Summer 2017

Malignant Hyperthermia

David Kanotz
david.kanotz@otterbein.edu

Malignant Hyperthermia

David J. Kanotz, BSN, CCRN
Otterbein University, Westerville, Ohio

Introduction

Each year, thousands of inpatient and outpatient surgeries are performed daily in the United States. During surgery, advanced practice nurses and physicians must attentively monitor their patients for possible unforeseen complications that can arise intra or post operatively such as malignant hyperthermia (MH). Malignant hyperthermia is a life-threatening skeletal muscle disorder that presents as a hypermetabolic response to several inhaled anesthetics and to the depolarizing muscle relaxant succinylcholine. It is extremely important for certified registered nurse anesthetists (CRNA) to understanding the pathophysiology, clinical symptoms, and treatment plan of MH due to their vital role in managing these patients in the operating room.

Signs and Symptoms

Having knowledge of the signs and symptoms that occur early and manifest late during an episode of malignant hyperthermia can have a profound effect on the outcome of patients. Rosenberg, Pollock, Schiemann, Bulger, & Stowell (2015) explain that, "... early recognition of the signs of MH and routine use of core temperature monitoring are essential in minimizing morbidity and mortality from MH" (p.3). Like any other medical condition, clinical symptoms can differ patient to patient. Malignant hyperthermia can develop as a gradual onset of clinical symptoms, to an abrupt, life threatening situation. Some of these clinical features include, but are not limited to: rising patient temperature, tachycardia, muscle rigidity, decreased Sao2, cola-colored urine, and a rise in end-tidal CO2 >55 mmHg. "A rise in the patient's end-tidal carbon dioxide (Etco2) concentration is often the earliest indication of malignant hyperthermia" (Carpenter, LaRiccia, & Papadakos, 2015, p. 45). By monitoring end-tidal carbon dioxide during surgery, Certified Registered Nurse Anesthetist (CRNA) and anesthesiologist are able to detect early increases in exhaled carbon dioxide, therefore prompting them to start assessing the underlying causes. Although MH is notable for high body temperatures, this sign may often come later than some of the other symptoms. "Hyperthermia, which may climb at a rate of 1° to 2 °C every 5 minutes and exceed 43.3 ° C (110 ° F), is often a late but confirming sign of MH" (Nagelhaus & Plaus, 2013, p. 792). The combination of symptoms including acidosis, hyperkalemia, and hyperthermia can potentially lead to cardiac irritability and arrhythmias. Therefore, cardiac monitoring is essential for patients undergoing surgery and receiving inhaled anesthetics. Knowing the signs and symptoms of MH and identifying them early can have drastic effects on the mortality of patients.

Pathophysiology

Understanding the pathophysiological effects of MH are important in understanding the clinical symptoms and treatment plan. Malignant Hyperthermia is a rare, autosomal-dominant disorder in which mutations of the ryanodine receptor type 1, located in the sarcoplasmic reticulum, cause uncontrolled release of calcium leading to prolonged muscle fiber contraction (Carpenter, LaRiccia, & Papadakos, 2015, p. 46). This occurs when patients who have this particular mutation receive inhaled anesthetics, or the depolarizing muscle relaxant succinylcholine. Due to the large amount of calcium released from the sarcoplasmic reticulum, skeletal muscle throughout the body contracts and causes a massive increase in muscle metabolism. According to Nagelhout & Plaus (2014), "skeletal muscle constitutes 40% to 50% of our body mass, so relatively small changes in muscle metabolism may produce the dramatic systemic biochemical changes observed with MH" (p. 792). As the MH develops, the sarcoplasmic reticulum becomes damaged, therefore releasing potassium, creatine kinase, and myoglobin to the extracellular fluid. Which is why symptoms of MH include: elevated potassium and creatine kinase levels, as well as dark cola-colored urine (myoglobin).

Significance of Pathophysiology

As stated earlier, it is important for healthcare providers to know and understand the pathophysiology of MH. By doing so, diagnoses and treatment can be implemented early, hopefully decreasing the chance of significant damage to the patient. One of the most important treatments to initiate early is to remove the triggering anesthetic as soon as possible. Seifert, Wahr, Pace, Cochrane, & Bagnola (2014) explain that, "untreated MH can produce cardiac arrest, kidney and liver failure, abnormal blood coagulation, internal hemorrhage, neurological injury, cardiovascular collapse, and death" (p. 189). In any medical condition, knowledge of the underlying cause can help healthcare providers interpret signs and symptoms, and distinguish different diagnoses.

