Residual neuromuscular blockade creates excess perioperative morbidity. Quantitative neuromuscular monitoring devices may help ensure full recovery from neuromuscular blocking agents and have been demonstrated to reduce complications associated with residual neuromuscular blockade. We studied the effectiveness of educational efforts to introduce quantitative monitoring at a large academic medical center, with predefined main outcome measures of self-reported familiarity with use of the device and actual device uptake. Anonymous surveys of knowledge, skills, and attitudes toward the devices were administered before and after the education effort. Monitor use rates were quantitatively assessed through 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. Users agreed that residual blockade was an important topic before and after education, and reported improvement in their ability to use the devices after education. Clinical utilization of the monitors increased from 23% to 40% of eligible cases, with the increased rate sustained in the follow-up period. Education, assessed as improved self-reported proficiency, was associated with measurable increases in utilization of new technology. However, the rate of uptake, even when applied to a problem the users agreed was important, was modest.

Keywords: Acceleromyography, clinical technology, neuromuscular blockade, postoperative complications, residual neuromuscular blockade.

Nondeteriorating muscle relaxants are frequently used by anesthesia practitioners during surgery to facilitate surgical procedures and to provide for anatomical access during intracavitary surgical procedures. The quantity of nondepolarizing muscle relaxant molecules still present at the effect site at the end of each procedure directly affects return of full neuromuscular function with wide variation between patients. Clinically, patients with a train-of-four (TOF) ratio less than 0.9 can experience residual neuromuscular blockade (RNMB) and inadequate muscular function in the postoperative period. In particular, pulmonary complications, especially in patients who are seriously ill or have many comorbidities, can include hypoxemia, patient discomfort, prolonged stay in the postanesthesia care unit (PACU), reintubation, admission to the critical care unit, and perioperative mortality.

Recent studies described here have repeatedly demonstrated that RNMB is a problem in the United States. Critical respiratory events in the PACU are almost always associated with severe RNMB. Neuromuscular blocking agents, which are used in most general anesthetics, significantly increase the risk of respiratory complications. Even a small amount of RNMB (ie, TOF ratio < 0.9) has been associated with hypoxemic events in the PACU. Bulka et al found a higher incidence of postoperative pneumonia in patients who had received neuromuscular blocking drugs (NMBDs). Additionally, patients who did not receive any reversal of NMBDs were 2.26 times more likely to contract pneumonia after surgery. Kumar et al conducted pulmonary function testing in postoperative patients and demonstrated a decrease in forced vital capacity and peak expiratory flow in all RNMB cases that were evaluated, which confirmed the impairment of respiratory muscle function. These authors concluded that impaired respiratory muscle function is a major problem in patients with RNMB. Clinical manifestations of RNMB include misdirected swallowing, aspiration, impaired hypoxic ventilatory drive, diplopia, difficulty speaking, and generalized weakness. In addition, the complexity
of a patient’s current condition and comorbid diagnoses can further increase the risk of RNMB complications.\textsuperscript{5}

**Rationale**

Quantitative evaluation of nondepolarizing muscle relaxant effect and the return of full neuromuscular function is available but not yet in widespread use.\textsuperscript{7} Currently, the most common method in the United States for evaluation of nondepolarizing muscle relaxant effect remains the qualitative peripheral nerve stimulator. Providers using this neuromuscular monitor typically employ a tactile or visual TOF technique, which relies on subjective interpretation. Several variables can influence provider judgments, ranging from monitor functionality to anatomical placement or differences in interpretation among clinicians. Bhananker et al,\textsuperscript{8} Capron et al,\textsuperscript{9} Murphy et al,\textsuperscript{2,10,11} and Sauer et al\textsuperscript{3} have all recently demonstrated that subjective assessment of manual or visual TOF is not a sensitive measure of neuromuscular function. In the study by Bhananker and colleagues, there was 97\% agreement among providers when the TOF count was 0 or 4, but only 36\% agreement when it was 1, 2, or 3. Clinicians also assessed a higher TOF count than was actually present 96\% of the time (as verified by a more accurate and objective monitor), thus setting the stage for overuse of neuromuscular blockade.\textsuperscript{8} Clinically, administering more NMBD than is needed can result in inadequate muscular function in the postoperative period. In particular, the respiratory accessory muscles and pharyngeal muscles are most affected, which places patients at higher risk of hypoventilation, hypoxemia, and microaspiration.\textsuperscript{1} Moreover, RNMB prolongs PACU length of stay, with implications for operating room and hospital patient flow in congested hospitals.\textsuperscript{10} Although new neuromuscular blockade reversal agents for NMBDs, such as sugammadex, have recently become available for use in the United States and will likely improve the pharmacodynamics of reversal through a more direct mechanism of molecular encapsulation, the importance of using objective measures of neuromuscular function will remain relevant.\textsuperscript{12-14}

