PRE-HOSPITAL PROVIDERS USE OF KETAMINE FOR RAPID SEQUENCE INTUBATION

by

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A DNP Project Submitted to the Faculty of the

COLLEGE OF NURSING

In Partial Fulfillment of the Requirements
For the Degree of

DOCTOR OF NURSING PRACTICE

In the Graduate College

THE UNIVERSITY OF ARIZONA

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THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

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ACKNOWLEDGMENTS

I would like to express a deep appreciation to the Gilbert Fire and Medical Department. I would like to thank this department not only for their willingness to participate in this project but also for the service they provide to the citizens of Arizona.

DEDICATION

This project is dedicated to Marie, Zyon and Rhys Whitley.

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ABSTRACT

Patients are injected with anesthetics to produce analgesia, amnesia, and arreflexia for many different reasons such as surgery, invasive procedures, and emergency interventions; one anesthetic induction technique is rapid sequence intubation (RSI). The RSI technique is performed to safely control the airway in patients needing immediate airway management. A particular induction anesthetic with increased use in the pre-hospital arena is ketamine. In October 2016, Ketamine was added to the RSI protocol of one pre-hospital organization whereby providers can use ketamine as an induction agent.

Purpose. The purpose of this project is to determine if there is a relationship between pre-hospital providers (PHPs) choice of using ketamine to facilitate intubation and knowledge about the anesthetic agent in regards to the adult trauma patient.

Setting. The setting to this project was a local pre-hospital organization located in Gilbert, Arizona.

Participants. The participants of this project are PHPs who maintain an active national and Arizona Department of Health Services (AZDHS) certification as emergency medical technician-paramedics (EMT-P).

Method. An online survey was disseminated that included questions regarding frequency of ketamine use, knowledge of ketamine as well as questions regarding their choice of induction agent.

Results. The response rate was 32.3%. The majority of PHP's have greater than 10 years experience as a certified emergency paramedic (68.8%) and less than half (38.7%) of the certified emergency paramedics (CEP) have used ketamine for RSI. Of the respondents that have

used ketamine as an induction agent, the majority (66.0%) would choose ketamine over another induction agent. While the majority of respondents rate themselves as knowledgeable in the pharmacological profile of ketamine (93.8%), the majority has also had less than five hours of training on ketamine (59.4%). The overwhelming majority agreed that they would benefit from training on aspects of ketamine.

Conclusion. The seasoned CEP's would choose ketamine over other induction agents for RSI of the adult patient. The choice to use ketamine is based upon self-reported pharmacological knowledge of the drug. The limited occurrence of RSI and use of ketamine supports continual training on the use of ketamine and the RSI technique.

INTRODUCTION

Ketamine is an anesthetic drug administered for several different occasions (Gunning, Perkins, & Quinn, 2007). Structurally similar to phencyclidine (PCP), ketamine is a N-methyl-D-aspartate (NMDA) receptor antagonist that produces dissociative anesthesia by neuroinhibition (Stoelting & Hillier, 2006). While ketamine has been approved by the Food and Drug Administration (FDA) for clinical use for over half a century, the precise mechanisms of action remain largely a mystery. The hypnotic effects of ketamine appear to be in part mediated by blockade of NMDA receptors, yet cholinergic, aminergic, and opioid systems appear to have a role in both positive and negative modulation of sedation and analgesia. Furthermore, ketamine has been found to be effective as an antidepressant and as an intervention for chronic pain. These effects are most likely due to a secondary mediation in structural synaptic connectivity that is mediated by a neuronal response to the ketamine-induced hyper-glutamatergic state (Sleigh, Harvey, Voss, & Denny, 2014). Ketamine has a wide range of clinical applications, which include sedation, analgesia, and anesthesia. Ketamine is currently the only anesthetic induction agent with analgesic properties. (Barash, Sayyid, & Assaf, 2009). Lastly, ketamine produces dose dependent stimulation to the central nervous system (CNS), which in turn leads to an increase in catecholamine outflow and preserved hemodynamic status in most patients (Chang, Raty, Ortiz, Bailard, & Mathew, 2013).

As a result of increased catecholamine outflow, ketamine produces increases in systemic blood pressure, cardiac output, heart rate and myocardial oxygen consumption (Kurdi, Theerth, & Deva, 2014). Conversely, a critically ill patient may experience a decrease in cardiac output and blood pressure due to a depletion of endogenous catecholamines from overtaxing the

homeostatic stress response (Kurdi, Theerth, & Deva, 2014). Therefore, knowledge about the pharmacology, indications, and contraindications of this medication is crucial in order to safely administer it as an induction agent.

Patients are injected with anesthetics to produce analgesia, amnesia, and arreflexia for many different reasons such as surgery, invasive procedures, and emergency interventions; one anesthetic induction technique is rapid sequence intubation (RSI). The technique of RSI is performed to safely and effectively control the airway in patient populations who need immediate airway management (Ehrenfeld, Cassedy, Forbes, Mercaldo, & Sandberg, 2012). Patient populations that may benefit from the use of RSI include those at an increased risk for gastric regurgitation, which may lead to aspiration or a blockage of the airway (Ehrenfeld, Cassedy, Forbes, Mercaldo, & Sandberg, 2012). These patient populations include those with a history of gastro-esophageal reflux disease (GERD) and obesity, as well as pregnant and traumatically injured patients who may have just consumed a meal (Gebremedhn, Gebeyehu, Ayana, Oumer, & Ayalew, 2014). Trauma patients are normally first treated by pre-hospital providers.

Pre-hospital providers (PHP) are defined as health care providers trained and certified or licensed by the state, who practice emergency assessment and care in the out-of-hospital setting (Al-Thani, El-Menyar, & Latifi, 2014). The primary goal of the PHP is to establish and maintain physiologic and hemodynamic stability and transport to tertiary care facility when indicated (Al-Thani, El-Menyar, & Latifi, 2014). The PHPs in this project will include Arizona Certified Emergency Paramedics (CEP). Ketamine has recently been added to the Arizona Emergency Medical Services (AEMS) offline protocols as an alternate induction agent for RSI (Appendix

A). It is logical to assume there is a need to examine PHPs decision-making process of choosing to use ketamine to ensure optimal patient outcome.

Background Knowledge

Trauma is the third leading cause of death among all age groups with blunt trauma constituting a significant portion of morbidity and mortality among adults (Al-Thani, El-Menyar, & Latifi, 2014). Nearly 80% of all trauma patients are first assessed by PHPs before definitive care is established (Al-Thani, El-Menyar, & Latifi, 2014). One of the assessment questions includes which type of anesthetic to administer for this high-risk population. Once a decision is made to administer anesthetics, the type and amount of anesthetic used in a rapid sequence intubation (RSI) varies greatly among providers (Stoelting & Hillier, 2006). Propofol has become the most widely used induction anesthetic in the United States by anesthesia providers (Stoelting & Hillier, 2006). The rapid onset and short duration of propofol's effects make it highly desirable among clinicians. Although the use of propofol has increased, the use of ketamine as an induction agent has decreased since it was first approved by the FDA in 1970 (Barash, Sayyid, & Assaf, 2009). This may be attributed to the untoward side effects produced by the drug. Among these side effects, it has been documented that ketamine at intubating dosages may produce an increase in intracranial pressure (ICP), cerebral metabolic rate of oxygen consumption (CRMO2) intraocular pressure (IOP), secretions, cerebral blood flow (CBF) and hallucinations (Chang, Raty, Ortiz, Bailard, & Mathew, 2013). 2013). Conversely, subsequent evidence shows that intubating doses of ketamine, up to 5mg/kg produce little to no negative impact on cerebral hemodynamics (Chang, Raty, Ortiz, Bailard, & Mathew, 2013).

According to Barash, Sayyid, & Assaf, (2009), ketamine, in the pre-hospital setting, is effective for RSI and sedating violent, combative patients.

