Pseudocholinesterase Deficiency: Implications in Anesthesia

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Introduction
The use of neuromuscular blocking medications is a frequent and essential practice in establishing a secure airway in patients preparing for surgery or in emergent situations such as respiratory distress. As an anesthesia provider it is vital to know the mechanism of action, expected duration, and metabolism of these powerful blocking agents, particularly succinylcholine. A potential outcome complication that may occur in patients that have been administered succinylcholine is prolonged neuromuscular blockade due to the deficiency of pseudocholinesterase, the enzyme produced in the liver and present in plasma that metabolizes succinylcholine (Almind & Bredeney, 2011). In patients with a pseudocholinesterase deficiency, succinylcholine is not broken down as quickly as would be expected, which produces a prolonged neuromuscular block. These patients will need continuous ventilator support postoperatively and often admission to the intensive care unit until muscle strength is restored (Stoelting & Hiller, 2015). Identifying these patients at risk and recognizing the signs of deficiency are key in avoiding complications associated with an abnormally prolonged neuromuscular block.

Pathophysiology

- Pseudocholinesterase deficiency is an enzyme produced in the liver that metabolizes neuromuscular blocking agents, particularly succinylcholine and mivacurium, as well as some local anesthetics.
- Pseudocholinesterase deficiency is caused by either a homozygous or heterozygous allele with a genetic variant of the enzyme itself. An individual that is homozygous for the enzyme is at risk of the clinical sign that occurs in one in every 3,500 people, the neuromuscular blocker blood levels will likely last four to eight times longer and this genotype is more likely to experience apnea and the inability to be taken off of the ventilator post-operatively.
- Once the NMB is administered to acetylcholine receptor sites causing sustained depolarization for a relatively short period of time in which the patient experiences skeletal muscle fasciculations followed by fascial paralysis.
- Succinylcholine diffuses away from the NMB that is acting peripherally and will return. Typically, an intravenous dose of succinylcholine is rapidly hydrolyzed by pseudocholinesterase within 9 to 13 minutes in which 90% of the muscle strength will be restored, however its duration of action will be prolonged in a deficient patient depending on the type of genetic abnormality present.

Significance of Pathophysiology

- While pseudocholinesterase deficiency is not one of the most common complications seen with general anesthesia, it can be fatal if not recognized and treated properly.
- Since we know there is a genetic link, a thorough pre-operative assessment should be completed including family history of this condition. Sometimes asking if the patient or a family member was admitted to the ICU or had to be on the ventilator for longer than expected after surgery will help to reveal a pseudocholinesterase deficiency.
- The deficiency is most often found after succinylcholine has already been given and it is discovered that the patient's muscle function has not returned within the expected time frame.
- There is no treatment for this genetic condition, however supportive care, particularly ventilator support, must be given until the medication has been adequately metabolized and the patient has regained muscle strength (Stoelting & Hiller, 2015).

In order to screen for pseudocholinesterase deficiency, there are multiple other causes that may be present.

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Signs and Symptoms

- A patient with pseudocholinesterase deficiency will not experience signs or symptoms unless he or she is administered a neuromuscular blocking agent.
- The major presenting sign is prolonged skeletal muscle paralysis including the diaphragm and intercostal muscles that are required for the patient to breathe. Apnea and a lack of movement or muscle twitches when using a peripheral nerve stimulator will present until the medication is metabolized by the body which may not occur for up to 60 minutes (Whiteman, et al, 2012).
- The peripheral nerve stimulator is a method for monitoring neuromuscular blockades in which electrodes are placed either on the facial or ulnar nerve and stimulated using various modes to produce a muscle twitch. Train-of-four is a commonly used mode in which four simultaneous stimuli are delivered and the number and strength of the muscles is observed by the anesthesia provider. The goal after using a neuromuscular blocking agent and prior to extubation is to observe four twitches without any fade which relates to the strength of the twitch. An individual with a pseudocholinesterase deficiency may not produce any twitches depending on the type of genetic variation (Nagelhout, & Plaus, 2013).

Implications for Nursing Care

- Nursing anesthesia providers to know the mechanism of action and potential adverse effects of all medications including neuromuscular blockers in order properly recognize and treat a pseudocholinesterase deficiency.
- Always ensure muscle function using train of four monitoring with a peripheral nerve stimulator prior to an after a neuromuscular blockade is given. This will allow for comparison and the provider can be more confident in the degree of muscle strength recovery prior to making the decision to extubate the patient (International Anesthesia Research Society, 2016).
- Do not extubate a patient that has not experienced muscle recovery, provide full ventilator support, and make arrangements for a ventilator set-up in the PACU (Pseudocholinesterase Deficiency, 2016).
- Avoid the use of succinylcholine unless absolutely necessary and do not give until the benefits outweigh the potential costs (Quresi, 2012).
- PACU and ICU nurses should familiarize themselves with the significance of a pseudocholinesterase deficiency, the use of a peripheral nerve stimulator, and the necessary care for these patients postoperatively.

Additional Resources

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References

Normal Respiration (no drug present)
Nondepolarizing Block
Depolarizing Block (Succinylcholine)

Phase I
Phase II

TOF ratio
Fade
Constant but maintained
TOD > 4.9
Fade

Common TDF Guidelines:
TDF 0-12:0-5 indicates adequate surgical relaxation
TDF >14.9: needed for safe extubation & recovery after surgery


Conclusion

- This condition will not affect the patient’s everyday life, however it may become a life threatening condition if the patient is under general anesthesia for surgery.
- For this reason anesthesia providers should always consider using less invasive airway options or nerve blocks, both of which would not require the administration of neuromuscular blocking agents, like succinylcholine.
- If the use of a NMB cannot be avoided and there are no absolute contraindications, then providers must be prepared to recognize, assess, and provide support to a patient that presents with a pseudocholinesterase deficiency.


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