With use of a more precise instrument for measurement of neuromuscular function, negative patient outcomes associated with RNMB can be reduced. Additionally, use of quantitative monitors can lead to reduced length of stay, improved patient satisfaction, and lower cost of healthcare.\textsuperscript{15} 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 to 1. Through piezoelectric technology and based on the Newton law of motion (force equals mass times acceleration), the movement of a transducer on the thumb after stimulation of the ulnar nerve generates voltage. This voltage is collected, quantified, and analyzed to generate discrete clinical data (Figure 1).\textsuperscript{16} Substantial muscle weakness is present when the TOF ratio is less than 0.9.\textsuperscript{2} At present, no other commercially available monitor except acceleromyography can exclude RNMB.\textsuperscript{9,11}

**Purpose of the Project**

The purpose of this quality improvement project was to improve neuromuscular monitoring knowledge and practice in the anesthesia department of an academic medical center by implementing a blended-curriculum educational program. By blended, we mean a curriculum drawing from multiple modalities, including face-to-face education, online materials, and trained clinical experts (nurse anesthetists, anesthesiology residents, and attending anesthesiologists) present to assist in the clinical learning environment.

Todd et al\textsuperscript{17} reported that patients who arrive in the PACU after traditional qualitative monitoring have a TOF ratio of less than 0.9 in 31\% of cases. We had no reason to believe that our own results would be different, so we conducted a multistep quality improvement process to assess the rate of RNMB at our hospital, to acquire and release accelerographic monitoring, and to subsequently implement a blended educational curriculum to reinforce their use.

**Methods**

Group-level assessments of RNMB among PACU patients, as well as the recording and potential future reporting of group-level survey data about attitudes and education about the device and device use during cases was undertaken. A quality improvement project was implemented using a preintervention/postintervention design to evaluate the effectiveness of the implementation of a blended educational program. The focus of this educational program was on the implementation of a clinical practice guideline for use of a quantitative neuromuscular monitor (acceleromyography). The setting for the project was an academic medical center with 39 adult operating rooms, which were staffed by a single anesthesiology department. This was a second effort to introduce the technology,
because the initial deployment had been informal. The monitors had been introduced with little educational effort outside a departmental email message and brief vendor demonstration. The complexity of the device, as well as its limitations, yielded marginal use at that time.

In October 2015, each of our 39-room main operating room suites was equipped with a quantitative neuromuscular blockade monitoring device (Philips 865383 IntelliVue NMT Module, Philips Healthcare, Andover, MA). Concomitant with its release, the device was briefly introduced to clinicians by informal training sessions led by vendor representatives in the anesthesia break room, and via emails of instructions for monitor use to all anesthesia clinicians. This period of use, before the educational intervention, is called phase 1 in our analysis of the project. Use of quantitative neuromuscular blockade monitoring was measured by extraction of automatically recorded data from the electronic health record (EHR) throughout the project and was judged to be underutilized. Six months after initial monitor release, our intervention was conducted in an effort to boost utilization. We called the education period phase 2 in our analysis. Following the education intervention, we continued to track monitor use in the operating room, and we called this period phase 3.

Ethical Considerations. Because this work was done with a Food and Drug Administration–approved device fully implemented for routine patient care, it was judged to represent quality improvement work. The departmental quality improvement committee approved the project before implementation.

