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Andrew Miller
Southern Illinois University Edwardsville

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Development and Evaluation of a Malignant Hyperthermia

Computer-Based Learning Project

Andrew Miller

Introduction of Problem

Malignant hyperthermia (MH) is a rare, potentially lethal skeletal muscle syndrome that occurs after genetically susceptible individuals are exposed to volatile anesthetics or succinylcholine (Diu & Mancuso, 2012). The volatile anesthetics sevoflurane, desflurane, and isoflurane are the most commonly used agents for the maintenance of anesthesia in the operating room (Ebert & Lindenbaum, 2013). Succinylcholine, one of the most popular neuromuscular blocking agents, is the only ultra-rapid onset duration relaxant currently available (Donati, 2013). A response plan, staff preparation and education, and prompt recognition of the signs of MH are essential to prevent death and severe complications related to MH (MHAUS, 2017c). The purpose of this project was to develop a comprehensive computer-based learning (CBL) module about MH for a tertiary care center in central IL and evaluate the effectiveness of the CBL by assessing perioperative staff knowledge.

Literature Review

The symptoms of MH have been reported since the 1900’s and the incidence rose with increasing frequency until the late 1960’s (Britt, 1987). Malignant hyperthermia was named by Dr. Gordon, a professor of anesthesia at the University of Toronto, in 1966 (Britt, 1987). After the mid 1960s, the death rate from MH slowly declined due to increased awareness, increased research, and advances in patient monitoring. In 1975 dantrolene was successfully used to treat MH in Landrace pigs (Britt, 1987).

RYR1 and CACNA1S are the two main gene mutations associated with this inherited disorder. RYR1, the most important gene, is an ion channel in the sarcoplasmic reticulum of skeletal muscle that releases calcium for muscle contraction to occur (Rosenberg et al., 2015). In MH, after exposure to triggering agents, the RYR1 ion channel remains open causing an uninhibited release of calcium and persistent muscle contraction (Schneiderbanger et al., 2014). The results are increased temperature, increased CO2 production, increased oxygen consumption, and the release of potassium and creatinine kinase as the membrane integrity of the cells fails (Hopkins, 2007).

The first step to prepare for MH starts with developing a response plan that includes education and training (Dirksen, Van Wicklin, Mashman, Niederer, & Merritt, 2013). Providing annual MH education with mock drills and completing a comprehensive preoperative assessment on every patient is necessary in order to prevent an MH reaction (Rosenberg, Pollock, Schiemann, Bulger, & Stowell, 2015). Then the operating room (OR) must be prepared, and an anesthesia plan developed which is free of MH triggering agents once a patient is identified as MH susceptible. Preparing the OR entails preparing the anesthesia machine per manufacturer's instructions, removing all volatile anesthetics from machine, and considering the use of activated charcoal filters (MHAUS, 2017f).

The clinical signs of MH crisis include an increase in heart rate, body metabolism, CO_2 production, muscle rigidity, and fever (MHAUS, 2017c). Treatment is often delayed because these symptoms are nonspecific and can be seen in a wide variety of conditions like sepsis, malignant neuroleptic syndrome, serotonergic syndrome, thyroid storm, hyperthyroidism, and pheochromocytoma (Diu & Mancuso, 2012). Once MH is recognized all triggering agents should be stopped, and the MH rapid response plan should be initiated (MHAUS, 2017a). Dantrolene is the only antidote and should be given as soon as possible to reverse the effects of MH (Diu &

Mancuso, 2012). Dantrium/Revonto and Ryanodex are the two forms of dantrolene sodium available to treat MH (MHAUS, 2017a). After administration of dantrolene, symptomatic treatment for the hyperthermia, acidosis, rhabdomyolysis, myoglobinemia, and hyperkalemia may be necessary.

