Best Practice for Anesthesia for ECT: Quality Improvement Review and Guideline Development for ADU SRNAs at Florida Hospital

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Abstract

Electroconvulsive Therapy (ECT) is a safe and effective treatment for various psychiatric disorders. ECT treatment entailed the delivery of an electrical current via electrodes applied to the scalp that produce a generalized therapeutic seizure. Due to the nature of the procedure and for patient safety and comfort, the anesthetic of choice is general anesthesia. Unlike other general anesthesia cases, the anesthetic goals for ECT are a rapid induction, deep muscle relaxation without interference with seizure quality and length, and a rapid emergence. Due to the fast pace, multiple providers, and a multitude of distractions during ECT procedures, new providers, such as Student Registered Nurse Anesthetists (SRNAs), are at an increased risk for committing a medication error. This lack of knowledge and understanding of the ECT procedure and clinical setting can potentially impact patient care.

Henceforth, the primary purpose of this project was to design a protocol intended to establish a safe process for preparing and labeling high-risk medications commonly used during ECT treatments by SRNAs. The sample population utilized in this project was the Adventist University of Health Sciences' Nurse Anesthetist Program SRNAs class of 2018. The intervention used to address the problem is through a pre-test, a 30 to 45 minute PowerPoint presentation, and a post-test. The anticipated outcome of the PowerPoint presentation was an increase in the level of knowledge and understanding of the participants as demonstrated by improved post-test scores, indicating an effective PowerPoint presentation. The statistical analysis results of the pre- and post-test indicated significant increase in the level of knowledge of SRNAs after the PowerPoint presentation.

Problem Statement

Electroconvulsive Therapy (ECT) is a standard of treatment for various psychiatric disorders such as schizophrenia, bipolar disorder, and major depression. The exact mechanism of how ECT works to alleviate the symptoms associated with these psychiatric disorders is unknown. However, what is known is that the effectiveness of ECT depends on the quality and duration of the induced seizure (Wagner, Mollenberg, Rentrop, Werner, & Kochs, 2005). ECT procedures are performed under general anesthesia. Unlike other general anesthesia cases, the anesthetic goals for ECT are a rapid induction, deep muscle relaxation without interference with seizure quality and length, and a rapid emergence. Due to the fast pace, multiple providers, and a multitude of distractions during ECT procedures, new providers, such as Student Registered Nurse Anesthetists (SRNAs), are at an increased risk for committing a medication error. This lack of knowledge and understanding of the ECT procedure and clinical setting can potentially impact patient care. At this time, there are no established protocols for SRNAs new to ECT rotation regarding the best practice for medication preparation processes during ECT.

The absence of a standardized protocol for ECT medication preparation at Florida Hospital can lead to a serious issue. Because of the fast-track and rapid turn-over during ECT procedures, any providers new to the service without proper orientation are at an increased risk for making an error. The purpose of this project was to design a protocol intended to establish a safe process for preparing and labeling high-risk medications commonly used during ECT treatments by SRNAs.

An additional goal for this project was to develop an orientation package for all SRNAs new to ECT rotation at Florida Hospital. The outcome of this orientation package was to allow SRNAs to become familiar with the ECT procedure, medications commonly used for ECT, and

expectations during ECT anesthetic management as a means to improve care and to reduce medication errors.

The sample population that was utilized in this project was the Adventist University of Health Sciences' Nurse Anesthetist Program SRNAs class of 2018. The intervention that was used to address the problem was through a pre-test, a 30 to 45 minute PowerPoint presentation, and a post-test. The anticipated outcome was an increase in the level of knowledge and understanding of the participants as demonstrated by improved post-test scores, indicating an effective PowerPoint presentation.

Review of Literature

According to the World Health Organization, depression is the leading cause of disability worldwide. In the United States, more than 14 million Americans are diagnosed with depression each year, and about 50% of the newly diagnosed patients do not respond to pharmacotherapy alone (Freeman & Berger, 2016). Electroconvulsive Therapy (ECT) is considered to be effective as a sole treatment for psychiatric disorders or in combination with pharmacologic treatment. Currently, the amount of ECT procedures has surpassed the number of myocardial revascularizations, appendectomies, and hernia repairs in the United States (Freeman & Berger, 2016). However, the use of ECT still generates significant controversy due to its history, risk of memory loss, and other cognitive sequelae associated with ECT. Despite the controversy, the American Psychiatric Association supports the use of ECT as an effective treatment for individuals with severe depression, bipolar disorder, and schizophrenia that are resistant to pharmacotherapy. A first option for treatment includes three ECT treatments a week for 6 to 12 sessions. Some patients may show improvement after five treatments, but it may be necessary to have treatments on a monthly basis to prevent relapses (Freeman & Berger, 2016).

The main purpose of ECT was designed to treat patients with disorders such as major depression, bipolar disorders, mania, and schizophrenia. ECT is also indicated in the treatment of depressive disorder associated with symptoms such as catatonia, vegetative dysregulation, inanition, and suicidal ideation as well as treatment for Parkinson's disease (Nagelhout & Plaus, 2014).

While the exact mechanism of ECT is unknown, there are several theories in the literature that explain the mechanism of action of ECT and the improvement of depressive symptoms. Furthermore, the anticonvulsant theory postulates that ECT increases blood brain permeability resulting in increased drug delivery to brain tissue (Fosse & Read, 2013; Haskett, 2014). Evidence to support this theory comes from EEG and cerebral blood flow studies after an ECT treatment. In addition, several studies indicated changes in the neurotransmitter receptors and second messenger receptors on magnetic resonance spectroscopy of patients that underwent ECT. ECT treatment entails a variable-frequency electrical current via electrodes applied to the scalp that produce a generalized therapeutic seizure (Freeman & Berger, 2016). Currently, there are two acceptable electrode probe placements for the administration of the electrical stimulus: bilateral or unilateral pulse stimulation. Kellner, Tobias, & Wiegnad, (2010), performed an extensive literature review that indicated bilateral pulse stimulation is the "gold standard" for ECT. However, bilateral pulse stimulation has a greater risk of memory loss than unilateral pulse stimulus but shows greater clinical improvement in symptoms (Kellner, Tobias, & Wiegand, 2010).

History

ECT was first reported in 1938 by the neurologist Ugo Cerletti. Historically, an ECT procedure was carried out with no medications and no anesthesia (Kelly & Kelly, 2013). The lack of muscle relaxants during ECT treatment led to many injuries associated with motor

activity during induced convulsion (Wagner et al, 2005). Consequently, this type of treatment created misconceptions within the general public and eventually lost popularity amongst patients. Today, electroconvulsive therapies are performed under general anesthesia which reduces the risk of injury during convulsion and provides amnesia during the treatment (Keller & Bryson, 2012).

The introduction of muscle relaxation reduced the risk of injury due to muscle spasms and bone fractures (Kelly & Kelly, 2013). Muscle relaxation for ECT was introduced in 1950 as a great advantage to prevent musculoskeletal injury from the motor involvement of a seizure (Keller & Bryson, 2012). The first muscle relaxant used for ECT treatments was curare until 1951, when succinylcholine gained popularity and continues to be considered the drug of choice for muscle relaxation for patients undergoing an ECT procedure (Hick & Black, 1999). At the present time, the addition of general anesthesia to ECT treatments has helped the procedure to regain popularity within the general population (Freeman & Berger, 2016).

