

IMPLEMENTATION OF ACCELEROMYOGRAPHY TO INCREASE USE OF QUANTITATIVE NEUROMUSCULAR BLOCKADE MONITORING

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INTRODUCTION

- Background:** Residual neuromuscular blockade (RNMB) creates excess perioperative morbidity. Quantitative neuromuscular monitoring devices may help ensure full recovery from neuromuscular blocking agents and has been demonstrated to reduce complications associated with residual neuromuscular blockade. We studied the effectiveness of educational efforts to introduce quantitative monitoring to a large academic medical center, with pre-defined main outcome measures of (1) self-reported familiarity with use of the device and (2) actual device uptake.
- Methods:** Acceleromyographic neuromuscular transmission monitors were released into the clinical environment concomitant with brief introductions by vendor representatives and e-mailed instructions for their use. Six months after release, a blended education curriculum including face-to-face education, online materials and trained super-users was implemented to formally re-introduce the monitors to users. Anonymous surveys of knowledge, skills, and attitudes toward the devices were administered before and after the education effort. Monitor use rates were quantitatively assessed by both manual and automatic monitor data entry into the electronic medical record. Before-and-after results were compared by run charts, unpaired t-tests (correcting for multiple comparisons) and examination of 99% confidence intervals. This quality improvement project was IRB-exempt.

HYPOTHESIS

- By utilizing a more precise instrument for measurement of neuromuscular function, negative patient outcomes such as **hypoxemia, patient discomfort, prolonged post-anesthesia care unit stay, reintubation, critical care admission, and perioperative mortality** can be reduced. Additionally, use of quantitative monitors could lead to **reduced length of stay, improved patient satisfaction, and lower cost of health care.**
- Proper educational preparation will enhance the safe adoption of new technology in the workplace.
- Acceleromyography provides a quantifiable measure of neuromuscular function by measuring the TOF ratio (comparing the fourth stimulus response to the first) on a scale of 0-1. Significant muscle weakness is present when the TOF ratio is less than 0.9. No other current commercially available monitor except acceleromyography can exclude RNMB.

RESULTS

- The program was **effective in increasing the utilization of a new neuromuscular monitoring modality by 74%** among clinicians. We also demonstrated that the impact on provider workflow was not perceived to be a significant barrier to adoption after education.
- Anesthesia practitioners' attitudes regarding RNMB was not significantly changed by the project.** This is likely due to the fact that those who were surveyed believed strongly, both before and after implementation that RNMB is a clinically significant problem for patient care and thus the scores did not change.
- Perceived impediments to the utilization of the monitor (time to setup and calibrate, change in workflow of anesthesia induction, positioning of the thumb for free adduction, and consistent monitor values) remained a perceived barrier to NMT use.** Also, despite the educational effort, the inability to ensure free thumb adduction, in surgical cases when both arms are tucked at the sides, for example, continued to be a physical barrier to utilizing the monitoring device.

TABLES

Table 1: Statistical Analysis

	Pre-Education (Mean ± SD)	Post-Education (Mean ± SD)	Difference (Post-Pre)	p-value	99% CI of the (Post-Pre) Difference
Please rate your agreement with each of the following statements: 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree					
Residual neuromuscular blockade is a problem that impacts patient care outcomes in anesthesiology.					
I received adequate information on the operation of the NMT monitor.	4.38 ± 0.79	4.24 ± 0.81	-0.14	0.2583	(-0.46, 0.18)
I am now confident that I know how to fully utilize the NMT monitor.	2.55 ± 1.31	3.39 ± 1.14	0.85	*1.03E-05	(0.36, 1.33)
Estimate how many times you have used the NMT monitor for patient care.	2.92 ± 1.26	3.58 ± 0.95	0.65	*0.0001117	(0.22, 1.08)
How confident would you rate your ability to: 1=not confident at all; 2=a little confident; 3=somewhat confident; 4=fairly confident; 5=extremely confident					
Apply the monitor to the patient?	27.4 ± 33.7	62.1 ± 124	34.7	0.02912	(-6.6, 76)
Calibrate the monitor?	3.93 ± 1.23	4.58 ± 1.01	0.65	*0.0001964	(0.2, 1.09)
Utilize the TOF and TOFr stimulation mode?	3.46 ± 1.31	4.20 ± 1.23	0.74	*0.0002053	(0.23, 1.24)
Interpret the monitor values for TOF and TOFr?	3.56 ± 1.21	4.27 ± 1.18	0.72	*0.0001562	(0.24, 1.2)
Utilize the PTC stimulation mode?	3.72 ± 1.21	4.08 ± 1.10	0.35	0.04644	(-0.11, 0.81)
Interpret the PTC monitoring values?	2.86 ± 1.32	3.38 ± 1.49	0.52	0.02033	(-0.06, 1.09)
Adjust the stimulation current?	3.00 ± 1.34	3.44 ± 1.31	0.44	0.03322	(-0.09, 0.97)
Utilize the monitor without calibration?	2.87 ± 1.59	3.65 ± 1.36	0.78	*0.0006349	(0.2, 1.37)
Change the automatic time interval for stimulation?	3.18 ± 1.58	3.77 ± 1.21	0.59	0.005441	(0.04, 1.14)
Interpret error messages from the monitor?	3.80 ± 1.65	4.30 ± 1.01	0.50	0.01175	(-0.01, 1.02)
Troubleshoot the monitor?	2.34 ± 1.28	3.05 ± 1.52	0.71	*0.001913	(0.12, 1.29)
How much do each of the following factors contribute to your decision NOT to use the NMT device? 1=does not impact at all; 2=impacts a little bit; 3=impacts somewhat; 4=impacts a fair bit; 5=impacts a great deal					
The time to setup and calibrate the device	2.23 ± 1.17	3.11 ± 1.68	0.87	*0.00031	(0.26, 1.48)
The change in workflow for anesthesia induction (forget to apply and calibrate)	3.59 ± 1.21	3.08 ± 1.32	-0.52	0.01018	(-1.03, 0)
The positioning of the patient precludes free thumb adduction.	3.89 ± 1.17	3.38 ± 1.33	-0.51	0.01107	(-1.02, 0.01)
The monitor returns values that are inconsistent with clinical signs of muscle relaxation.	4.15 ± 1.10	3.95 ± 1.18	-0.19	0.28	(-0.66, 0.27)
	4.24 ± 1.19	3.70 ± 1.36	-0.55	*0.007403	(-1.07, -0.02)

