

Panoramic, screen-based simulator of neuromuscular blockade administration, monitoring and reversal

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Introduction:

There is renewed interest in neuromuscular blockade (NMB) monitoring and reversal with the continued significant incidence of residual postoperative NMB and the fairly recent availability of sugammadex. We developed the Simulated Anesthesia App (SAA), an interactive screen-based simulator to practice NMB administration, NMB monitoring, and NMB reversal including with sugammadex.

Methods:

We implemented in Adobe Director an interactive screen-based simulator of the operating room (OR) and anesthesia activities. To have only one main screen represent the entire OR, we developed a dynamic panoramic representation of the OR that allows the entire OR to “fit” within one screen as a scrolling panoramic photograph, Fig. 1. We simulated activities and equipment like intubation (video clips), laparoscopy (video clips), a NMB monitor, an anesthesia machine with user-adjustable flowmeters and vaporizers, gas analysis (by modeling breathing circuit dynamics like wash-in and washout) and physiological monitoring. We used PK/PD parameters from official package inserts to simulate, via compartmental models, drugs like oxygen, sevoflurane, isoflurane, glycopyrrolate, neostigmine, succinylcholine, fentanyl, propofol, rocuronium and sugammadex. Scrolling time plots of drug concentrations and circuit gas concentrations respond to user actions like drug administration and provide line of sight of future concentrations, Fig. 2. We included the package inserts used for our PK/PD models into the SAA as searchable PDF files. An event log captures all user actions and is a tool to go back in time and undo mid-case events, e.g., taking a different decision without re-starting the scenario. For each new user interaction, the models forecast all parameters up to three hours. A scrolling timeline allows users to jump forward and backward in time, e.g., to skip periods of no activity or to undo a prior action.

Results:

During verification of the SAA, the output of each model of the SAA was compared to the source like the package insert. Drug concentrations, clinical durations and recovery times matched source materials. Anesthesiologists who used the SAA deemed that its output matched what they observe in their clinical practice. A short (6 minute) video of the SAA is at <https://simulation.health.ufl.edu/technology-development/#PanoramicSimulations>

Discussion:

The SAA has a “taximeter” option that allows setting a dollar value for a minute of OR time and the cost of materials used and displays a running sum of the total cost. We are exploring re-purposing the SAA to include the carbon footprint of each item or consumable used during an anesthetic.



Figure 1. The panoramic user interface, facing the patient. The scrolling timeline and clock are at the top. Tools and options are selectable within the photograph-based scene and in two columns on the right and left sides of the screen. The user is selecting the mathematical models viewer (enlarged icon, upper right)

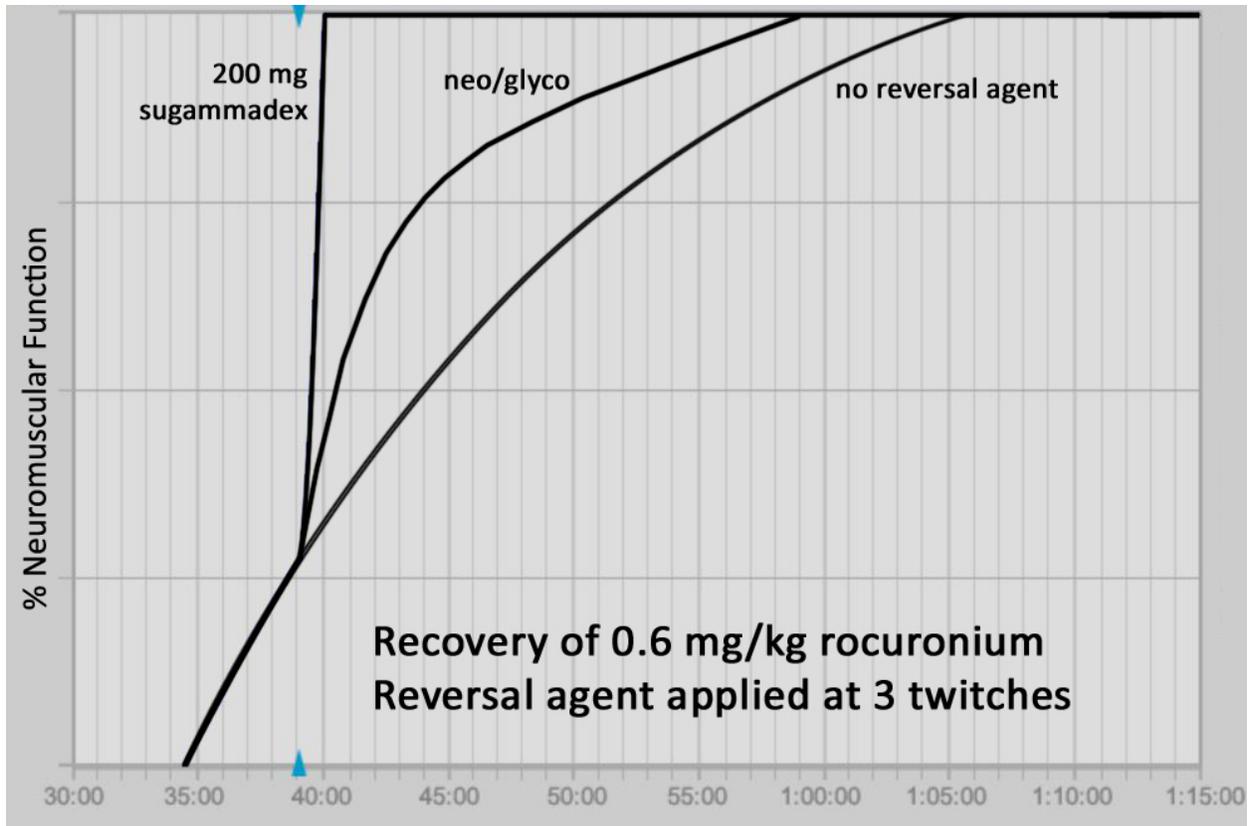


Figure 2. Three superimposed graphs of neuromuscular function recovery from the mathematical models viewer. The triangular caret at the timeline indicates the current time during the simulation.