Malignant Hyperthermia

Brandon Kinnamon
brandon.kinnamon@otterbein.edu

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Underlying Pathophysiology

Malignant hyperthermia is an autosomal dominant trait with a mutation of the ryanodine receptor (RYR1) (Henryk Dirksen, et al., 2011, p. 1108).

When exposed to an environmental (heat stroke) or pharmacological trigger, the mutation on RYR1 causes an uncontrolled release of calcium from the sarcoplasmic reticulum in skeletal muscles (Rogier, Pollock, Schimpansen, & Roser, 2015, p. 4).

The only gene showing potential MH-causing mutation is CACNA1S (Rosengren, et al., 2015, p. 4).

The depolarizing muscle relaxant succinylcholine and volatile anesthetics including halothane, isofluorane, enflurane, sevoflurane, methoxyflurane, and desflurane can all trigger MH (Schneiderbanger, et al., 2014, p. 356-357).

The uncontrolled release of calcium in the muscle leads to sustained contraction causing a rise in exhaled carbon dioxide, the observable muscle rigidity, and generates heat which leads to a dramatic rise in body temperature (Seifert, Walf, Pace, Cochrane & Bagnola, 2014, p. 187).

When muscles become rigid they can no longer produce adenosine triphosphate (ATP) which leads to cellular damage and leakage of potassium, creatine kinase, and myoglobin from the muscle cells (Brandom & Callahan, 2015, p. 115).

This leakage results in metabolic acids, cardiac arrhythmias, and myoglobinuria (Brandom & Callahan, 2015, p. 115).

To compensate for the increased body temperature, hyperventilation, vasodilation, and catecholamine release all occur in an attempt to lower the increased end-tidal carbon dioxide levels. Hyperthermia, flushing, and tachycardia followed by cyanosis of the periphery (Brandom & Callahan, 2015, p. 115).

If not halted this hypermetabolic state can lead to cardiac arrest, hemorrhaging, and brain damage (Ali, Taguchi & Rosenberg, 2003).

Significance of Pathophysiology

- Malignant hyperthermia is a life-threatening, and is associated with administration of anesthetic agents and neuromuscular blocking agents.

- It can occur rapidly, or slowly delayed, in any facility that administers the potential triggering agents. This means that reactions can occur in the operating room (OR), post anesthesia care unit (PACU), or the intensive care unit (ICU) (Seifert, et al., 2014, p. 190).

- Without proper recognition, the affected patient can suffer dire consequences. Cardiac arrest, disseminated intravascular coagulation, kidney failure, heart failure, brain damage, and even death are potential outcomes if treatment is not initiated and supportive care provided (Seifert, et al., 2014, p. 189).

- This makes the pathophysiology of MH extremely significant and it is vital that the anesthetic provider, PACU nurse or ICU nurse recognize the condition so it can be treated.

Conclusions

- Malignant hyperthermia is a rare and life-threatening condition which is affected by anesthetic agents used during induction and general anesthesia (Carl, Fors, Gettrup & Novotny, 2014, p. 95).

- It is vital that nurses and anesthetic providers know what to monitor and what actions to take if a potential patient develops MH.

- Simulations can assist in preparing personnel for a potential MH crisis in a safe environment, and this practice has been used regularly by anesthesia professionals since 1994 (Carl, et al., 2015, p. 124).

- MHAUS has organized mock drills for entry into the national data bank for families and anesthesia providers on malignant hyperthermia (Brandom, 2015, p. 124).

- Future research on MH will likely focus on genetics and the phenotypic variability of ryanodine related conditions (Dirksen, et al., 2011, p. 115).

- Accurately predicting which patients are susceptible to MH could provide new providers to avoid possible triggering agents while still providing excellent care to those patients.

References (cont.)


