IMPROVING PERIOPERATIVE KNOWLEDGE AND CONFIDENCE OF LOCAL ANESTHETIC SYSTEMIC TOXICITY MANAGEMENT THROUGH EDUCATION AND CLINICAL SMULATION

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Table of Contents

Dedication and Acknowledgments

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Abstract

Background: Local anesthetic systemic toxicity (LAST) is a life-threatening event that can occur after the administration of local anesthetics. Although LAST is a sparsely occurring event, reaction and recognition to the initial signs and symptoms followed by prompt treatment ensure effective, life-saving treatment. Providing perioperative staff with education and simulated LAST scenarios have shown to improve knowledge and confidence in LAST crisis management which translates to better preparedness if ever faced with this crisis. **Purpose:** The purpose of this project was to provide clinical anesthesia providers and perioperative nursing staff with LAST education via simulation and case scenarios to improve awareness, confidence, knowledge, and responsiveness to a critical LAST crisis. **Methods:** A mixed-methods design was used to evaluate knowledge and confidence following the education and mock LAST scenario. **Results:** Results provided information consistent with increased average mean scores of both knowledge and confidence across all categories. Participants' post-evaluation questionnaires inferred information from the presentation and mock scenario were beneficial to practice and improved baseline knowledge and confidence. **Conclusion:** The results of this project have shown that knowledge and confidence improved for both RN and anesthesia providers. These findings may provide grounds for practice change for perioperative team members by changing the focus of assessments during local anesthetic administration. It is also recommended from the results of this project to incorporate LAST crisis management training into the new hire orientation program.

KEYWORDS
Local anesthetics, local anesthetic systemic toxicity, LAST, crisis management, simulation

Background and Significance

Local anesthetic systemic toxicity (LAST) is a life-threatening event that can occur after the administration of local anesthetics. Although LAST is a sparsely occurring event, reaction and recognition of the initial signs and symptoms followed by prompt treatment ensure effective, life-saving treatment. Confidence of perioperative provider recognition of LAST onset and knowledge of LAST treatment may be inadequate given the rarity of this critical event. It has been suggested that perioperative staff learn how to adequately manage critical events, such as LAST, at an accelerated rate after participating in event-specific, simulation-based training and education in opposition to providers who wait for these experiences in the clinical setting (Park et al., 2010). Furthermore, simulation of low-volume catastrophic events has proven to develop an increased knowledge base and knowledge retention of perioperative healthcare workers while simultaneously improving self-efficacy, communication, and teamwork (Bevil et al., 2020).

The incidence of LAST has been trending downward over the past 20 years. Since the introduction and increasing use of ultrasound-guided regional anesthesia techniques, reported cases of LAST have been trending down anywhere from 3% to 10% per year (Neal et al., 2018). While ultrasound-guided regional techniques have drastically reduced the incidence of LAST, serious complications still occur with seizures and cardiac arrest occurring in about 0.03% of regional nerve blocks (Neal, 2016). Although the incidence of LAST is very low, its consequences are devastating without proper intervention. These statistics validate the need for adequate simulation-based education, as providers are unlikely to have keen awareness and confidence while experiencing LAST in the clinical setting. Simulation and case-specific scenarios can provide perioperative staff with improved awareness and confidence when dealing with real-life LAST crises (Hinde et al., 2016).

According to Neal et al., the use of the American Society of Regional Anesthesia and Pain Medicine (ASRA) checklist for LAST results in the superior medical management of simulated LAST events in comparison to teams that do not utilize the ASRA checklist (2012). Furthermore, crises resource management that has been implemented during orientation programs and continuing education strengthens participation and preparedness for crisis response in healthcare professionals while simulation of crises provides improved nontechnical skills such as decision making, situational awareness, exchange of information, and assertiveness Rudy et al., 2007; Yee et al., 2005). In low occurrence, high acuity events such as LAST, the use of checklists, and simulation training can improve the management of crises.

Purpose

The purpose of this project was to provide clinical anesthesia providers and perioperative nursing staff with LAST education via simulation and case scenarios to improve awareness, confidence, knowledge, and responsiveness to a critical LAST crisis. Knowledge retention of LAST management was assessed to understand the effectiveness of the provided education. The project question was as follows: does an educational intervention on LAST improve perioperative healthcare provider knowledge and confidence when managing a LAST crisis? It is hypothesized that perioperative staff will have increased recognition of LAST and increased confidence, knowledge, responsiveness, and knowledge retention of LAST management following simulated LAST training.

The objectives of this DNP project are as follows:

- To identify perioperative healthcare providers' baseline knowledge of LAST crisis management.
- To identify perioperative providers' confidence of LAST management.

- To develop a mock LAST simulation in a local hospital setting.
- To measure the change in knowledge and confidence of perioperative providers following LAST simulation education in the immediate time following simulation, and again after six months.
- To compare results with previously published evidence of simulation-based LAST training.

The long-term goal is to provide information that will lead to the initiation of LAST simulation training and education for new anesthesia providers and perioperative nursing staff during the initial orientation period following employment. The proposed education and simulation will instill these qualities into anesthesia providers and perioperative nurses, rendering these individuals capable of efficiently managing LAST crises; this, in turn, will produce increased patient outcomes in settings that undergo LAST education and simulation.

Review of Current Evidence

An extensive review of the current literature was conducted to understand LAST history, pathophysiology, prevention, treatment, current guidelines, and staff education. Eleven articles were reviewed using the CINAHL Complete, PubMed, and ProQuest Central databases through the UNC Greensboro library webpage. Searches of the databases were conducted using Boolean operators to combine truncated terms such as, “Local anes* systemic toxicity AND periop* AND simulation”. Multiple searches were conducted using several advanced search inclusion criteria such as, “Peer Review Articles, Meta-Analysis, Systematic Review”, and custom publication dates ranging from 5 to 15 years. The articles were reviewed and the majority of articles focused on the central theme of improving patient outcomes by improving perioperative healthcare workers’ critical event management skills through education and simulation. The underlying theme suggests that crisis management improves readiness in perioperative staff through the increase of knowledge base, the definition of roles, and proper treatment.

History of Local Anesthetics

Local anesthetics are used to prevent pain by blocking nerve transmissions of pain to the brain and providing pain relief in the postoperative period with minimal central effects. Local anesthetics were introduced with the use of cocaine in the late 1800s. The development of bupivacaine in 1957 was the first long-acting local anesthetic with reported dose-dependent separation between sensory and motor function (Dillane & Finucane, 2010).

Local anesthetics work by blocking sodium channels on peripheral nerves and also in the brain and heart. The site of local anesthetic injection occurs peripherally. Eventually, local anesthetics pass through the central nervous system at small doses as metabolism occurs. If too much local anesthetic is present in the body, systemic toxicity can occur, leading to central nervous system (CNS) instability and eventually cardiovascular collapse. After nearly a decade, case reports began to surface of bupivacaine-induced cardiovascular collapse followed by unsuccessful resuscitation (Dillane & Finucane, 2010). There was no treatment for LAST other than supportive care and benzodiazepines to stop seizures until the introduction of intralipid therapy in 2008.

Clinical Manifestation

The most severe cases of LAST result in CNS toxicity and cardiac toxicity following intravascular injection of local anesthetics, however, it is possible to induce LAST without direct intravascular injection. CNS toxicity results from elevated plasma levels of local anesthetics in the CNS causing interruption of neurotransmission between excitatory and inhibitory pathways

(Dillane & Finucane, 2010). Initially, the inhibitory pathway is suppressed which results in overstimulation of the excitatory pathway and is manifested by light-headedness, dizziness, tinnitus, blurred vision, involuntary muscle twitching, and eventually seizures. With increased plasma concentrations, excitatory pathways are blocked which manifest as CNS depression, reduced levels of consciousness, and coma (Dillane & Finucane, 2010).

Cardiac toxicity is also associated with increased plasma concentrations of local anesthetics. At lower concentrations, during the CNS excitatory phase of toxicity, hypertension and tachycardia are observed which soon lead to ventricular arrhythmias, negative inotropy, conduction delays, and cardiovascular collapse seen with higher plasma concentrations of local anesthetics (Dillane & Finucane, 2010).

Prevention and Treatment of LAST

The safety of local anesthetic use has improved and there are many protocols in place to prevent the occurrence of LAST. Ultrasound-guided regional anesthesia and maximum local anesthetic doses are two guidelines that have drastically reduced LAST events in patients undergoing regional anesthesia. Ultrasound-guided regional anesthesia allows the provider to directly visualize the spread of the local anesthetic into the correct location which greatly reduces inadvertent intravascular injection. Furthermore, many institutions have implemented maximum allowable doses which have resulted in decreased incidence of LAST.

