Practice Improvements Based on Participation in Simulation for the Maintenance of Certification in Anesthesiology Program

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ABSTRACT

Background: This study describes anesthesiologists' practice improvements undertaken during the first 3 yr of simulation activities for the Maintenance of Certification in Anesthesiology Program.

Methods: A stratified sampling of 3 yr (2010–2012) of participants' practice improvement plans was coded, categorized, and analyzed.

Results: Using the sampling scheme, 634 of 1,275 participants in Maintenance of Certification in Anesthesiology Program simulation courses were evaluated from the following practice settings: 41% (262) academic, 54% (339) community, and 5% (33) military/other. A total of 1,982 plans were analyzed for completion, target audience, and topic. On follow-up, 79% (1,558) were fully completed, 16% (310) were partially completed, and 6% (114) were not completed within the 90-day reporting period. Plans targeted the reporting individual (89% of plans) and others (78% of plans): anesthesia providers (50%), non-anesthesia physicians (16%), and non-anesthesia non-physician providers (26%). From the plans, 2,453 improvements were categorized as work environment or systems changes (33% of improvements), teamwork skills (30%), personal knowledge (29%), handoff (4%), procedural skills (3%), or patient communication (1%). The median word count was 63 (interquartile range, 30 to 126) for each participant's combined plans and 147 (interquartile range, 52 to 257) for improvement follow-up reports.

Conclusions: After making a commitment to change, 94% of anesthesiologists participating in a Maintenance of Certification in Anesthesiology Program simulation course successfully implemented some or all of their planned practice improvements. This compares favorably to rates in other studies. Simulation experiences stimulate active learning and motivate personal and collaborative practice improvement changes. Further evaluation will assess the impact of the improvements and further refine the program. (Anesthesiology 2015; 122; 1154–69)

IN 2010, simulation programs endorsed by the American Society of Anesthesiologists (ASA) began offering a high-fidelity, mannequin-based simulation experience to satisfy the American Board of Anesthesiology requirements for the Maintenance of Certification in Anesthesiology Program (MOCA®) simulation course, specifically, for the Practice Performance Assessment and Improvement (PPAI) requirement.[1*]

The American Board of Medical Specialties requires member boards to include a PPAI element for the Program for Maintenance of Certification (ABMS MOC®). For other disciplines, for example, primary care specialties, PPAI

What We Already Know about This Topic

- MOCA requires assessment and improvement of practice performance
- Simulation courses established under the aegis of the American Society of Anesthesiologists include follow-up evaluation of whether these courses affected subsequent practice

What This Article Tells Us That Is New

- In a review of 634 MOCA simulation course participants, 94% successfully implemented some or all of their planned practice improvements, which focused mostly around environment or systems changes, teamwork skills, and personal knowledge

This article is featured in "This Month in Anesthesiology," page 1A. Preliminary results from this study were presented at the American Society of Anesthesiologists (ASA) Simulation Education Summit on May 18, 2013, in Chicago, Illinois, and as a late-breaking abstract at the ASA Annual Meeting on October 14, 2013, in San Francisco, California.

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* The American Board of Anesthesiology Maintenance of Certification in Anesthesiology Program (MOCA) Web site. Available at: http://www.theaba.org/Home/anesthesiology_maintenance. Accessed April 6, 2014.

may be accomplished by improvements derived from chart review. A more realistic contextual framework was deemed necessary for anesthesiologists because they care for patients in a dynamic, stressful environment requiring quick decisions.[2] Simulation, which has been shown to create a realistic environment similar to a patient care setting,[3,4] was chosen as a required PPAI activity to stimulate practice improvement. It allows anesthesiologists to experience and reflect on their performance particularly during situations of crisis and high acuity—situations when patient care is most critical. MOCA case scenarios, often drawn from real closed claims cases, include life-threatening, sometimes rare, conditions requiring urgent patient management and teamwork skills for optimal outcome.

