

Episode 77: Reversal of Neuromuscular Blockade

On this episode: Dr. Jed Wolpaw

In this episode, episode 77, I discuss reversal of neuromuscular blockade. This is a follow up to [episode 66](#) in which I covered neuromuscular blockade.

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Background

- 2010 survey showed that more than half of the providers in the US and Europe did not use reversal of neuromuscular blockade.
- When testing for reversal, clinical strength (tidal volume, sustained head lift) is typically use. This is not adequate as most patients can hold their head for 5 seconds even if Train of Four is less than 0.5.

What are some ways to test for reversal of blockade?

- To review, the TOF ratio is the ratio of fourth twitch to first twitch given 4 maximum stimuli every 0.5 seconds. Adequate recovery is a TOF ratio of 0.9, or where the 4th twitch is 90% of the first twitch. The human hand is not good at determining this ratio, which is especially important given the risk of aspiration and pulmonary complications. It's more accurate to use an acceleromyograph (AMG).
 - Tetanus (50-100 hz over 5 seconds) to determine fade
 - Double burst (2 short 50hz burst separated by 750 milliseconds)
 - Post-tetanic stimulation (50 hz for 5 seconds, wait 3 seconds, count 1 stimulation every second). The tetanic stimulation mobilizes acetylcholine at the prejunctional membrane to the motor endplate. This method is important for determining where you are in deep blockade, also for sugammadex dosing.
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How is neuromuscular blockade actively reversed?

- Acetylcholine-Esterase inhibitors

- ↑ Acetylcholine in junction to compete with non-depolarizing blockers. There is a ceiling effect, thus a maximum dosage. Also, no effect during deep blockade because can't compete with high amounts of blocker.
- Even with 4 twitches, it can take up to 10-15 minutes to fully reverse. Reversing after the surgeon finishes and extubating 3 minutes later may not be adequate!

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Reversal	Peak effect	Dose	Adjunct
Neostigmine	7 to 10 min	70 mcg/kg, max 5 mg	Glycopyrrolate
Pyridostigmine	12 to 15 min	350 mcg/kg	Glycopyrrolate
Edrophonium	1 to 2 min	1.5 mg/kg	Atropine

- For neostigmine, typically use 5 mg (in 5 mL), then equivalent volume of glycopyrrolate 5 mL (1 mg). Neostigmine causes bradycardia, thus give glycopyrrolate to block muscarinic effects.
- Volatile anesthetics interfere with reversal of neuromuscular blockers. A patient blocked with atracurium and TIVA will recover faster than if with atracurium and desflurane.
- Important to use AMG or give reversal even after just an intubating dose of NMB. 10% of patients with intubating dose of blocker still don't have ToF of 0.9 after 4 hours.

How does sugammadex work?

- Still need to reverse cisatracurium despite degradation via Hoffman-Elimination.
- Eliminates rocuronium or vecuronium (2.5x less), not pancuronium/ cisatracurium, and creates concentration gradient outside the neuromuscular junction into the plasma. The **rocuronium concentration in plasma increases because measurement includes encapsulated blocker as well.**
- Rocuronium is eliminated through the biliary system but when encapsulated, eliminated through renal. Dialysis can remove (high flux), and not recommended in ESRD.
- **Dosing using twitches**

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ToF twitches	Dose
2+	2 mg/kg
1	4 mg/kg
0	Use Post-Tetanic Stimulation
Post-Tetanic Stimulation	
2+	4 mg/kg
<2	16 mg/kg or wait until 2 twitches

- For dosing, use actual body weight, not lean or predicted.
- Neostigmine can only reverse shallow blockade, and recovery is still 10x longer.
- No known side effects to baby in utero.
- Side effects: anaphylaxis and bradycardia (more with emergent dose)
- Interfere with OCP up to 7 days
- **If reintubating**, use nonsteroidal blockers like cisatracurium, or use succinylcholine. Avoid using roc/vec up to 24 hours after sugammadex. Some studies show that RSI dose (1.2 mg/kg) of roc given after sugammadex reversal can still produce blockade in 3 minutes.

How are neuromuscular blockers reversed in your practice?

Review Questions

Link jumps to appropriate section

[How does the rocuronium concentration change in plasma after using sugammadex?](#)

[What is the dosage used for sugammadex if 2 twitches on ToF?](#)

[What is the dosage used for sugammadex if 2 twitches on post-tetanic stimulation?](#)

[Which NMB would you use when reintubating after reversal?](#)

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Notes by [Brian Park](#)