The use of lipid emulsion therapy (LET) has revolutionized treatment and is now the gold standard for treatment of LAST (Neal, 2016). Paired with prompt recognition of LAST and the American Society of Regional Anesthesia and Pain Medicine (ASRA) checklist for local anesthetic toxicity, clinical management has drastically improved, resulting in improved patient outcomes (Neal et al., 2012).

ASRA Checklist/Protocol for LAST

The ASRA Checklist (Appendix C) is a tool that has proven to provide superior crisis management to perioperative healthcare workers undergoing simulated LAST events (Neal et al., 2012). The ASRA checklist improves crisis management by providing direct access to the appropriate tasks that are needed to treat LAST. Simply having the ASRA checklist available to follow during a LAST event result in a higher number of correct tasks performed regardless of the level of training or education. The checklist was recently updated in 2020 and includes an easy-to-read flowsheet. This checklist standardizes the treatment of LAST and drastically improves care by providing doses for direct treatment of LAST as well as modified doses of life support medications during resuscitation efforts (Neal et al., 2012).

Using Simulation for Perioperative LAST Training

While there are advances in treatment, human errors still occur during a crisis. The use of training and didactic education for crisis management of LAST events has been extensively studied to reduce human error. Bevil et al. evaluated knowledge retention of perioperative nursing staff regarding LAST using simulation and found that educational exercises and simulation increased the knowledge base, self-efficacy, communication, and teamwork of perioperative nurses (2020). Knowledge, self-efficacy, teamwork, and communication are important factors during a crisis because time and decision-making are vital to the survival of the patient and produce improved outcomes in crisis events. Furthermore, educational gaps regarding the symptoms and treatment of LAST have been identified. In response, programs such as mock drills and simulations have been shown to improve the knowledge gaps and increase baseline knowledge (Ferry & Cook, 2020). To improve LAST crisis management, a training program involving both didactic education and simulation that is integrated into hospital orientation and carried out yearly can provide healthcare professionals with the confidence, knowledge, and framework for successful patient outcomes. Overall, providers and nurses with an increased knowledge base, decreased knowledge gap, higher levels of self-efficacy, strong communication skills, and strong teamwork skills are proficient in the management of a crisis event.

Limitations to mock scenarios and simulations include the absence of measuring direct patient outcomes. This is due to the rarity of LAST as healthcare workers are not likely to encounter such an event during their careers. There are no current studies that address patient outcomes following crisis intervention training due to the decreased incidence. However, simulation training has been shown to improve staff knowledge and increase confidence and comfort levels following simulation (Ferry & Cook, 2020).

Theoretical Framework

Jerome Bruner's Discovery Learning Theory was used to aid in the implementation of this DNP project. This theory is a constructivism theory that builds off the works of Jean Piaget and Seymour Papert. Bruner describes discovery learning as a method where individuals in problem-solving situations draw on previous knowledge and experiences to build upon, and improve that knowledge through questioning, manipulating, and experimenting (1961). Essentially, there is a foundation of knowledge, and upon this foundation, greater or new knowledge is achieved through increased personal experiences with an emphasis on hands-on experimentation. A result of the discovery learning theory is that learners are more likely to remember tangible learning experiences in comparison to traditional classroom education through lecture and text.

Bruner's discovery learning theory has led to various learning models, including simulation-based learning. The simulation of a LAST drill introduced anesthesia providers to a critical event that most have likely read about and have not experienced firsthand in clinical practice. Knowledge regarding LAST management was assessed post-simulation. Retention of knowledge was assessed one month after the simulation. According to Bruner's theory, anesthesia providers will have a greater understanding of the clinical manifestations of LAST and the correct sequence of events that are needed to prevent catastrophic outcomes in this low volume, high acuity event. The outcomes should be increased knowledge and retention after simulation. Furthermore, when challenged with a LAST event, confidence and proficiency will lead to effective management and increased patient outcomes.

Methods

Design

A mixed-methods design was used to evaluate knowledge and confidence following the education and mock LAST scenario. A quantitative design allows a better understanding of perioperative staff knowledge and confidence while qualitative responses in the form of open-ended responses during the post-test questionnaire allow for better understanding of barriers to practice change. This was achieved by gathering quantitative data from the sample, analyzing the data, and adding qualitative measures to improve the understanding of the project question.

Translational Framework

The Iowa Model of Evidence Based Practice is a model developed in the 1990s that has been used to help drive practice change through evidence found in research (citation needed). This model was utilized in this project as it provides a pathway to help identify and implement practice change.

The first step in the Iowa model is to identify opportunities for clinical improvements. For this project, an improvement of perioperative staff knowledge and confidence regarding LAST and the steps to take following recognition of a LAST crisis has been identified as a critical need at the project site. The purpose of this project is to increase perioperative staff knowledge and confidence when encountering a LAST crisis.

The next steps in the Iowa model are to determine if this topic is a priority, form a team, and conduct research. LAST is a priority at this site due to the current lack of systematic training for LAST events for new and current staff. A team has been formed consisting of the PI and the site champion, a CRNA that works in the anesthesia department at the project site. Research was conducted and the current literature was reviewed, assembled, and synthesized to assess how to improve current systems. Sufficient evidence points to increased knowledge and comfort levels of perioperative staff following education and simulation of high acuity, low-frequency events such as LAST (citation).

Designing and piloting the practice change, determining if the change is appropriate, integrating and sustaining the practice change, and disseminating results are the final steps to the Iowa model. The design of this project engages the staff by providing education and subsequently allowing the staff to utilize the newly acquired knowledge in an interactive mock LAST scenario. A follow-up questionnaire was used to determine if practice change has occurred and has been integrated into the project site. Additionally, the survey provided data on the improvements to the program for the future to sustain practice change.

Setting

The project took place in the perioperative area of a southeastern U.S. short-term acute care, non-profit, hospital containing 196 staffed beds. This hospital provides services to a wide age range and includes operative services for patients in need of orthopedic, bariatric, obstetrics and gynecology, general, plastic, podiatry, ophthalmology, urology, vascular, and ear, nose, and throat procedures. Approximately 9000 inpatient and outpatient procedures are performed at this location yearly.

Sample

The sample for this project represented the population of perioperative healthcare workers. Participants were limited to staff that works in the perioperative area and include registered nurses working in the preoperative area, intraoperative area, and post-operative area of the facility as well as anesthesia providers including, certified registered nurse anesthetists, student registered nurse anesthetists, and anesthesiologist assistants. All available individuals listed above were invited to participate in the LAST education and mock simulation. Information regarding this exercise was disseminated by word of mouth on whiteboards in each unit where information is typically shared about weekly meeting times and subjects. The sample size was determined by the number of individuals that met the inclusion criteria and choose to participate via convenience sampling.

Intervention

Current evidence supports the use of both didactic education alongside simulation to increase knowledge and confidence during crises intervention (Park et al., 2010; Rudy et al., 2010; Yee et al., 2005). Education was conducted followed by a simulated LAST scenario for perioperative nurses and anesthesia providers. The education consisted of a 13 slide PowerPoint presentation (Appendix D) that included statistics about LAST, the pharmacology of local anesthetics, the pathophysiology of LAST, the signs and symptoms of LAST, the role of perioperative nurses and anesthesia providers during LAST, and two case scenarios about LAST.

Following the PowerPoint presentation, there was a mock drill where participants followed a simulation script about a LAST crisis. The total presentation and mock drill time were approximately 30 minutes. This took place in the morning before scheduled work hours in the post-anesthesia care unit (PACU) at the project site. Staff were recruited through the respective managers.

Data Collection

Following a brief introduction, the participants received a paper information sheet and the pre-intervention questionnaire. Following survey completion, the participants were asked to seal the paper questionnaire in an envelope. A twenty-minute education session commenced followed by a mock patient scenario simulation. The date this project took place was August 6th, 2021. A follow-up post-intervention paper survey was provided for the participants to complete approximately one month after the initial knowledge and simulation intervention. The perioperative nurse manager and chief CRNA distributed the post-intervention questionnaire. These paper surveys were provided with envelopes for the participants to seal upon completion.