The addition of a simulation course supports the American Board of Medical Specialties' desired evolution of MOC from a recertification program to a lifelong learning and self-assessment program.[5–7] This use of simulation, specifically in the PPAI element of MOCA, deliberately incorporates an experiential strategy to activate the learners to reflect on ways to improve their practice, especially concerning management of challenging situations. Most MOCA simulation courses confer continuing medical education (CME) credit consistent with changes in CME that emphasize practice improvement.[8–10]

Maintenance of Certification in Anesthesiology Program simulation courses are offered at simulation programs endorsed by the ASA.[1] To qualify for MOCA credit, participants in these programs are required to propose practice improvement changes prompted by course participation. They are also required to complete a follow-up report within 90 days of the course on their actions and the status of meeting the improvement goals they had set. In this report, we present the results of 3 yr of course data with respect to the practice improvements proposed by participating anesthesiologists and their success in implementing those plans. Specifically, our primary aim is to assess the frequency and type of improvements that were completed and any factors that influence completion. Secondary aims are to assess the number of improvements that were deemed measurable and to analyze the frequency and type of non-anesthesiologist healthcare providers targeted by the anesthesiologists' improvement plans.

Materials and Methods

Study Design

We conducted a retrospective mixed-methods analysis of practice improvement plans proposed and implemented after simulation course participation.

Data Resources/Materials

With University of California, Los Angeles Institutional Review Board (Los Angeles, California) approval, we reviewed de-identified self-reported data collected from participants after a daylong MOCA simulation course taken at an ASA-endorsed simulation center. Data from the first 3 yr of MOCA simulation courses, from January 2010 to December 2012, were compiled and analyzed. The practice improvement reports from all participants enrolled in MOCA simulation courses during this time period were eligible for inclusion in this study. The course logistics and program development are described in detail in a previous article.[1] We have provided the postcourse data collection forms in appendices 1 and 2. In brief, course participants were asked to list at least three practice improvement plans that they would implement after the course. ASA contacted each person *via* e-mail on a monthly basis, asking them to provide a follow-up report on whether each plan was completed (yes/no/partially). Participants were also asked to write about the details of implementation success or obstacles encountered. Such a follow-up report was required within 90 days of the course for a participant to receive credit for this part of their MOCA requirements.

Sampling

Of 1,275 course participants eligible for analysis, we randomly sampled 50% for review and coding. To ensure comprehensive representation, sampling was stratified as follows:

1. By simulation center: The number of sampled participants per center was proportional to the total number of course participants per center, except at centers that enrolled less than five participants. In those centers, all participants were included in the sample.
2. By years of practice: Equal numbers of participants were selected from among those above and below the median practice duration (7 yr for the entire pool of available participants).
3. By practice setting: The number of sampled participants in academic, community, and military/other practice was proportional to the number from those settings in the total pool of eligible participants.

Development of Coding Scheme

Using an iterative process, we developed a coding scheme for characterizing the practice improvement plans and follow-up reports. We used an analytic process of coding that is consistent with grounded theory and qualitative research.[11–13] Each codeable unit of text (a phrase/statement that was determined by the investigators to convey a single distinct idea) was categorized according to our coding scheme. Items coded included categories and subcategories (topic themes and subtopics), target (whether improvements were directed toward the participants themselves or involved others), measurability (whether the plan was specific and sufficiently detailed to allow observable or quantifiable measurement of progress), and completion (whether the plan was implemented). Each participant submitted at least three plans for analysis. Many participants proposed two distinct improvements within each plan; these were each coded and counted separately. Measurability and completion were determined per plan rather than per improvement.

For the first step, four study investigators (A.R.B., Y.M.H., R.H.S., and J.B.C.) reviewed and discussed the first 10 participants' practice improvement plans together to get a general sense of emerging themes (fig. 1). We agreed to code plans as either measurable or not measurable and assigned the following targets: self, other anesthesia providers, other non-anesthesia physicians (*e.g.*, surgeons), and other non-anesthesia non-physician personnel (*e.g.*, pharmacists, operating room/intensive care unit/postanesthesia care unit nurses). To code themes from the narratives, the investigators independently reviewed 25 participants' plans to develop keywords and to generate coding categories. These were discussed again as a group to calibrate interpretation of the written comments. Discrepancies were noted and resolved by consensus. We had few disagreements on determining the keyword coding. For entries that were vague or nonspecific, such as one or two word statements (*e.g.*, entries such as "Communication" or "Intraosseous access"), we agreed to code them on a broad topic/category basis, rate them as "not measureable" and assign the target as "self" (as opposed to colleagues).