Local Problem

In January 2016, ketamine was approved by the Arizona Department of Health Services (AZDHS) and added to the Arizona Emergency Medical Services (AEMS) standing protocols as an alternate induction agent during RSI (Appendix A) (AZDHS, 2016). The AEMS offline protocol provides written medical direction for all Arizona municipal emergency medical service (EMS) departments, as well as some private EMS organizations (AZDHS, 2016). Ketamine became an alternate first line medication for induction during RSI in addition to the previous single choice of etomidate (Appendix A). While ketamine and etomidate are both used for induction during RSI, their characteristics and mechanisms of action are quite different. The addition of ketamine to the previous protocol excludes algorithmic factors for determining the use of etomidate rather than ketamine, leaving the choice based upon providers knowledge and clinical judgment (Appendix A) (AZDHS, 2016).

Purpose

The purpose of this Doctor of Nursing Practice (DNP) project is to determine if there is a relationship between PHPs choice of intubating agent and knowledge of ketamine on the adult trauma patient. According to the Institute of Medicine (IOM) advanced practice registered nurses (APRN) can attain evidence-based research to implement essential advances to evidence-based practice (Brown, Wickline, Ecoff, & Glaser, 2009). As an APRN, the goal of this project is to gain a better understanding of the determining factors used by the PHP in deciding to use ketamine in a stressful clinical setting for RSI. There are many variables to consider when

exploring the medication regimen and protocol of a PHP. Some of these variables may include formal education, personal observations during practice, patient co-morbidities, type of traumatic injury, healthcare organization culture and cost (Stoelting & Hillier, 2006).

Through a survey (Appendix C) and an integrated literature review (Table 1), the data collected in this project may facilitate recommendations to EMS providers, and organizational stakeholders, such as medical directors and organization commanders. These recommendations will provide guidance based upon the relationship between knowledge of ketamine and PHP choice of ketamine as an intubating agent during RSI. Basic and Advanced Emergency Medical Technicians (EMT), as well as pre-hospital Registered Nurses (RN), may benefit from the results of this project through an improved understanding of the evidence-based factors that determine whether ketamine is an appropriate alternative to etomidate as displayed in Appendix D.

TABLE 1. *Evidence Appraisal Table*

Evidence Appraisal Table

Project Question: What is the current knowledge and decision-making practices among Arizona pre-hospital providers related to the routine use of ketamine during rapid-sequence intubation of adult trauma patients?

Author / Article	Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question	Theoretical Framework	Design	Sample (N)	Data Collection (Instruments/tools)	Findings
Baraka, A. S., Sayyid, S. S., & Assaf, B. A. (1997)/ Thiopental-rocuronium versus ketamine-rocuronium for rapid-sequence intubation in parturients undergoing C-section.	Ketamine with rocuronium sufficient for adequate intubation conditions. Thiopental or ketamine was used as the sole induction drug without using opioids as a part of premedication	None	Double-blind parallel Random control trial	N=40 Female patients ASA physical status 1 or 2 Pregnant 20 patients by thiopental. 20 patients, by ketamine. Age 31 years old (+/- 6 years) Weight 175 lbs (+/- 25 lbs)	Apgar scores of the newborns were assessed at 1 and 5 min. Two-sample Student's t-test were used to compare data. Chi squared analysis was used to compare the intubation scores and the Apgar scores. P < 0.05 was considered significant.	The proportion of patients who had good or excellent intubating scores was significantly higher in the ketamine-rocuronium group (20/20) than in the thiopental-rocuronium group (5/20).

TABLE 1-*Continued*

Author / Article	**Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question**	**Theoretical Framework**	**Design**	**Sample (N)**	**Data Collection (Instruments/tools)**	**Findings**
Dewhirst, E., Frazier, W. J., Leder, M., Fraser, D. D., & Tobias, J. D. (2013). Cardiac arrest following ketamine administration for rapid sequence intubation. *Journal of intensive care medicine*	Did the use of ketamine lead to cardiac arrest in the patients within the review.	None	Retrospective observational review	N=2 Pediatric patients experienced cardiac arrest following the administration of ketamine for rapid sequence intubation (RSI).	Review of 2 pediatric patients who went into cardiac arrest following administration of ketamine. Literature review	Ketamine relies on a secondary sympathomimetic effect for its cardiovascular stability, cardiovascular and hemodynamic compromise may occur in patients who are catecholamine depleted. Adrenal suppressed or septic patients may have depleted catecholamines.

TABLE 1-*Continued*

Author / Article	**Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question**	**Theoretical Framework**	**Design**	**Sample (N)**	**Data Collection (Instruments/tools)**	**Findings**
Filanovsky, Y., Miller, P., & Kao, J. (2010). Myth: ketamine should not be used as an induction agent for intubation in patients with head injury.	To investigate the origin of the myth/ source of research to Ketamine should not be used as an induction agent for intubation in patients with head injury. Investigate the characteristics of ketamines relationship to traumatic brain injury.	None	Systematic review of retrospective and prospective (chart review) studies.	Variable sample size of 11 different randomized prospective studies between (N= 20-30).	Searches conducted through EMBASE and MEDLINE. Study abstract reviewed	In 1970, studies (with many variables) showed ketamine to raise ICP in head injury patients to an unsafe factor. More recent studies show that ketamine is the perfect induction agent for brain injured patients for its hemodynamic and perfusion stability.

TABLE 1-*Continued*

Author / Article	**Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question**	**Theoretical Framework**	**Design**	**Sample (N)**	**Data Collection (Instruments/tools)**	**Findings**
Geiger, S., Stemmler, H. J., Strecker, N., Tischer, J., Pastore, A., Hausmann, A., & Horster, S. (2012). Hemodynamic monitoring by USCOM during rapid sequence intubation (RSI) with Etomidate/Fentanyl or Ketamine/Midazolam.	Difference in hemodynamics between ketamine and etomidate by SVI, stroke volume index; CI, cardiac index; and SVRI, systemic vascular resistance index.	None.	Non-randomized, observational pilot study	N=40 Etomidate/fentanyl (n=20), or ketamine/midazolam (n=20)	USCOM is a noninvasive cardiac output monitor based on the transthoracic measurement of Doppler flow velocity over the aortic and pulmonary outflow tract. CO measurement is the intermittent thermodilution technique which itself has its own inherent variability	Hemodynamic changes were considerably higher within the etomidate group compared to the ketamine group. (E 7.6 mg/h vs K 1.06 mg/h, p 0.01). Stroke volume index (SVI) and cardiac index (CI) increased during RSI (+3.8%/+3.0%) within the ketamine group, while SVI and CI decreased during RSI within the etomidate group.

TABLE 1-*Continued*

Author / Article	**Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question**	**Theoretical Framework**	**Design**	**Sample (N)**	**Data Collection (Instruments/tools)**	**Findings**
Ledowski, T. & Wulf, H. (2001). *The influence of fentanyl vs. s-ketamine on intubating conditions during induction of anaesthesia with etomidate and rocuronium.* Europe Journal pf Anesthesiology. (8):519-2	Investigated the combination of etomidate and *s*-ketamine with regard to its suitability for modified rapid-sequence induction using rocuronium for muscle relaxation.	None	Prospective, randomized and double-blinded study	N=90 3 groups N=30 etomidate N=30 Placebo(fentanyl) N=30 ketamine	Identifying intubating conditions. Measurement of aterial blood pressure and Heart rate changes on induction	Intubating conditions were best using etomidate and *s*-ketamine (23 excellent, 7 good, 0 poor) compared with the control (8, 16, 6 respectively) and fentanyl groups (7, 21, 2 respectively) ($P < 0.01$). While heart rate and arterial pressure remained stable in the control and fentanyl groups during induction, both significantly increased in the ketamine group ($P < 0.01$).