Data collection remained anonymous and posed minimal risks to the participants. Participant information was kept anonymous and no identifying information was collected. Surveys were linked by using the participant's mothers' birth month followed by the last two digits of their telephone number. This provided an arbitrary three-digit or four-digit number that was used to identify respondents to link the results. Once the envelopes containing the paper questionnaires were collected, they were stored in a secure, sealed folder in the possession of the PI. Completed paper survey forms were filed at UNCG in a locked cabinet. After 3 years of secure storage, the surveys are to be securely shredded. The LAST knowledge and confidence scores were filed on paper, then transferred into an Excel sheet, and were stored in the PI's password-protected personal laptop which is under his control at all times. Paper scores were kept in a secure locked cabinet at all times. No identifying information was attached to any of the scores collected. The files were uploaded to BOX.uncg.edu, which is a secured 3-lock system, and were secured on a hard drive. Data will not be accessed in unsecured areas where others may view the files. Everything will be deleted after 3 years using an eraser program. The quality information project results will be shared with the anesthesia and perioperative nursing departments but will be done so in a summary format upon the PI's program completion and no participant names will be used. Only the PI and the DNP faculty will have access to the anonymous data. All information in this project will be kept confidential unless disclosure is required by law.

Instruments

Participants were given the combined participant information and pre-intervention evaluation instrument (Appendix A). This form instructs the participants to create a personal participant identification as well as gather information regarding their practicing role. Furthermore, the pre-evaluation instrument portion evaluated participant knowledge of LAST and comfort of managing a LAST event in the specific facility. Participants answered questions on a five-point Likert scale that consisted of the following options; strongly disagree, disagree, undecided, agree, and strongly agree.

One month following the education and mock scenario provided by the PI, the LAST postintervention instrument (Appendix B) was distributed to the participants. This instrument included the same questions provided in the LAST pre-intervention instrument with the addition of open-ended questions to evaluate practice change, barriers, and effectiveness of the educational intervention.

Data Analysis

The data was initially analyzed using descriptive statistics. Data was paired from pre and post-survey results (n=12). This data was then analyzed using descriptive statistics to assess the mean results for positive answers (agree or strongly agree). The data was further analyzed using paired t-tests to identify any statistically significant changes between the pre and post-survey. These responses were separated by each of the 13 questions on the survey and the percentage of response rates for each Likert-scale category (strongly disagree, disagree, undecided, etc.) was tabulated for each question. The average of these response rates was then calculated. Finally, the average response rate for each Likert-scale category (strongly disagree, disagree, undecided, etc.) was compared in both groups (pre-and post-evaluation surveys).

Furthermore, data were analyzed using paired t-tests comparing this category's pre-evaluation survey responses to the post-evaluation survey responses. The purpose of this analysis is to focus on the mean results as well as the p-values to determine any statistical significance between the two surveys due to the education and simulation intervention.

The descriptive statistics consisted of four separate groups of data based upon the Likert-scale responses from each participant. The four groups included in this survey were based on question types and were categorized as follows: "symptoms and treatment questions" (questions 1, 2, and 4), "location and content questions" (questions 3, 5, 12, and 13), "medication questions" (questions 6, 7, 8, and 9), and "confidence questions" (questions 10 and 11). The responses of "agree" and "strongly agree" which correlate with the numbers 4 and 5 on the Likert scale, are considered to be positive results that show either a good knowledge or confidence level of the participant. The data analysis for these categories consists of comparison of the pre-and post-intervention survey percentages of positive responses.

The post-evaluation survey contained open-ended questions that were analyzed for common themes and compared with the overall analysis of the pre-and post-intervention questionnaires.

Results

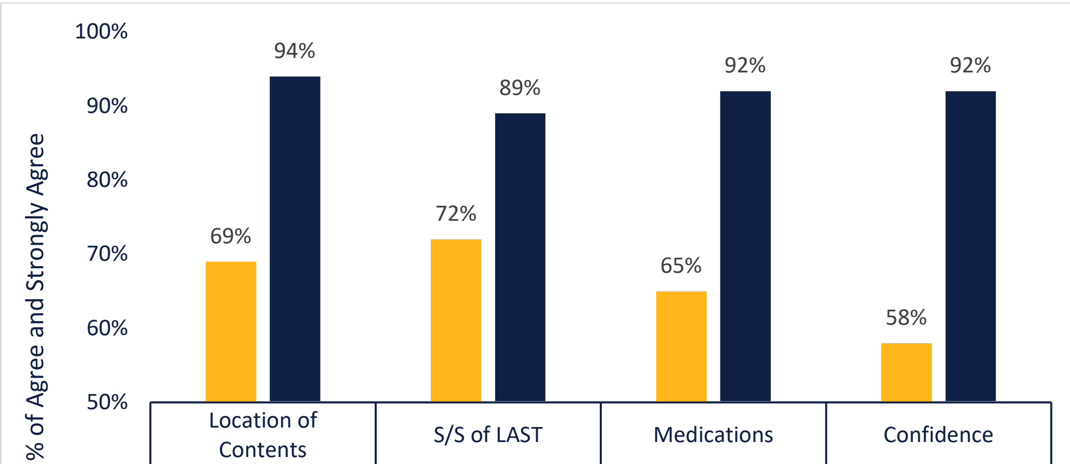
Paired t-tests compared average mean scores between pre-and post-evaluation surveys and resulted in an increase in scores for each of the 13 questions. Five out of the 13 questions showed statistically significant p-values ($p<0.05$). The questions that resulted in statistically significant data are question 3 ($p=0.03$), question 7 ($p=0.03$), question 8 ($p=0.01$), question 11 ($p=0.03$), and question 12 ($p=0.01$).

The overall results of the descriptive data show an increase in positive response rate across all four questions categories. Of the three questions about symptoms and treatment of LAST, there were 36 responses in each survey. The pre-intervention survey consisted of 23 positive responses out of 36 (72%) while the post-intervention survey consisted of 32 out of 36 positive responses (89%). This data shows that there was a 17% increase in knowledge regarding the symptoms and treatment of LAST.

There were four questions about the location and content of LAST rescue kits and checklists which contained 48 responses in each survey. The pre-intervention survey consisted of 33 positive responses out of 48 (69%) while the post-intervention survey consisted of 45 out of 48 positive responses (94%). This data shows that there was a 25% increase in knowledge regarding the location and content of LAST rescue tools and equipment.

Furthermore, there were four questions about medications associated with LAST which contained 48 responses in each survey. The pre-intervention survey consisted of 31 positive responses out of 48 (65%) while the post-intervention survey consisted of 44 out of 48 positive responses (92%). This data shows that there was a 27% increase in knowledge regarding the medications associated with LAST.

The final category contained two questions about confidence levels when confronted with LAST. This category included 24 responses in each survey. The pre-intervention survey consisted of 14 positive responses out of 24 (58%) while the post-intervention survey consisted of 22 out of 24 positive responses (92%). This data shows that there was a 34% increase in confidence related to managing a LAST crisis.



	Location of Contents	S/S of LAST	Medications	Confidence
Pre	69%	72%	65%	58%
Post	94%	89%	92%	92%

Part II of the post-evaluation questionnaire provided the participants with seven open-ended questions. These questions focused on the preparedness of LAST management, barriers to preventing and treating LAST, practice change when participating in local anesthetic administration, and the overall benefit of the project presentation.

According to the 12 participants who completed both the pre-and post-evaluation questionnaires, eleven stated that there are no barriers to preventing or treating LAST at the facility. However, there was one anesthesia provider who identified a barrier to preventing LAST. The response was, “Having all departments participate in education, especially OB staff”.

Finally, in regards to the overall benefit of the project presentation, there was overwhelming support. The majority of participants agreed that vigilance has improved with patients who are receiving local anesthetics. Increased knowledge of early signs of LAST helps providers report early symptoms of LAST and leads to improved safety culture, which in turn leads to improved patient outcomes (Hinde et al., 2016). One participant claims vigilance has increased due to improved knowledge about LAST stating the ability to, "ask the patient more specific questions about the signs and symptoms of LAST". All 12 of the participants who completed both the pre-and post-evaluation questionnaires agreed that this training exercise should be incorporated into the orientation program at this facility.

Discussion

Multiple studies have shown that incorporating education and simulation involving crisis events has yielded improved knowledge, confidence, and teamwork dynamics in a plethora of different healthcare team settings (Bevil et al., 2020; Hinde et al., 2016; Paige et al., 2015; Park et al., 2010; Rudy et al., 2007; Yee et al., 2005). The same holds true for crises events such as LAST. With the improvement of knowledge and confidence comes the assumption of decreased adverse patient outcomes in the scenario where healthcare workers provided with this training are faced with the crises event they have encountered through simulation.

For the participants in this study, the same holds true when looking at the results from the pre-and post-evaluations. When considering the data provided by this quality improvement project, one must first understand that the participants involved are trained healthcare professionals, not novice learners. This results in a baseline knowledge level of a LAST crisis that exceeds the average person. Because of this, the data is skewed to the right and does not follow a pattern of normal distribution. This results in data that sees smaller gaps in mean difference between pre-and post-evaluation responses from participants. The baseline knowledge of the participants, paired with the increase in knowledge gap proves that Bruner's discovery learning method was utilized as the participants in problem-solving situations drew on their previous knowledge and experiences to improve their current knowledge.