To reach saturation of themes, two investigators (A.R.B. and Y.M.H.) independently reviewed an additional 200 plans to identify further topic categories for the coding scheme. Each separately generated a list of categories and subcategories and included examples to provide an operational definition for the coding scheme. After evaluation of 200 participants' plans, we had reached saturation in terms of new coding categories, and the lists were consolidated. Authors R.H.S. and J.B.C. reviewed the consolidated categories with A.R.B. and Y.M.H. and made further refinements to clarify the coding category wording and their definitions. All discrepancies were resolved by group discussion, acknowledging that we could not gather additional information since responses were de-identified, precluding contact with participants to clarify their responses. Finally, four authors (A.R.B., Y.M.H., R.H.S., and J.B.C.) coded 20 of the same participants' data with the consolidated, final coding scheme (appendix 3) to assess whether consensus could be reached and whether the keywords identified were comprehensive. We calculated interrater reliability for categories and measurability and determined *a priori* that a κ value of 0.75 would be considered an acceptable interrater reliability to finalize the coding scheme among three raters who analyzed the data. The interrater reliability for pair-wise comparisons was 0.92 (average κ for category; range, 0.83 to 1.0) and 0.89 (average κ for measurability; range, 0.78 to 1.0).

Statistical Analysis

We performed content analysis on all textual data. Three investigators (A.R.B., Y.M.H., and R.H.S.) each independently coded one third of the written narratives from the sample using the final coding scheme for categorization coding. We resolved questions through discussion and consensus between all three coders. Using an Excel (Microsoft, USA) spreadsheet function, we counted the words for the combined plans of each participant and for their implementation follow-up report. We computed frequency distributions of text length (histograms and percentiles, 25, 50, and 75%) as one indicator of effort and thought put into the plans.

Using JMP v11 (SAS Institute Inc., USA), SPSS v22 (IBM Corporation, USA), and Stata/IC v.13.1 (StataCorp LP, USA), we conducted a descriptive analysis to determine the frequencies of categories for the improvement plans. We examined how practice setting, measurability, years of experience, targets of plans, and simulation center affect completion using univariable and multivariable models.

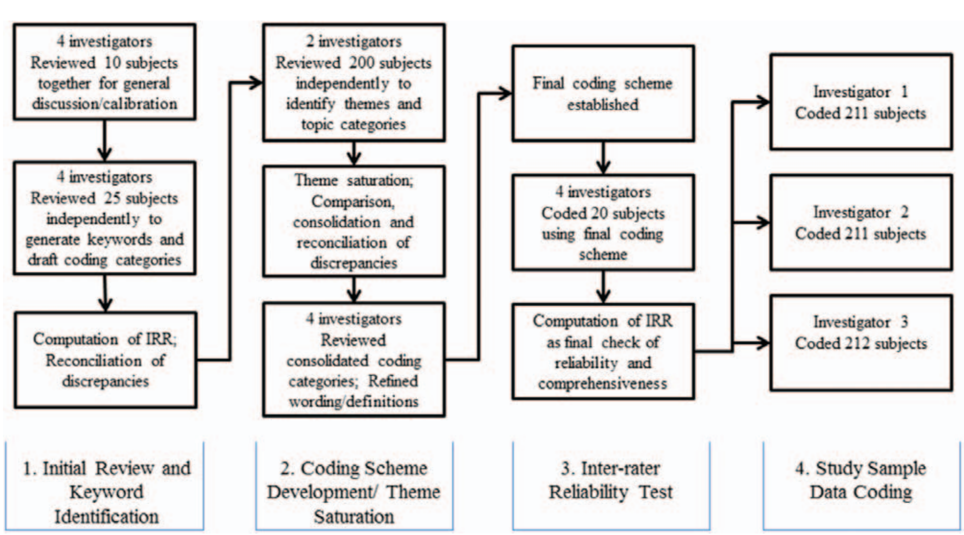

Fig. 1. Flow diagram of coding process. An illustration of the iterative process of coding scheme development. IRR = interrater reliability.

We recoded the three-category completion variable into a dichotomous variable, combining the categories of partially completed and completed into a single category, which was used as the outcome variable in a series of random-intercept logistic regressions. We used random-intercept models to account for the fact that participants had more than one plan and traditional (fixed effects) models for variables that were participant, and not plan, specific (setting, experience, and center). We used the following predictor variables: setting, measurability, experience, target, and simulation center. Setting was coded as a three-level variable: academic, community, and military/other; measurability, a binary variable (yes or no); and experience, a continuous variable (number of years). Target was coded as a continuous variable comprised of the sum of targets from four categories: self, anesthesia providers (*e.g.*, other anesthesiologists, certified nurse anesthetists), non-anesthesia physicians (*e.g.*, surgeons), and non-anesthesia non-physician providers (*e.g.*, nurses, pharmacists, allied health professionals). Simulation centers with less than 10 sampled participants were collapsed into a single group, which was treated as a center during analysis.