Anesthesia Management

The anesthetic goals for ECT are to provide a rapid induction with rapid loss of consciousness, adequate muscle relaxation to prevent injury with minimal interference from seizure activity, and a rapid recovery of spontaneous ventilation and consciousness (Wagner et al., 2005). The effectiveness of ECT treatment is significantly influenced by the quality and duration of the induced seizure. The goal of ECT is to produce an electroencephalogram (EEG) seizure that lasts long enough to elicit an optimal antidepressant effect (Pal & Pal, 2015). The electrical shock delivery during ECT treatment usually lasts 2 to 8 seconds and is followed by seizure activity of 30 to 60 seconds (Wagner et al., 2005).

Although an ECT treatment may be considered safe when administered by trained personnel, a thorough medical history is important in order to reveal any life threatening

situations related to the treatment or the administration of anesthesia. Moreover, patients are usually on a variety of medications that may cause an adverse reaction with anesthetic agents or interfere with the actual ECT treatment. Patients should stop taking anti-epileptic medication the night before as those may interfere with the onset and quality of the seizure. Patients on benzodiazepines should be tapered off due to its anticonvulsant effects. Lithium prolongs the onset and the duration of action of the muscle relaxant such as succinylcholine and may induce post treatment agitation (MacPherson, 2015). The risks of an ECT treatment are due to the treatment itself, an advertent airway complication, or a reaction to the provision of anesthesia.

While most sources do not list absolute contraindications to ECT, according to Nagelhout & Plaus (2014), there are several contraindications, such as pheochromocytoma, recent myocardial infarction, recent cerebrovascular infarction, recent intracranial surgery, intracranial mass, and unstable cervical spine. Relative contraindications to ECT includes angina, congestive heart failure, pacemaker or ACID, pulmonary disease, major bone fracture, glaucoma, retinal detachment, thrombophlebitis, and pregnancy (Nagelhout & Plaus, 2014).

Induction agents utilized in general anesthesia contain anticonvulsive properties and counteract the convulsive treatment applied during ECT (MacPherson, 2015). The selection of hypnotic agent is geared to provide amnesia without interference to the induction, duration, and quality of the seizure. The most commonly used induction agents employed in ECT are methohexital, propofol, and etomidate (Freeman & Berger, 2016). Several sources site Methohexital as the “gold standard” hypnotic for ECT treatment (source; source; source). Although methohexital doses vary from different sources, the average range fluctuates from 0.75 to 1.5mg/kg. It is preferred over other induction agents due to its ultra-short acting, non-interference with seizure activity, and side effect profile (MacPherson, 2015).

Despite its influence in seizure reduction, propofol is gaining popularity when it comes to ECT treatment. Nevertheless, it is recommended to use small doses for induction since doses greater than 1 mg/kg may shorten the ECT evoked duration of seizures (Wagner et al., 2005). Etomidate, on the other hand, is known to increase seizure duration when compared to propofol or methohexital and is favored due to its hemodynamic stability. Unfortunately, etomidate has been associated with myoclonic activity that may interfere with seizure assessment and is linked to high incidence of emesis and confusion post treatment. Etomidate is generally reserved for those patients who receive suboptimal seizure treatment with the use of propofol or methohexital or for hemodynamically unstable patients (Wagner et al., 2005).

According to MacPherson (2015), there are existing controversial data on the use of remifentanil during ECT treatments as a co-induction agent. The issue arises to which action contributes to a better quality and duration of seizure; the controversy is whether the addition of remifentanil or the reduction of the hypnotic agent dose is the primary contributor of an enhanced quality and duration of seizure (MacPherson, 2015). According to Begec et al., 2013, a randomized, crossover study found no difference in seizure duration between propofol (1mg/kg) alone and the use of propofol (0.5 mg/kg) and remifentanil (1 mcg/kg) during ECT treatment. Nonetheless, remifentanil can be considered a drug of choice when used in combination with another induction agent to create the same level of anesthesia, maintain hemodynamic stability, and minimal interference with a therapeutic seizure.

Another induction agent, not widely used in the ECT arena due to its hemodynamic side effects is ketamine. Ketamine can be a preferable agent due to its lack of respiratory depressant properties. Nevertheless, because of augmenting effects on blood pressure and heart rate, it can contribute to unwanted hyper dynamic state post ECT treatment (Wagner et al., 2005). Even so,

the latest research indicates that there is increased interest on the use of ketamine for its intrinsic antidepressant effects and improved cognitive function right after ECT; certainly more research is needed in this area (MacPherson, 2015). Other anesthetic agents widely used in general anesthesia, such as benzodiazepines and volatile agents, are not recommended in a single ECT treatment due to their anticonvulsant effects (Wagner et al., 2005).

Once amnesia is achieved, a muscle relaxant is given. Although, complete paralysis is not required, the introduction of a muscle relaxant during ECT treatment is to minimize the vigorous physical response to convulsions. A neuromuscular blocker of choice that is widely used in ECT treatment is succinylcholine, which is favored for its fast onset and quick return of spontaneous respirations. The dose usually utilized in the ECT environment is 0.5 mg/kg to 1 mg/kg, lower than an induction dose for general anesthesia. In patients that suffer from post ECT agitation associated with increased lactate levels, the dose can be increased to 1 mg/kg to 1.5 mg/kg. The patient is pre-medicated with 5mg of rocuronium as a defasciculating dose. Patients on whom succinylcholine is contraindicated, such as in neuroleptic malignant syndrome and pseudocholinesterase deficiency, there is an option of employing rocuronium and sugammadex. A case study presented by Saeki, Kwon, Migita, Fukuda, and Hamada (2011) demonstrated the successful use of rocuronium (0.6 mg/kg) reversed with sugammadex (2 mg/kg).

Cardiovascular response to ECT is demonstrated by an immediate parasympathetic discharge. The parasympathetic phase corresponds to the tonic part of the seizure and is demonstrated by hypotension, bradycardia that can lead to asystole, and increased salivation; this period can last from 5 to 10 seconds. This period is immediately followed by a sympathetic discharge demonstrated by tachycardia, hypertension, and increased myocardial oxygen demand. The sympathetic discharge correlates to the clonic period of the seizure and may last 1 to 3

minutes but can last as long as 10 minutes. Intracerebral effects to ECT observed include increased cerebral blood flow of 100% to 400%, increased CMRO2, and increased intracranial pressure (Freeman & Berger, 2016). Other physiologic changes have been observed after ECT treatment such as hyperglycemia in insulin-dependent diabetic patients.

Adjunctive supportive medications utilized during an ECT treatment are geared to controlling hemodynamic changes, and treating myalgia and nausea. Anticholinergics such as atropine or glycopyrrolate 0.2 mg is given IV or IM prior to induction of anesthesia to diminish the parasympathetic response. Intravenous beta-blockers are widely used for the treatment of the sympathetic response after ECT; labetalol and esmolol are the preferred antihypertensives in this setting due to their rapid onset. For those patients that cannot tolerate the hypertensive period during ECT, such as those with intracranial or aortic aneurysms, nitroglycerin IV and sodium nitroprusside has demonstrated to be effective in the prevention of hypertension post ECT (Freeman & Berger, 2016). Other preemptive treatments such as the use of calcium channel blockers and alpha 2 agonists have been successfully used for the reduction of a significant sympathetic discharge, although cautious preparation and planning is indicated (Wagner et al., 2005).

Medical Errors

The environment in which an ECT treatment takes place can be very fast paced and distracting due to multiple teams and providers. It is recognized that, in many healthcare settings, distractions are common. It is well known to other disciplines that distraction and frequent interference increases the risk for errors. Moreover, it has been implicated that interruption within anesthesia delivery increases the level of critical incidents (Campbell, Arfanis, & Smith, 2012). A few keys distractors noted during ECT treatment at Florida Hospital are new providers

unfamiliar with ECT setting and work flow, multiple teams of providers, limited space for medication preparation, and colleague interaction.