When looking at all categories of data, there is an increase in positive responses. There was a 28% increase in positive responses (agree or strongly agree) when evaluating knowledge and confidence overall. The paired t-test data show improvement in mean responses which indicate improvement in both knowledge and confidence based on the question category. Furthermore, the descriptive data showed improved positive response rates in all four question categories. Three categories were based on knowledge while the fourth category was based on confidence. These results indicate an overall improvement in the knowledge and confidence of the anesthesia providers and registered nurses that participated in this project.

While these results show improvement, they are indicative of a meaningful intervention at the project facility. Increased positive responses can directly be linked to increased knowledge and confidence about a LAST crisis. Both the registered nurses and the anesthesia providers that participated in this quality improvement project have shown that their knowledge and confidence have increased and therefore, the patients at this facility are provided with healthcare workers in the perioperative area that are more prepared to intervene and intervene efficiently during a LAST crisis. This implies that patients at this facility are likely to see better outcomes of a LAST crisis when compared to patients at facilities that do not offer this type of education and simulation (Hinde et al., 2016).

The open-ended responses from the post-evaluation questionnaire gave insight to the thoughts of each participant. There are common themes that were recognized in these responses that support the continued efforts to disseminate information about LAST. One participant noted that one barrier to preventing LAST was to have all departments involved with a direct mention of the OB department. This type of training should be included in all areas where toxic doses of local anesthetics are possible. The OB department was not available for this education and mock scenario presentation although efforts were made to incorporate that department during the presentation sessions. This participant feels preventing LAST in the OB department is a barrier, likely because there was not a gained knowledge and confidence level of OB staff regarding LAST.

In regards to the preparedness of LAST management, there is an overall theme that both RN and anesthesia providers feel more prepared to manage LAST due to the educational session and the mock scenario. One participant wrote that preparedness to manage LAST has improved due to "better understanding of signs and where the kit is located in the Pyxis". This theme continues amongst the RN participants in regards to practice change as noted by the response, "more confident in prevention and assessment of LAST".

Overall, this project was well received and 100% of the participants agree that this type of training is beneficial to team knowledge and confidence and should be included in this particular facility.

Limitations

Limitations were identified during the implementation of this project. The initial limitation pertains to the sample size. The sample size was a convenience sample of people who were available on the day of the presentations. Ideally, there would be a minimum of 30 participants providing data in both pre-and post-evaluation questionnaires with each of their questionnaires being linked. However, only 27 participants took place in the pre-evaluation process and 13 participants took time to fill out the post-evaluation questionnaire. Only 12 questionnaires were able to be linked. Furthermore, less than half of the people did the post-evaluation survey. Additionally, some staff were no longer employed at the post-evaluation survey time. This contributed to the small number of completed post-evaluation surveys. There was only one day of presentations, increasing the number of presentation days would likely increase the convenience sample size. Finally, the post-evaluation questionnaire was provided to the participants 1 month after the pre-evaluation questionnaire and presentation. A longer timeframe between pre-and post-evaluation questionnaires would provide a better understanding of the knowledge and confidence gained by the participants. Additionally, this would provide information regarding the timeframe needed to provide refresher presentations about LAST.

Recommendations for Future Study

The first recommendation for future projects is to develop a more thorough pre-and post-evaluation questionnaire with questions that are distributed evenly amongst the categories of knowledge and confidence. A deeper understanding of confidence may be better linked to performance in a crisis than knowledge alone. Longitudinal assessment of knowledge gaps could enhance the quality of the educational intervention to include vital content. Presentations that include all departments can possibly boost morale, therefore this is important to consider.

Relevance and Recommendations for Clinical Practice

Multidisciplinary members of the perioperative team agreed that this project presentation is something that is beneficial and should be included in the orientation portion for this facility. It is recommended that this facility incorporate crisis management for LAST, including a mock drill, into the orientation program for new employees in areas where there is a risk of LAST.

Additionally, this should be included in a yearly educational intervention and simulation in departments that administer LA. This will undoubtedly improve clinical practice based on the results of this project.

Conclusion

This project aimed to provide clinical anesthesia providers and perioperative nursing staff with LAST education via simulation and case scenarios to improve awareness, recognition, confidence, and knowledge of a critical LAST crisis. The results showed an increase in awareness, knowledge, and confidence in the perioperative team. Reaction and recognition to the initial signs and symptoms followed by prompt treatment ensures effective, life-saving treatment. Providing perioperative staff with education and simulated LAST scenarios has been shown to improve both knowledge and confidence in LAST crisis management. The increase in participant knowledge, confidence, and awareness may improve clinical outcomes in a LAST event and improve patient safety. These findings may provide grounds for practice change for perioperative team members by changing their assessment focus during local anesthetic administration. Simulation and education on low-occurrence high acuity events increased participant awareness, recognition, confidence, and knowledge. This may translate to improved patient outcomes in a LAST event.

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Appendices

Appendix A. Local Anesthetic Systemic Toxicity (LAST) Pre-Intervention Evaluation Instrument

Participant ID ________________________________

(Mother's Birth Month + Last 2 digits of phone number. "Example 717")

Local Anesthetic Systemic Toxicity (LAST)

Participant Information

Each Participant will be assigned an anonymous identifier that is labeled "Participant ID" on each form.

The Participant ID will be in the following format, mother's birth month followed by the last 2 digits of phone number.

For Example, ... Mother was born in JULY and last two digits are 17 → 717

This will be used to link questionnaire responses for pre- and post-intervention questionnaires.

Please put your Participant ID in the designated sections at the top of this page and the all-other pages you receive.

1. What is your practicing role?

Perioperative RN (Pre, Post, Intra) _____ **Anesthesia Provider _____**

Other ____

Pre-Intervention Evaluation Instrument

1: (Strongly Disagree); 2 (Disagree); 3 (Undecided); 4 (Agree); 5 (Strongly Agree)

Questions	1 Strongly Disagree	2 Disagree	3 Undecided	4 Agree	5 Strongly Agree
1. I can recognize the signs/symptoms of LAST.					
2. I know the initial steps in treating a patient with LAST.					
3. I know where the closest LAST kit/cart is located.					
4. I know what the ASRA checklist is.					
5. I know where the ASRA checklist is located.					

Participant ID ______________________________
(Mother's Birth Month + Last 2 digits of phone number. "Example 717")

6. I know the dose of lipid emulsion to administer to a patient experiencing LAST.					
7. I understand some ACLS medications have different doses for LAST.					
8. I know the modified ACLS medication doses for LAST.					
9. I know common ACLS medications to avoid during LAST.					
10. I feel confident in managing a patient experiencing LAST.					
11. I feel confident in managing cardiac arrest during LAST.					
12. I know where the LAST kit is located.					
13. I am familiar with the contents of the LAST kit.					

Appendix B. Local Anesthetic Systemic Toxicity (LAST)Post-Intervention Evaluation Instrument

Participant ID ____
(Mother's Birth Month + Last 2 digits of phone number. "Example 717")

Local Anesthetic Systemic Toxicity (LAST)

Instructions

Each Participant will be assigned an anonymous identifier that is labeled "Participant ID" on each form.

The Participant ID will be in the following format, mother's birth month followed by the last 2 digits of phone number.

For Example, ... Mother was born in JULY and last two digits are 17 → 717

This will be used to link questionnaire responses for pre- and post-intervention questionnaires.

Please put your Participant ID in the designated sections at the top of this page and the all-other pages you receive.

Post-Intervention Evaluation Instrument

Part I.

1: (Strongly Disagree); 2 (Disagree); 3 (Undecided); 4 (Agree); 5 (Strongly Agree)

Questions	1 Strongly Disagree	2 Disagree	3 Undecided	4 Agree	5 Strongly Agree
1. I can recognize the signs/symptoms of LAST.					
2. I know the initial steps in treating a patient with LAST.					
3. I know where the closest LAST kit/cart is located.					
4. I know what the ASRA checklist is.					
5. I know where the ASRA checklist is located.					
6. I know the dose of lipid emulsion to administer to a patient experiencing LAST.					
7. I understand some ACLS medications have different doses for LAST.					
8. I know the modified ACLS medication doses for LAST.					