Predictors with unadjusted *P* values less than 0.20 in the univariable analysis were retained in the multivariable analysis. A Bonferroni correction was made to the *P* value of the variables in the multivariable model to account for multiple comparisons (adjusted *P* value = unadjusted *P* value times the number of variables in the multivariable model). An α value of 0.05 was used for all tests of statistical significance.

Results

Between January 2010 and December 2012, 1,275 individuals enrolled in 303 MOCA simulation courses at 29 different simulation centers located in 20 states. Fourteen participants were excluded because their follow-up reports were not available at the time of analysis. Stratified sampling identified 634 course participants (50% of 1,261) for coding and analysis (fig. 2).

Of the 634 participants analyzed, approximately 41% (262) were from academic settings, 54% (339) were from community practice settings, and 5% (33) were from military or other settings. These proportions were representative of the entire pool of course participants. Participants who characterized their work environment as a combination of two or more of these areas were placed in the category labeled "other." The participants' median number of years in practice was seven, with an interquartile range of 4 to 9 yr (range, 1 to 43 yr). The number in the sample from the 29 simulation centers varied (range, 2 to 59 participants) due to their differing number of total MOCA participants during the study period. All but 10 of the 634 were enrolled in MOCA.

Based on the sampling scheme, a total of 1,982 plans (554 participants had three plans and 80 had four plans) were analyzed for text length, categorization, target, completion, and measurability. On analysis, these plans contained a total of 2,453 improvements (some plans contained two improvements).

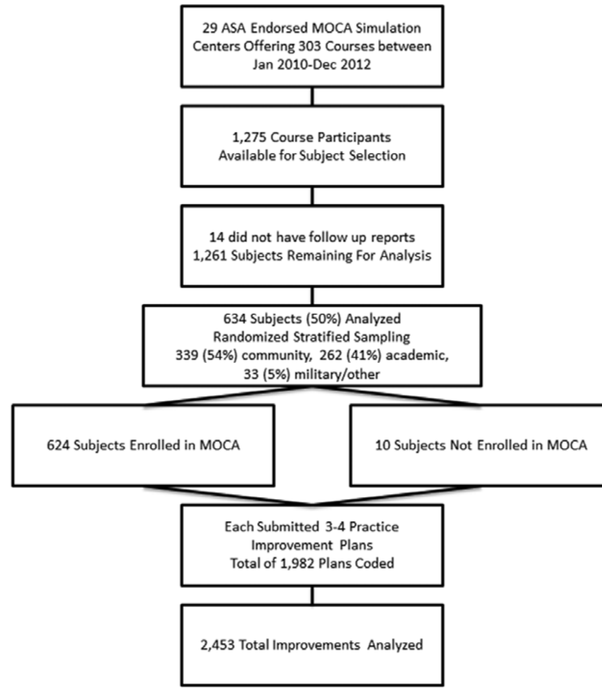

Fig. 2. Study sample. Descriptive statistics and study sample demographics are outlined based on the sampling schema. Each participant was required to submit at least three practice improvement plans and some included two distinct improvements within each plan. ASA = American Society of Anesthesiologists; MOCA = Maintenance of Certification in Anesthesiology Program.

Practice Improvement Plans Submitted and Implemented

Each of the 2,453 improvements was assigned to one of seven categories (table 1). Of the seven categories, improvements were most often categorized as related to the work environment ("system," 33% of 2,453 improvements), teamwork skills (30%), or personal knowledge (29%). Other categories were significantly less frequent: handoff (4%), procedural skills (3%), patient communication (1%), and other (<0.2%). Examples of significant improvements implemented are in table 2.[14]

Completion, Measurability, Targets, and Word Count of Plans

Table 3 summarizes completion, measurability, and targets of the practice improvement plans. Of 1,982 plans rated for measurability, 74% (n = 1,467) were considered specific enough to qualify as measurable. Based on follow-up reports, 79% (n = 1,558) of plans were fully completed, 16% (n = 310) were partially completed, and 6% (n = 114) were

