# NMBM Accel – A Novel Programmable Prototype Neuromuscular Block Monitor

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Assessment of neuromuscular transmission is essential for competent management of balanced anesthetic technique. Available devices and methods for clinical monitoring range from very simple to sophisticated, with proportional prices. Despite evolution of hardware implementations, conceptually little has changed since Viby-Mogensen introduced the double-burst stimulus pattern [1]. We have produced a programmable prototype neuromuscular block monitor designed to address clinical and research issues.

Clinical difficulty monitoring very small muscle responses during profound block, or completeness of reversal, are persistent blind spots using current technology and stimulus patterns. Advances in pharmacology increase demand for profound muscle relaxation to facilitate challenging surgical procedures, while production pressure for rapid turnover between procedures encourages inadequate attention to complete reversal to neuromuscular block -- hazards for patient safety and opportunities for improvement [2].

The historical standard of measuring force of adductor pollicis contraction to ulnar nerve stimulation is too difficult and impractical for routine clinical application. Many sensing alternatives attempt to provide easily usable alternatives for routine clinical practice. Likewise, numerous neuromuscular transmission stimulus patterns have been employed clinically, each with advantages and disadvantages for interpretation.

As a capstone project, a team of four undergraduate senior Biomedical Engineering students at Bucknell University designed and implemented an Arduino-based neuromuscular stimulator with a faculty advisor and a clinical mentor. Three-axis accelerometry was employed in this prototype as the most accessible response parameter [3]. Design and programming included a logic board supporting an Arduino processor, pulse trigger and output current pulse generator, accelerometer data capture and display, 3D printed case and accelerometer finger clip, and clinician stimulus selector control (single twitch, train-of-four, double-burst, tetanus, post-tetanic count). Measured response was displayed graphically on an LCD display in the prototype. A USB port provided for programmability and could output acquired data.

Thus far this prototype has produced a novel neuromuscular block monitor. Control of hardware design and programmability provide opportunities to exploit capabilities of modern electronics and microsensors to expand the dynamic range for monitoring from profound block to complete recovery of neuromuscular transmission.

**References:**
1 Engbaek J, Ostergaard D, Viby-Mogensen J. Double burst stimulation (DBS): a new pattern of nerve stimulation to identify residual neuromuscular block. Br J Anaesth 1989;62:274-278

2 Brull SJ, Kopman AF. Current Status of Neuromuscular Reversal and Monitoring: Challenges and Opportunities. Anesthesiology 2017;126:173-190

3 Hemmerling TM, Le N. Brief review: Neuromuscular monitoring: an update for the clinician. Can J Anaesth 2007;54:58-72