Study Title:	**Understanding the cognition and decision making of community anesthesiologists in their management of end-of-case neuromuscular blockade: A mixed methods study.** **NCT 04195178**
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2.1 Objectives & Hypotheses	2.1.1. Study Objectives We propose a remotely conducted prospective observational mixed-methods study using clinical vignettes and cognitive interviews (CIs) to better understand the decision making approaches and preferences of practicing community anesthesiologists with regard to the management of non-depolarizing neuromuscular blockade (NMB) at the end of general endotracheal anesthesia cases. The **objectives** of this initial study are to begin to understand: 1. When and *why* do community anesthesiologists choose to reverse NMB? 2. What are the preferences of community anesthesiologists regarding their decisions to reverse NMB, and what are the clinician and clinical case factors that influence those decisions? 3. What are the operational knowledge gaps of anesthesia professionals regarding their ability to follow best-practice evidence for the reversal of NMB? 4. Why do anesthesia professionals diverge from best-practice approaches and guidelines for the reversal of NMB? More generally, the program objective is to *refine and validate a novel methodology to delineate clinicians' decision-making strategies and triggers*. 2.1.2. Study Hypotheses For this initial study, we **hypothesize** that: 1. The clinical vignette-based decision survey method will describe the distribution of clinical variables and factors important to the decisions for community anesthesiologists' decision to reverse NMB. 2. There will be measurable differences in clinician demographics and practice attributes between those who closely follow evidence-based expectations for reversal of NMB and those who do not. We expect community practitioners who do not reverse NMB in accordance with current best evidence to be older, to not be fellowship trained or subspecialty certified, and to practice in lower acuity settings.
2.2 Background & Rationale, Significance of Selected Topic & Preliminary Data	2.2.1. Background and Significance Residual neuromuscular blockade (NMB) following general anesthesia continues to be a major problem for post-surgical patients.[1-4] Numerous studies now demonstrate that 20% to almost 60% (median of ~40%) of post-operative patients have residual blockade (i.e., weakness),[1,5-7] which can cause respiratory insufficiency, aspiration, and pneumonia.[1,7-10] Neither clinical signs of motor strength (e.g., hand grip, head lift)[11,12] nor qualitative twitch monitoring (i.e., visual or tactile assessment of train-of-four)[13,14] are reliable indicators of

adequate NMB reversal. While qualitative twitch monitoring is widely used, quantitative NMB monitors is a much more reliable method of assessing the degree of NMB and determining the need for reversal.[3]

Until the introduction of suggamadex, reversal of NMB agents (most commonly rocuronium or vecuronium) was accomplished with neostigmine or another anti-cholinesterase drug. These drugs can be ineffective if dosed inappropriately,[15] although a recent study by Murphy et al., showed that neostigmine administration in the face of near complete recovery of NMB was not associated with more weakness, a common misconception.[12] While suggamadex use appears to significantly reduce the incidence of residual NMB, it does not eliminate the problem,[1,16,17] especially if quantitative NMB monitoring is not used. [18]

As a result of ample scientific and clinical evidence, there is now a consensus among knowledgeable experts on the best practices for management of NMB.[4] Yet, a substantial proportion of community anesthesiologists do **not** follow these practices. They:

1) Do not use quantitative NMB monitors (which do have technical challenges to their use;[19])
2) Use clinical signs (e.g., hand grip, head lift) and/or qualitative twitch monitoring (e.g., presence of 4 twitch with a train of four stimulation);[8,13]
3) Fail to reverse or inadequately reverse NMB (e.g., because a sufficient duration of time has elapsed since the last dose of NMB);[11,20] and
4) Do not believe that their patients ever experience significant adverse events due to residual neuromuscular blockade.[20,21]

We know very little about the underlying reasons and motivation for these common clinical behaviors (decisions) that deviate from evidence-based best practices. Some have assumed that these practitioners have knowledge gaps (i.e., that they do not know or believe the literature evidence). However, many physicians fail to practice according to best evidence even when they know that evidence.[22]

Decision Making in Anesthesia. While there is ample medical literature about 'normative' (analytical) decision-making[23,24] as well as clinical decision-making in chronic care settings,[23,25,26] much less is known about decision making in acute care situations like anesthesiology. Prior research, primarily in other domains like aviation and the military, in 'naturalistic decision-making'[27,28] (also called 'fast thinking'[23]) are relevant but currently provide limited guidance on the role of different contextual factors in specific acute care decisions. We know that cognitive biases can adversely affect clinical decisions[29,30] but, with some

exceptions (risk tolerance in emergency room admitting decisions),[31,32] little is known about how such biases affect most clinical decisions.