TABLE 1-*Continued*

Author / Article	**Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question**	**Theoretical Framework**	**Design**	**Sample (N)**	**Data Collection (Instruments/tools)**	**Findings**
Lyon, R. M., Perkins, Z. B., Chatterjee, D., Lockey, D. J., & Russell, M. Q. (2015). Significant modification of traditional rapid sequence induction improves safety and effectiveness of pre-hospital trauma anesthesia	The aim of this study is to compare the safety and effectiveness of a traditional RSI protocol using etomidate and suxamethonium with a modified RSI protocol using fentanyl, ketamine and rocuronium.	None	Comparative cohort study	N=261 Group 1 (n=116), Group 2 RSI (n=145) Group 1: etomidate with succinylcholine Group 2: Ketamine, fentanyl and Rocuronium.	Outcomes measured included laryngoscopy view, intubation success, hemodynamic response to laryngoscopy and tracheal intubation, and mortality.	Pre-hospital RSI using fentanyl, ketamine and rocuronium produced superior intubating conditions and a more favorable hemodynamic response to laryngoscopy and tracheal intubation.

TABLE 1-*Continued*

Author / Article	**Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question**	**Theoretical Framework**	**Design**	**Sample (N)**	**Data Collection (Instruments/tools)**	**Findings**
Morris, C., Perris, A., Klein, J., & Mahoney, P. (2009). Anesthesia in haemodynamically compromised emergency patients: does ketamine represent the best choice of induction agent?.	Do the hemodynamic changes with the use of Ketamine as an induction agent justify its use in rapid sequence intubation.	None	Meta-analysis literature review	13 relevant clinical studies with variability to sample size and exclusions.	Laryngoscopy view, intubation success, hemodynamic response to laryngoscopy and tracheal intubation, and mortality.	Ketamine represents a very rational choice for rapid sequence induction in hemodynamically compromised patients. This includes patients with brain injury. Although this does not amount to definitive evidence that ketamine is superior in this scenario.

TABLE 1-*Continued*

Author / Article	**Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question**	**Theoretical Framework**	**Design**	**Sample (N)**	**Data Collection (Instruments/tools)**	**Findings**
Patanwala, A. E., McKinney, C.B., Erstad, B. L., & Sakles, J. C. (2014). Retrospective Analysis of Etomidate Versus Ketamine for First-pass Intubation Success in an Academic Emergency Department.	The objective of this study was to compare first-pass intubation success between patients who received etomidate versus ketamine for rapid sequence intubation (RSI) in the emergency department (ED).	None.	Retrospective analysis of prospectively collected data	N=2098 Etomidate (*n* = 1,983) Ketamine (*n* = 115)	Primary outcome measure was first-pass (intubation) success. A multivariate analysis was conducted to determine if sedative type was associated with first-pass success, after adjusting for potential confounders and baseline differences.	First-pass success occurred in 77.0% of patients in the etomidate group and 79.1% of patients in the ketamine group. Etomidate and ketamine are associated with equivalent first-pass success when used in RSI. Ketamine may be an appropriate alternative to etomidate for RSI in the ED.

TABLE 1-*Continued*

Author / Article	Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question	Theoretical Framework	Design	Sample (N)	Data Collection (Instruments/tools)	Findings
Sibley, A., Mackenzie, M., Bawden, J., Anstett, D., Villa-Roel, C., & Rowe, B. H. (2011). A prospective review of the use of ketamine to facilitate endotracheal intubation in the helicopter emergency medical services (HEMS) setting. *Emergency Medicine J.*	This study examined the use of ketamine in helicopter emergency medical services (HEMS). The use of ketamine: what demographics, conditions and vital signs with its use.	None.	Prospective cohort study	N= 71 patients received ketamine to facilitate endotracheal intubation.	Demographics, medical condition, intubation conditions, vital signs (pre and post drug administration) differences were compared using paired t tests.	Ketamine was used most often in men (52 (73%)), and the median age was 49 years and 30 (42%) were performed on scene. The median ketamine dose was 80 mg. Mean arterial pressure (2.3 mmHg; 95% CI: -8.0 to 3.3) and heart rate (0.45 beats/min, 95% CI: -4.9 to 4.0) changes failed to reach statistical or clinical significance.

TABLE 1-*Continued*

Author / Article	**Qual: Concepts or phenomena Quan: Key Variables Hypothesis Research Question**	**Theoretical Framework**	**Design**	**Sample (N)**	**Data Collection (Instruments/tools)**	**Findings**
Topcuoglu, P.T., Uzun, S., Canbay, O., Pamuk, G. & Ozgen, S. (2010). Ketamine, but not priming, improves intubating conditions during a propofol-rocuronium induction.	Both ketamine and priming may shorten the onset time of rocuronium. This study investigates the effects of ketamine and priming as components of a propofol induction on intubating conditions and onset of neuromuscular block.	None.	Prospective randomized double-blind study	N=120 American Society of Anesthesiologists (ASA) I–II patients 4 groups: (n=30) control, priming, ketamine, and ketamine-priming.	Intubating conditions when patients induction agents were primed, primed with ketamine, ketamine by itself, a control with no ketamine and	Intubating conditions were graded excellent in 20% of the control group, 30% of the priming group, 47% of the ketamine group, and 57% of the ketamine-priming group.

Study Question

What is the current knowledge and decision-making practices among Arizona pre-hospital providers related to the routine use of ketamine during rapid-sequence intubation of adult trauma patients?

FRAMEWORK AND SYNTHESIS OF EVIDENCE

Theoretical Framework

As a planned action theory, the Ottawa Model of Research Use (OMRU) is a multifaceted, interdisciplinary model that aides in the transfer of new innovation into practice (Logan & Graham, 2004). The OMRU uses a six-step process to assist in research development and implementation (Logan & Graham, 2004). These elements are research innovation, potential adopters, practice environment, implementation of interventions, adoption, and health-related outcomes (Logan, & Graham, 2004). The word *resolution* can be defined as the act of finding an answer to a problem or conflict (Merriam-Webster Online Dictionary, n.d). Yet, a resolution to a specific issue does not happen by mere chance. A resolution is best accomplished through a clearly defined process. In healthcare, there are many different theories and frameworks that set the stage for a problem to be solved. The clearly defined process to facilitate this project is the utilization of the OMRU theoretical framework.

Application of OMRU

The first step and cornerstone concept of the OMRU, research innovation, can be described as "setting the stage" (Logan & Graham, 2004). This process encompasses combining existing evidence-based practice with the perceptions from change agents that may lead to new research, intervention or even practice guideline changes (Logan & Graham, 2004). While

functioning under a set protocol, PHPs still have to make decisions based on options in the pre-hospital arena. The addition of ketamine as an induction agent for RSI is extremely new to the state of Arizona for PHPs. This change in practice or change in Arizona pre-hospital protocol (Appendix A) needs to be assessed for PHPs adequacy to implement the new protocol (Logan & Graham, 2004). There is no standard protocol for medications used for accomplishing RSI (Walls & Murphy, 2012). This situation calls for knowledge regarding how PHPs determine when or if it is suitable to use ketamine as an induction agent for RSI of adult trauma patients. This problem can be assessed by answering the following question: "What is the relationship between knowledge of ketamine and the PHP choice of intubating agent in RSI for adult trauma patients?"

This leads to the second step of the OMRU framework, potential adopters who can be described as the authoritative individuals, key stakeholders or change agents and their role in the utilization of innovations (Logan & Graham, 2004). In order to properly assess the use of ketamine the key stakeholders must be identified. Pre-hospital providers and medical directors are key stakeholders and change agents in the implementation of all aspects of pre-hospital ketamine use. The aspects of potential adopters are comprised of all that may utilize the innovation to include all practitioners and patients. The knowledge, skill, awareness and intentions of the change agents and potential adopters will be used to assess the current relationship between knowledge and choice of ketamine in RSI for adult trauma patients (Logan & Graham, 2004).

The next step in the OMRU model is the practice environment or clinical setting. The practice environment includes the physical and conceptual setting as well as the workload,

individuals involved and guidelines (Logan & Graham, 2004). The practice environment plays a particularly key role in both contributing to research results as well as implementing research results. There are several variables within the practice environment that need to be taken into account. In order to implement a change in practice or intervention, the physical, cultural and sociological factors need to be taken into account (Logan & Graham, 2004). For example, the practice environment for this project is a stressful one, which displays unpredictable physical and sociological factors for any given incident. If an RSI is being performed outside of a definitive healthcare facility the setting is automatically considered a critical event with limited resources.