Interventions. As in most anesthesiology departments, neuromuscular blockade was traditionally monitored in our department using handheld qualitative nerve stimulators (SunStim, SunMed LLC, Grand Rapids, MI) before phase 1. The project timeline is shown in Figure 2. Initial implementation (phase 1) of the monitors occurred rapidly after purchase, using notification of availability along with dissemination of information provided by the company. However, there was no institution-specific or focused clinical education. Uptake was low, perhaps because of perceived complexity of the technology and its perceived disturbance to the normal workflow of anesthesia induction (ie, time to apply the monitor and calibrate). Subsequently, the educational program was developed to reintroduce the use of accelerographic monitors, this time using deliberate education. The target audience for the program included all hands-on anesthesia providers working in the medical center. Certified Registered Nurse Anesthetists, attending anesthesiologists, anesthesiology residents, student registered nurse anesthetists, and anesthesiology fellows received the educational program during phase 2. The convenience sample that responded to the survey (Table 1) included more than 100 providers providing care in 39 adult operating rooms and assigned to clinical duty during the months of implementation.

All anesthesia providers were asked to complete the educational program (Table 2) and use the accelerographic monitors with the educational intervention (phase 2).
myography devices for guidance of NMBD dosing and reversal. However, anesthesiologists who were supervising the anesthetics were enlisted as project facilitators rather than as the end users of the devices. They acted as coaches and subject matter experts related to the monitors and RNMB. Their participation was instrumental in verifying that anesthesia learners rotating between different clinical locations had the requisite knowledge to use the monitors properly. Similarly, CRNAs were trained as expert users and were frequently present at induction, offering to help with application and setup of the monitor.

- **Study of the Interventions.** All educational materials were reviewed by subject matter experts (both nurse anesthetists and anesthesiologists) for content validity. A preintervention survey, using RedCap (Vanderbilt University, Nashville, TN), was conducted that measured the practitioners’ (1) understanding of RNMB and (2) knowledge of how to operate the accelerometer and its features (see Table 1). This survey was distributed electronically at the end of phase 1, before the educational program to establish a baseline with respect to attitudes about RNMB and knowledge about use of the monitors. The baseline survey was conducted after the monitors had been purchased and installed in the clinical environment but before the educational program.

A formal in-service presentation (consisting of a multidisciplinary panel of internal subject matter experts, including nurse anesthetists and anesthesiologists) described the scope of the problem of RNMB. This face-to-face presentation was essential to frame the problem as one critical enough to warrant a change in clinical practice. Approximately 200 attendees were present (approximately 55% of the clinical providers). It was equally important to have an archived, online recording of the initial in-service presentation for those who were unable to attend because of scheduling conflicts. This online resource ensured that all department members and trainees received the same material and also allowed rereview as needed at their convenience. An additional online resource was developed and launched and included an additional quick reference video that highlighted the most critical features of the monitors and how to use them. Following the initial presentation, multiple face-to-face demonstrations were conducted in public areas so that the clinicians could examine the device, ask questions, and strategize their own clinical adaptation of the device. This occurred over several days so that maximum exposure to all stakeholders could be achieved. At the same time, a group of acceleromyography clinical champions was established to serve as the reference persons for the new device for questions that would arise in real time during patient care. These individuals (nurse anesthetists, anesthesiologists, and resident anesthesiologists) were able to be present or easily available to answer questions about the implementation of the device and to troubleshoot any problems that might occur during initial transition from the use of qualitative monitors. As recommended by Cooper,16 a specific checklist was created for use by clinical experts during all return demonstrations to validate that use of technology was appropriate (Figure 3).

- **Measures.** Data were collected over 5 quarters (15 months) from September 10, 2015, to November 25, 2016. The acceleromyography devices were deployed to 39 operating rooms in the main operating room suite. Initial deployment was on October 1, 2015. The blended education program began on April 29, 2016. During the education program, the clinical champion group was available to assist the clinicians in their use and interpretation of the new technology.

Device utilization rates were collected via the EHR, which in this academic medical center has a distinct field called TOF ratio. The acceleromyography units interface with the physiologic monitors to return data to the clinicians, and those data are also exported to the EHR into a designated field. Permission to access these data was provided by the Department of Anesthesiology. Utilization rates were then calculated by comparing the number of anesthesia cases that had documented TOF ratio to the total number of cases in which nondepolarizing muscle relaxants were administered. No identifiable patient data were collected for the purpose of this quality improvement project.

