Ease of Application of Various Neuromuscular Devices for Routine Monitoring

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Introduction

Postoperative residual weakness continues to be a patient safety threat [1]. Subjective evaluations to confirm recovery with a peripheral nerve stimulator (PNS) can provide some information; however, this technique is unreliable as clinicians are unable to detect the presence of fade at train-of-four (TOF) ratios > 0.4 [2]. As such, quantitative neuromuscular monitors are recommended as an evidence-based approach to confirming adequate recovery of neuromuscular function postoperatively and reduce possible complications related to residual weakness [3]. Unfortunately, many clinicians are unfamiliar with employing such devices. As such, there is concern among the anesthesia community that the introduction of such objective monitoring into practice would be exceedingly laborious and could cause workflow delays in the operating room. This study investigates how long it takes experienced nurse anesthetists to apply and utilize various neuromuscular devices, as well as their perception regarding the ease of application of these devices.

Methods

After IRB approval, 20 nurse anesthetists were consented and participated in an educational session that familiarized them with 3 devices- SunStim Plus PNS (SunMed,Grand Rapids, MI, USA) (Figure 1), IntelliVue NMT (Philips, Amsterdam, the Netherlands) (Figure 2), and TetraGraph (Senzime B.V., Uppsala, Sweden) (Figure 3). After this session, participants were timed while placing each monitor on patients in a real world setting. For the quantitative devices, participants were also timed when obtaining calibrated baseline TOF ratios following induction of general anesthesia but before administration of neuromuscular blocking agents (NMBA). These baseline measurements were recorded and participants were surveyed about their background with neuromuscular monitoring as well as how easy they found it to apply and calibrate (when possible) these devices.

Table 1: Time to Connect

Time to Connect (sec)	Median (range)	Mean (SD)	
IntelliVue	46 (28 - 90)	52 (17)	**< 0.001**
PNS	29 (16 - 58)	33 (13)	
Tetragraph	62.8 (32 - 101)	63 (19)	
Pairwise Comparisons			
IntelliVue vs Tetragraph	-8 (-45, 35)	-11 (24)	0.053
IntelliVue vs PNS	19 (-14, 59)	19 (18)	**< 0.001**
PNS vs Tetragraph	-30 (-60, 27)	-30 (21)	**< 0.001**

Table 2: Calibration Results

	IntelliVue (N=20)	Tetragraph (N=20)	Difference (N=20)	p value
Time to calibrate (sec)				0.002
Mean (SD)	39 (21)	21 (16)	-18 (28)	
Range	15 - 100	6 - 72	-88 - 49	
Median	34	14	-16	
Did the device calibrate?				0.289
No	6 (30.0%)	2 (10.0%)	6 (100.0%)	
Yes	14 (70.0%)	18 (90.0%)	2 (14.3%)	
First TOFR				0.27
Mean (SD)	104 (16)	103 (7)	-5 (13)	
Range	69 - 139	90 - 120	-34- 9	
Median	102	102	-5	

Figure 1: PNS Application

Figure 2: Philips IntelliVue NMT Application

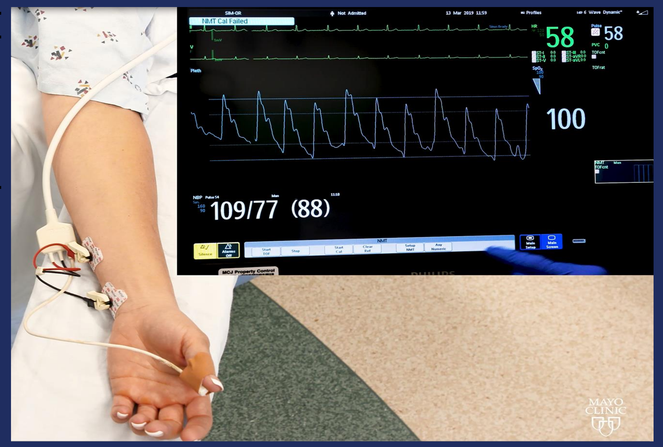

Figure 3: TetraGraph Application

Table 3: Provider Perception

	Mean (SD)	P-Value
Difficulty Calibrating		**0.001**
IntelliVue	4.5 (3.3)	
Tetragraph	0.4 (0.6)	
Difficulty Applying		**0.021**
IntelliVue	1.6 (2.0)	
PNS	0.3 (0.7)	
Tetragraph	1.2 (1.5)	
Pairwise Comparisons		
Difficulty Applying		
IntelliVue vs Tetragraph	0.45 (2.50)	0.44
IntelliVue vs PNS	1.30 (2.03)	**0.042**
PNS vs Tetragraph	-0.85 (1.50)	**0.048**

Discussion

It takes a little over 18 seconds longer to apply a quantitative neuromuscular monitor than a PNS (Table 1). While this difference reached statistical significance, this relatively minimal additional time represents an inappropriate barrier to the application of quantitative monitors. Among the two quantitative monitors investigated, participants were able to apply IntelliVue faster than TetraGraph, however, they were able to obtain calibrated baseline TOF ratios faster and easier with TetraGraph (Table 2). Regardless of which quantitative monitor was utilized, these experienced nurse anesthetists found the application and utilization of such devices relatively straightforward (Table 3).

References

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