Medical errors are the third leading cause of death in the United States. According to one prospective observational study, one in 20 perioperative medication administrations resulted in a medication error with up to one third of them leading to adverse drug events (Nanji, Patel, Shaikh, Seger, & Bates, 2016).

The National Coordinating Council for Medication Error Reporting and Prevention (2016) defines a medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient or consumer" (para. 1).

The greatest medication-intensive areas in a hospital are the operating rooms and perioperative areas. It has been widely studied that these areas use the most medications, including high risk medications, than any other in the hospital, but implement the least number of safety measures. Additionally, the leading cause of adverse drug events in the operating room during the delivery of anesthesia is human error (Brown, 2014).

The anesthetist is responsible for prescribing, mixing, labeling, administering, and documenting medications without secondary safety checks. Anesthesia is the healthcare department with the most utilization of high-alert medications. According to the Institute of Medicine, approximately $29 billion is spent each year on preventable medical adverse events and $2 billion of them are accredited to adverse drug events (Brown, 2014).

To assist with improvement of anesthesia practice, the Anesthesia Patient Safety Foundation (APSF) created a standardization for safer medication administration based on three principles: standardization, technology, and prefilled or premixed medications (Brown, 2014).

First, the APSF recommends the standardization of high-alert medications and recommended that such medications be mixed and prepared by pharmacy staff such as phenylephrine and ephedrine. Second, the standardization of the anesthesia workspace such as arrangement and layout of medications and equipment; specifically, the removal of the anesthetist-prepared medications and the addition of prefilled syringes whenever possible to prevent provider error in the preparation of medications. And finally, for the standardization of technology, the APSF recommends the implementation of barcode medication administration software that will alert the anesthesia provider of the medication, concentration, and dose as a secondary form of verification (Brown, 2014).

After an extensive review of the literature, it was found that there is very limited information on best practice guidelines to maintain safety and to eliminate distraction in the ECT procedure room environment.

Project Description

The primary objective of this capstone project was to create procedural recommendations to provide guidelines to all SRNAs new to ECT clinical rotation on safe medication preparation in the fast paced environment of ECT at Florida Hospital. Additionally, an orientation package was developed for all SRNAs new to ECT clinical rotation. This orientation package will allow all new SRNAs to be familiar with the location ECT procedures are performed at Florida Hospital, the ECT set-up, patient preparation/interview, the induction phase, the shock therapy phase, and the emergence phase. This orientation package included an easy to follow guide in order to help the SRNAs prepare for ECT clinical rotation. It is intended that each SRNA will have this orientation package with them during ECT rotation for easy and quick reference.

The second objective of this project was to increase SRNAs level of knowledge and understanding of ECT procedures and to create a safe environment for the selection of medications during their ECT rotations. A new approach towards the safe selection, labeling, and administration of medications will be designed in order to prevent medication errors during an ECT treatment. This capstone project aimed to prevent medication error in ECT by standardizing the medication preparation process during ECT rotation. For instance, all lidocaine will be drawn up in 6 mL syringes, Rocuronium will be drawn up in a 3 mL syringes, Succinylcholine will be drawn up in a 12 mL syringes, and Propofol will be drawn up in a 20 mL syringes. This capstone project was submitted to the ADU Scientific Review Committee (SRC) and the ADU Institutional Review Board (IRB) for approval.

The population that was utilized for this project were the junior SRNAs at Adventist University of Health Sciences (ADU) in the fall of 2016 during a clinical conference meeting. The sample method was by convenient sampling during the clinical conference meeting. The anticipated sample size of this project was 25 students from the 2018 SRNA cohort at ADU.

Evaluation Plan

First, an informed consent (Appendix A) was obtained from all junior SRNAs from the 2018 cohort that attended the presentation. Prior to the presentation, a pre-test (Appendix B) was given to the attendees to evaluate the current knowledge and understanding regarding ECT procedure, drugs commonly used in ECT, anesthetic management for ECT, and potential for medication error. Subsequently, a post-test (Appendix B) was given after a PowerPoint presentation on ECT. The independent treatment variable included a PowerPoint presentation that covered the orientation of ECT, general information regarding ECT procedure, and medication error prevention measures during the clinical conference meeting. A post lecture test

was given to evaluate the effectiveness of the information presented. The difference between the pre-test and post-test scores is the dependent variable of the study. A significant variance between the pre and post-test was anticipated, with the post tests showing a greater improvement after the presentation, thus reflecting an effective PowerPoint presentation.

To maintain confidentiality of assessments, the researchers conducted this project in such a way that will ensured that information is submitted without participants' identification. The pre- and post-test will not contain any identifiable information. Numbers were placed on the top of the pre- and post-test and the information were submitted to the statistician according to the numbers. Thus, the researchers did not have access to any participants' identities.

The anticipated outcome of this project was to enhance the knowledge and understanding regarding ECT procedure, commonly used drugs during ECT, anesthetic management during ECT, and potential for medication error. The students will be able to recognize elements of environmental distractions during treatments and, in turn, use a proactive approach to eliminate them. The anticipated benefit of this project was an increase in the level of knowledge and understanding of ECT in all SRNAs new to ECT clinical rotation. After attending the presentation and being provided with an orientation package for ECT rotation, SRNAs will become familiar with the ECT procedure, medications commonly used for ECT, and what to expect during ECT anesthetic management as a means to improve care and to reduce medication errors.

Results

The project was successfully completed via the PowerPoint and the ECT orientation package that was presented to the 22 juniors from ADU SRNAs class of 2018. The reason that we picked this population was that the SRNAs have not had any exposure to ECT procedure.

This way we can fully assess the effectiveness of our intervention. We anticipated the sample size to be 25, however, our sample size was only 22. The method that was utilized to measure the effectiveness of the project intervention was a pre- and post-test. The pre- and post-test comprised of ten questions and these questions were grouped into three categories to assess the level of knowledge regarding anesthesia management, ASA monitors, and medication errors during ECT treatment. Surprisingly, question 1 of the pre-test, which asked "ECT procedure is commonly performed under what type of anesthesia?", 13 of 22 participants answered monitored anesthesia care (MAC) and only 8 out of 22 participants answered general anesthesia. However, the score on the post-test is the mirror image of the pre-test; 14 out of 22 participants answered general anesthesia. The questions regarding ASA monitors, consents, and medication errors all have 100% correct answer rate. This does not come as a surprised since all of the participants are registered nurses with at least 1 year of critical care experience.

A note of disclosure, the pre- and post-test was administered by the researchers and the raw data was also compiled by the researchers. The raw data was sent to Dr. Roy Lukman, the Chairman of the Scientific Review Committee at ADU for statistical analysis. As demonstrated below, mean score for the pre-test is 8.2273 and the mean score for the post-test is 9.0000. However, there are significant differences in the standard deviation between the pre- and post-test. In addition, the paired samples *t* test (sig. 2-tailed) showed a $p < 0.001$ and the negative *t* value in the chart below indicates that the mean score for the post-test is significantly greater than the mean score for the pre-test. On further analysis, there was a significant average difference between the pre-and post-test score ($t_{21} = 4.822$, $p < 0.001$). On average, the post-test scores were 0.773 points higher than the pre-test scores (95% Confident Interval [1.105, 0.4394]). Based on statistical analysis and variance between the pre- and post-test after the 40

minute PowerPoint presentation, the results indicated a significant increase in the level of understanding of the participants.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTest Scores	8.2273	22	1.30683	.27862
	PostTest Scores	9.0000	22	.97590	.20806

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PreTest Scores - PostTest Scores	-.77273	.75162	.16025	-1.10598	-.43948	-4.822	21	.000

Conclusion

The presentation objective, in regards to education and environment awareness, were achieved and the SRNAs involved were able to improve their post-test scores based on the presentation provided. However, there are several limitations noted in this project. First, the sample size only comprised of 22 participants and the sampling method is that of convenience sampling, which could lead to bias. Second, the protocol created is specific only to one practice location and to only one anesthesia group at Florida Hospital. Nevertheless, we felt that our project had major implications to SRNAs clinical experience and patient safety during ECT treatment at Sherman. Our hope through this project is to create a sense of awareness and to increase the level of knowledge of SRNAs going through ECT rotation. Through our project, we also hope to enhance SRNAs clinical experience and eliminate medication errors through awareness.