Most of the time the diagnosis of MH is made by the clinical signs and symptoms that present after receiving triggering agents, like succinylcholine and volatile inhalational anesthetics (Dui & Mancuso, 2012). The caffeine halothane contracture test (CHCT), developed in 1970, is the gold standard for diagnosing MH and to determine a person's susceptibility to the disease (Larach, Brandom, Allen, Gronert, & Lehman, 2015). Another way to screen for MH is a blood test that looks for one of the 31 variants of RYR1 mutations (Schneiderbanger et al., 2014). Although this test can be nonspecific, it is an important tool, especially with patients that have a family history of malignant hyperthermia (Schneiderbanger et al., 2014).

Project Methods

The goals for this project were to develop a comprehensive computer-based learning module about MH for a tertiary care center in central Illinois and evaluate the effectiveness of the CBL on perioperative staff knowledge. This CBL module provided continuing education to staff on the triggering agents, signs and symptoms, and treatment for MH. The CBL module also allowed the tertiary care center to be in accordance with CMS guideline 482.25(b)(8)**.** The long-term goal is that this CBL module will be able to provide annual continuing education.

The CBL was assigned to perioperative staff members as a self-study educational program and was available for one month. All nurses who care for patients in the operating room or in a recovery area, such as ICU and OB, were included in the project. The project's sample included 124 nurses and anesthesia providers from the host facility that took the CBL in the allotted one-month time frame.

Southern Illinois University Edwardsville's Institutional Review Board (IRB) evaluated this project and considered it IRB exempt. After approval from IRB, the project was then evaluated and approved by St. John's Hospital Research Review Committee. The two human subject's risks are loss of confidentiality and time inconvenience.

Evaluation

This project was a nonexperimental and included a pretest and posttest to assess the effectiveness of the CBL at increasing perioperative staff knowledge on MH. The outcomes were measured via the pretest and posttest questionnaire consisting of 10 questions. The results were analyzed by the project owner in order to maintain anonymity of participants. The CBL was made available to anesthesia providers and perioperative registered nurses through the hospitals online education program called HealthStream.

The pretest and post-test score data was not matched; therefore, the author was unable to analyze knowledge gained per individual or per question. So, it is unknown if specific knowledge was obtained after participants completed the CBL. However, the average post-test score was 93% compared to the average pretest score of 70%. These results suggest this project was effective in increasing perioperative staff knowledge on MH.

The CBL power point took multiple months, a lot longer than anticipated, to complete. The power point was edited and reviewed multiple times by various people to ensure appropriateness for the specific audience. Revisions were completed by email and by coordinating meetings with the author, team leader, and external stakeholder. The author found it difficult at times to coordinate everyone involved to meet in person to review the project. Once the power point was complete, the CBL was submitted to the education coordinator at the host facility for implementation. One unforeseen circumstance was that the coordinator decided to leave the CBL open for three months instead of the one month that was originally discussed. In hindsight, the author was unrealistic in thinking that all staff would be able to take the CBL in the original allotted time frame of one month.

Impact on Practice

The increased knowledge from the CBL will help decrease morbidity and mortality should a MH reaction occur. The long-term impact is that this CBL module will be able to provide annual continuing education to all healthcare professionals in departments that use and recover patients exposed to MH triggering agents. The long-term goal is to make mortality from a MH reaction a “never event.” This project could easily be replicated at any facility that needs continuing education on MH. In the future, the CBL module should be a mandatory educational module that has to be completed by a predetermined deadline. Having the module open for three to six months would provide adequate time for all staff to complete.

Conclusion

Succinylcholine and volatile inhalational anesthetics continue to play a large role in anesthesia care. Although these medications have great benefits, they have very detrimental side effects in MH susceptible patients. Continuing education of perioperative staff is an integral part of emergency preparedness. This project evaluated the benefits of using a CBL module to meet the educational needs of perioperative staff. The results of this project suggested the CBL was effective in increasing perioperative staff knowledge on MH. Future efforts should focus on improving mock drills related to preparing the OR room for a MH patient and responding to a MH reaction.

Andrew Miller, NA-DNP student
andmill@siue.edu
ammiller44@yahoo.com