The fourth step in the OMRU is intervention implementation elements, which include barrier management, transfer strategies and follow-up strategies (Logan & Graham, 2004). Barrier management allows the proper identification and resolution of barriers that promote adoption of the innovation (Logan & Graham, 2004). Transfer strategies facilitate training plans for ease of adoption and follow-up strategies produce sustainability within the innovation (Logan & Graham, 2004). As previously mentioned, the practice environment in which PHPs function may create barriers to properly assess provider implementation of ketamine as an induction agent for RSI. Another identified barrier is the fact that multiple PHPs may be involved in an RSI event. One PHP may actually administer the medications while another PHP intubates the patient. This may create conflicting decisions regarding the administration of ketamine. Another potential barrier is the training that is involved when there is an addition of a new drug to the offline protocols. An online survey will be the intervening tool that will address the study question and these potential barriers.

The final steps depict the degree of adoption, including both the initial and ongoing assessment. The initial and ongoing assessment includes measurable data collection, outcomes, and variables (Graham & Logan, 2004; 2010). The application of the adoption and outcome steps will be dependent on the results from the choices of PHPs in regard to the use of ketamine during RSI of an adult patient. All variables including patient, provider and organizational systems consequences and effect should be taken into consideration (Graham & Logan, 2004; 2010). Although there are many other theories and frameworks that may have their place within this project, the OMRU framework will best facilitate this inquiry.

Synthesis of Evidence

A synthesis of evidence was conducted to evaluate the perceptions among healthcare providers related to the routine use of ketamine during rapid-sequence induction and intubation in the adult trauma patient. A literature review using the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Google Scholar, and PubMed resulted in over 150 results related to the use of ketamine. This literature search was refined using the following keywords: ketamine, RSI, induction, rapid-sequence, and pre-hospital provider, resulting in ten articles (Table 1). Although a great amount of data was revealed through this search, none of the data illustrated the views of the PHP, which further highlights the need to understand the relationship between the knowledge of ketamine and PHPs choice of intubating agent.

As previously discussed, the new addition of ketamine to the Arizona valley offline protocol (Appendix A) as an RSI induction agent, raises the concern of PHPs clinical judgment in ketamine's necessity, applicability and benefit in comparison to the previously used protocol. Ketamine has been shown to increase catecholamine response (Geiger et al., 2012). The

increased release of catecholamines upon administration of ketamine may increase cardiac output and stroke volume by 8% higher than etomidate (Geiger et al., 2012). Although this pilot study by Geiger et al. (2012) identifies differences between ketamine and etomidate as primary induction agents, it does not offer any information about the hemodynamic changes induced by ketamine or etomidate in comparison to the patients' baseline parameters; it only compares the drugs to each other. Comparison to the patient's baseline hemodynamics would prove beneficial in determining the benefit and applicability of ketamine.

Since studies show an increase in cardiac output following the administration of ketamine it is beneficial to highlight a study by Dewhirst et al. (2013) that explored the cardiovascular effects of ketamine in a retrospective observational review of subjects who presented with cardiac arrest after the administration of ketamine. The researchers concluded that patients with a decrease in catecholamines might demonstrate adverse effects upon administration of ketamine, although pre-existing conditions can also cause depletion in circulating catecholamines. It was not concluded that the administration of ketamine correlated to cardiac arrest.

Another conclusion that cannot be drawn through this literature review is unsafe increases in intracranial pressure (ICP) after ketamine administration. As far back as 1970, studies analyzed ketamine and showed the drug caused unsafe increases in ICP (Filanovsky, Miller, & Kao, 2010). A systematic review of the studies that concluded an unsafe increase in ICP was completed to evaluate not only recent studies, but studies that give insight into the origin of a misconception of ketamine (Filanovsky, Miller, & Kao, 2010). This review appraised 11 studies and found tremendous gaps within the studies. Further review of recent pertinent studies concluded ketamine does not cause unsafe levels of ICP, but in fact may be a perfect

agent for those with cerebral changes (Filanovsky, Miller, & Kao, 2010). Previous misconceptions of increased ICP in regards to ketamine were reported in the past, it is now essential to determine if these misconceptions exist among PHPs.

Outside of hemodynamic changes associated with the use of ketamine, one needs to be able to rely on the ability of the drug to create an ideal intubating condition. Two separate double-blind parallel random control trials evaluated the intubating conditions after the use of ketamine. Both trials showed optimal intubating conditions in comparison to other induction agents (Baraka & Sayyid, 1997; Ledowski & Wulf, 2001).

PHPs function within a much different setting than those healthcare providers functioning in a definitive care environment therefore it necessary to review literature within the pre-hospital arena. A pre-hospital evaluation of ketamine use was completed by Sibley et al. (2012) This prospective cohort study displayed the hemodynamic similarities of those induced with ketamine during RSI in the pre-hospital setting with those in the definitive healthcare setting and found no statistical significance.

This project is to understand the relationship between the PHP choice of intubating agent and their knowledge of ketamine of an adult trauma patient. A determining factor to this inquiry could simply be the ability of ketamine to produce adequate intubation conditions. Patanwala, McKinney, Erstad, and Sakles (2014) conducted a retrospective analysis of intubating condition in the EMS specialty. This study concluded that 79% of subjects were successfully intubated on the first attempt compared to 77% of those intubated with etomidate. If ketamine produces efficacious intubating conditions, it may show the decision-making of the PHP to choose ketamine based upon a previous successful experience.

A multimodal approach to anesthesia induction has proven beneficial (Lyon, Perkins, Chatterjee, Lockey, & Russell, 2015). The use of ketamine in combination with other anesthetics as a multimodal approach to anesthesia induction was analyzed in several studies (Lyon, Perkins, Chatterjee, Lockey, & Russell, 2015; Morris, Perris, Klein, & Mahoney, 2009; Topcuoglu, Uzun, Canbay, Pamuk, & Ozgen, 2010). All three of these studies postulate that ketamine in combination with other drugs such as versed and fentanyl, provide hemodynamic stability, effective intubating conditions, and decreased response to laryngoscopy (Lyon, Perkins, Chatterjee, Lockey, & Russell, 2015; Morris, Perris, Klein, & Mahoney, 2009; Topcuoglu, Uzun, Canbay, Pamuk, & Ozgen, 2010). Other studies highlight the effectiveness of ketamine as a sole induction agent. These particular studies exhibit a polypharmacological approach using ketamine can be beneficial as well (Lyon, Perkins, Chatterjee, Lockey, & Russell, 2015; Morris, Perris, Klein, & Mahoney, 2009; Topcuoglu, Uzun, Canbay, Pamuk, & Ozgen, 2010). This multimodal approach to anesthesia induction has not been applied largely to the pre-hospital arena. The synthesis from this study illustrates the need to examine the germane use of a multimodal approach to RSI in the pre-hospital arena.

In conclusion, this synthesis of studies supports the notion that ketamine may very well be an appropriate anesthetic for induction of anesthesia, yet ketamine is used 65% less often than other induction agents in anesthesia (Morris, Perris, Klein, & Mahoney, 2009). Furthermore, while there is evidence supporting the benefits of ketamine, none of these studies have been conducted in the setting of PHPs. This gap in the literature further supports the value of this DNP project in identifying the perceptions that exist among PHPs related to the decision to utilize ketamine during rapid-sequence intubation in the adult trauma.

METHODS

Design

The methodology for this DNP project was a descriptive design. A survey was appropriate for this project to investigate the relationship between provider knowledge about ketamine and deciding to use one induction medication over another. Results will be used to provide recommendations to further progress this healthcare practice (Polit & Beck, 2012). A survey (Appendix C) was emailed to various PHPs to evaluate their decision to use or not use ketamine. Furthermore, the survey was used to identify the frequency in which ketamine is used by PHPs in RSI and the factors influencing the PHPs decision, to use or not use ketamine as an RSI agent.