Participant ID ___________________________________
(Mother's Birth Month + Last 2 digits of phone number. "Example 717")

9. I know common ACLS medications to avoid during LAST.					
10. I feel confident in managing a patient experiencing LAST.					
11. I feel confident in managing cardiac arrest during LAST.					
12. I know where the LAST kit is located.					
13. I am familiar with the contents of the LAST kit.					

Local Anesthetic Systemic Toxicity (LAST)

Post-Intervention Evaluation Instrument

Part II.

1. Have you changed your daily practice when participating in local anesthetic administration?

YES/NO? If so, how?

____

____

____

____

2. Do you feel more prepared to manage LAST?

YES/NO? Why or why not?

____

____

____

____

Participant ID ____________________________________
(Mother's Birth Month + Last 2 digits of phone number. "Example 717")

3. Are there currently any barriers at your facility that prevent you from preventing LAST?

YES/NO? Is yes, explain.

____

____

____

____

4. Are there currently any barriers at your facility that prevent you from treating LAST?

YES/NO? If yes, explain.

____

____

____

____

5. Was the educational session and mock scenario about LAST beneficial to your practice?

YES/NO? Why or why not?

____

____

____

____

Participant ID ______________________________

(Mother's Birth Month + Last 2 digits of phone number. "Example 717")

6. Do you feel you have an improved vigilance pertaining to patients who receive/received local anesthetics?

YES/NO? Explain

____

____

____

____

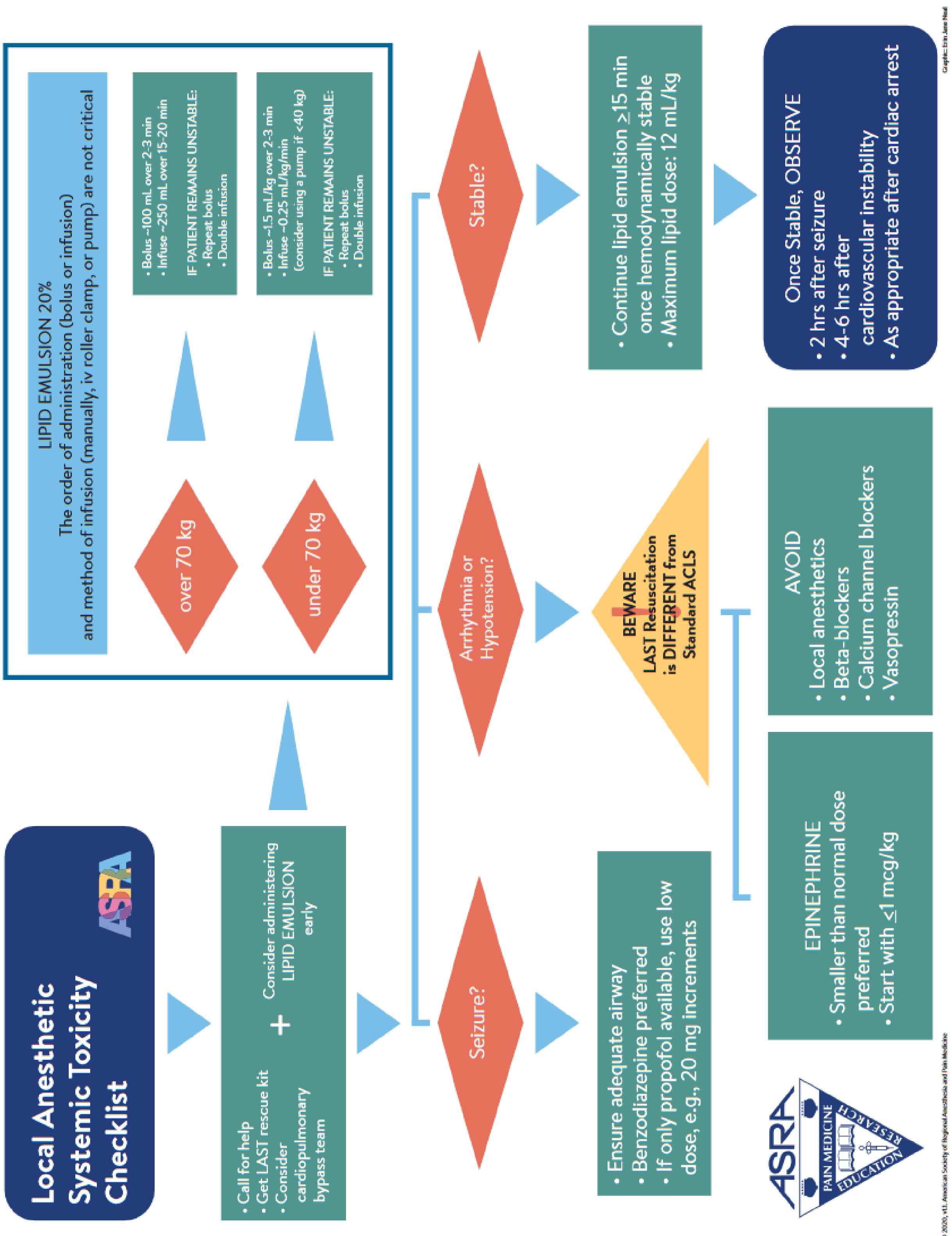
7. Do you think this training exercise should be incorporated in the orientation program at this facility?

____

____

____

Appendix C. Figure 1



Appendix D – PowerPoint Presentation

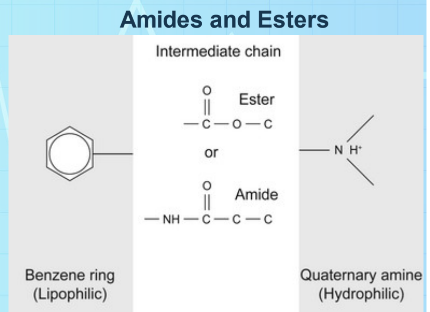
Local Anesthetic Systemic Toxicity (LAST)

Daniel Willingham, SRNA

What are Local Anesthetics?

- Local anesthetics are used to produce analgesia and anesthesia for multiple types of surgical procedures.
- Local anesthetics have a molecular structure that consists of a lipophilic portion and a hydrophilic portion that are separated by a connecting hydrocarbon chain.
- Local anesthetics are broken down into two classes based on their molecular structure.
- Amide versus Ester local anesthetics are determined by the intermediate (hydrocarbon) chain. This differentiation determines where the local anesthetic is metabolized and plays an important role in allergic reactions.
- Esters (procaine, chloroprocaine, tetracaine, benzocaine) are metabolized via hydrolysis by cholinesterase in the plasma
- Amides (lidocaine, prilocaine, mepivacaine, bupivacaine, levobupivacaine, ropivacaine) are metabolized via microsomal enzymes in the liver. Metabolism of amides happens slower than esters making drug accumulation and systemic toxicity more likely.

Amides and Esters



Local Anesthetic Mechanism of Action

- Local anesthetics bind to specific sites in voltage -gated sodium channels, blocking sodium current leading to reduction of neuronal, cardiac, and central nervous system excitability
- Produce conduction blockade (prevention of transmission of nerve impulses) by inhibiting sodium ions from passing through the sodium channels in nerve membranes.
- This slows the rate of depolarization making cells unable to reach threshold potential.
- When threshold potential is not reached, there is no propagation of an action potential.
- Resting transmembrane potential or threshold potential are not altered by local anesthetics.

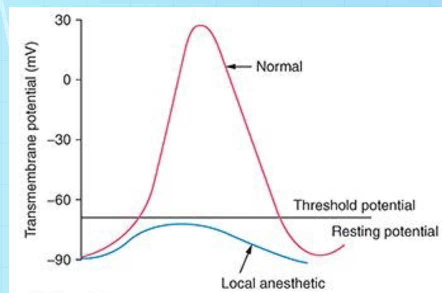
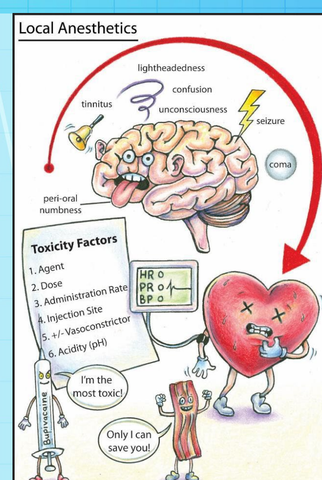


FIGURE 10-4 Local anesthetics slow the rate of depolarization of the nerve action potential such that the threshold potential is not reached. As a result, an action potential cannot be propagated in the presence of local anesthetic and conduction blockade results.