- **Data Analysis.** Anonymous electronic surveys (see Table 1) were completed by 114 participants (of a possible 367 participants; response rate of 37%) before the educational program, with 64 subjects (same participant pool; response rate of 17.5%) completing the postprogram survey. Surveys were collected without unique identifiers, so a matched-pairs analysis was not possible. The surveys used a 5-point Likert scale for each item. We assumed that the ordinal Likert scale points (response choices) were equally distributed along an underlying continuum of possible responses and used this assumption to justify treating the data as if they came from a continuous distribution. Thus, differences in aggregated preprogram and postprogram survey responses were evaluated using 2-sample t tests. There were 19 separate items in the survey, so we made a Bonferroni correction for 19 comparisons, each with a P value of .05 considered to be statistically significant. After the Bonferroni correction, we considered P < .0026 for any individual comparison to denote statistical significance. We also computed the 99% CI for difference in each before-and-after comparison reported from the survey responses.

Quantitative monitoring use before and after the education initiative is reported as a simple fraction of the total cases receiving nondepolarizing neuromuscular blocking agents in each time period. We also followed quantitative monitor use over time using a simple run
### Table 2. Statistical Analysis of Survey Responses Before and After Educational Intervention

<table>
<thead>
<tr>
<th>Survey item</th>
<th>Pre-education, mean (SD)</th>
<th>Post education, mean (SD)</th>
<th>Mean difference (Post − Pre)</th>
<th>P value</th>
<th>99% CI of the (post − pre) difference&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Please rate your agreement with each of the following statements: 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual neuromuscular blockade is a problem that impacts patient care outcomes in anesthesiology.</td>
<td>4.38 (0.79)</td>
<td>4.24 (0.81)</td>
<td>−0.14</td>
<td>.2583</td>
<td>(−0.46, 0.18)</td>
</tr>
<tr>
<td>I received adequate information on the operation of the NMT monitor.</td>
<td>2.55 (1.31)</td>
<td>3.39 (1.14)</td>
<td>0.85</td>
<td>1.03E−05</td>
<td>(0.36, 1.33)</td>
</tr>
<tr>
<td>I am now confident that I know how to fully utilize the NMT monitor.</td>
<td>2.92 (1.26)</td>
<td>3.58 (0.95)</td>
<td>0.65</td>
<td>.001</td>
<td>(0.22, 1.08)</td>
</tr>
<tr>
<td>Estimate how many times you have used the NMT monitor for patient care.</td>
<td>27.4 (33.7)</td>
<td>62.1 (12.4)</td>
<td>34.7</td>
<td>.0291</td>
<td>(−6.6, 76)</td>
</tr>
<tr>
<td><strong>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</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apply the monitor to the patient?</td>
<td>3.93 (1.23)</td>
<td>4.58 (1.01)</td>
<td>0.65</td>
<td>.002</td>
<td>(0.2, 1.09)</td>
</tr>
<tr>
<td>Calibrate the monitor?</td>
<td>3.46 (1.31)</td>
<td>4.20 (1.23)</td>
<td>0.74</td>
<td>.002</td>
<td>(0.23, 1.24)</td>
</tr>
<tr>
<td>Utilize the TOF and TOFr stimulation mode?</td>
<td>3.56 (1.21)</td>
<td>4.27 (1.18)</td>
<td>0.72</td>
<td>.002</td>
<td>(0.24, 1.2)</td>
</tr>
<tr>
<td>Interpret the monitor values for TOF and TOFr?</td>
<td>3.72 (1.21)</td>
<td>4.08 (1.10)</td>
<td>0.35</td>
<td>.0464</td>
<td>(−0.11, 0.81)</td>
</tr>
<tr>
<td>Utilize the PTC stimulation mode?</td>
<td>2.86 (1.32)</td>
<td>3.38 (1.49)</td>
<td>0.52</td>
<td>.0203</td>
<td>(−0.06, 1.09)</td>
</tr>
<tr>
<td>Interpret the PTC monitoring values?</td>
<td>3.00 (1.34)</td>
<td>3.44 (1.31)</td>
<td>0.44</td>
<td>.0332</td>
<td>(−0.09, 0.97)</td>
</tr>
<tr>
<td>Adjust the stimulation current?</td>
<td>2.87 (1.59)</td>
<td>3.65 (1.36)</td>
<td>0.78</td>
<td>.006</td>
<td>(0.2, 1.37)</td>
</tr>
<tr>
<td>Utilize the monitor without calibration?</td>
<td>3.18 (1.58)</td>
<td>3.77 (1.21)</td>
<td>0.59</td>
<td>.0054</td>
<td>(0.04, 1.14)</td>
</tr>
<tr>
<td>Change the automatic time interval for stimulation?</td>
<td>3.80 (1.65)</td>
<td>4.30 (1.01)</td>
<td>0.50</td>
<td>.0118</td>
<td>(−0.01, 1.02)</td>
</tr>
<tr>
<td>Interpret error messages from the monitor?</td>
<td>2.34 (1.28)</td>
<td>3.05 (1.52)</td>
<td>0.71</td>
<td>.019</td>
<td>(0.12, 1.29)</td>
</tr>
<tr>
<td>Troubleshoot the monitor?</td>
<td>2.23 (1.17)</td>
<td>3.11 (1.68)</td>
<td>0.87</td>
<td>.0003</td>
<td>(0.26, 1.48)</td>
</tr>
<tr>
<td><strong>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</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The time to set up and calibrate the device</td>
<td>3.59 (1.21)</td>
<td>3.08 (1.32)</td>
<td>−0.52</td>
<td>.0102</td>
<td>(−1.03, 0)</td>
</tr>
<tr>
<td>The change in workflow for anesthesia induction (forget to apply and calibrate)</td>
<td>3.89 (1.17)</td>
<td>3.38 (1.33)</td>
<td>−0.51</td>
<td>.0111</td>
<td>(−1.02, 0.01)</td>
</tr>
<tr>
<td>The positioning of the patient precludes free thumb adduction.</td>
<td>4.15 (1.10)</td>
<td>3.95 (1.18)</td>
<td>−0.20</td>
<td>.28</td>
<td>(−0.66, 0.27)</td>
</tr>
<tr>
<td>The monitor returns values that are inconsistent with clinical signs of muscle relaxation.</td>
<td>4.24 (1.19)</td>
<td>3.70 (1.36)</td>
<td>−0.55</td>
<td>.007</td>
<td>(−1.07, −0.02)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Each item was presented with a 5-point Likert scale for responses; higher scores denote greater agreement with the statement.