Implications for Nursing Care

Nurse Anesthetists and Anesthesiologists are at the forefront of patient care in the operating room, therefore it is extremely important for them to implement care as soon as possible when someone is suspected of developing MH. One of the first steps in preventing issues is interviewing patients before surgery and retrieving a medical and family history. This is especially important since MH is an autosomal-dominant disorder. "Family members (ie, children, siblings) of a patient with MH susceptibility have a 50% chance of inheriting a gene defect for MH and becoming MH susceptible" (Seifert, Wahr, Pace, Cochrane, & Bagnola, 2014, p. 190). When MH is suspected, it is vital that the operating room staff works cohesively to collect materials and medications to treat the patient. Emergency interventions that are required include obtaining a cooling blanket and ice to treat hyperthermia, correcting acidosis, increasing the patients fraction of inspired oxygen to 100% and ventilation, discontinuing anesthetics if possible, grabbing the MH cart, and giving Dantrolene. Dantrolene must be given as soon as possible to prevent serious damage to the patient. "Dantolene ...is a skeletal muscle relaxant that inhibits the excitation-contraction in skeletal muscle without affecting muscle electrical properties" (Carpenter, LaRiccia, and Papadakos, 2015, p. 47). Quick and immediate action by the operating room staff, CRNA, and anesthesiologist can have profound effects on the outcome of patients with MH.

Conclusion

Malignant Hyperthermia is a serious, life-threatening disorder that develops when people receive inhaled anesthetics and or succinylcholine. By having basic knowledge of the signs, symptoms, and pathophysiology, medical teams are able to diagnose the disorder quickly in the operating room, and activate the protocol in treating MH. It is the responsibility for all members of the healthcare team, but especially the CRNA or anesthesiologist, to recognize the early signs of MH, and respond appropriately.

References

Brandom, B., & Callahan, P.(2015). Malignant hyperthermia. Advances in Anesthesia, 33(1), 113-128. http://dx.doi.org/10.1016/j.aan.2015.07.007

Cannon, S.(2017). Mind the magnesium, in dantrolene suppression of malignant hyperthermia. *Proceedings of the National Academy of Sciences, 114(18)*, 4576-4578. www.pnas.org/cgi/doi/10.1073/pnas.1704103114

Carpenter, V., LaRiccia, B., & Papadakos, P.(2015). Malignant hyperthermia in a trauma patient. *Journal of the American Academy of Physician Assistants, 28*(1), 45-47. doi: 10.1097/01.jaa.0000453862.54702.78

Chapman, M. (2015). *Anesthesia 101: What You Need to Know Before Your Next Cosmetic Procedure* [Online image]. Retrieved July 6, 2017 from http://www.smartbeautyguide.com/news/safety/anesthesia-101-cosmetic-procedure/#.WW_O9dPyvhM

Hopkins, P.(2017). Malignant hyperthermia. Anaesthesia & Intensive Care Medicine. 18(6), 321-323. https://doi-org.proxy.lib.ohio-state.edu/10.1016/j.mpaic.2017.03.006

Musselman, M., & Saely, S.(2012). Diagnosis and treatment of drug-induced hyperthermia. *American Journal of Health System Pharmacy, 70*(1), 34-42. doi: 10.2146/ajhp110543

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

Rathmell, J. (2014). *Malignant Hyperthermia in the Ambulatory Surgery Center: How Should We Prepare?* [Online Image] Retrieved July 7,2017 from http://anesthesiology.pubs.asahq.org/article.aspx?articleid=1917705

Rosenberg, H., Pollock, N., Schiemann, A., Bulger, T., & Stowell, K. (2015). Malignant hyperthermia: a review. *Orphanet Journal of Rare Diseases.* doi: 10.1186/s13023-015-0310-1

Seifert, P., Wahr, J., Pace, M., Cochrane, A., & Bagnola, A.(2014). *Association of perioperative Registered Nurses, 100*(2), 189-202. http://dx.doi.org/10.1016/j.aorn.2014.06.014

OTTERBEIN UNIVERSITY