Systemic Toxicity

- LAST is due to an excess plasma concentration of a local anesthetic
- Plasma concentrations are determined by rate of entrance into systemic circulation, redistribution of the local anesthetic, and metabolism.
- The most common mechanism of toxicity is accidental direct intravascular injection during peripheral nerve block or epidural anesthesia
- Factors that influence toxicity include dose administered, vascularity of injection site, presence of epinephrine, and physiochemical properties of the local anesthetic (potency, onset, duration, toxic plasma concentration, pK, protein binding)



Systemic Toxicity

$6? Aç®ÃÑ©

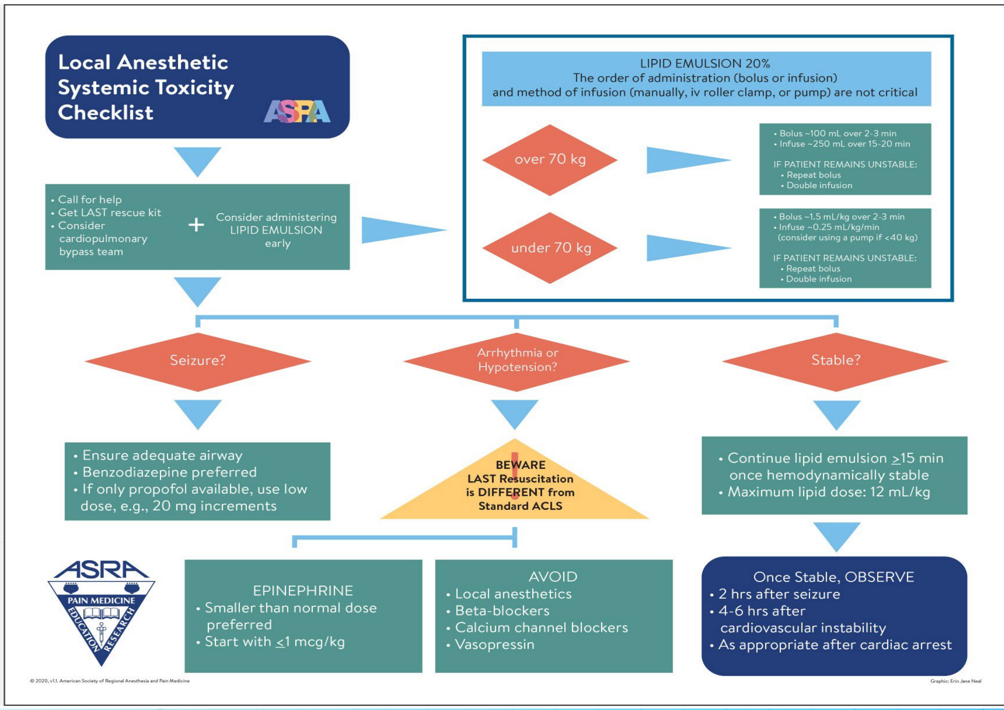
- Minor Signs/Symptoms
  - Tongue and perioral numbness
  - Paresthesias
  - Restlessness, Anxiety
  - Tinnitus, Blurred Vision
  - Muscle fasciculations + tremors
- Major Signs/Symptoms
  - Tonic-clonic seizures
  - Global CNS depression
  - Hypotension
  - Decreased level of consciousness
  - Apnea
- Initial excitatory manifestations reflect depression of inhibitory cortical neurons/inhibition of GABA release

$E? Aç®ÃÑ©

- Early Signs: Hypertension and tachycardia
- Late Signs
  - Peripheral vasodilation + profound hypotension
  - Sinus bradycardia, AV blocks
  - Conduction defects (Prolonged PR, Prolonged QRS)
  - Ventricular dysrhythmias
  - Cardiac arrest

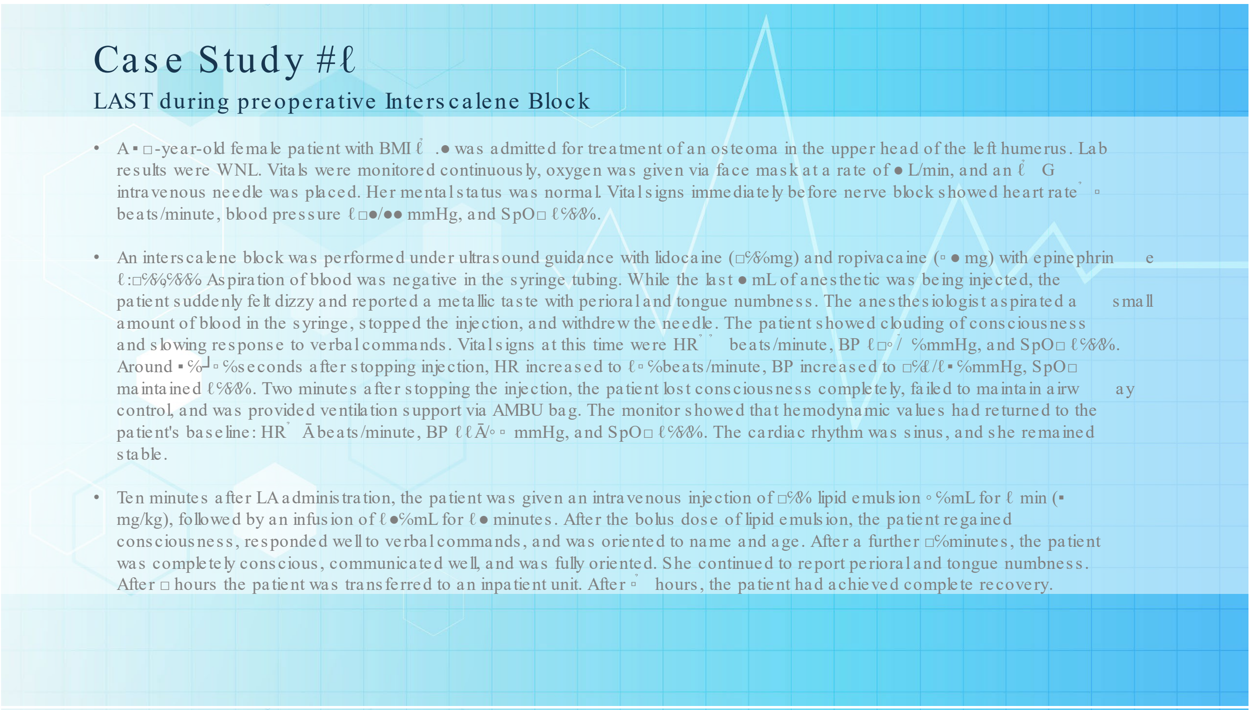
Treatment for LAST

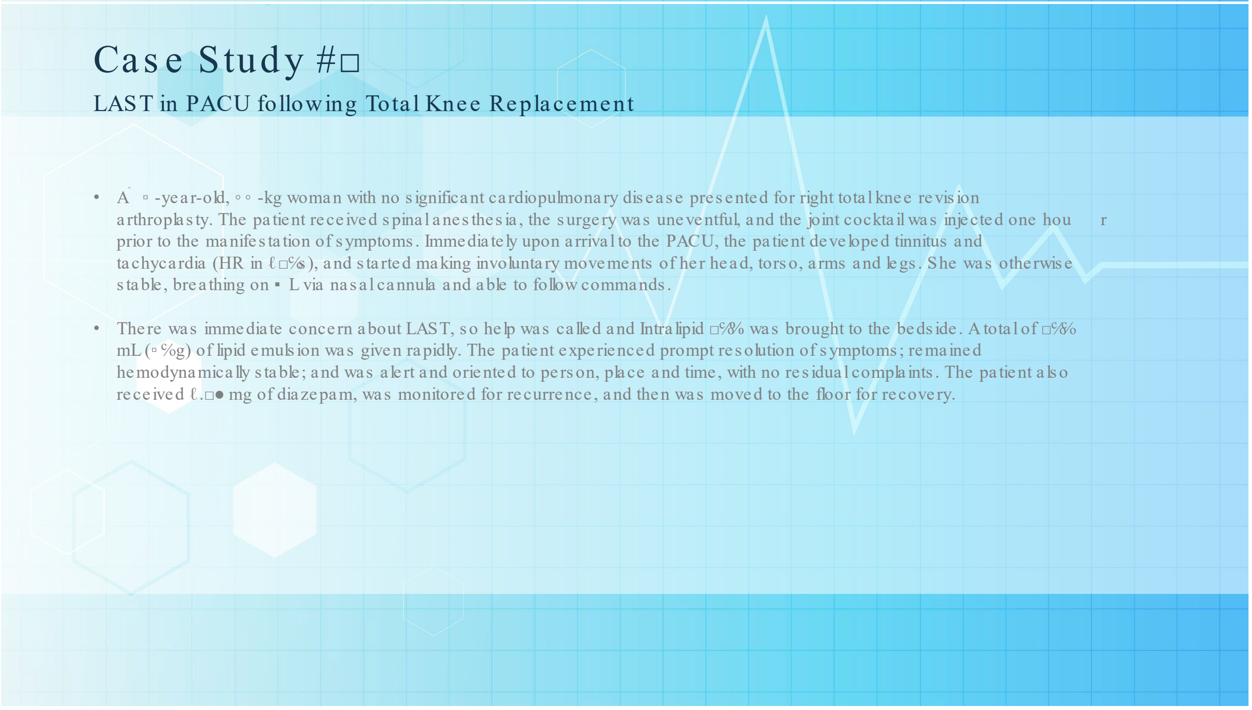
- Call for help!
- Ventilate with 100% oxygen
- Get the LAST rescue cart/kit
- Avoid acidosis, raise the seizure threshold
- Stop seizures: benzodiazepines or propofol (if no hypotension and no benzodiazepines available, give slowly in 20mg increments)
- Administer lipid emulsion
- ACLS – Epinephrine dose during pulselessness?
- Avoid:
  - Calcium channel blockers
  - Beta blockers
  - Vasopressin
- Cardiopulmonary bypass…