Studying the 'Why' of Decision Making. Current methods to study *why* clinicians make specific decisions have limitations. Traditional survey methods have been unreliable and are prone to various biases that diminish the likelihood that individual's responses will accurately reflect actual practices. Survey methods have not been paired with immediate follow-up one-on-one cognitive interviews that can get at the underlying reasons behind the recorded answers as we now propose to do in the revised methods. Retrospective data mining, which depends on routine clinical documentation of the variables of interest can tell you what individuals do (within the constraints of documentation accuracy and completeness) but not why. Direct observations during clinical care may be the most reliable method of discerning what clinicians do but are inefficient, expensive, and without cognitive probes or interviews will not adequately reveal the rationale for the decisions (e.g., it could be the "right" decision but for the wrong reasons). Yet, asking the clinician for their decision rationale *in the moment* can be disruptive and is often unwelcome.

Observation of behavior during simulated care is more efficient and cost-effective but again, without additional methods, does not adequately inform our understanding of the cognitive processes underlying those behaviors. In contrast, cognitive interviews, such as the Critical Decision Method,[33] target the underlying cognitive processes associated with prior or hypothetical decisions. While perhaps the best method to ascertain the contextual factors influencing decisions, cognitive interviews can still be influenced by memory reshaping, hindsight bias, and other cognitive biases. In the present study, we propose to *combine* low-fidelity simulations (using clinical vignettes) that force clinicians to make targeted decisions followed immediately by focused cognitive interviews to discern why they made those specific decisions.

Our research team has conducted studies of decision-making and situation assessment, primarily of anesthesiologists during simulated care.[34-40] We have also done appreciable cognitive research informing the design and evaluation of informatics-based decision support.[41-43]

Since the original proposal, Naguib et al (ref) conducted an innovative survey study to assess anesthesiologists' understanding of existing evidence regarding neuromuscular blockade pharmacology and monitoring. They conducted an internet-based international survey of practicing anesthesiologists asking respondents to answer nine true/false questions related to the use of neuromuscular blocking drugs. Participants were also asked to rate their confidence in the accuracy of each of their answers on a scale of 50% (pure guess) to 100% (certain of

answer). 1,629 anesthesiologists completed the survey. The respondents correctly answered only 57% of the questions. In contrast, the mean confidence exhibited by the respondents was 84%, significantly greater than their accuracy. Of the 1,629 respondents, 1,496 (92%) were overconfident. While the authors clearly demonstrate overconfidence by anesthesiologists' about their knowledge regarding neuromuscular blocking agent pharmacology and monitoring, it is unknown to what extent this overconfidence contributes to their previously demonstrated deviation from evidence-based guidelines {REF}. Also, their study design did not optimally measure actual knowledge about this content domain nor how anesthesiologists approach management decisions about neuromuscular blockade, monitoring and reversal in actual practice.

2.2.2 Rationale for Study and Choice of Methods

We are interested in studying why experienced clinicians make certain decisions regarding the monitoring and reversal of neuromuscular blockade and, in particular, why they make decisions that are contrary to known evidence and currently accepted best practices. As described above, the decision to reverse NMB at the end of a general anesthetic is a good choice for study because: 1) it has been well documented that a substantial percentage of practitioners do not follow best practices; 2) the variables are *largely* circumscribed and well described; and 3) it can be framed as a binary decision.

The goals of our original proposal, achieving a more complete understanding of anesthesia professionals' management of neuromuscular blockade, remain important to improving patient safety. With the revised protocol, we will also advance general knowledge about the use of cognitive interviews (CIs), particularly in combination with surveys, to investigate clinicians' clinical management decisions.