The SRNAs participants expressed the great impact this had on them as they were preparing to participate in their ECT rotation. The topic on medication errors was geared towards the ECT environment but is applicable to all the steps of the anesthesia care. The audience

expressed that the awareness provided through personal accounts helped them to be reminded of the importance of protocols, attentiveness, and situational awareness.

Future implications for practice in an ECT environment include the safe selection and administration of medications. The intended presentation will become a very useful tool for future SRNA students to help them prepare for their ECT rotations.

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APPENDIX A: Informed Consent

ADU NAP CAPSTONE PROJECT – INFORMED CONSENT

Our names are **Thu-Hien Nguyen & Patricia Calcetto**, and we are MSNA students in the Nurse Anesthesia Program (NAP) at Adventist University of Health Sciences (ADU). We are doing a Capstone Project called *Best Practice for Anesthesia for ECT: Quality Improvement Review and Guideline Development for ADU SRNAs at Florida Hospital*. This project is being supervised by **Dr. Steve Fowler**. We would like to invite you to participate in this project. The main purpose of this form is to provide information about the project so you can make a decision about whether you want to participate.

WHAT IS THE PROJECT ABOUT?

The purpose of this project is to design a protocol intended to guide a safe process for preparing and labeling high-risk medications commonly used during ECT treatments by SRNAs. The second purpose of this project is to develop an orientation package for all SRNAs new to ECT rotation at Florida Hospital. The outcome of this orientation package is to allow SRNAs to become familiar with ECT procedure, medications commonly used for ECT, and what to expect during ECT anesthetic management.

WHAT DOES PARTICIPATION IN THIS PROJECT INVOLVE?

If you decide to participate in this project, you will be asked to complete an anonymous pre-assessment, attend a classroom presentation, and then complete an anonymous post-assessment. The assessment will address knowledge and understanding regarding ECT clinical rotation. Your participation by attendance at the presentation and completion of the survey is anticipated to take approximately 60 minutes.

WHY ARE YOU BEING ASKED TO PARTICIPATE?

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

WHAT ARE THE RISKS INVOLVED IN THIS PROJECT?

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

ARE THERE ANY BENEFITS TO PARTICIPATION?

We don't expect any direct benefits to you from participation in this project. The possible indirect benefit of participation in the project is the opportunity to gain additional knowledge about ECT procedure, medications commonly used in ECT, and what to expect during ECT anesthetic management.

HOW WILL THE INVESTIGATORS PROTECT PARTICIPANTS' CONFIDENTIALITY?

The results of the project will be published, but your name or identity will not be revealed. To maintain confidentiality of assessments, the investigators will conduct this project in such a way to ensure that information is submitted without participants' identification. The pre- and post-test will not contain any identifiable information. Numbers will be placed on the top of the pre- and post-test and the information will be submitted to the statistician according to the numbers. Thus, the investigators will not have access to any participants' identities.

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

Your participation will cost approximately 60 minutes of your time, but will require no monetary cost on your part. You will not be paid to participate.

VOLUNTARY CONSENT

By signing this form, you are saying that you have read this form, you understand the risks and benefits of this project, and you know what you are being asked to do. The investigators will be happy to answer any questions you have about the project. If you have any questions, Thu-Hien Nguyen email address (cantythu@gmail.com) & Patricia Calcetto email address (pcalcetto@gmail.com). If you have concerns about the project process or the investigators, please contact the Anesthesia Program at (407) 303-9331.

_____ _____

Participant Signature **Date**

_____

Participant Name (PRINTED LEGIBLY)

APPENDIX B: Pre and Post Test

Pre and Post-Test

1. ECT procedure is commonly performed under what type of anesthesia?
    - **a. General**
    - b. Regional
    - c. MAC

2. What is the third leading cause of death in the United States?
    - a. Trauma
    - b. Cancer
    - **c. Medical error**
    - d. Heart disease

3. According to the World Health Organization, what is the leading cause of disability worldwide?
    - a. Hypertension
    - b. Stroke
    - c. Migraine
    - **d. Depression**

4. What is the major purpose of muscle relaxation during ECT procedure?
    - a. Amnesia effect
    - **b. Injury prevention from motor involvement with induced seizure**
    - c. Airway management
    - d. Reduction in the duration of seizure

5. Which of these medications have minimal interference with seizure amplitude and duration during ECT treatment?
    - a. Propofol
    - b. Etomidate
    - **c. Methohexital**
    - d. Ketamine

6. What monitors are recommended by the ASA for ECT procedure?
    - a. EKG
    - b. Pulse oximetry
    - c. BP
    - d. Capnography
    - **e. All of the above**

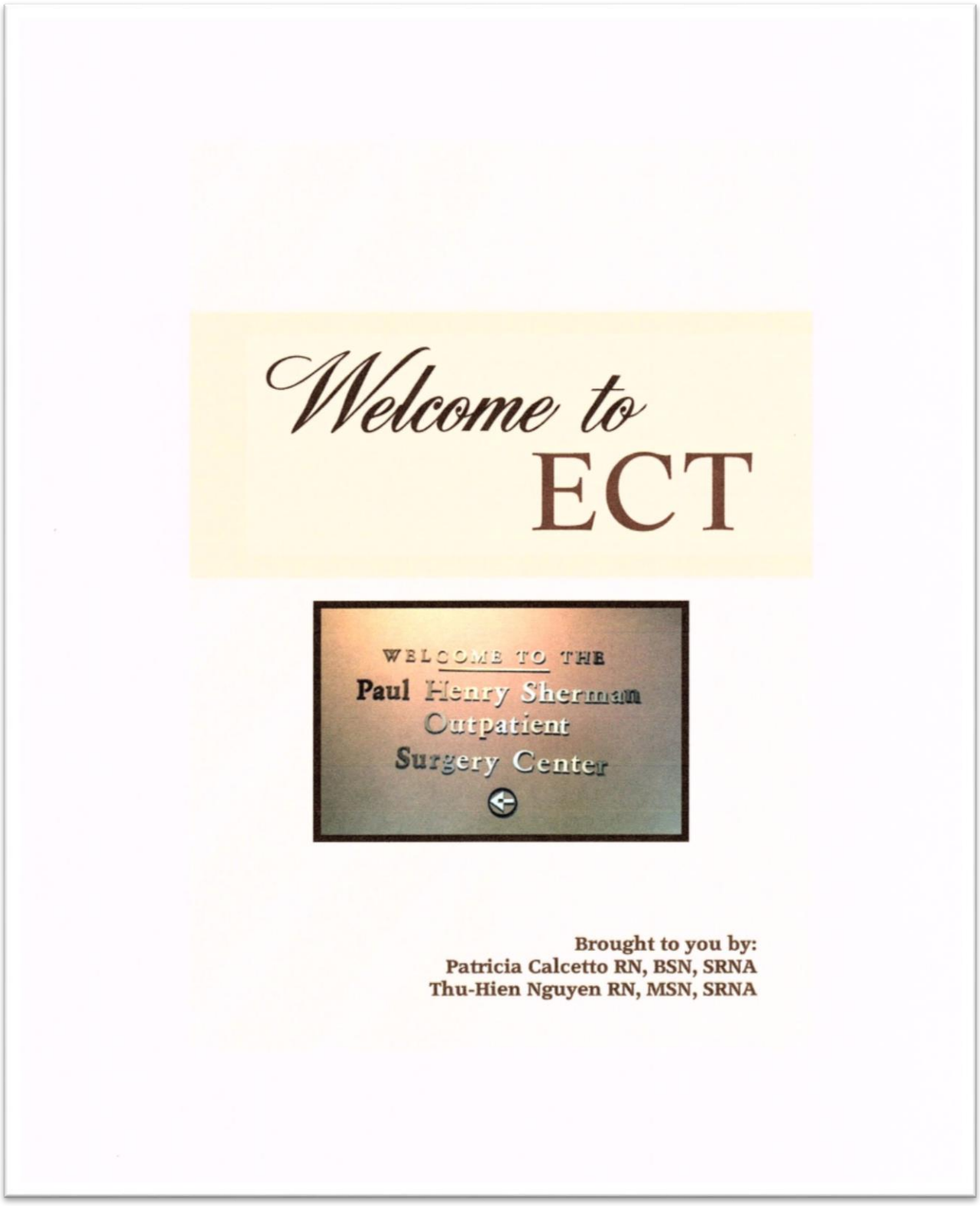
7. What is the purpose of rocuronium during ECT procedure?
    - a. Primary choice of muscle relaxation for ECT treatment
    - **b. For defasciculation and prevention of myalgia**
    - c. Reduce severity of seizure
    - d. Induce amnesia