Table 1. Most Prevalent Practice Improvement Plans within Each Category

Category and Subcategories*	Percent within Category
1. System (N = 820; 33% of total 2,453 improvements)	
Equipment/Medications (n = 258): procure equipment or medications for a unit or hospital	32%
Education (n = 212): teach others about managing specific emergencies, *e.g.*, difficult airway	26%
Checklist (n = 127): create/implement cognitive aids in practice settings	15%
Policy (n = 92): create departmental or institutional processes and procedures	11%
Simulation (n = 85): use simulation as a tool for training and quality improvement	10%
2. Teamwork/CRM (N = 737, 30% of total 2,453 improvements)	
Communication (n = 412): improve communication by voicing mental models and concerns; clarifying roles; using directed, closed-loop strategies, *etc*.	56%
Leadership (n = 139): improve leadership skills by assuming/designating a leader, delegating tasks, exercise assertiveness, and encourage input from team	19%
Situation (n = 60): improve situation awareness by maintaining vigilance, being aware of cognitive errors, and minimizing common errors	8%
Resource (n = 48): use available resources such as personnel, plan, equipment, and cognitive aids	7%
Help (n = 28): call for help early	4%
3. Knowledge (N = 699, 29% of total 2,453 improvements)	
Guideline (n = 312): review specific treatment algorithms and clinical guidelines	45%
Function/location (n = 228): find out how equipment works and where it is located within practice setting	33%
Application (n = 68): apply the lessons learned in the course to practice, such as use a specific skill for a procedure or situation	10%
Policy (n = 46): review hospital policies and guidelines such as emergency evacuation or mass hemorrhage protocols	7%
Literature (n = 31): review and stay up to date with current articles to practice evidence-based medicine	4%
4. Handoff (N = 88, 4% of total 2,453 improvements)	
Communication (n = 52): improve communication during transfer of care	59%
Checklist (n = 31): develop or use a checklist for handoffs	35%
5. Procedure (N = 82, 3% of 2,453 improvements)	
Airway (n = 57): practice difficult airway procedures such as cricothyrotomy or use specific tools such as fiber-optic bronchoscopy, *etc*.	70%
Access (n = 10): practice intraosseous line placement	12%
Ultrasound (n = 10): use ultrasound as diagnostic tool	12%
6. Patient (N = 27, 1% of total 2,453 improvements): improve skills in communicating with patients	
7.Other (N = 4, <0.2% of total 2,453 improvements): anything that does not fit into the above categories	

* Only the most frequently identified subcategories are listed; therefore, subcategory numbers do not add up to total N in each category.
CRM = crisis resource management.

not completed within the 90-day reporting period. The target of the plan included self in 89% of plans and others in 78% of plans. Of those that involved others, the following were included: other anesthesiologists/anesthesia providers (50% of plans), non-anesthesia physicians (16% of plans), and non-anesthesia non-physician providers (*e.g.*, nurses, 26% of plans). The median word count of plans was 63 (interquartile range, 30 to 126; minimum, 5; maximum, 444) and of the follow-up reports was 147 (interquartile range, 52 to 257; minimum, 1; maximum 842) (fig. 3, A and B).

Predictors That Affect Completion

In the univariable models, center, practice setting (academic, community, and military/other), and years of experience did not predict completion (table 4, individual center data not shown). If plans were deemed measurable, the odds of completion increased by a factor of 1.95 (odds ratio, 1.95; 95% CI, 1.01 to 3.76; $P = 0.047$). When participants targeted other anesthesia providers or interprofessional colleagues (*e.g.*, surgeons, nurses, or pharmacists), they were more likely to complete their plans (table 4). Participants who targeted only themselves, and no one else were less likely to complete their plans (odds ratio, 0.29; 95% CI, 0.11 to 0.78; $P = 0.015$) than participants who targeted any other group.

Predictors with P value less than 0.20 in the univariable analysis (measurability, experience, and target) were retained in the multivariable analysis; setting and center were dropped. In the multivariable model, measurability no longer predicted the likelihood of completion (odds ratio, 1.57; 95% CI, 0.79 to 3.08; $P = 0.591$; table 5). Experience was not statistically significant in the multivariable model ($P = 0.276$). However, after controlling for the other predictors, target was significant in the multivariable model. Participants who target more groups of interprofessional colleagues in their plans have increased odds of completing their plans (odds ratio, 1.29; 95% CI, 1.06 to 1.57; $P = 0.036$).