Setting

The setting for this project was a pre-hospital organization located in Arizona. The location was at several different fire stations within the Arizona pre-hospital organization, and the survey was accessed via secured computers. The location and time of conducting the surveys was at a time and place where PHPs duties and readiness were not interrupted. The survey was open for one week, which allowed ample time for participants to take the survey within their 48-hour shift. The projected time for completion was five to ten minutes. This survey had "progress saved" options so that if a provider has to respond to an incident for any reason they may stop and restart the survey when deemed appropriate (Snow & Mann, 2013).

Participants

The participants of this project were PHP's who currently maintain an active National and AZDHS certification as emergency medical technician-paramedics (EMT-P). The pre-

hospital organization employs 197 Fire and Rescue employees 180 of the 197 employees are line firefighters and 99 of the firefighters are also certified EMT-P's. Inclusion criteria for participants in this study were: (a) English speaking providers; that, (b) independently practice under AZDHS valley offline protocols (Appendix A); and, (c) have access to the use of ketamine. Exclusion criteria for this study were: (a) emergency medical technician-basic (EMT-B) certifications; (b) PHP's who are licensed but not actively in a patient care role; and, (c) PHP's with less than one-year experience as a certified emergency paramedic.

Methods for Evaluation

Survey Tool

A survey was completed by pre-hospital providers using Qualtrics as the data collection tool (Snow & Mann, 2013). The survey (Appendix C) included 17 multiple-choice and Likert scale questions in regards to frequency of ketamine use, determinants of ketamine use as well as self-competency questions in regards to ketamine use within the survey. The specific tool used to disseminate the survey was Qualtrics software. Qualtrics is a computer-based software that allows users to create individual surveys for mass dissemination (Snow & Mann, 2013). The Qualtrics survey was delivered to participants individually on an electronic device. This user-friendly software is cost-free with appropriate licensure from the University of Arizona.

Ethical Considerations

The human subjects in the project were active, certified emergency paramedics within the state of Arizona. The survey was voluntary. No personal information was used and all responses from participants were anonymous. There was no direct benefit or compensation for participation in this survey. There were no identified physical risks for participating in this research. The

survey data collected was downloaded to a secure hard drive. The data was destroyed after proper analysis is complete.

Volunteer participation was explained to all willing and able potential PHPs. Through email, all potential PHPs were notified of the projects anonymity and volunteer status. Only the participant's years as a CEP provider were used and they were informed that they retain the right to withhold information or withdraw from the study at any point (Polit & Beck, 2012). The explanation of the study to the volunteer PHPs was completed without coercion. The intricacies of the project were also fully disclosed to all potential participants before they agreed to be in the project.

The PHPs in this project, as well as the entire pre-hospital organization, are free from any liability, harm or tarnishing of reputation. No physical risks were identified in this project, but there may be some psychological risks that were protected. Since this project had the goal of identifying knowledge and factors in decision–making among PHPs about ketamine, the results of the data were reported as a group and not individually.

Data Analysis

Data analysis was performed through Qualtrics data management to examine the descriptive statistics for frequency distributions of the variables. The frequency of ketamine use and the determining factors for the use or avoidance of ketamine was analyzed using mean, median and mode. Open-ended answers were examined for emerging patterns and themes that were then placed within a specific categorization. To sustain credibility, the sharing of data with participants took place to confirm an accurate representation of evidence (Polit & Beck, 2012). Through a survey and an integrated literature review, the qualitative and quantitative data

collected in this project will facilitate recommendations to EMS providers, and organizational stakeholders and allow for a better understanding of the relationship between the knowledge of ketamine and the choice by the PHP to use it during RSI. Basic and Advanced Emergency Medical Technicians (EMT) as well as pre-hospital Registered Nurses (RN) can benefit from this project through an executive summary that will be presented to stakeholders with recommendations based on the project results.

RESULTS

Outcomes

The survey was sent out to 99 certified emergency paramedics at a local Arizona pre-hospital organization. The survey was open for one week to accommodate all three of the organizations different shifts. A total of 32 participants responded to the survey, which represents a 32.3% response rate. All variables were calculated in percentage values. Table 2 shows the knowledge and competency of the study sample and frequency of ketamine use.

TABLE 2. *Certified Emergency Paramedic Demographics*

Characteristic		Frequency (n=32)	Percent
Years as a certified emergency paramedic provider			
Valid	1 year	1	3.1
	2 years	5	15.6
	> 5 years	4	12.5
	> 10 years	22	68.8
	Total	**32**	**100.0**
Number of rapid sequence intubations (RSI) performed			
Valid	< 5	16	50.0
	> 5	6	18.8
	> 10	6	18.8
	> 20	4	12.5
	Total	**32**	**100.0**

TABLE 2. - *Continued*

Characteristic		Frequency (n=32)	Percent
Is the use of ketamine for RSI within the protocols in which you practice under?			
Valid	Yes	31	96.9
	No	1	3.1
	Total	**32**	**100.0**
Have you used ketamine for RSI under a medically directed protocol?			
Valid	Yes	12	37.5
	No	20	62.5
	Total	**32**	**100.0**

TABLE 3. *Frequency and Effectiveness of Ketamine Use*

Characteristic		Frequency (n=32)	Percent
If yes, how many times have you used ketamine for RSI?			
	Never	19	59.4
	< 5 times	10	31.3
	> 5 times	1	3.1
	Total	**30**	**93.8**
How would you rate the effectiveness of ketamine for adequate sedation for RSI?			
Valid	Extremely adequate	11	34.4
	Slightly adequate	3	9.4
	Neither adequate nor inadequate	14	43.8
	Total	28	87.5
	System	4	12.5
	Total	**32**	**100.0**
Have you used other induction agents for RSI?			
Valid	Yes	31	96.9
	Not sure	1	3.1
	Total	**32**	**100.0**
If yes, would you choose ketamine over another induction agent?			
Valid	Yes	10	31.3
	No	9	28.1
	Unsure	13	40.6
	Total	**32**	**100.0**

TABLE 3 - *Continued*

Characteristic		Frequency (n=32)	Percent
Effectiveness of ketamine for adequate sedation for RSI over other induction agents			
Extremely adequate		7	21.9
Slightly adequate		2	6.3
Neither adequate nor inadequate		21	65.6
	Total	30	93.8
System		2	6.3
	Total	**32**	**100.0**
Intubating conditions after the use of ketamine for RSI			
Extremely adequate		4	12.5
Slightly adequate		3	9.4
Neither adequate nor inadequate		23	71.9
	Total	30	93.8
System		2	6.3
	Total	**32**	**100.0**

TABLE 4. *Choice of Ketamine Over Another Induction Agent*

Characteristic	Response
Factors leading to choose ketamine over another induction agent?	
Classification:	
Sedation	"Better patient sedation." "Its effectiveness to sedate."
Previous experience	"I have never used it and would be willing to try based on my experience with ketamine to sedate excited delirium and combative patients." "I've seen it work for ED"
Pharmacological profile	"I like the sparing of the respiratory drive and using ketamine in a DSI procedure." "Less risk of hypotensive side effects."
Ease of use	"Ketamine has the same math to find dosage as succs making it easier to use, it's also better for head injury patients."
Individual	"It was the new agent and wanted to become familiar with it." "Research suggests it works better."