Your Role

- Inform the patient to notify you immediately if they have any changes in mentation, taste, or vision
- Inject local anesthetic in ●ml increments, aspirating between each injection
- Monitor the patient for at least ▪%minutes after they receive local anesthetics
- Understand the signs and symptoms associated with toxicity
- Familiarize yourself with treatment protocols
- Know the location of the closest lipid rescue kit and the ASRA checklist for LAST


Case Study #ℓ
LAST during preoperative Interscalene Block
A ▪ □-year-old female patient with BMI ℓ .● was admitted for treatment of an osteoma in the upper head of the left humerus. Lab results were WNL. Vitals were monitored continuously, oxygen was given via face mask at a rate of ● L/min, and an ℓ G intravenous needle was placed. Her mental status was normal. Vital signs immediately before nerve block showed heart rate ▫ beats/minute, blood pressure ℓ□●/●● mmHg, and SpO□ ℓ%%.
An interscalene block was performed under ultrasound guidance with lidocaine (□%mg) and ropivacaine (▫ ● mg) with epinephrine ℓ:□%%%. Aspiration of blood was negative in the syringe tubing. While the last ● mL of anesthetic was being injected, the patient suddenly felt dizzy and reported a metallic taste with perioral and tongue numbness. The anesthesiologist aspirated a small amount of blood in the syringe, stopped the injection, and withdrew the needle. The patient showed clouding of consciousness and slowing response to verbal commands. Vital signs at this time were HR beats/minute, BP ℓ□▫/ %mmHg, and SpO□ ℓ%%. Around ▪%┘▫%seconds after stopping injection, HR increased to ℓ▫%beats/minute, BP increased to □%ℓ/ℓ▪%mmHg, SpO□ maintained ℓ%%. Two minutes after stopping the injection, the patient lost consciousness completely, failed to maintain airway control, and was provided ventilation support via AMBU bag. The monitor showed that hemodynamic values had returned to the patient's baseline: HR Ābeats/minute, BP ℓℓĀ/▫▫ mmHg, and SpO□ ℓ%%. The cardiac rhythm was sinus, and she remained stable.
Ten minutes after LA administration, the patient was given an intravenous injection of □%% lipid emulsion ▫%mL for ℓ min (▪ mg/kg), followed by an infusion of ℓ●%mL for ℓ● minutes. After the bolus dose of lipid emulsion, the patient regained consciousness, responded well to verbal commands, and was oriented to name and age. After a further □%minutes, the patient was completely conscious, communicated well, and was fully oriented. She continued to report perioral and tongue numbness. After □ hours the patient was transferred to an inpatient unit. After ▫ hours, the patient had achieved complete recovery.


Case Study #□
LAST in PACU following Total Knee Replacement
A ▫-year-old, ▫▫ -kg woman with no significant cardiopulmonary disease presented for right total knee revision arthroplasty. The patient received spinal anesthesia, the surgery was uneventful, and the joint cocktail was injected one hour prior to the manifestation of symptoms. Immediately upon arrival to the PACU, the patient developed tinnitus and tachycardia (HR in ℓ□%s), and started making involuntary movements of her head, torso, arms and legs. She was otherwise stable, breathing on ▪ L via nasal cannula and able to follow commands.
There was immediate concern about LAST, so help was called and Intralipid □%% was brought to the bedside. A total of □%% mL (▫%g) of lipid emulsion was given rapidly. The patient experienced prompt resolution of symptoms; remained hemodynamically stable; and was alert and oriented to person, place and time, with no residual complaints. The patient also received ℓ.□● mg of diazepam, was monitored for recurrence, and then was moved to the floor for recovery.

Mock Drill

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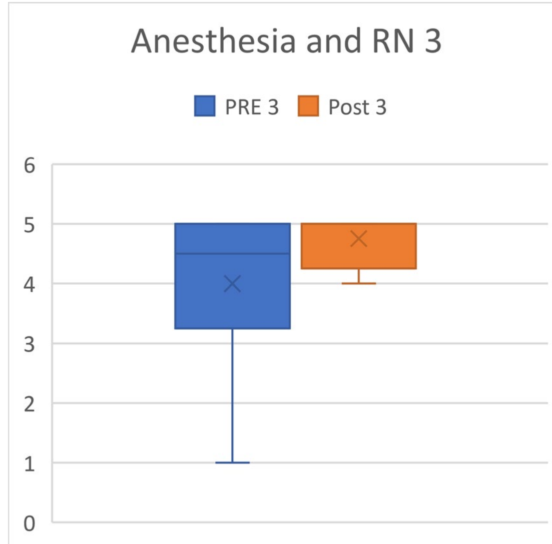
THANK YOU↓

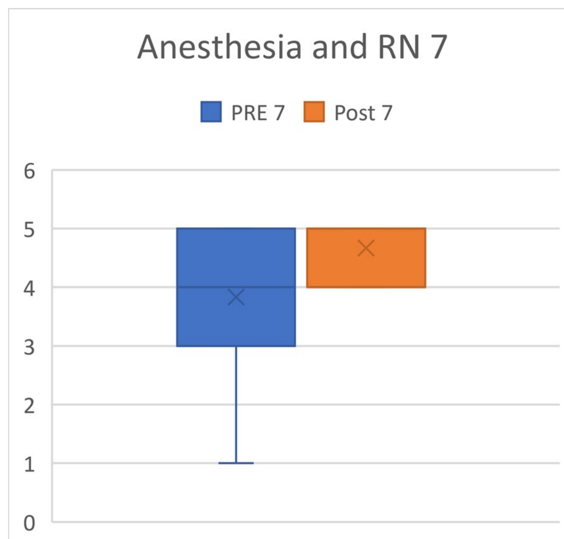
Appendix E - Tables/Charts

Paired t-tests

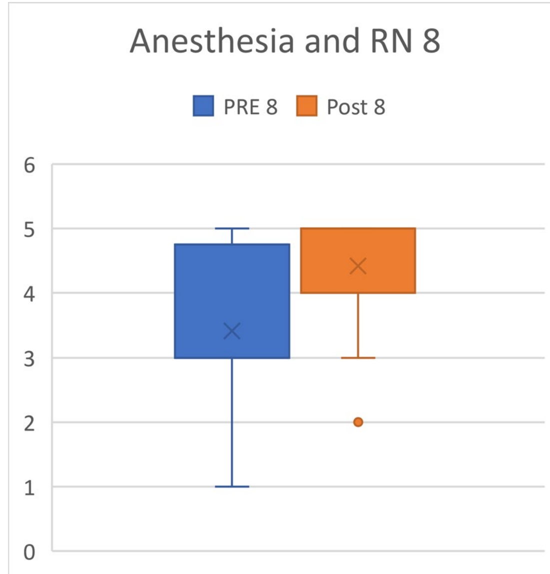
	PRE 3	*Post 3*
Mean	4	4.75
Variance	1.818182	0.204545
Observations	12	12
Pearson Correlation	0.298142	
Hypothesized Mean Difference	0	
df	11	
t Stat	-2.01705	
P(T<=t) one-tail	0.034382	
t Critical one-tail	1.795885	
P(T<=t) two-tail	0.068764	
t Critical two-tail	2.200985	