2.2.3 Rationale for Proposed Change in Study Methods

Because this study was originally designed to be conducted one-on-one in-person with community anesthesiologists, the onset of COVID-19 in the Spring of 2020 shut down our research for two years. As COVID-19 receded in the second half of 2021, study team members across all sites conducted numerous pilot sessions, often done face-to-face, with both experienced and resident physicians. We used specially designed case vignettes and different versions of a survey tool with the goal of eliciting accurate decision descriptions expressed as curves. In parallel, we invested in initial software development to be able to generate clinician's decision curves from participant responses in near real-time so they could be available for the subsequent cognitive interviews. However, in these face-to-face pilot interactions, the anesthesiologist participants appeared consistently to report clinical practices and management decisions that they thought would be expected of them (i.e., "the oral boards answer") rather than what they might actually do in their clinical work. Further, despite repeated restructuring of the clinical vignettes and questions necessary to create decision curves, we determined that it was not possible to obtain unbiased curves within a reasonable time-period to conduct the study as originally designed.

	As described in the (new) last paragraph of the Section 2.2, we have identified an alternative method to decision elicitation using a survey tool that includes confidence self-assessment for each answer. There is evidence that this approach can generate data that may be closer to what community anesthesiologists would actually do in clinical practice [4,20, REF]. We propose to adopt this survey method with the modification of contextualizing the questions by preceding them with clinical vignettes that will provide the foundation for decision exploration during the subsequent cognitive interview (see **Section #2.3, Study Design**). Further, we believe it is no longer feasible to conduct this study face-to-face and now propose to conduct the revised study interactions virtually. The original study design was going to recruit participants via ASA MOCA courses. However, between modifications in the MOCA requirements and the persistence of the COVID pandemic, MOCA course offerings and enrollments are no longer sufficient to achieve the study aims. The proposed clinical vignette-based survey followed by pragmatic cognitive interviews will be feasible within current constraints and allow us to address the original study objectives.
2.3 Study Design	This will be a prospective observational simulation study of 36 experienced community anesthesiologists using clinical vignettes and cognitive interviews to better understand the decision-making approaches and preferences of practicing community anesthesiologists regarding the management of neuromuscular blockade (NMB) at the end of general endotracheal anesthesia cases. As described in more detail below, an anonymous survey will be distributed electronically to a national sample of anesthesiologists responding to a request to participate. We will strive to obtain survey responses from at least 150 experienced practitioners. All participants will receive the same survey which will include essential demographic questions, clinical vignette-based questions about neuromuscular blockage management and questions about their confidence in their answers. At the end of the survey, participants will be asked to indicate their interest in participating in a follow-up cognitive interview (CI). Thirty-six participants will then be randomly chosen to participate in the CI which will be conducted remotely by an experienced cognitive interviewer. These volunteer participants' responses will be made available to the CIs without revealing participant identity (e.g., a randomly generated code number instead of participant name will be used and none of the collected demographic data will be available to the CIs). Transcripts of the cognitive interviews will be coded by investigators blinded to participant identify.
24 Study Procedures	2.4.1 Study Participants Study participants will be a national sample of board-certified anesthesiologists who practice in community settings. We will recruit until 150 eligible participants have completed the entire survey and 36 participants have agreed to be interviewed. *Inclusion criteria* will be community anesthesiologists who are at least 0.5 FTE clinical and at least 50% of their cases involve general anesthesia.

Exclusion criteria will be those anesthesiologists who are less than two years post-residency training, anesthesiologists who are in an academic practice, those who spend less than 50% of their work week personally performing or supervising intraoperative anesthesia cases, those with practices that do not include at least 50% general anesthesia, and anesthesiologists who do not routinely make decisions about whether or not to reverse NMB during intraoperative anesthesia cases. Thus, for example, an anesthesiologist who has exclusively or largely a chronic pain practice would be excluded from this study.

2.4.2 Recruitment Procedures

We will recruit and consent participants online via various methods and through our contacts with subspecialty societies and specific community practice groups. An email will be sent to interested participants with a link to the survey. The survey will start with an IRB-approved e-consent process. Participants will be informed that all data will be anonymous or confidential. This will be followed by basic demographic and general clinical practice questions (Note that this survey has already been developed). Those participants who meet our inclusion criteria (see next paragraph) will be considered 'eligible' for participation while those who are excluded will be thanked and not continue with the study.

Eligible participants and will be presented with the clinical vignette-based decision questions. The entire survey process is expected to take less than 30 minutes. At the end of the survey, eligible participants will be asked if they are interested in enrolling in the second phase of the study about which they will be informed and then asked to sign an additional consent form. Their contact information will be obtained. We will recruit 36 consenting participants for the on-line cognitive interviews.