<sup>b</sup>CIs that do not encompass 0 were considered meaningful.

<sup>c</sup>After Bonferroni correction for multiple (19) comparisons, P < .0026 was considered to denote statistical significance for any individual comparison.

Abbreviations: TOF, train-of-four; TOFr, train-of-four ratio.
chart. We constructed the chart by plotting the percentage of monitored cases vs the total number of cases with indications for monitoring (nondepolarizing drug used), week by week during the pre-education phase (phase 1). There were 28 weeks of monitor usage in phase 1, and we used the weekly percentage of cases using quantitative monitoring to set a median for baseline quantitative monitoring use (Figure 4). We followed this chart during phases 2 and 3, looking for excursions in quantitative monitoring use from the baseline. The median of weekly percent utilization (phase 1 vs other phases) of acceleromyography monitors during general anesthetics in which NMBDs were used in combination with typical neuromuscular reversal agents was established as the
Results

We released the quantitative monitors into the main operating room of our hospital and quantified use as the weekly fraction of cases receiving nondepolarizing NMBDs that also had quantitative blockade monitoring (see Figure 1). Figure 4 shows the run chart of quantitative monitor use week by week as the project progressed. Because of inadequate education on initial launch, the acceleromyography monitors were fully “reimplemented” with a more robust educational program by the second month of phase 2 of the project. Provider utilization rates increased from an initial baseline median of 24% to a weekly median use of 40% after the education period. During phase 2, the fraction of cases using quantitative monitoring exceeded the phase 1 baseline each week, and there was a strong signal of a shift in performance within 8 weeks of starting the education program. A global comparison of quantitative monitoring utilization showed 20% in phase 1 (1,484/7,152 NMBD cases) vs 40% in phase 3 (2,607/6,576 NMBD cases). The percentage of patients who received quantitative monitoring increased by 74% relative to baseline.

