjunct to the program's didactic curriculum and will be available for all USM anesthesia students through the NAP application. Due to these cases being of high acuity low occurrence, the anesthesia provider can benefit from this DNP project by utilizing the cognitive aid created.

Thirty-six total anesthesia providers surveyed this DNP project, ranging from SRNAs to CRNAs who wished to participate. It began by assessing the provider's familiarity with current practices and guidelines of the anesthetic management of the BDD during organ procurement procedures. Participants were then asked if they had ever been the provider during these cases and, if so, what practices were used. The feedback of this DNP project was optimistic in both qualitative and quantitative data. Survey participants did not give any criticism or recommendations for the DNP project, however; several comments received suggested they would utilize this cognitive aid in the future.

Limitations

As with many research projects, this study had its limitations. One limitation of this study was its small sample size. While 70 invitational emails were sent out, only 36 people chose to participate in the survey. Of those 36 participants, only four had been the anesthesia provider for at least one BDD organ procurement procedure. Only one CRNA

was able to provide feedback, with the remaining participants being SRNAs of the first, second, and third-year levels. More input from experienced CRNAs on what techniques they utilized during organ procurement procedures could have been valuable to this DNP project. However, because these types of procedures do not occur on a routine basis, sufficient information was able to be compiled through the literature for the benefit of anesthesia providers of all levels of experience.

The lack of qualitative feedback also demonstrated another limitation of this DNP project. While the survey was kept to a minimum of 10 multiple choice questions and one comment section, the chosen participants who evaluated this DNP project are under time constraints due to job status or full-time anesthesia students juggling the classroom and clinical setting. Consequently, additional survey questions would have increased survey response time and deterred the people who answered from participating. While additional responses would have provided better qualitative and quantitative data for this DNP project, the number of questions and amount of time were kept to a necessary minimum to encourage an increased response rate and decrease the inconvenience of time.

Conclusion

In conclusion, this best practice recommendations DNP project for the anesthetic management of BDDs during organ procurement was developed using the most up-to-date and current evidence-based literature and guidelines. The cognitive aid designed alongside this DNP project has the potential to be a valuable tool for anesthesia providers with all levels of experience. The nature of these procedures makes them high-acuity low occurrence, so the cognitive aid provided can be a resourceful tool to both SRNA and CRNA

APPENDIX A – IRB Approval Letter

Office *of*
Research Integrity

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

118 COLLEGE DRIVE #5116 • HATTIESBURG, MS | 601.266.6756 | WWW.USM.EDU/ORI

NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident submission on InfoEd IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.

PROTOCOL NUMBER:	23-0040
PROJECT TITLE:	Anesthetic Management of Brain-Dead Donors During Organ Procurement Procedures: Best Practice Recommendations
SCHOOL/PROGRAM	Leadership & Advanced Nursing
RESEARCHERS:	PI: Cindel Mayerhoff Investigators: Mayerhoff, Cindel~Mclain, Nina Elisabeth~
IRB COMMITTEE ACTION:	Approved
CATEGORY:	Expedited Category
PERIOD OF APPROVAL:	14-Mar-2023 to 13-Mar-2024

Donald Sacco

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

APPENDIX B – Survey Recruitment Letter

Dear Participants,

My name is Cindel Mayerhoff, and I am a DNP student in the Nurse Anesthesia Program at USM. I would like to request your participation in my research on best practice recommendations for the anesthetic management of brain-dead donors during organ procurement procedures.