8. A medication error may occur at what point during the process?
    a. Selecting the medication
    b. Drawing up the medication
    c. Labeling the medication
    d. Administering the medication
    e. All of the above

9. Which of the following is not one of the five "rights" for medication administration?
    a. The right patient
    b. The right route
    c. The person administering
    d. The right drug
    e. The right dose

10. Per Florida Hospital policy, consents and pre-anesthesia assessment checklist for ECT procedure are valid for how many days?
    a. 40 days
    b. 30 days
    c. 20 days
    d. 10 days

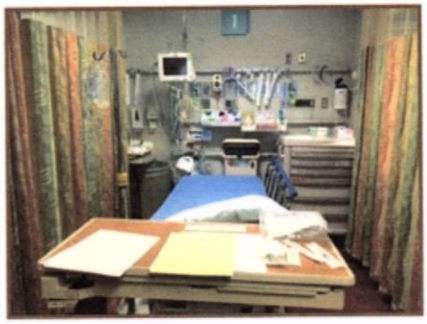
APPENDIX C: Orientation Package

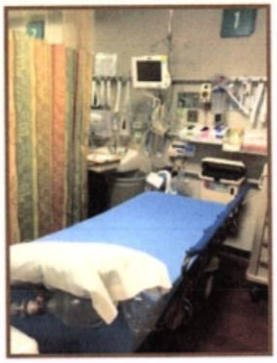


FH South: Sherman Outpatient

- **PHONE #:**
- **ARRIVAL TIME: 5:20 AM**
- **SHERMAN OP SURGERY CENTER PACU PHASE I**

- **Enter at 3rd Level Parking Garage**
- **Follow the hallway next to the coffee shop**
- **Take elevators to the 4th floor**
- **When you see the "Welcome to Sherman"sign turn left**
- **Continue walking and on the right side swipe yourself in**
- **Continue walking and enter "Phase I Recovery" you are there**

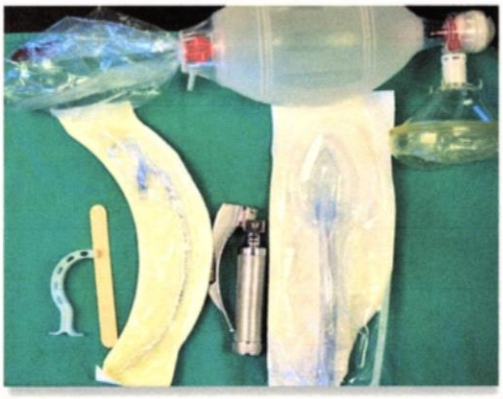




ECT Procedure Sequence

- Pre-op the patient
- Place IV and give glycol (0.2mg IV)
  - Treats the bradycardia from the initial parasympathetic discharge from the seizure activity
- Place the bite block
- Hyperventilate the patient with 100% O2
- Give beta blockers if indicated
- Give induction agent
- Give muscle relaxant
- After fasciculation, stand clear of patient, then the shock will be delivered
- Seizure Goal: 30-60 seconds long
- Continue assisted ventilation until spontaneous respiration return
- The parasympathetic discharge is often followed by a sympathetic discharge associated with HTN and tachycardia
  - Treated with esmolol or labetalol

Anesthesia Set Up



What you will Need:

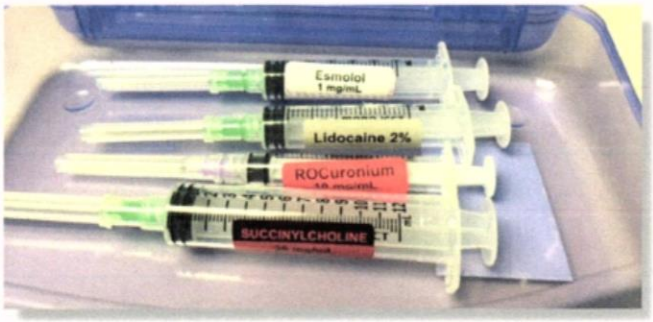
- Emergency airway equipment readily available
- Cart
- Suction
- Ambu Bag
- Oral Airway and Tongue blade
- Bite Block
- O2 supply
- Peripheral IV
- Meds
- Paper charts

ECT Anesthesia Plan

- Muscarinic Anticholinergic Drugs
  - Glycopyrrolate 0.2 mg IV/IM
  - Minmize oral and respiratory secretions
  - Prevent bradycardia & asystole
- Anesthetic Plan: General Anesthesia with Mask Management
- Adjunct Medications:
  - Labetalol or Esmolol: to treat HTN and Tachycardia
  - Ketorolac: to treat myalgia (given by RN)
  - NSAIDS: to treat myalgia (given by RN)
- Rocuronium 5mg defasciculating dose
- Most commonly used induction agent:
  - Methohexital (0.75 – 1 mg/kg IV bolus)
    - Gold Standard
    - Advantage: short duration of action & less interference with seizure activity
  - Other alternative induction agents:
    - Etomidate (0.15 – 0.3 mg/kg)
    - Propofol (0.5mg-1mg/kg)
    - Ketamine not used in ECT worsen hemodynamic response
    - Remifentanil: may be used to decrease the induction agent dose and prolong seizure duration
- Muscle Relaxation:
  - Succinylcholine: 0.5 - 1mg/kg

MacPherson, 2015

Medication Guidelines



- **Bring the box and the recipe card to the top of anesthesia cart**
- **Do not engage in conversations when drawing your medications**
- **Medications will be drawn as follows:**
  - **Rocuronium: 3 ml syringe**
  - **Lidocaine: 5 ml syringe**
  - **Esmolol or Labetalol: 5 ml syringe**
  - **Succinylcholine: 12 ml syringe**
  - **Methohexital: Premixed**
  - **Propofol: 20 ml syringe**