Table 2. Examples of Implemented Plans

1	I printed, laminated, and spiral bound a series of 12 critical event checklists for use in the ORs in my hospital. Health system leadership distributed the cognitive aid to all the hospitals in our system.
2	I realized how haphazard my approach is to common scenarios. To rectify that, I started using index cards and created a collection of various scenarios that I might encounter in the OR. I wrote down the differential diagnosis in each case and the algorithm that I should follow. I have been carrying this stack of index cards with me to the OR and practice these algorithms with my residents. Hopefully, by repeating these over and over again, I will be more methodical when such a situation does arise.
3	I met with our OR nurse managers about improving communication. The nurses told me that they want more opportunities for education for their RNs, so I have held educational conferences about improving communication for the preoperative and PACU nurses. The second such conference was held yesterday, and I have received positive feedback about our anesthesiologists taking the time to present these topics to the nurses.
4	I created a handoff template that included key information such as relevant and abbreviated medical history, difficulty of intubation, IV access, and plans for extubation. I carry these cards with me and placed several in the top drawer of the anesthesia cart so that other providers have access to them. Not only has this made my handoff to other providers easier but they also now know what information to expect me to request of them, so communication is more efficient.
5	I became interested in the use of intraosseous access for fluid administration after I had occasion to use this technique, which I learned in the course, during a code to successfully resuscitate a patient. I organized grand rounds for our department that focused on the use of these devices for urgent/emergency access.
6	Since the simulation course I have reviewed management of the various abnormal cardiac rhythms which have changed considerably since I last reviewed them!! More importantly, I have made efforts within our department to limit “turn over” of medically complex cases. We also created a system for the anesthesia team to use when turnover is absolutely necessary. Finally, I have made more of an effort to communicate effectively with the whole team during crisis situations.
7	After the SIM course, I had an opportunity to talk to the chief pharmacist for our hospital. Unfortunately, he was not aware of the purpose of lipid emulsion use for LAST. I discussed this with him and gave him references including LipidRescue Web site information. We decided to place lipid emulsion in each crash cart in areas in the main OR and Ambulatory Surgery Center where local anesthetics are frequently used. We also made laminated cards with lipid rescue protocol and placed them in each crash cart. I also presented importance of lipid rescue in local anesthetics intoxication and adequate use of lipid rescue at Morning Conference.
8	Until my MOCA simulation training, I did not know that the Ambulatory Surgery Center where we do many regional anesthetics did not have lipid emulsion available in case of LAST. I met with the OR manager and the members of my department to discuss the use of lipid emulsion in LAST and to identify a plan to acquire and stock lipid emulsion. We have acquired the medication and have a plan to make sure it is in the block carts.
9	After coming back from the course, I examined the contents of our MH cart. To our surprise, all the dantrolene vials inside the cart were expired. We also realized that we did not have enough vials for the appropriate dose of dantrolene for an adult patient. After fixing these two immediate problems, we discussed putting in place a new system so we can assure that the MH cart is checked and properly stocked. We placed a laminated card on top of the MH cart with the next date when the contents of the MH cart should be checked, the expiration date of dantrolene vials, and the total amount of dantrolene needed (36 vials).
10	The course made me realize that the surgical team in the OR actually might not have an in-depth understanding about the anesthetic plans and risks of the case. I now explain these to the surgeons and nurses. To my surprise, they have shown significant interest in these facts. This has improved our communication and my own vigilance and preparedness for the case.
11	Much to our surprise, we discovered at our MOCA course that we are not familiar with the way our resuscitation equipment (such as our defibrillator) works, and we know very little about its function. We now run mock drills so we learn how to use this equipment, and should we need it in an emergency.
12	My hospital does not have guidelines on the perioperative management of patients with OSA. We have a large population of morbidly obese patients. I believe this is a prime setting for initiation of hospital-wide guidelines for the management of patients with OSA. Unfortunately, I have been unable, up to this time, to successfully implement standing OSA guidelines. Practitioners in both the surgical and anesthesia specialties were hesitant to initiate guidelines that would apply to all patients and rather wanted to approach each patient on a case-by-case basis. Although frustrating to not have been able to get a consensus on standing hospital-wide guidelines, there were some positive outcomes. I have promoted awareness among my colleagues of the dangers of OSA. Many did not even know that the ASA had issued practice guidelines. Many practitioners felt that the STOP Bang scoring system is a useful tool—they had not seen it before. Furthermore, I believe I have promoted awareness in having surgeons tell their patients to bring their CPAP machines to the hospital.