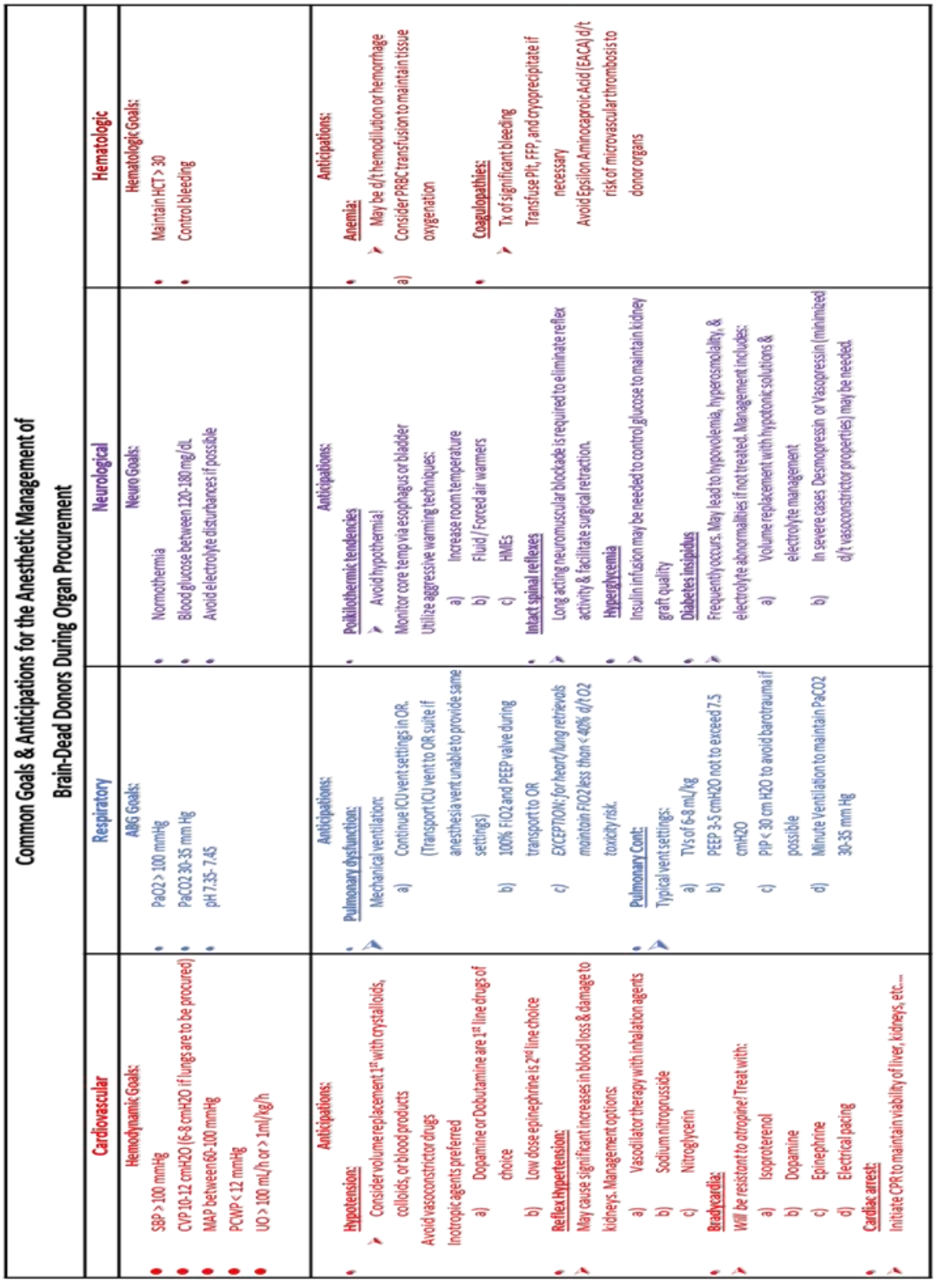
Participation in this study will take less than 10 minutes and consists of completing an overview of a cognitive aid and an electronic survey for this project, which details common goals and anticipations for the anesthetic management of brain-dead donors during the organ procurement process. This questionnaire is 100% voluntary and will be kept anonymous and confidential. There will be no consequences for non-participation, and at any time you wish to withdraw from participation, you may exit the browser with no repercussions. To contrast, there is no compensation for participation, but individuals may benefit from the results of this project.

Informed consent is included in the questionnaire and is necessary for participation. This DNP project and informed consent have been reviewed by The University of Southern Mississippi Institutional Review Board #23-0040. The informed consent is provided below and should be examined before completing the questionnaire.