Recipe Card Example

Sign Date and Time after completed

Jane Doe	Kg. 70	Treatment #5
Rocuronium	5mg	
Lidocaine	30 mg	
Succinylcholine	70mg	
Methohexital	70 mg	
Esmolol	30mg	
Post:		
Zofran 4mg		
Ketorolac 30 mg		

ECT Additional Information

Absolute Contraindications to ECT:

- **Pheochromocytoma**
- **Recent myocardial infarction (<4-6 weeks)**
- **Recent cerebrovascular accident (<3 months)**
- **Recent intracranial surgery (<3 months)**
- **Intracranial mass lesion**
- **Unstable cervical spine**

Relative Contraindications to ECT:

- **Angina**
- **Congestive heart failure**
- **Pacemaker, AICD**
- **Severe pulmonary disease**
- **Major bone fracture**
- **Glaucoma**
- **Retinal Detachment**
- **Thrombophlebitis**
- **Pregnancy**

Possible Physiologic Effect s of ECT:

Parasympathetic Response during the Tonic Phase of Seizure:

- **Decreased Heart Rate**
- **Hypotension**
- **Bradydysrrhythmias**

Sympathetic Response During the Clonic Phase of a Seizure:

- **Tachycardia**
- **Hypertension**
- **Tachyarrythmias**

Cerebral:

- **Increased cerebral blood flow**
- **Increased intracranial pressure**

Nagelhout & Plaus (2014), pg. 1278

The authors would like to thank:
Project Mentor: Robert London, MD JLR Group
Project Chair: Steve Fowler DNP, CRNA
And the Nurse Anesthesia Program for their continued support during this capstone project

Disclaimer: These recommendations are by no mean a complete coverage of ECT procedures at FH Sherman and the anesthetic plan may vary based on the patient's medical history

References:

MacPherson, R. D. (2015). Which anesthetic agents for ambulatory electro-convulsive therapy? *Current Opinion Anesthesiology*, *28*(6), 656-661. http://dx.doi.org/10.1097/ACO.0000000000000251

Nagelhout, J. J., & Plaus, K. L. (2014). *Nurse anesthesia* (5th ed.). St. Louis, MO: Elsevier.

APPENDIX D: Power Point Presentation

Mechanism of Action

- The aim of ECT is to induce a therapeutic clonic seizure lasting for at least 15 seconds
- The exact mechanism of action of ECT is unknown
- Hypothesized that ECT increases blood brain permeability resulting in increased drug delivery
- Changes are noted in the Neurotransmitter receptors and second messenger system
  - Changes in Dopamine, Muscarinic, and cholinergic receptors
  - G-protein coupling receptors
  - Activity of adenylyl cyclase
  - Regulation of calcium in neurons

Indications for ECT

- Severe depression associated with:
  - Psychosis
  - Catatonic stupor
  - Suicidal intent
  - Refusal to eat
- Bipolar Disorder
  - Severe or treatment-resistant manic
- Schizophrenia
  - Resistant to medications or severe symptoms
- 70% of patients where antidepressants have failed respond positively to ECT

AMERICAN PSYCHIATRIC ASSOCIATION GUIDELINES FOR ECT

Guidelines For ECT

- Staffing role and responsibilities
  - Anesthesia provider responsibilities generally include
    - 1) managing the airway
    - 2) administering ultra-brief anesthetic and relaxant agents
    - 3) monitoring cardiopulmonary function
    - 4) managing acute adverse events
- Equipment
  - Providers should identify the equipment to be available in administering ECT
  - Providers should assure availability of supplies needed in the ECT treatment area to induce anesthesia, monitor physiologic functions, provide ventilation and resuscitation
    - Suction
    - Deliver intermittent positive-pressure oxygen (ambu)
    - Monitor vital signs
    - The treatment area should also contain equipment for intubation and resuscitation

Guidelines for ECT

- Pre-ECT treatment
  - Completed anesthesia assessment & medical history
  - Anesthesia Informed Consent
- Treatment Procedures
  - Providers need to clearly identify and define roles and responsibilities
  - Airway management during ECT is the responsibility of the anesthesia provider
    - 1) verification that required equipment is properly functioning and emergency airway equipment readily available
    - 2) determine the ability to provide adequate ventilation prior to administration of muscle relaxant
    - 3) provide positive-pressure ventilation until spontaneous ventilation return
    - 4) ensuring protection of teeth and other oral structures

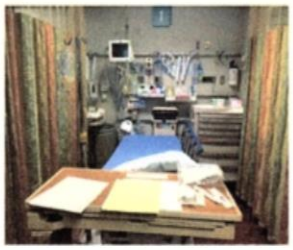
Guidelines for ECT

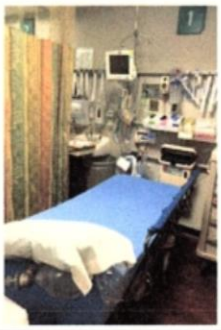
- Medications for treatment
  - Medications should be individualized based on patients needs
  - ECT should be carried out using ultra-brief, light general anesthesia
  - Unconsciousness should last only several minutes
  - Muscle relaxant should be used to modify convulsive motor activity and enhance airway management

Anesthesia Implications

- At Florida Hospital, ECT is performed in PACU at Sherman Center
- The anesthetic requirements for ECT include:
  - Amnesia
  - Airway management
  - Non interference with seizure quality and duration
  - Prevention of injury from the seizure
  - Management of hemodynamic changes
  - Smooth and rapid emergence

FH South: Sherman Outpatient





John Doe **Age: 26** **Treatment # 6**
All: Toradol, Keppra Wt: 128 kg Ht: 5'9"

Pre:
Ofirmev 1000 mg
Zofran

Meds:

Labetalol 15 mg
Lidocaine 60 mg
Zemuron 5mg
Propofol 300 mg - Succinylcholine 200 mg

****** LMA # 5 *********

Post:
Ketorolac 30 mg

Jane Doe **Age: 56** **Treatment # 6**
All: PCN, Lamictal Wt: 68 kg Ht: 5'5"

Pre:
Zofran 4 mg
Robinul 0.2 mg

Meds:
Esmolol 10 mg
Zemuron 5mg
Brevital 80 mg - Succinylcholine 100 mg

***** Do not wake patient, let her wake up on her own *********

Post:
Ativan 2 mg

Pre-Op for ECT

- Medical History
  - Absolute Contraindications
    - Pheochromocytoma (Nagelhout, pg1278)
    - Researches indicated no absolute contraindications to ECT
  - Relative Contraindications
- Bite guard prior to induction
- Glycopyrrolate 0.2 mg
  - Given by RN pre-induction to prevent salivation, bradycardia, & asystole
- Some patients will have an order for Labetalol or Esmolol to decrease the degree of hemodynamic response

BOX 52-17

Absolute and Relative Contraindications to Electroconvulsive Therapy

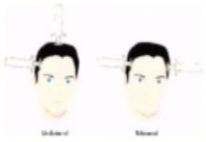
Absolute Contraindications to ECT
- Pheochromocytoma
- Recent myocardial infarction (less than 4-6 weeks ago)
- Recent cerebrovascular accident (3 months ago or less)
- Recent intracranial surgery (3 months ago or less)
- Intracranial mass lesion
- Unstable cervical spine

Relative Contraindications to ECT
- Angina
- Congestive heart failure
- Cardiac rhythm management device (pacemaker, automatic internal cardiac defibrillator [AICD])
- Severe pulmonary disease
- Major bone fracture
- Glaucoma
- Retinal detachment
- Thrombophlebitis
- Pregnancy