TABLE 5. *Knowledge and Competency of the Certified Emergency Paramedic*

Characteristic		Frequency (n=32)	Percent
Self-competency for adequately performing RSI intubation?			
Valid	Extremely competent	9	28.1
	Competent	21	65.6
	Unsure	2	6.3
	Total	**32**	**100.0**
Self-competency for using ketamine as an induction agent for RSI intubation			
Valid	Extremely competent	12	37.5
	Competent	14	43.8
	Unsure	6	18.8
	Total	**32**	**100.0**
Self-knowledge rating of the pharmacological profile of ketamine			
Valid	Extremely knowledgeable	4	12.5
	Knowledgeable	26	81.3
	Unsure	2	6.3
	Total	**32**	**100.0**
Hours of training related to the use of ketamine for RSI			
Valid	< 5	19	59.4
	< 10	8	25.0
	< 20	3	9.4
	> 20	2	6.3
	Total	**32**	**100.0**
Do you feel that pre-hospital providers can benefit from an education tool related to the decision?			
Valid	Yes	30	93.8
	Unsure	2	6.3
	Total	**32**	**100.0**

The majority of respondents have been certified emergency paramedics (CEP) for greater than 10 years (68%). In regards to training, the majority of respondents (59.4%) state they have had less than five hours of training on ketamine for RSI. The majority of respondents rate themselves as competent in the ability to adequately perform RSI, followed by (28.1%) as extremely competent. Despite the majority of respondents being CEP's for greater than 10 years, half of the study sample has performed RSI less than five times (50%). The majority of

participants (96.9%) have the ability to use ketamine as an induction agent for RSI under the active protocol in which they follow. Less than half (38.7%) of the CEP's who fall under this protocol have used ketamine for RSI. Of those that have used ketamine for RSI only one respondent has used ketamine for RSI greater than five times (3.1%).

Despite the respondent's limited use of Ketamine for RSI, 34.4% of the participants described ketamine as extremely adequate for inducing patients during RSI, though the majority was neutral in this response. The majority of respondents (96.9%) have used other induction agents for RSI. Respondents would choose ketamine over another induction agent (31.3%), followed by (28.1%) of respondents that would not choose ketamine over another induction agent, the additional respondents (40.3%) were unsure if they would choose ketamine over another induction agent.

The reasons for choosing ketamine over another induction agent vary greatly. The overwhelming majority (81.3%) of respondents rated themselves as knowledgeable in regards to the pharmacological profile of ketamine. Three of the respondents were on one accord that they would choose ketamine over another induction agent based upon its exceptional sedating effects with excited delirium and combative patients. Other respondents would choose ketamine based upon hemodynamic benefits such as "less risk for hypotensive side effects," "sparing of respiratory drive" and "it's better for head injury patients." Other reasons are "its effectiveness to sedate," "research suggests it works better." The overwhelming majority (93.8%) of participants agree that PHP's can benefit from an education tool related to the decision-making process on choosing ketamine as an induction agent for RSI.

DISCUSION

Summary

This is a unique study as it sought to find the relationship between the pre-hospital providers' knowledge and the use of ketamine as an induction agent for rapid-sequence intubation with a local pre-hospital organization. Despite evidence that supports the adequacy of ketamine to provide appropriate sedation for RSI, it appears that a substantial uncertainty between the PHP's knowledge and choice of induction agent exist. The study question is answered by showing that the majority of participants found ketamine to be adequate as an induction agent. All but one of the participants has used other inductions agents, yet the majority of participants would choose ketamine rather than choosing another agent. Now that the PHP's choice of induction agent is known, the factors that lead them to this choice can be uncovered. The results reported the PHP self-reported being knowledgeable about the pharmacological profile of ketamine. Furthermore, the PHPs' choice of induction agent was proven to be based upon knowledge of the pharmacological profile of ketamine as open-ended answers to choice of induction agent were largely based upon observation and pharmacological aspects. This study also displayed that while there are a wide array of seasoned PHP's within the sample size, the occurrence of performing of RSI is not frequent. The limited occurrence of RSI maybe the reason why the majority of participants agree that there would be a benefit to an educational tool related to the use of ketamine as an induction agent for RSI.

Relationship to Other Evidence and Framework

As stated previously, the Ottawa Model of Research Use (OMRU) is a multifaceted, interdisciplinary model that can assist in research development and implementation (Logan &

Graham, 2004). The OMRU's six-step process was a guide in the maturation of this project. Likewise, the OMRU is applicable in disseminating the project findings and implementing the recommended strategies. The OMRU's implementation step consist of barrier management, transfer strategies and follow-up strategies (Logan & Graham, 2004). A barrier to this research project is the limited clinical experience the PHP in intubating patients as well as using the ketamine RSI protocol. These barriers can be curbed with proper education and continued training with the ketamine RSI protocol. Transfer strategies can aide in the implementation of education. Transfer strategies are tactics used to transfer innovation into practice and facilitate training plans for ease of adoption and follow-up strategies produce sustainability within the innovation (Logan & Graham, 2004). A training plan can be developed to incorporate simulation of an adult trauma patient with initiation of the RSI protocol. PHPs could frequently simulate the correct dose of ketamine, the sign/symptoms, adverse effects and contraindications involved with this protocol to improve outcomes. Follow-up after action reviews (AAR) can occur whenever the actual protocol is used to assess outcomes and sustainability.

The final steps to this theoretical framework are adoption and outcomes. The application of adoption utilizes all variables including the patient, provider and organizational systems consequences (Graham & Logan, 2004; 2010). The PHPs' stakeholders may present with some resistance to additional training in an area they may feel already adequate in, with a desire to focus training on other areas. On the contrary 96% of the respondents stated they do find a benefit to having additional education in to ketamine use. The initial and ongoing assessment includes measurable data collection, outcomes, and variables (Graham & Logan, 2004; 2010). Follow-up or after action reviews (AAR) can occur whenever the actual protocol is used to

assess outcomes, sustainability and the relationship between knowledge of the PHP and the use of ketamine.

Study Limitations

The sample size of this project (38.9%) can be a limiting factor to these projects findings. Possibly leaving the survey open for a longer period of time with a reminder email may increase the response rate. Furthermore, another limiting factor is the amount of RSI performed. Another limitation is that half (50%) of all participants have intubated less than five times. Another limitation may be the fact that the majority (59.4%) of respondents have never used ketamine as an induction agent for RSI. Additionally, a possible limitation could be the legitimacy of self-competency questions instead of factual questions regarding ketamine to assess knowledge. Likewise, the fear of repercussion from admission to inadequacy could have altered the participants responses. Lastly, the short timeframe that ketamine has been active in the CEP's protocol as an RSI induction agent (less than one year) can limit results.

Interpretation

Despite the above limitations, the primary purpose of this evaluation was addressed. This project has brought some insight into the relationship between the PHPs self-reported knowledge and decision to use ketamine. Additionally, the limited frequency in which ketamine is used within the pre-hospital organization was reported. This study revealed that the overwhelming majority of PHPs have the ability to use Ketamine as an induction agent for RSI. In spite of this fact, the majority of respondents had not yet used ketamine as an induction agent for RSI. Several explanations may exist for this low number. First, this may be due to the addition of ketamine as an induction agent occurring less than a year ago. Second, it was found that the

majority of respondents have intubated less than five patients, so deductive reasoning can lead one to conclude the reason the majority of PHP's have not yet used ketamine for RSI is due to the limited number of RSIs being initiated. Despite the limited use of ketamine, not one respondent stated that ketamine was inadequate in its effectiveness to sedate, even still the majority of participants responded in a neutral position. Furthermore, all respondents have used other induction agents for RSI, yet the majority of respondents state they would choose ketamine over another induction agent based on previous observation and training.

The pretext for choosing ketamine as the induction agent for RSI varied among respondents. Yet the majority of respondents chose ketamine over etomidate based upon knowledge of the hemodynamic effects produced by ketamine. For some respondents, the hemodynamic and sedative effects have been seen under a separate protocol involving ketamine. The same organization uses ketamine to sedate delirious and combative patients. In fact, some respondents chose ketamine based upon the objective effects of ketamine within this subsequent protocol. It can be interpreted that the choice of induction agent from the respondents is based upon the pharmacological profile of ketamine and clinical experience.

In regards to clinical experience, it was found that substantial clinical experience is present in these respondents, with the majority of PHP's in the sample size having greater than 10 years' experience as a certified emergency paramedic. While the majority of respondents rate themselves as knowledgeable about the pharmacological profile of ketamine, the majority have also had less than five hours of training on ketamine. This finding illustrates that while the respondents may have sufficient knowledge on ketamine's pharmacological profile, they indicated additional training might prove beneficial.