To minimize the risk of bias, we will inform potential participants that this is a study of decision making without disclosing the study's specific objectives or hypotheses. Further, we will also conceal the name of the Grantor. At the end of each study, we will disclose all of this information to the participant. We have experience getting IRB approval to do this in previous studies of clinician behavior and decision-making.

2.4.3 Participant Demographic and Practice Survey

Each participant will complete an already designed and tested web-based demographic survey that includes questions about their prior clinical training, prior clinical experience, and current clinical practice attributes. This is a modified version of the demographic survey we developed and used in the ongoing AHRQ-funded IMPACTS trial which was based on the completed and published AHRQ-funded Simulation-Assessment Research Group (SARG) Maintenance of Certification in Anesthesia (MOCA) project.[38] Our goal will be to collect enough

information (**Table 1**) about each participant's prior training and experience as well as about the nature of their current clinical practice (i.e., types of cases, volume, solo vs. group practice, etc.) to discern whether there are meaningful differences in NMB reversal decision making based on the distribution of these clinician-descriptive variables (Hypothesis 2).

Self-selection bias threatens the generalizability of outcomes in all human studies, since one cannot force randomly chosen individuals to participate. Nonetheless, there are techniques to optimize the heterogeneity of study participants. With only 36 study participants in the cognitive interview component of the study, we will not be able to stratify on more than a few key variables (e.g., small vs. large practice size, hospital vs. ambulatory practice, age cohorts, complexity of cases, etc.). As can be seen by these examples, there is likely to be appreciable correlation among some of these variables (e.g., those in ambulatory practices might be expected to do less complex cases than those working in tertiary care facilities). We will be able to explore such potential overlaps in advance using demographic data collected previously in the SARG MOCA study[38] and from more extensive demographic data obtained in the SARG IMPACTS study. From this, we will choose the best 'strata' on which to recruit participants to achieve better heterogeneity. We will use no more than 3 strata since it will be necessary to consider all strata combinations.

Table 1. Participant Variables to be Obtained in the Survey.

Data Element	**Sub-Element Description**	**Expected Categories or Data Elements**
Study site	NA	1-3
Geographic location	Pacific - CA, OR, WA, AK, HI West - AZ, CO, ID, MT, NM, NV, UT, WY Midwest - KS, IA, MN, MO, ND, NE, SD West South Central - AR, LA, OK, TX East North Central - IL, IN, MI, OH, WI East South Central - AL, KY, MS, TN South Atlantic - DE, FL, GA, MD, NC, SC, VA, WV Middle Atlantic - NY, NJ, PA New England - CT, MA, ME, NH, RI, VT	
Participant ID		00000
Participant demographics	Age	00.0 Years
	Declared gender	Male or Female
	Year graduated from residency	0000
	Years in practice	00.0
Participant training	Fellowship training	Y/N and type
	Additional clinical training	Y/N and type
	Subspecialty certification	Y/N and type
	Primary ABA certification date	00/0000
	Last ABA recertification date	00/0000

	Date of last exposure to didactics about neuromuscular blockade reversal	00/0000
Practice attributes	Average work week in hours	000.0 hrs
	% of week providing anesthesia care	00.0 %
	% of time doing cases alone (solo or non-supervision)	00.0 %
	% of cases done in a standalone surgicenter or office practice?	00.0 %
	Focus of practice	Primary types of cases performed*
	% of all cases in which NMB used	00.0 %
	Sugammadex use	Never to Always
	Quantitative monitoring use	Never to Always

* Categories of practice focus are: Acute pain/regional, ambulatory, cardiac, chronic pain, critical care, general (colorectal, ENT, orthopedics, plastics, urology, etc.), hepatic, obstetrics & gynecology, neurosurgical, pediatric, trauma, vascular, and other. Those who do mostly acute pain/regional or chronic pain will be excluded from this study.

Survey design and implementation. We have appreciable experience designing and successfully administering demographic and related survey tools for anesthesia professionals.[38,45-48] Further, we have captured many of the data elements in **Table 1** in a prior simulation-based study of board-certified anesthesiologists.[38] However, during the first phase of this study (i.e., first 6 months), we intend to pilot test and refine the survey tool. We present a draft survey during early stage interviews (see below) and inquire as to whether any elements are missing or potentially misleading. The final survey tool will be deployed via a web portal to maximize data capture efficiency.