Nagelhout, J. J., & Plaus, K. L. (2014) *Nurse anesthesia* (5th ed.). St. Louis, MO: Elsevier. Pg 1278

ECT Procedure

- General anesthesia with Neuromuscular blockade
  - Prevent psychological and physical trauma
  - Rapid recovery
- An electrical current is applied transcutaneously to the brain via two electrodes positioned either bilaterally or unilaterally
  - Bilateral ECT more commonly used
    - Faster clinical recovery
    - More therapeutic response
  - Unilateral ECT performed on the non-dominant hemisphere
    - Minimal cognitive adverse effect
    - But is less effective



ECT Procedure

- Pre-op the patient
- Make sure you have a working IV
- Place the bite block
- Give induction agent
- Give muscle relaxant
- Hyperventilate the patient with 100% O2
  - Help with seizure quality/duration & pre-oxygenate
- After fasciculation, stand clear of patient, then the shock will be delivered
- Seizure Goal: 30-60 seconds long
- Continue assisted ventilation until spontaneous respiration return
- The parasympathetic discharge is often followed by a sympathetic discharge associated with HTN and tachycardia
  - Treated with esmolol or labetalol

Clinical Guidelines

- Muscarinic Anticholinergic Drugs
  - Glycopyrrolate
  - Minimize oral and respiratory secretions
  - Prevent bradycardia & asystole
- Anesthetic Plan: General Anesthesia with Mask Management
- Most commonly used induction agent:
  - **Methohexital (0.75 – 1 mg/kg IV bolus)**
    - Gold Standard
    - Advantage: short duration of action & less interference with seizure activity
  - Other alternative induction agents:
    - Etomidate (0.15 – 0.3 mg/kg) known to increase seizure duration
    - Propofol (strong anticonvulsant property)
    - Remifentanil: may be used to decrease the induction agent dose and prolong seizure duration without reducing the depth of anesthesia. Not currently employed at FH

TABLE
ECT Anesthetic Agents

Anesthetic Agent	Effects on Seizure	Usual Dosage	Other Considerations
Ketamine	Promotes	0.5-1.0 mg/kg	Longer recovery, elevates BP
Etomidate	Weakly promotes	0.15-0.30 mg/kg	High cost
Fentanyl with droperidol	Neutral		Incomplete anesthesia
Methohexital	Inhibits	0.5-1.0 mg/kg	Most commonly used
Thiopental	Inhibits	1.5-2.5 mg/kg	Cardiac arrhythmias
Propofol	Strongly inhibits	0.75-1.5 mg/kg	
Alfhesin	Strongly inhibits	0.6 mg/kg	
Benzodiazepines	Strongly inhibits		Longer apnea

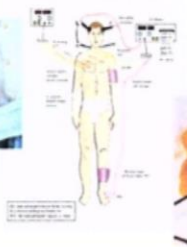
Neuromuscular Blockage for ECT

- Rocuronium 5mg (defasciculating dose)
  - To avoid myalgia
  - Can give Ofirmev or Toradol to prevent myalgia
- Muscle Relaxant:
  - **Succinylcholine 0.5 – 1.5 mg/Kg drug of choice**
  - Short-acting to protect the airway and decrease motor activity associated with the induced seizure
  - Prevent bone fractures and physical injury related to motor activity during the seizure
  - Decrease oxygen utilization by muscles during seizure
  - The elimination half-life ~ 47 seconds

Adjunct Medications

- Atropine or Glycopyrrolate:
  - to attenuate the parasympathetic discharge also used as antisialogogue
- Nitroglycerin or Sodium Nitroprusside
  - Beneficial in patients with intracranial or aortic aneurysms
- Esmolol or Labetalol:
  - to attenuate the sympathetic response
- Ketorolac:
  - to treat myalgia and headaches specially in young patients
- Zofran
- Ofirmev: Given by RN prior to treatment

Shock Delivery



Physiologic Response to ECT Delivery

Initially Parasympathetic Discharge (15 sec)

- Coincident with the tonic phase
- Bradycardia
- Salivation

Sustained Sympathetic Discharge (1 – 3 min)

Norepinephrine and epinephrine increase immediately after ECT

- Coincident with the clonic phase
- Tachycardia
- Hypertension
- Dysrhythmias and T-Wave changes

Physiologic Response to ECT Delivery

- Cerebral effects:
  - Generalized motor seizures in patients without neuromuscular blockade
  - Marked increase in cerebral blood flow (100%-400%)
  - Increased Intracranial Pressure
  - Increased CMRO2
- Musculoskeletal:
  - Myoclonic-tonic contractions, bone fractures, joint dislocations, myalgia, and arthralgia, dental damage and lacerations to the oral cavity

BOX 52-16

Possible Physiologic Effects of Electroconvulsive Therapy

Cardiovascular

Parasympathetic Response During Tonic Phase of Seizure

- Decreased heart rate
- Hypotension
- Bradydysrhythmias

Sympathetic Response During Clonic Phase of Seizure

- Tachycardia
- Hypertension
- Tachydysrhythmias

Cerebral

- Increased cerebral blood flow increases of 100% to 400% above baseline are possible
- Increased intracranial pressure

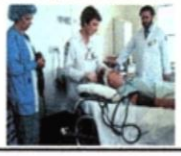
Other

- Increased intraocular pressure
- Increased intragastric pressure

Nagelhout, J. J., & Plaus, K. L. (2014). *Nurse anesthesia* (5th ed.). St. Louis, MO: Elsevier. Pg 1278

ECT Environment

- Fast paced and rapid turnover
- Very distracting
  - Multiple teams and providers
  - ECT RN, Psychiatrist, Anesthesia provider
- Limited space for medication preparation
- Increased risk for medical errors



Medical Errors

- Third leading cause of death in the United States
- The National Coordinating Council for Medication Error Reporting and Prevention (2016) defines a medication error as "*any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient or consumer.*"
- The anesthetist is responsible for prescribing, mixing, labeling, administering, and documenting medications without secondary safety checks
- Institute of Medicine
  - $20 billion spent on preventable adverse events
    - $2 billions are accredited to adverse drug events

Recommendations

- The Anesthesia Patient Safety Foundation (APSF) proposed 3 principles
  - 1) Standardization
    - Anesthesia workspace
    - Arrangement and layout of medications and equipment
  - 2) Technology
    - Implementation of barcode medication administration software
  - 3) Prefilled or premixed medications
    - High alert medication: succinylcholine, phenylephrine, ephedrine

ECT Clinical Guidelines

- PACU phone #: 407-303-2021
- Arrival at 0520: Notify a team member if unable to come
- Greet the patient and obtain medical history if older than 30 days
- Bring medication box with recipe card to the anesthesia cart
- Sign and date the recipe card

Jane Doe Kg 70 Treatment #5
Alt PCN wt. 70 kg Ht 5'9"

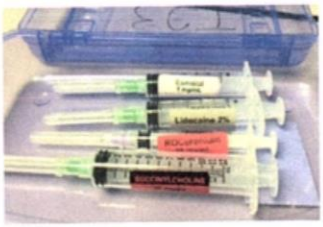
Pre Medications (RN)
Zofran 4mg
Robinul 0.2 mg

Esmolol 30 mg
Lidocaine 60 mg
Rocuronium 5mg
Brevitol 100 mg – Succinylcholine 80 mg

Post (RN)
Ketorolac 30 mg

Medication Selection Process

1) Rocuronium: 3 ml syringe
2) Lidocaine: 5 ml syringe
3) Esmolol or Labetalol: 5 ml syringe
4) Succinylcholine: 12 ml syringe
5) Methohexital: Premixed syringe
6) Propofol: 20 ml syringe



Airway Set UP

Be prepared for an emergency

1st drawer of anesthesia cart

2nd drawer of anesthesia cart

3rd drawer of anesthesia cart

5th drawer of anesthesia cart

Where Do I Go?