It would prove beneficial to conduct subsequent studies that incorporate a larger sample size and respondents that have used ketamine in practice for greater than one year. Future studies may include PHP's from different states and regions. Additional literature reviews may aide in answering the study question by contrasting different pre-hospital entities such as flight paramedics and combat paramedics within the armed forces that have used ketamine for longer periods of times. Moreover, investigating this study question from additional healthcare providers such as pre-hospital registered nurses may corroborate findings to help develop more precise evidence-based guidelines and protocol.

Conclusion

In conclusion, there is a wide array of anesthetic drugs, regimens, and techniques in practice today. These different aspects of induction agents are specific to each patient with a plethora of different implications. There are countless acceptable rationales to vary anesthetic plans, resulting in anesthetic drugs, regimens and techniques used that differ among providers. This DNP project sought to identify the relationship between the PHP's knowledge and the choice to use ketamine as an induction agent for RSI in the adult trauma patient. The project concluded that the majority of PHPs would choose ketamine over another induction agent and that the choice to use ketamine is based upon self-reported pharmacological knowledge of the drug. Yet, a very small part of the sample size has actually used ketamine under this new RSI protocol. Additionally, the project concluded a possible relationship between the knowledge and use of ketamine based upon previous use of ketamine under a different sedation protocol for combative patients. The limited occurrence of RSI and use of ketamine is the reason for recommended strategies to include education on the use of ketamine in the required continuing

education for PHPs. Continued studies with a larger sample size that has used ketamine as an induction agent in RSI for a longer period of time may be beneficial in providing optimal care during a critical event

OTHER INFORMATION

Projected Budget

The projected budget for this DNP project is minimal. The researcher predicts costs incorporating the following elements: printing materials, snacks for participants and travel to research site (Appendix B)

Timeline

- November 2016- Develop survey
- December 2016- Confirm/ approval from the pre-hospital organizations EMS captain, facility and location of survey
- March 2017- Conduct survey of anesthesia provider
- March 2017- Data analysis
- April 2017- Finalize project
- April 2017- Project ready for presentation

APPENDIX A:

PROJECT SURVEY

AEMS Red Book

Rapid Sequence Intubation (RSI)

Adult (≥ 15 y/o)

Pre-oxygenate the patient for 4- 5 minutes with 100% oxygen

↓

Apply and maintain cricoid pressure until tube placement is confirmed

↓

Sedate the patient
Etomidate (Amidate)
0.3 mg/ kg IV over 30- 60 seconds
Or
Ketamine 1.5 mg/kg IV over 30- 60 seconds.
Max 150 mg

↓

Paralyze the patient
Succinylcholine (Anectine) 1.5 mg/ kg

↓

Intubate and confirm tube placement
(End-tidal CO2 detector required)
In-line capnography recommended. Reading should be maintained between 35-45.

↓

Yes ← Successful? → No

Indications for RSI
-Respiratory failure
-Loss of gag or protective airway reflexes
-GCS < 8
-Severe head trauma
-Spinal cord injuries
-Facial and/ or airway burns
-Asthma or respiratory illnesses

Contraindications for RSI
-Cardiac Arrest is a contraindication for RSI
-History of malignant hyperthermia

Signs/ Symptoms of ICP

-Altered LOC
-Headache
-Nausea/ vomiting
-Increased systolic pressure
-Decreased pulse
-Widened pulse pressure
-Irregular respiratory pattern

1. Sedation with **Etomidate (Amidate)** should occur in 30-60 seconds
2. Paralysis with **Succinylcholine (Anectine)** should occur in < 1 min
3. If unable to ventilate adequately, assess need for rescue airway device.
4. If unable to ventilate patient with BVM or rescue airway device, perform surgical cricothyrotomy.

↓

Post-Intubation Sedation.
Refer to Sedation Off-line, as needed.

↓

Pain Management
Refer to Pain Management Off-line, as needed.

↓

Place NG/OG tube if indicated → Courtesy notification to receiving facility

APPENDIX B:

PROJECTED BUDGET

Projected Budget

Expense Items	Requested Amount
Travel (To/From Fire Stations)	$25.00
Operations	
Equipment (SPSS, Qualtrics)	$0.00
Materials and Supplies (Snacks, Paper)	$50.00
Printing/Marketing	$15.00
Other (unexpected cost TBD)	$50.00
Total	**$140.00**

APPENDIX C:

RAPID SEQUENCE INTUBATION (RSI) PROTOCOL

DNP Project Survey

The purpose of this Doctor of Nursing Practice (DNP) project is to assess pre-hospital provider's (PHP) perceptions and decision-making process related to the routine use of ketamine during rapid-sequence intubation on the adult trauma patient with the designated pre-hospital organization.

DNP project survey

Q1 How many years have you been certified as an emergency paramedic provider?

- ☐ 1 year (1)
- ☐ 2 years (2)
- ☐ 3 years (3)
- ☐ 4 years (4)
- ☐ Greater than 5 years (5)
- ☐ Greater than 10 years (6)

Q2 How many rapid sequence intubations (RSI) have you performed?

- ☐ None (1)
- ☐ Less than 5 (2)
- ☐ Greater than 5 (3)
- ☐ Greater than 10 (4)
- ☐ Greater than 20 (5)

Q3 Is the use of ketamine for RSI within the protocols in which you practice under?

- ☐ Yes (1)
- ☐ Not sure (2)

- □ No (3)

Q4 Have you used ketamine for RSI under a medically directed protocol?

- □ Yes (1)
- □ No (2)

Q5 If yes, how many times have you used ketamine for RSI?

- □ Never (1)
- □ Less than 5 times (2)
- □ Greater than 5 times (3)

Q6 How would you rate the effectiveness of ketamine for adequate sedation for RSI?

- □ Extremely adequate (1)
- □ Slightly adequate (2)
- □ Neither adequate nor inadequate (3)
- □ Slightly inadequate (4)
- □ Extremely inadequate (5)

Q7 Have you used other induction agents for RSI?

- □ Yes (1)
- □ Not sure (2)
- □ No (3)

Q8 If yes, would you choose ketamine over another induction agent?

- □ Yes (1)
- □ No (4)
- □ Unsure (5)

Q14 If yes, what factors led you to choose ketamine over another induction agent?

Q9 How would you rate the effectiveness of ketamine for adequate sedation for RSI over other induction agents you have used?

- □ Extremely adequate (1)
- □ Slightly adequate (2)
- □ Neither adequate nor inadequate (3)
- □ Slightly inadequate (4)
- □ Extremely inadequate (5)

Q10 How would you rate the intubating conditions after the use of ketamine for RSI?

- □ Extremely adequate (1)
- □ Slightly adequate (2)
- □ Neither adequate nor inadequate (3)
- □ Slightly inadequate (4)
- □ Extremely inadequate (5)

Q11 How competent would you rate yourself with adequately performing RSI intubation?

- □ Extremely competent (1)
- □ Competent (2)
- □ Unsure (3)
- □ Incompetent (4)
- □ Extremely incompetent (5)

Q12 How competent would you rate yourself with using ketamine as an induction agent for RSI intubation?

- □ Extremely competent (1)
- □ Competent (2)

- □ Unsure (3)
- □ Incompetent (4)
- □ Extremely incompetent (5)

Q13 How would you rate your knowledge of the pharmacological profile of ketamine?

- □ Extremely knowledgable (1)
- □ Knowledgable (2)
- □ Unsure (3)
- □ Inadequate knowledge (4)
- □ No knowledge (5)

Q16 How many hours of training have you had related to the use of ketamine for RSI?

- □ none (1)
- □ less than 5 (2)
- □ less than 10 (3)
- □ less than 20 (4)
- □ greater than 20 (5)

Q17 Do you feel that pre-hospital providers can benefit from an education tool related to the decision-making related to choosing the most appropriate anesthesia induction agent within your current RSI protocol?