Examples are edited to maintain anonymity.

ASA = American Society of Anesthesiologists; CPAP = continuous positive airway pressure; IV = intravenous; LAST = local anesthetic systemic toxicity; MOCA = Maintenance of Certification in Anesthesiology Program; MH = malignant hyperthermia; OR = operating room; OSA = obstructive sleep apnea; PACU = postanesthesia care unit; RN = registered nurse; SIM = simulation; STOP BANG = an acronym for the sleep apnea screening questionnaire (see Reference 14): **S**noring, **T**ired/fatigued/sleepy, **O**bserved apnea, **P**ressure (high blood pressure, medications), **B**ody mass index >35 kg/m^2; **A**ge >50 yr, **N**eck circumference >40 cm, **G**ender = male.

Table 3. Completion, Measurability, and Targets of Practice Improvement Plans

Item	n (%)
Completed	
Fully	1,558 (79)
Partially	310 (16)
No	114 (6)
Measurable	
Yes	1,467 (74)
No	515 (26)
Target of plan*	
Targeted self	1,764 (89)
Targeted others	1,546 (78)
Other anesthesiologists/anesthesia providers	990 (50)
Non-anesthesia physicians (*e.g.*, surgeons)	320 (16)
Non-anesthesia non-physicians (*e.g.*, nurses, pharmacists)	525 (26)

* There can be multiple targets per plan. Percentages are based out of total n of 1,982 plans.

Discussion

In this analysis of practice improvement plans, 94% of participants reported implementing at least one improvement within 3 months after an MOCA simulation course, and 79% implemented three or more practice improvements within this period (table 3). Practitioners identified challenges to completion of plans that were personal, staff, surgeon, and/or institution related, similar to other reports.[15] However, these barriers did not prevent a high rate of success in implementation. Importantly, plans that target interprofessional team members resulted in higher likelihood of completion. Perhaps these participants feel more accountable when colleagues from other disciplines are targeted, or perhaps those who attempt interprofessional interventions are self-selected as more motivated to conduct practice improvement.

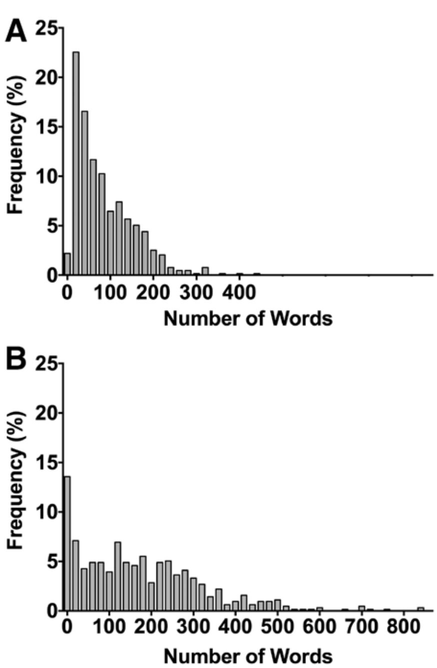

Fig. 3. (*A*) Practice improvement plan total text length. The distribution of word count for the sum of each participants' three to four practice improvement plans submitted after a Maintenance of Certification in Anesthesiology Program (MOCA) simulation course. Median: 63 (interquartile range [IQR], 30–126; minimum, 5; maximum, 444). (*B*) Practice improvement plan follow-up total text length. The distribution of word count as proxy for degree of effort for the follow-up response. Median: 147 (IQR, 52–257; minimum, 1; maximum, 842).

To date, other specialties have not incorporated mannequin-based simulation in MOC so we compare our results to those of other CME programs. However, the impact of CME programs has been questioned, leading to widespread calls for CME reform.[16,17] Many CME participants do not change their practice as a result of the activities. Lecture-based programs are particularly unlikely to change performance.[18]

Purkis[19] described a "commitment to change" (CTC) strategy for CME, suggesting that adults are more likely to implement what they identify as relevant. In research studies examining CTC compliance, CME participants had a 47 to 87% rate of implementation of their stated goals.[7,20–22] Participants were self-selected, and the proportion sampled varied considerably, so these results may not be generalizable.