1) Level 3 King Garage

2) Go Straight

3) Take the elevator To the 4th floor

4) Swipe badge

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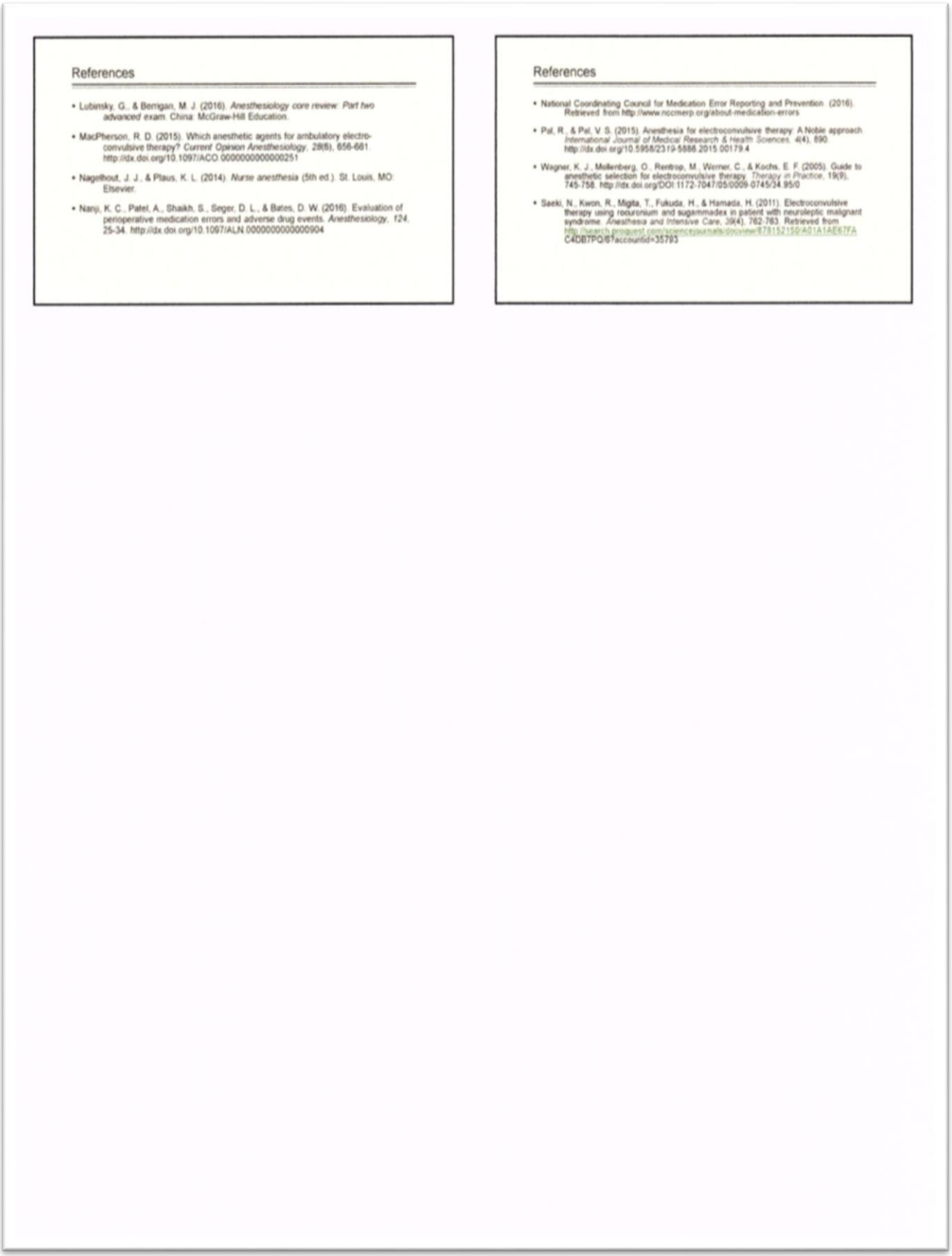

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APPENDIX E: Capstone Poster

ADVENTIST UNIVERSITY OF HEALTH SCIENCES
Florida Hospital's University

Best Practice for Anesthesia for ECT: Quality Improvement Review and Guideline Development for ADU SRNAs at Florida Hospital

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Sigma Theta Tau International Honor Society of Nursing

Problem Statement

Electroconvulsive Therapy (ECT) is a safe and effective treatment for various psychiatric disorders. For patient safety and comfort, the anesthetic of choice is general anesthesia. Unlike other general anesthesia cases, the anesthetic goals for ECT are a rapid induction, deep muscle relaxation without interference with seizure quality and length, and a rapid emergence. Because of the fast pace, multiple providers, and a multitude of distractions during ECT procedures, new providers, such as Student Registered Nurse Anesthetists (SRNAs), are at an increased risk for committing a medication error. This lack of knowledge and understanding of the ECT procedure and clinical setting can potentially impact patient care

Objective

Henceforth, the primary purpose of this project was to design a protocol intended to establish a safe process for preparing and labeling high-risk medications commonly used during ECT treatments by SRNAs.

Literature Review

Electroconvulsive Therapy (ECT) is considered to be effective as a sole treatment for psychiatric disorders or in combination with pharmacologic treatment (Freeman & Berger, 2016).

Nowadays, an ECT procedure is performed under General Anesthesia and anesthetic goals are to produce a rapid induction, deep muscle relaxation, and rapid emergence with spontaneous respirations (Kelly & Kelly, 2013).

Although there is no one specific hypnotic medication, Methohexital is considered the "gold standard" hypnotic for ECT treatments (MacPherson, 2015).

Medical errors are the third leading cause of death in the United States. According to the one prospective observational study, one in 20 operative medication administrations resulted in a medication error with up to one third of them leading to adverse drug events (Nanji, Patel, Shaikh, Seger, & Bates, 2016).

To assist with improvement of anesthesia practice, the Anesthesia Patient Safety Foundation created a standardization, technology, and prefilled or premixed medications (Brown, 2014).

Methods

The sample population utilized in this project was the Adventist University of Health Sciences' Nurse Anesthetist Program SRNAs class of 2018. The intervention used to address the problem is through a pre-test, a 30 to 45 minute PowerPoint presentation, and a post-test.

Results

The ECT orientation package was presented to 22 SRNA in the Fall of 2016 during our clinical conference meeting. The pre- and post-tests were administered anonymously and no identifying information was collected. The results from the pre- and post-tests were analyzed via a paired t-test.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test Scores	8.2273	22	1.30693	.27862
	Post-Test Scores	9.0000	22	.97590	.20806

Missed Questions
Pre-Test vs. Post-Test

Conclusion

On average, the post-test scores were 0.773 points higher than the pre-test scores (95% Confident Interval [1.105, 0.4394]). Based on statistical analysis and variance between the pre- and post-test after the 40 minute PowerPoint presentation, the results indicated a significant increase in the level of understanding of the participants.

We felt that our project had major implications to SRNAs clinical experience and patient safety during ECT treatment at Sherman. Our hope through this project is to create a sense of awareness and to increase the level of knowledge of SRNAs going through ECT rotation. Through our project, we also hope to enhance SRNAs clinical experience and eliminate medication errors through awareness.

References

References available upon request.