If you have any questions about this project or participation, please reach out to me by the information provided below. Thank you for your time and feedback to help improve this study.

Thank you,
Cindel Mayerhoff
Cindel.mayerhoff@usm.edu
601-616-9439

APPENDIX C – Cognitive Aid



Common Goals & Anticipations for the Anesthetic Management of Brain-Dead Donors During Organ Procurement

Cardiovascular

Hemodynamic Goals:

- SBP > 100 mmHg
- CVP 10-12 cmH2O (6-8 cmH2O if lungs are to be procured)
- MAP between 60-100 mmHg
- PCWP < 12 mmHg
- UO > 100 mL/h or > 1ml/kg/h

Anticipations:

- **Hypotension:**
  - Consider volume replacement 1st with crystalloids, colloids, or blood products

  Avoid vasoconstrictor drugs

  Inotropic agents preferred

  a) Dopamine or Dobutamine are 1st line drugs of choice
  b) Low dose epinephrine is 2nd line choice
- **Reflex Hypertension:**
  - May cause significant increases in blood loss & damage to kidneys. Management options:
    a) Vasodilator therapy with inhalation agents
    b) Sodium nitroprusside
    c) Nitroglycerin
- **Bradycardia:**
  - Will be resistant to atropine! Treat with:
    a) Isoproterenol
    b) Dopamine
    c) Epinephrine
    d) Electrical pacing
- **Cardiac arrest:**
  - Initiate CPR to maintain viability of liver, kidneys, etc....

Respiratory

ABG Goals:

- PaO2 > 100 mmHg
- PaCO2 30-35 mm Hg
- pH 7.35- 7.45

Anticipations:

- **Pulmonary dysfunction:**
  - Mechanical ventilation:
    a) Continue ICU vent settings in OR. (Transport ICU vent to OR suite if anesthesia vent unable to provide same settings)
    b) 100% FiO2 and PEEP valve during transport to OR
    c) *EXCEPTION: for heart/lung retrievals maintain FiO2 less than < 40% d/t O2 toxicity risk.*
- **Pulmonary Cont:**
  - Typical vent settings:
    a) TVs of 6-8 mL/Kg
    b) PEEP 3-5 cmH2O not to exceed 7.5 cmH2O
    c) PIP < 30 cm H2O to avoid barotrauma if possible
    d) Minute Ventilation to maintain PaCO2 30-35 mm Hg

Neurological

Neuro Goals:

- Normothermia
- Blood glucose between 120-180 mg/dL
- Avoid electrolyte disturbances if possible

Anticipations:

- **Poikilothermic tendencies**
  - Avoid hypothermia!

  Monitor core temp via esophagus or bladder

  Utilize aggressive warming techniques:
  a) Increase room temperature
  b) Fluid / Forced air warmers
  c) HMEs
- **Intact spinal reflexes**
  - Long acting neuromuscular blockade is required to eliminate reflex activity & facilitate surgical retraction.
- **Hyperglycemia**
  - Insulin infusion may be needed to control glucose to maintain kidney graft quality
- **Diabetes insipidus**
  - Frequently occurs. May lead to hypovolemia, hyperosmolality, & electrolyte abnormalities if not treated. Management includes:
    a) Volume replacement with hypotonic solutions & electrolyte management
    b) In severe cases Desmopressin or Vasopressin (minimized d/t vasoconstrictor properties) may be needed.

Hematologic

Hematologic Goals:

- Maintain HCT > 30
- Control bleeding

Anticipations:

- **Anemia:**
  - May be d/t hemodilution or hemorrhage

  Consider PRBC transfusion to maintain tissue oxygenation
- **Coagulopathies:**
  - Tx of significant bleeding

  Transfuse Plt, FFP, and cryoprecipitate if necessary

  Avoid Epsilon Aminocaproic Acid (EACA) d/t risk of microvascular thrombosis to donor organs

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