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Katie Carroll
Otterbein University, katie.carroll@otterbein.edu

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Turning Up the Heat on Malignant Hyperthermia
Katie Carroll, RN, BSN, CCRN
Otterbein University, Westerville, Ohio

Introduction
Surgeries are common, everyday procedures within the walls of America’s hospitals. According to Orser, Mazer, and colleagues (2013), roughly 1.3 billion surgeries were performed in 2000. With such a high number of patients in North America and given anesthesiologists' success rate, one of the major complications of anesthesia is malignant hyperthermia—a hypermetabolic state that can be potentially fatal. Early detection and proper intervention can cause multiple reactions within the body leading to metabolic and muscular damage, acidosis, dysrhythmia, kidney failure, neurologic injury, and ultimately death (Wahl, Paus, Gschwend, & Bagdade, 2014). The incidence of this condition is estimated to be 1 in 15,000 in children and 1 in 2,000-10,000 in adults (Redmond, 2001). Although considered a rare event, the mortality rate of an malignant hyperthermia was eighty percent in 1960 and has steadily declined to less than ten percent by 1980 (Saleh, 1992). The concern, however, revolves around the fact that malignant hyperthermia is a hereditary disorder. Therefore, understanding the genetic effects and how severe the symptoms of malignant hyperthermia are can help to detect such a disorder.

Pathophysiological Processes
Malignant Hyperthermia (MH) is considered a pharmacological disorder as it is an autonomic dominant disorder activated by the introduction of certain anesthetic agents solely or in conjunction with a neuromuscular blocker known as succinylcholine (Stratman, Flynn, & Hatton, 2009). Typically, an otherwise susceptible patient will develop a reaction if the MH agent is introduced. If untreated, malignant hyperthermia can cause muscle rigidity, hyperthermia, coagulopathy, neurologic injury, and metabolic acidosis leading to kidney failure (Redmond, 2001). If untreated, malignant hyperthermia is imperative for the healthcare team to familiarize themselves with the clinical signs and symptoms of this condition. The sooner treatment is initiated, the better the chance of survival is. In fact, any coagulopathy and neurologic injury that occurs at the start of the operation is considered malignant hyperthermia; it must be treated immediately. For this reason, the healthcare team should arise. One recommendation that the surgery team was working towards equipping each person with a specific task in order to establish the intervention needed to safely care for a MH patient. For example, multiple members needed to collaborate to dilate the trachea, whereas another coaxed the patient into calm, another documented the event, etc. (Cates, Reitz, & Koons, 2011). PACU and ICU nurses also need to be educated as many signs and symptoms of MH present early in the OR but in the PACU or critical care units (Barnes, Stovall, & Ferron, 2015). Nurses need to provide education for the OR team for increased vigilance and symptoms of malignant hyperthermia patients intraoperatively. The first signs are tachycardia, generalised muscle rigidity, cardiac arrhythmia, and electrolyte imbalances. Other early signs are tachycardia, generalised muscle rigidity, cardiac arrhythmia, and electrolyte imbalances. Early detection is paramount when dealing with malignant hyperthermia.

Case Study
A 22 year old male presented to a military hospital after being injured by an improvised explosive device. He presented with a penetrating injury to the left thigh; radiological findings confirmed a left linear fracture. The patient was conscious and able to answer questions, he denied any allergies or past medical history. The man was prepared for surgery and given ketamine, 50 mg; atropine, 10 mg; and succinylcholine 120mg for rapid sequence intubation. Post induction vital signs are as follows: blood pressure (BP) 115/60 mmHg, heart rate (HR) 90, respiratory rate (RR) 14, oxygen saturation (SaO2) 100%, and tidal carbon dioxide (ETCO2 41 mmHg, temperature 96.6 degrees F. General anesthesia was maintained with sevoflurane. Approximately two hours in the operating room, the patient experienced temperature 111.8 degrees Fahrenheit and was administered atropine. The patient was ventilated. The patient was initially placed on the IV for fluids and electrolytes. The fever slowly declined to less than one degree Fahrenheit. The patient denied any allergies or past medical history. After the patient was moved to the PACU and ICU, the patient was monitored closely for signs and symptoms of MH. The patient was responded with hyperthermia, coagulopathy, neurologic injury, and metabolic acidosis leading to kidney failure (Redmond, 2001). Signs of Mg2+ were drawn; oxymorphone, renal failure, respiratory, and metabolic acidosis and hyperthermia. Once hyperthermia is identified, it can occur as quickly as twenty minutes due to oxygen consumption that is two to three times increased over normal consumption (Stratman, et al., 2009). All other vital signs are tachycardia, generalised muscle rigidity, cardiac arrhythmia, and electrolyte imbalances.

Signs and Symptoms
Unfortunately, other diseases such as thyrotoxicosis, rhabdomyolysis, pregnancy, and stress can also present similar symptoms such as MH making timely diagnosis a challenge. Moreover, many genetically susceptible patients undergoing general anesthesia will experience some of these signs; it is likely there will be no forewarning of this rapidly debilitating reaction. The signs and symptoms of MH can be classified as either early or late. Typically, the earliest signs can occur within minutes of exposure and include: increased and tidal carbon dioxide, respiratory acidosis, and agitation of the muscle mass. Other early signs are tachycardia, generalised muscle rigidity, cardiac arrhythmia, and electrolyte imbalances.

Nursing Implications
Malignant hyperthermia is a rare and fatal disorder that can be challenging to detect and treat. Due to the low incidence of MH events, medical personnel are often not familiar and/or confident in the management of such an event. Therefore, it is the responsibility of the healthcare team to familiarize themselves with the clinical signs and symptoms of MH. Additionally, the knowledge of how to perform MH, the expected treatments, and evaluation of successful intervention is a study done in the Midwest with all surgical personnel being placed in various simulations that were set to resemble a malignant hyperthermia crisis. The staff was educated on the disorder, simulation was completed, and all members were debriefed. The findings produced protocols and exercises that are done on a monthly basis to ensure all parties of the OR are prepared for MH if it should arise. One recommendation that was that they allow future anesthesia teams whom have suffered with MH, assuring they understand how critical this disorder can be and how pertinent it is for them to safely care for a MH patient. For example, multiple members needed to collaborative to dilate the trachea, whereas another coaxed the patient into calm, another documented the event, etc. (Cates, Reitz, & Koons, 2011). PACU and ICU nurses also need to be educated as many signs and symptoms of MH present early in the OR but in the PACU or critical care units (Barnes, Stovall, & Ferron, 2015). Nurses need to provide education for the OR team for increased vigilance and symptoms of malignant hyperthermia patients intraoperatively. The first signs are tachycardia, generalised muscle rigidity, cardiac arrhythmia, and electrolyte imbalances. Early detection is paramount when dealing with malignant hyperthermia.

Conclusion
Malignant hyperthermia is a complex, life-threatening crisis that presents multiple challenges yet can be successfully managed with rapid and proper treatment. Continued education is essential for early detection, education planning, swift implementation, and proficient evaluation of an MH event. Through collaborative discussions, strong intra-operative knowledge, and efficient interdisciplinary roles will only bolster the fight against MH and ensure significant reduction in morbidity and mortality (Stratman et al., 2009).