2.5.4 Clinical Variables

Based on survey studies,[19-21] a number of clinical variables have been implicated as affecting anesthesia professionals' decision as to whether or not to reverse NMB. **Table 2** indicates the most commonly cited clinical variables.

Table 2. Preliminary list of clinical variables affecting the reversal decision.

Clinical variables	Units, method, or example(s)
Time since last dose of NMB	Minutes
Fade of the TOF	Visual observation and/or tactile assessment
Type of NMB drug used	Rocuronium, vecuronium, atracurium
Total dose of NMB administered	Milligrams
Respiratory parameters	Tidal volume, respiratory rate
Breathing pattern	Irregular, shallow, "looks weak"
Ability to maintain head lift	>5 sec or >10 sec

Perceived muscle strength	Hand grip, other

2.4.5 Clinical Vignettes

Each study participant will read and respond to written clinical vignette scenarios in which they must answer 1-3 questions about the management of patients who have an existing level of neuromuscular blockade. Each answer will be followed by a self-assessment of their confidence in their answer.

The vignettes will be relatively brief, realistic, and sufficiently detailed to provide appropriate context for the questions (and the subsequent cognitive interviews). A sample vignette is:

> "Mr. Jones a 45-year old 85 kg (BMI 30) male smoker, otherwise healthy besides chronic low back pain, is undergoing a two-level lumbar laminectomy in the prone position under general endotracheal anesthesia. Induction 4 hours (240 minutes) ago was with propofol 160 mg, rocuronium 40 mg, lidocaine 100 mg, and fentanyl 250 mcg. Intubation was easy. Mr. Jones has been maintained with isoflurane in air. Blood loss has been 200 ml and adequate crystalloid to maintain euvolemia. He has been hemodynamically stable with good oxygenation and ventilation. The surgeon is closing. The patient has started breathing spontaneously and is on pressure support ventilation with an end-tidal CO2 of 34 mmHg. One additional dose of rocuronium 20 mg was administered 45 minutes ago. A standard qualitative twitch monitor on the left ulnar nerve suggests a TOF of 4."

Vignette design and implementation. Drs. Weinger and Slagle have experience doing vignette-based studies.[36,50] During Phase 1, we also will design 6 medically similar vignettes (A to F) and pilot test them with academic anesthesiologists and residents to assure their clinical equivalence with regard to NMB reversal-related factors. To design these vignettes, we will start with a more detailed and focused literature review. We will then interview experts in NMB, and also conduct brief individual interviews of senior residents, faculty, and CRNAs at each of our study sites to identify those variables most commonly mentioned as being important to their NMB reversal decisions (these interviews will also help us to refine the cognitive interview guide and approach). The goal is to design vignettes that create equipoise between decision options to maximize sensitivity. We have experience using this method to design vignettes.[50,51]

During the study period, *we will ask participants to focus on what they actually do in their usual clinical practice.* We will structure the facilitator guide to avoid any avoidable bias or priming.

2.4.6 Cognitive Interviews

Within two days of completing the survey, eligible participants who agree to be interviewed will be contacted to schedule a cognitive interview. which will preferably take place within the next two weeks. The ~30-minute cognitive interview will elicit their thought processes including, goals and judgments and their attitudes regarding their decisions. We will use a cognitive task analysis

