Spring 5-6-2022

Computer-Based Learning Module: Local Anesthetic Systemic Toxicity

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Executive Summary

Introduction of the Problem

Local anesthetics (LAs) have become one of the most commonly used medications due to an impressive history of efficacy and safety in medical and dental practices (Guler et al., 2020; İlhan & Demir, 2020; Raman et al., 2019; Sagir & Goyal, 2015). LAs provide a myriad of benefits including enhanced postoperative recovery, improved patient satisfaction, reduced opioid utilization, decreased incidence of postoperative nausea and vomiting, decreased hospital length of stay, and reduced risk of chronic postoperative pain (Dickerson & Apfelbaum, 2014). Despite the benefits listed above, any uses of LAs carry a risk of local anesthetic systemic toxicity (LAST). Even though LAST events are rare, optimal management requires the collaboration of an interdisciplinary team. All healthcare members involved in the care of patients receiving LAs should be properly informed of the benefits, risks, and any potential complications to improve patient outcomes should LAST occur.

Literature Review

Regional and neuraxial anesthesia utilizing LAs are used in a variety of settings including obstetrics, orthopedic procedures, such as joint replacements and arthroscopic procedures, and pain management. These techniques are employed throughout the perioperative period as well as in the outpatient setting (Raman et al., 2019). LAs have been shown to improve patient satisfaction; enhance postoperative recovery; reduce opioid utilization; and decrease the incidence of postoperative nausea and vomiting, hospital length of stay, and risk of chronic postoperative pain (Boretsky, 2019; Dickerson & Apfelbaum, 2014). Despite the widespread use of LAs, awareness of LAST and its treatment are limited among healthcare providers (Álvarez et

al., 2009; Guler et al., 2020; İlhan & Demir, 2020; Oksuz et al., 2018; Pinheiro et al., 2015; Sagir & Goyal, 2015).

Definition and Incidence

LAST is the result of rapid absorption of LAs into the systemic circulation resulting in toxic plasma levels of the drugs (Nagelhout, 2018). Several factors including injection site, dose, drug properties, test dose, patient comorbidities, and the use of adjuvants determine the rate and the extent of systemic absorption of LAs (Lin & Liu, 2017; Neal et al., 2018; Suzuki et al., 2018). Data regarding the incidence of LAST shows considerable variation due to the lack of a standard definition for LAST, with incidence ranging from 0.4 to 20 in every 10,000 cases (Dickerson & Apfelbaum, 2014; Liu et al., 2016; Safety Committee of Japanese Society of Anesthesiologists [SCJSA], 2019). More recently, the number of incidences and severities of LAST is on the decline due to the implementation of ultrasound-guided regional anesthesia (UGRA), which helps reduce the incidence of vascular injury, nerve injury, pneumothorax, phrenic nerve block, inadvertent vascular puncture, and LA dosages required (Barrington & Kluger, 2013; Barrington & Uda, 2018; Xu et al., 2016).

Prevention

Prevention of LASTs remains the most effective treatment, and safe administration of LAs plays a crucial role in reducing the incidence of LAST. Some strategies employed to minimize the risk of and to prevent LAST include using the smallest dose of LA necessary, being cognizant of maximum dosage, and utilizing UGRA (ASRA, 2018; SCJSA, 2019; Waldinger et al., 2020). Additional strategies include using LAs with low toxicity with markers such as epinephrine and administering small divided doses of LA with frequent aspiration tests

(ASRA, 2018; El-Boghdadly & Chin, 2016; Liu et al., 2016; Neal et al., 2018; SCJSA, 2019; Waldinger et al., 2020). Even though LAST events are rare, providers should maintain a high index of suspicion; early recognition and treatment implementation are the keys to improving patient outcomes and preventing this devastating event from occurring (Nedialkov et al., 2018; Raman et al., 2019).

Treatment

Successful treatment and management of LAST primarily depend on airway management to avoid hypoxia, hypercapnia, and acidosis (Neal et al., 2018). Failure to effectively manage LAST events can lead to worsening cardiac function, potentiating LAST's adverse effects, and crippling the resuscitative effort (Neal et al., 2018). Effective cardiopulmonary resuscitation and Advanced Cardiac Life Support efforts help support a patient's hemodynamic status and ensure sufficient blood flow to reduce LAs at the tissue levels (Neal et al., 2018).

The discovery of lipid emulsion therapy, called Intralipid 20%, has revolutionized LAST treatment, which was historically supportive (Baxter Healthcare Corporation, 2019; Karcioglu, 2017; Nie et al., 2020; Ok et al., 2018; Tampakis et al., 2020). Early administration of intralipid 20% is instrumental in managing and treating LAST events (Neal et al., 2018). Small doses of epinephrine, 1mcg/kg, should be administered initially to prevent increased afterload and impaired gas exchange (Neal et al., 2018).