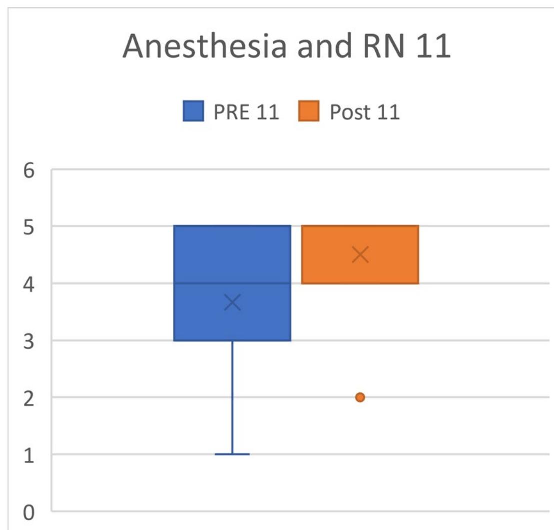
	PRE 7	*Post 7*
Mean	3.833333	4.666667
Variance	1.787879	0.242424
Observations	12	12
Pearson Correlation	0.184115	
Hypothesized Mean Difference	0	
df	11	
t Stat	-2.15894	
P(T<=t) one-tail	0.026902	
t Critical one-tail	1.795885	
P(T<=t) two-tail	0.053804	
t Critical two-tail	2.200985	



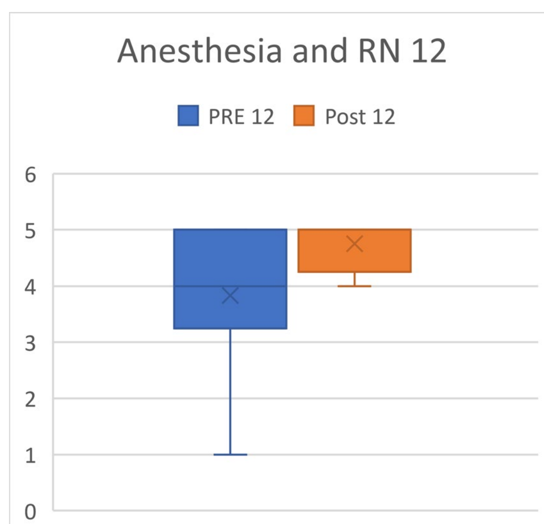
	PRE 8	*Post 8*
Mean	3.416667	4.416667
Variance	1.537879	0.992424
Observations	12	12
Pearson Correlation	0.288213	
Hypothesized Mean Difference	0	
df	11	
t Stat	-2.56905	
P(T<=t) one-tail	0.013047	
t Critical one-tail	1.795885	
P(T<=t) two-tail	0.026095	
t Critical two-tail	2.200985	



	PRE 11	*Post 11*
Mean	3.666667	4.5
Variance	1.69697	0.818182
Observations	12	12
Pearson Correlation	0.308607	
Hypothesized Mean Difference	0	
df	11	
t Stat	-2.15894	
P(T<=t) one-tail	0.026902	
t Critical one-tail	1.795885	
P(T<=t) two-tail	0.053804	
t Critical two-tail	2.200985	



	PRE 12	*Post 12*
Mean	3.833333	4.75
Variance	1.606061	0.204545
Observations	12	12
Pearson Correlation	0.237915	
Hypothesized Mean Difference	0	
df	11	
t Stat	-2.5606	
P(T<=t) one-tail	0.013245	
t Critical one-tail	1.795885	
P(T<=t) two-tail	0.02649	
t Critical two-tail	2.200985	



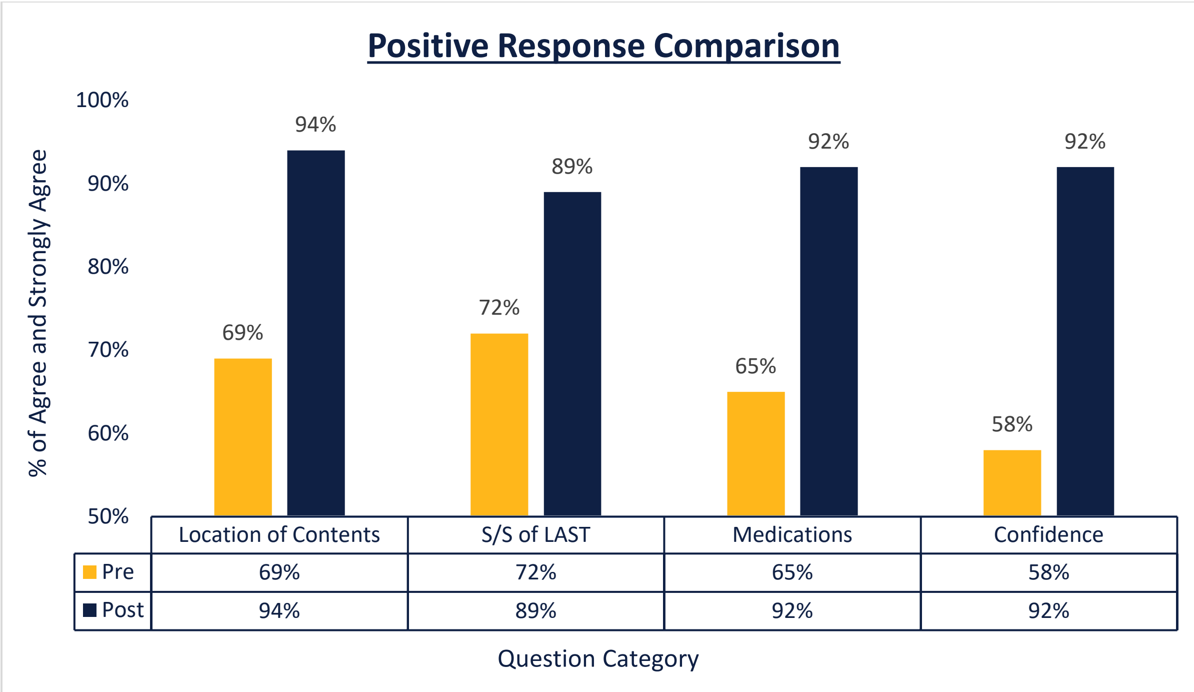
Descriptive Data

		Symptoms and Treatment of LAST				
PRE 1	PRE 2	PRE 4		Post 1	Post 2	Post 4
3	3	3		5	4	4
4	2	2		4	4	4
1	1	1		5	5	5
4	4	4		3	3	2
4	4	2		4	4	4
4	4	4		5	5	5
4	4	4		4	4	4
5	5	5		5	5	5
5	5	5		5	5	5
5	5	5		5	5	5
4	4	4		4	4	3
5	5	3		5	5	5
Positive Response = 23/36				32/36		↑ 17%
		72%		89%		

			Locationand Content Questions					
PRE 3	PRE 5	PRE 12	PRE 13		Post 3	Post 5	Post 12	Post 13
3	3	3	3		5	5	5	5
2	2	2	2		4	4	4	4
1	1	1	1		5	5	5	5
4	4	4	4		4	2	4	2
5	2	5	4		5	4	5	5
4	1	4	4		5	5	5	5
4	4	4	4		4	4	4	4
5	5	4	5		5	5	5	5
5	5	5	5		5	5	5	5
5	5	5	5		5	5	5	5
5	4	4	4		5	2	5	5
5	3	5	5		5	5	5	5
Poisitve response = 33/48					45/48			↑ 25%
		69%			94%			

			Medications for LAST					
PRE 6	PRE 7	PRE 8	PRE 9		Post 6	Post 7	Post 8	Post 9
3	3	3	3		4	5	5	4
4	2	2	4		4	4	3	4
1	1	1	1		5	5	5	5
4	4	3	3		2	4	2	2
4	4	3	4		4	5	5	5
4	4	4	4		5	5	5	5
4	3	3	3		4	4	4	4
5	5	5	5		5	5	5	5
5	5	5	5		5	5	5	5
5	5	5	5		5	5	5	5
4	5	4	4		4	4	4	4
5	5	3	5		5	5	5	5
Positive Response = 31/48					44/48			↑ 27%
		65%			92%			

	Confidence Questions			
PRE 10	PRE 11		Post 10	Post 11
3	3		4	5
2	2		4	4
1	1		5	5
3	3		1	2
4	4		4	5
4	4		5	5
3	3		4	4
4	5		5	5
5	5		5	5
5	5		5	5
4	4		4	4
5	5		5	5
Positive response = 14/24			22/24	↑ 34%
	58%		92%	


Positive Response Comparison
100%
90%
80%
70%
60%
50%
% of Agree and Strongly Agree
69%
94%
72%
89%
65%
92%
58%
92%
Location of Contents
S/S of LAST
Medications
Confidence
Pre 69% 72% 65% 58%
Post 94% 89% 92% 92%
Question Category