	(CTA) method that focuses on key decisions,[52] a technique we used in prior studies[53,54] and in the IMPACTS study. We will focus on the factors than appear to most influence the decisions of the participants with respect to the clinical vignettes and their answers to the questions. This method, based on an interview guide, consists of specific cognitive probes such as: "What were the factors you considered when you made the decision [not] to reverse this patient with these clinical attributes?" "Does this case remind you of a prior real case in which you [did or did not] choose to reverse the patient?" "What else might you do to make the decision?" Additionally, when the participant mentions a specific attribute that might have been a factor in their decision making, this will be explored further. In this regard, the interview will allow us to understand what factors are important considerations that experienced anesthesiologists use when deciding to use a reversal agent. The interviews will be audiotaped and transcribed (with participants' identity redacted from all transcripts) for analysis (see below). *Study Procedure Pilot Testing*. While we have done appreciable pilot testing of aspects of the proposed methods, we will still pilot test the entire revised procedure with anesthesiologists (residents or attendings). This will allow final refinement of the procedure as well as of the facilitator/interviewer guide. Before enrolling the first study participant, each already trained cognitive interviewer will pilot test the entire study procedure with a senior resident. This interview will be videotaped and sent to the Coordinating Center for review and 'sign off' by Anders and Weinger before allowing that interviewer to participate in study cases.
2.5 Statistical Analysis and Sample Size Justification	There will be two separate analyses – a quantitative analysis of the survey answers across participants *and* a qualitative analysis of the cognitive interviews. The quantitative analyses will be designed and conducted by the CRISS biostatistician, Matthew Shotwell, PhD while the qualitative analysis will be overseen by Shilo Anders, PhD a human factors engineer. The PI will be responsible for oversight of all analysis, interpretation, and dissemination activities. In these analyses, we will: a. Capture individual participants' responses to the survey question b. Conduct regression analyses to identify participant attributes that associate with specific decision patterns to reverse or not reverse the patient. c. Use robust qualitative methods (based on grounded theory) to iteratively code the interviews to discern the factors that influence the reversal decision. 2.5.1 Coding of survey responses Survey responses will be used to construct an overall evidence-based practice score for each participant that represents the degree to which participants adhere to evidence-based expectations for reversal of NMB in their daily practice. The overall score is the count of survey responses that are consistent

with evidence-based expectations and the respondent indicated greater than or equal to 70% confidence in their response.

2.5.2 Numeric and Graphical Descriptions of the Survey Results

Participant demographic and clinical practice characteristics (**Table 1**) will be summarized in a tabular fashion. These summaries will be stratified by dividing participants into thirds according to the tertiles of the overall evidence-based practice score derived from survey responses. Quantitative factors will be summarized using the median and interquartile range (IQR), and categorical factors will be summarized using percentages. In order to quantify the unadjusted associations between participant factors and clinical decision variables, tests for homogeneity in participant factors across strata will be implemented using the Kruskal-Wallis test or Chi-square test, as appropriate.

2.5.3 Statistical Analyses

A multivariable regression analysis will be implemented, using a proportional odds logistic regression, to evaluate the adjusted associations between participant demographic and clinical practice characteristics versus overall evidence-based practice score scores. A relaxed-lasso method will be used to select which participant characteristics are used in the regression analysis.[55] This method selects factors using a lasso method (where the lasso penalty is selected using a cross-validation to avoid model overfitting). Clinical decision variables are then regressed onto the selected participant factors without lasso penalty. The un-penalized regression analysis, and the associated Wald-type 95% confidence intervals and tests will form the basis for statistical inferences.

In general, the lasso variable selection technique puts all variables on the same footing, in the sense that any and all might be excluded from the regression model. However, the following characteristics will be will be *not* be subject to exclusion by the lasso method: routine use of sugammadex in clinical practice, sex, and years of practice.

For all regression analyses, the relevant graphical and quantitative regression diagnostics will be examined.[56] Alternative model structures or data transformations will be considered where necessary to achieve acceptable diagnostics. The effects of independent variables and covariates will be modeled in an additive fashion (i.e., without interactions), and quantitative covariates will be modeled using splines to allow for possible nonlinear associations. No adjustment will be made to control a familywise type-I error rate.[57] All statistical tests will be implemented using a fixed type-I error rate of 5%.

2.5.4 Sample Size

The analyses described above are largely exploratory or qualitative. We use the Wilcoxon test, which is closely related to proportional odds logistic regression, to provide a gauge of statistical precision. For a type-I error of 5%, there is approximately 80% power to detect a concordance probability of 76% when there are 17 participants in each of two groups (36 total). The concordance probability is the probability that a randomly chosen participant in one group will have a greater outcome (i.e., overall evidence-based practice score) than a randomly chosen participant in the other group. Thus, the proposed sample size is sufficient to identify associations between participant characteristics and evidence-based practice scores, if the strength of association is similar to that represented by a concordance probability of 76%. In addition, these results will also provide much-needed preliminary data for a larger study to understand this type of clinical decision-making more fully.