Project Methods

The goal of this doctoral practice project was to disseminate the most recent evidence-based practice to providers and staff members by creating a computer-based learning (CBL) module on LAST. The module was designed for all hospital staff caring for patients receiving

LAs. The project was based on a non-experimental pretest-posttest single group design consisting of a convenience sample of certified registered nurse anesthetists (CRNAs), physician anesthesiologists (MDAs), and registered nurses (RNs) who take care of the aforementioned patient population at a large tertiary care facility in central Illinois. The project assessed participants' knowledge before and after implementation of the CBL module by utilizing the same questions on the pretest and posttest to precisely evaluate the module's effectiveness. This project fell within the quality improvement guidelines and, therefore, was exempt from IRB from both Southern Illinois University Edwardsville and St. John's Hospital Review Committee.

Evaluation

Tools and Measures

A CBL module for LAST was developed in the form of a PowerPoint and distributed to RNs, CRNAs, and MDAs at HSHS St. John's Hospital – Springfield at the beginning of November 2021. The module was disseminated via HealthStream, a web-based learning management system designed to help healthcare organizations to create, manage, and conduct regulatory compliance training for staff members. The module was published as a part of the staff's mandatory annual training. Data collection was performed until the second week of December 2021. The CBL consisted of a five-question pretest, one of which is a clinical scenario question, the learning module itself, and an identical five-question posttest to assess the effectiveness of the CBL. A minimum of 80% was required to pass the posttest, which could be attempted multiple times to achieve the passing grade. The questions were presented in a multiple-choice format and addressed the benefits of LAs and LAST treatment. A total of 120 participants started the CBL, and four of the participants did not complete the posttest. Hence, one hundred and sixteen participants' pre- and posttest results were analyzed to determine the

impact of the education material on the participants. No demographic information was collected, and no data for individual questions was made available to the investigator.

Results

The effectiveness of the CBL was measured by comparing the pretest and posttest scores after implementation of the CBL to determine if there was an increase in knowledge regarding LAST. The average pretest score was 55%; the average of the posttest was 87% with an average of 1.3 attempts, which was 32% higher compared to the pretest. The fact that 39% of the participants scored 40% or below on the pretest and that the average pretest score was 55% identified LAST knowledge deficit and emphasized the necessity for further education on LAST.

Limitations

The most significant limitation of this project was the lack of demographic information and specific data for the individual questions of the CBL module; only the overall pretest and posttest scores were provided to the investigator. Therefore, it is difficult to determine which aspects or specific questions of the CBL can be improved for future projects. In addition, the lack of demographic data made it impossible to compare staff scores from different experience levels or in different roles.

Another limitation of the project was the use of a convenience sample. The CBL module was available to participants for five weeks and was to be completed at the participants' convenience. The long period of availability may have allowed time for participants to discuss the CBL module and its questions before completing it, leading to an improvement in participants' scores. The CBL was made available starting in November to the beginning of December 2021 during the holiday season. Ninety-seven percent of the participants completed

the module during the first week of December. Additionally, increased hospital admissions related to COVID-19 could have potentially influenced the number of participants in this CBL during the data collection period as evidenced by the lowered number of participants when compared to previous implementations of CBLs at this facility.

Lastly, the CBL method enabled the primary investigator to conveniently disseminate information. However, this method failed to take the participants' different knowledge and feedback into consideration. It is difficult to urge participants to build upon their existing experience and knowledge, make the lesson meaningful, and allow them to assume a more active role in their learning experience given the online, independent-learning format. Without engagement, the CBL may risk learners' thinking processes.

Impact on Practice

The result of this project demonstrated an improvement in the knowledge deficit of LAST and its treatment. The project emphasized the importance of continuing education in utilizing the most recent evidence-based practice and in ensuring that recognition and treatment can be implemented as swiftly as possible. Because no individual data for each question was made available to the investigator, it was difficult to determine if specific knowledge was enhanced after CBL completion. However, as mentioned above, the improvement in the posttest scores implied that there were some benefits from participating in the CBL module, which could potentially lead to improved patient outcomes should the LAST event occur. The long-term impact of this project is that the CBL will be utilized as an annual mandatory training as well as training for new employees. The project has the potential to be disseminated to other facilities in the health system that require updated education on LAST. An increase in sample size and more data points would support the validity and rigor of the project.

Conclusions

Local anesthetics have become the cornerstone of multimodal as well as opioid-free anesthesia. Increased LA utilization can have a positive impact on patients' outcomes and satisfaction. With the advent of UGRA and improvements in injection techniques, the incidence of LAST has decreased significantly over the years. However, any use of LAs is associated with risk for potential complications such as LAST. Providers and staff members taking care of patients receiving LAs should be astutely aware of potential complications so that LAST signs and symptoms can be recognized, and treatments can be implemented as swiftly as possible. The use of lipid emulsion therapy has also revolutionized the LAST resuscitative efforts, resulting in an improvement in patient outcomes. Providers should also consider individual patients' comorbidities so that LA dosages and techniques can be adjusted accordingly. The importance of continuing education regarding LAs and LAST cannot be overstated, as demonstrated by the test score improvements noted in this project. Mandatory annual training will greatly help educate healthcare providers about LAST recognition, prevention, and management to improve patient outcomes. In summary, this learning module will help promote awareness, vigilance, and readiness among healthcare providers and has the potential to keep the patient safe should this life-threatening complication occur.

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