- □ Yes (1)
- □ No (2)
- □ Unsure (3)

APPENDIX D:

EXECUTIVE SUMMARY

Executive Summary

The purpose of this project was to determine if there is a relationship between pre-hospital providers (PHPs) choice of using ketamine to facilitate intubation and knowledge about the anesthetic agent in regards to the adult trauma patient. Patients are administered anesthetics to produce analgesia, amnesia, and arreflexia for many different reasons such as surgery, invasive procedures, and emergency interventions; one anesthetic induction technique is rapid sequence intubation (RSI). The technique of RSI is performed to safely and effectively control the airway in patient populations who need immediate airway management (Ehrenfeld, Cassedy, Forbes, Mercaldo, & Sandberg, 2012). Pre-hospital providers (PHP) practice emergency assessment and care in the out-of-hospital setting (Al-Thani, El-Menyar, & Latifi, 2014). The primary goal of the PHP is to establish and maintain physiologic and hemodynamic stability and transport to tertiary care facility when indicated (Al-Thani, El-Menyar, & Latifi, 2014).

This project was complete with the help from a local pre-hospital organization located in Gilbert, Arizona. The participants of this project are PHPs who maintain an active national and Arizona Department of Health Services (AZDHS) certification as emergency medical technician-paramedics (EMT-P). An online survey was disseminated that included questions regarding frequency of ketamine use, knowledge of ketamine as well as questions regarding their choice of induction agent.

The study question was answered through this survey by showing that the majority of participants found ketamine to be adequate for as an induction agent. All but one of the participants has used other inductions agents, yet the majority of participants would choose ketamine rather than choosing another agent. Furthermore, the results displayed the PHP self-reported being knowledgeable about the pharmacological profile of ketamine. Additionally, the PHPs' choice of induction agent was proven to be based upon knowledge of the pharmacological profile of ketamine as open-ended answers to choice of induction agent were largely based upon observation and pharmacological aspects. This study also displayed that while there are a wide array of seasoned PHP's within the sample size, the occurrence of performing of RSI is not frequent. It is recommended that PHPs include education on the use of ketamine in the required continuing education to include didactic and clinical education. It would prove beneficial to conduct subsequent studies that incorporate a larger sample size and respondents that have used ketamine in practice for greater than one year.

REFERENCES

Albanese, J., Arnaud, S., Rey, M., Thomachot, L., Alliez, B., & Martin, C. (1997). Ketamine decreases intracranial pressure and electroencephalographic activity in traumatic brain injury patients during propofol sedation. *Anesthesiology*, *87*(6), 1328-1334. http://dx.doi.org/10.1097/00000542-199712000-00011

Al-Thani, H., El-Menyar, A., & Latifi, R. (2014). Prehospital versus emergency room intubation of trauma patients in Qatar: A-2-year observational wtudy. *North American Journal of Medical Sciences*, *6*(1), 12. http://dx.doi.org/10.4103/1947-2714.125855

Arizona department of health services (2016). *Arizona emergency medical services red book.* Retrieved from http://www.aems.org/images/pdfs/redbook/chapter-3-1.pdf

Baraka, A., Sayyid, S., & Assaf, B. (1997). Thiopental-rocuronium versus ketamine-rocuronium for rapid-sequence intubation in parturients undergoing cesarean section. *Anesthesia & Analgesia*, *84*(5), 1104-1107. http://dx.doi.org/10.1213/00000539-199705000-00027

Barash, P. G., Cullen, B. F., & Stoelting. R. K. (2009). Intravenous anesthetics. In *Clinical anesthesia* (pp. 444-464) (6th ed.). Philadelphia PA: Lippincott Williams & Wilkins.

Bernard, S., Nguyen, V., Cameron, P., Masci, K., Fitzgerald, M., & Cooper, D. et al. (2010). Prehospital rapid sequence intubation improves functional outcome for patients with severe traumatic brain injury. *Annals of Surgery*, *252*(6), 959-965. http://dx.doi.org/10.1097/sla.0b013e3181efc15f

Brown, C., Wickline, M., Ecoff, L., & Glaser, D. (2009). Nursing practice, knowledge, attitudes and perceived barriers to evidence-based practice at an academic medical center. *Journal of Advanced Nursing*, *65*(2), 371-381. http://dx.doi.org/10.1111/j.1365-2648.2008.04878.x

Chang, L., Raty, S., Ortiz, J., Bailard, N., & Mathew, S. (2013). The emerging use of ketamine for anesthesia and sedation in traumatic brain injuries. *CNS Neuroscience & Therapeutics*, *19*(6), 390-395. http://dx.doi.org/10.1111/cns.12077

Dewhirst, E., Frazier, W., Leder, M., Fraser, D., & Tobias, J. (2013). Cardiac arrest following ketamine administration for rapid sequence intubation. *Journal of Intensive Care Medicine*, *28*(6), 375-379. http://dx.doi.org/10.1177/0885066612448732

Ehrenfeld, J., Cassedy, E., Forbes, V., Mercaldo, N., & Sandberg, W. (2012). Modified rapid sequence induction and intubation. *Anesthesia & Analgesia*, *115*(1), 95-101. http://dx.doi.org/10.1213/ane.0b013e31822dac35

Filanovsky, Y., Miller, P., & Kao, J. (2010). Myth: ketamine should not be used as an induction agent for intubation in patients with head injury. *CJEM, 12*(02), 154-157. http://dx.doi.org/10.1017/s1481803500012197

Gebremedhn, E. (2014). Techniques of rapid sequence induction and intubation at a university teaching hospital. *World Journal of Emergency Medicine, 5*(2), 107. http://dx.doi.org/10.5847/wjem.j.issn.1920-8642.2014.02.005

Graham, I. D. & Logan. J. (2004). Innovations in knowledge transfer and continuity of care. *Canadian Journal of Nursing Research, 36*(2), 89-103.

Gunning, M., Perkins, Z., & Quinn, T. (2007). Trench entrapment: is ketamine safe to use for sedation in head injury? *Emergency Medicine Journal*, *24*(11), 794-795. http://dx.doi.org/10.1136/emj.2007.053066

Kurdi, M., Theerth, K., & Deva, R. (2014). Ketamine: current applications in anesthesia, pain, and critical care. *Anesthesia: Essays and Researches*, *8*(3), 283. http://dx.doi.org/10.4103/0259-1162.143110

Ledowski, T. & Wulf, H. (2001). The influence of fentanyl vs. s-ketamine on intubating conditions during induction of anaesthesia with etomidate and rocuronium. *European Journal of Anesthesiology*, *18*(8), 519-523. http://dx.doi.org/10.1097/00003643-200108000-00006

Sibley, A., Mackenzie, M., Bawden, J., Anstett, D., Villa-Roel, C., & Rowe, B. (2011). A prospective review of the use of ketamine to facilitate endotracheal intubation in the helicopter emergency medical services (HEMS) setting. *Emergency Medicine Journal*, *28*(6), 521-525. http://dx.doi.org/10.1136/emj.2009.088237

Sleigh, J., Harvey, M., Voss, L., & Denny, B. (2014). Ketamine – more mechanisms of action than just NMDA blockade. *Trends in Anaesthesia and Critical Care*, *4*(2-3), 76-81. http://dx.doi.org/10.1016/j.tacc.2014.03.002

Stoelting, R. K. & Hillier, S. C. (2006). Nonbarbituate intravenous anesthestic druges. In *Pharmacology and Physiology in Anesthetic Practice*, (pp. 155-178) (4th ed.) Philadelphia PA: Lippincott Williams & Wilkins.

Topcuoglu, P., Uzun, S., Canbay, O., Pamuk, G., & Ozgen, S. (2009). Ketamine, but not priming, improves intubating conditions during a propofol–rocuronium induction. *Canadian Journal of Anesthesia/Journal Canadien D'anesthésie, 57*(2), 113-119. http://dx.doi.org/10.1007/s12630-009-9217-4

Walls, R. M. & Murphy, M. F. (2012). Rapid sequence intubation. In *Manual of emergency airway management*, (4th ed.). Philadelphia PA: Lippincott Williams & Wilkins.