2.7.5 Qualitative Analysis

Our *approach* will start with iterative coding and analysis of the narrative cognitive interview data, without knowledge of participant identity or attributes. We will initially code interview transcripts using a grounded theory approach.[58,59] Throughout the analysis, coding will remain flexible as different factors emerge as relevant to the decision making process. The approach will identify all articulated decision factors and themes, and their corresponding relationships, because it is grounded in the empirical data and unconstrained by prior cognitive theories that may not reflect the current dynamic acute care environment.[60] We will use a qualitative data analysis tool such as NVivo™[61] to facilitate coding.

The coding process will involve line-by-line analysis of 6 participant's interview transcripts. Two team members will identify short, coherent excerpts (phrases or sentences) and label them with one or more codes (e.g. type of factors that participants mentioned). The analysts will then meet and reach consensus on an initial code book. We will also capture ways that factors cluster together to create meaningful decision model themes for diagnosis or treatment.[62] We will then code the next 6 transcripts and refine the code book. The analysts will then meet with the entire research team to present and review their results to obtain feedback which will guide the final analysis. The next 6 transcripts will be used to assess coding reliability which will be deemed acceptable when inter-coder reliability is good (Kappa ≥0.7).[63,64] If unacceptable, then coding will continue iteratively until reliability is adequate. Coders will go back and recode as necessary the original cases. Once all transcripts are coded, the comprehensive set of factors and themes will be further explored through frequency analysis and examination of concurrent factors or clusters of factors around the various decision thresholds. If appropriate, an exploratory regression

	analysis could be performed between decision patterns and participant variables.
2.6 Adverse Experience Reporting	Not applicable.
2.7 References	**Citations** 1. Brull SJ, Kopman AF: Current status of neuromuscular reversal and monitoring: Challenges and opportunities. *Anesthesiology* 2017; 126: 173-190 2. Brull SJ, Prielipp RC: Neuromuscular monitoring and the cost of antagonism: when will we learn? *Anaesthesia* 2017; 72: 1557-1558 3. Murphy GS: Neuromuscular monitoring in the perioperative period. *Anesth Analg* 2017 4. Naguib M, Brull SJ, Kopman AF, Hunter JM, Fulesdi B, Arkes HR, Elstein A, Todd MM, Johnson KB: Consensus statement on perioperative use of neuromuscular monitoring. *Anesth Analg* 2017 5. Fortier L, McKeen D, Turner K, de Médicis É, Warriner B, Jones P, Chaput A, Poulio TJ, Galarneau A: The RECITE Study: A Canadian prospective, multicenter study of the incidence and severity of residual neuromuscular blockade. *Anesth Analg* 2015; 121: 366-72 6. Naguib M, Kopman AF, Ensor J: Neuromuscular blockade and postoperative residual curarisation: a meta-analysis. *Brit J Anaesth* 2007; 98: 302-16 7. Stewart P, Liang S, Li Q, Huang M, Bilgin A, Kim D, Phillips S: The impact of residual neuromuscular blockade, oversedation, and hypothermia on adverse respiratory events in a postanesthetic care unit: A prospective study of prevalence, predictors, and outcomes. *Anesth Analg* 2016; 123: 859-68 8. Naguib M, Brull SJ, Johnson KB: Conceptual and technical insights into the basis of neuromuscular monitoring. *Anaesthesia* 2017; 72 Suppl 1: 16-37 9. Bronsert M, Henderson W, Monk T, Richman J, Nguyen J, Sum-Ping J, Mangione M, Higley B, Hammermeister K: Intermediate-acting nondepolarizing neuromuscular blocking agents and risk of postoperative 30-day morbidity and mortality, and long-term survival. *Anesth Analg* 2017; 124: 1476-83 10. McLean D, Diaz-Gil D, Farhan H, Ladha K, Kurth T, Eikermann M: Dose-dependent association between intermediate-acting neuromuscular-blocking agents and postoperative respiratory complications. *Anesthesiology* 2015; 122: 1201-13 11. Brull SJ, Naguib M: How to catch unicorns (and other fairytales). *Anesthesiology* 2017 12. Murphy GS, Szokol JW, Avram MJ, Greenberg SB, Shear TD, Deshur MA, Benson J, Newmark RL, Maher CE: Neostigmine administration after spontaneous recovery to a train-of-four ratio of 0.9 to 1.0: A randomized controlled trial of the effect on neuromuscular and clinical recovery. *Anesthesiology* 2017

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