Table 2 lists the self-reported impacts of the educational program. Providers agreed that RNMB is a clinically important problem both before and after the educational program. Statistically significant \((P < .05; P < .0026\) after Bonferroni correction) change (or improvement) in survey scores after accounting for multiple comparisons was found in the following self-reported responses: “I received adequate information on the operation of the NMT monitor,” “I am now confident that I know how to fully utilize the NMT monitor” for patient care, as well as confidence in the provider ability to “apply the monitor to the patient,” “calibrate the monitor,” “utilize the TOF and TOF ratio stimulation modes,” and “interpret the PTC monitoring values.” (see Table 2). Inability to apply the device to an unrestrained thumb was a barrier to device use both before and after our education initiative. This is unsurprising: 22% of all anesthetics using NMBDs at our institution occur with both arms tucked at the patient’s sides. Respondents agreed less with the statement, “The monitor returns values that are inconsistent with clinical signs of muscle relaxation,” as a barrier to use, indicating that confidence in the device’s effectiveness improved with education (see Table 2).

Discussion

Effective examples for introduction of an available but not yet widely adopted quantitative neuromuscular blockade monitoring system and development of a new workflow for a large anesthesia department have not been widely reported in the literature. By implementing a blended-curriculum quality improvement educational program, we demonstrated change in practitioner knowledge, skill, and attitude with translation to safe clinical implementation of a new technology. Based on extensive literature evidence, we believe that this project has improved patient safety, as a surrogate measure, by decreasing RNMB after its implementation. 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 were not significantly changed by the project. This is likely because 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 set up and calibrate, change in workflow of anesthesia induction, positioning of the thumb for free adduction, and consistent monitor values) remained a perceived barrier to acceleromyography 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 using the monitoring device.

Further work is needed to encourage anesthesia providers’ use of the acceleromyography monitors. Educational efforts could be expanded to include surgeons (to reduce real or perceived production pressure associated with device application and calibration) and other surgical team members to help them to appreciate the benefits of acceleromyography monitoring and create additional support for implementation of the technology. At our institution, approximately 22% of general
anesthetics that use NMBDs have both arms tucked for surgical positioning. The use of positioning devices, such as arm “sleds” could be useful to allow for free thumb adduction. Increased appreciation of the impact of RNMB might help reduce barriers such as production pressure to start cases seen in the surgical environment. Incentivization strategies incorporating ongoing data reporting to individual providers and operating room teams should also be evaluated through a dashboard-type report to summarize individual use compared with the peer group. The quantitative monitors are less powerful than traditional handheld devices, stimulating with a lower voltage. The new devices are designed to detect low but clinically important levels of paralysis, whereas the qualitative monitors they replaced were designed to demonstrate deep levels of blockade. Clinician adaptation to this difference is an important factor in adoption. However, with less voltage in stimulation, the likelihood of direct muscle stimulation is reduced, which reduces RNMB. Because the acceleromyography monitors require calibration, any movement of the patient (ie, thumb or arm position) after calibration affects the subsequent data returned. Finally, although the increase in utilization relative to baseline is substantial, education alone was sufficient to motivate monitoring use in just 40% of cases. Thus, further interventions are required to achieve higher utilization in a larger percentage of cases.

Conclusion
Utilization of acceleromyographic technology has been shown in the literature to enhance patient care outcomes when NMBDs are administered. Despite the professional consensus on the effects of RNMB among providers, this problem continues to be a clinical challenge in anesthesia care. This project has the potential to serve as an exemplar for other settings wishing to adopt this or other new anesthesia technology. Furthermore, the ability of acceleromyography monitoring to enhance patient care through (1) a reduction in the number of RNMB events that are experienced, (2) decreased PACU length of stay, and (3) reduced total amount of NMBD administered has substantial promise for better patient care and as a subject for further research.

Introduction of equipment and technology into the clinical area should be done with adequate planning before initial release. Absent that, practitioner judgment of the utility of the device may preclude full utilization of the features of the device and the adoption and incorporation of the device into daily practice despite the relative value that it may provide.

REFERENCES


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DISCLOSURES
The authors have declared no financial relationships with any commercial entity related to the content of this article. The authors did not discuss off-label use within the article.