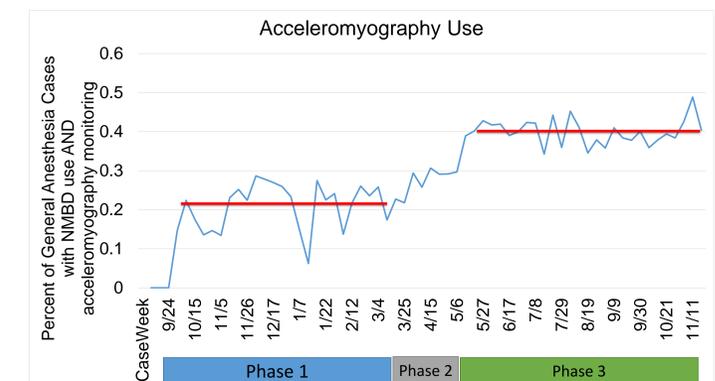
Before and after comparison of user survey responses. Each item was presented with a 5 point Likert scale for responses; higher scores denote greater agreement with the statement. After Bonferroni correction for multiple (19) comparisons, p<0.0026 is considered to denote statistical significance for any individual comparison (indicated with an *). 99% Confidence interval for the Post-Pre difference is also presented. CIs that do not encompass 0 were considered meaningful.

FIGURES

Figure 1: Project Timeline: The quality improvement project was implemented over quarters (Q) 3, 4, 5 or a total of 9 months.

Project Phases	Phase 1 09/01/2015- 03/31/2016		Phase 2 04/01/2016- 05/31/2016	Phase 3 06/01/2016- 11/18/2016	
	Q1	Q2	Q3	Q4	Q5
Quantitative monitor usage data collection	X	X	X	X	X
Phase 1: Monitors released to clinicians	X	X			
Review initial usage and uptake		X			
Phase 2: Pre-survey			X		
Provide educational experience			X		
Clinical support provided			X	X	X
Post-survey					X
Phase 3: Analyze usage, uptake				X	X
Discuss future research and refinement opportunities					X

Figure 2: NMT usage over time. In Phase 1, the monitors were released to the operating rooms without specific instruction and netted a median of 23% utilization. In Phase 2, the quality improvement project began, resulting in a period of instability where clinicians began to increase uptake of the device. Phase 3 followed the project, with a sustained median utilization of 40%. This represents a 74% increase in use of acceleromyography.



CONCLUSION

- Utilization of acceleromyographic technology has been shown in the literature to enhance patient care outcomes when neuromuscular blocking drugs are administered. Despite the professional consensus on the effects of RNMB among providers, this problem continues to present a clinical challenge in anesthesia care. This project has the potential to serve as an exemplar for other settings wishing to adopt this technology. Further, the ability of acceleromyography monitoring to enhance patient care through (1) a reduction in the number of RNMB events that are experienced and (2) decreased PACU length of stay and total amount of NMBD administered has substantial promise for better patient care and as a subject for further research.