In another highly selected sample, a study enrolled 144 primary care clinicians (physicians, nurse practitioners, and physician assistants) from among 800 participants. In this randomized controlled trial, 32% of lecture attendees in the control group (who were not asked to make a CTC) reported changes 7 days later, compared with 91% in the CTC group.[23] Among 352 Canadian family physicians who attended daylong interactive courses at 21 centers, 57% provided follow-up data that contained 935 commitment statements. Of these, 67% were completely implemented 6 months after the course.[24]

Because such data are self-reported, the actual implementation of plans after these activities is unknown. However, in a study that evaluated prescribing practices after an educational intervention, self-reported change was a valid means of assessing CME outcomes.[25] Implementation after MOCA simulation was higher than after other CME activities.[1,9] As suggested in a review of the impact of formal CME, interactive CME appears more likely than didactic sessions to effect change in practice.[18]

Change in Practice after Maintenance of Certification Activities

To our knowledge, we are the first to combine a mandatory CTC approach with the use of full-scale high-fidelity simulation as an educational intervention for MOC and CME. The Australian and New Zealand College of Anesthetists developed the Effective Management of Anesthetic Crises course in 2002, which uses simulation to provide Maintenance of Professional Standards credit. Their first year results from a 3 to 12 month postcourse survey indicated 55% of respondents

Table 4. Univariate Analysis with Completion as Outcome

Predictor Variable	Reference	Comparator Level	Odds Ratio	95% CI	*P* Value
Measurability	No	Yes	1.95	1.01–3.76	0.047
Setting	Academic	Community	0.69	0.30–1.60	0.389 (NS)
		Military/other	0.48	0.09–2.60	0.397 (NS)
Experience	1 yr	Per additional year	0.95	0.90–1.01	0.082 (NS)
Total number of target categories per plan	None	Per additional target	1.32	1.09–1.61	0.005
Number of plans targeting other anesthesia providers (other anesthesiologists, CRNA)	None	Per additional target	1.99	1.09–3.65	0.026
Number of plans targeting non-anesthesia physicians (*e.g.*, surgeons)	None	Per additional target	2.02	1.05–3.89	0.036
Number of plans targeting non-anesthesia non-physicians (*e.g.*, nurses, pharmacists)	None	Per additional target	2.41	1.41–4.11	0.001
Target self only (and no others)	No	Yes	0.29	0.11–0.78	0.015

CRNA = certified registered nurse anesthetist; NS = not significant.

(trainees and practicing physicians) reported making changes to their practice.[26] A subsequent survey of 216 participants yielded 98 responses, with 86% of respondents making changes to their clinical practice as a result of the course.[27] The American Board of Family Medicine uses self-assessment modules (screen-based clinical simulations) and practice performance modules, both of which are required as part of their 7-yr MOC cycle. An analysis of the first year of self-assessment module implementation revealed that 55% of participants agreed that they would make changes as a result of completing the online modules, but no follow-up of implementation was done.[28] A subsequent retrospective study showed greater improvements in patient care in physicians who completed self-assessment module/practice performance modules compared with those who did not.[29]

Because the American Board of Anesthesiology required a follow-up report about attempted implementation of the improvement plans after the MOCA simulation course, the high completion rates may not be surprising. Simulation was specifically chosen for its ability to actively engage participants, facilitate reflection, and create a sense of urgency likely to foster change. The combined features of engagement and reflective learning from simulation, coupled with the goal setting and follow-up attributes of a CTC approach, resulted in high compliance and implementation.

The fact that over three quarters of the participants identified colleagues and other team members as targets of their plans is noteworthy, particularly because it was not a specific requirement of practice improvement. MOCA simulation courses generally emphasize nontechnical skills, teamwork, and systems improvement in addition to clinical management. This suggests that the courses are creating real motivation to improve because involving others in improvement plans adds considerable effort to the process. Analysis of the word count of the plans and follow-up responses suggests that the majority of participants made more than a cursory effort in their written reports. The median follow-up text was over twice as long as the plans and more than 25% of follow-up reports were over 250 words.

The improvement plans addressed topics encountered during the simulation courses, with the plans divided nearly evenly among three categories: system issues, teamwork/communication skills (nontechnical skills), and personal (technical) knowledge, which implies that the courses stimulate reflection in all of these areas.

Relevance of MOCA Simulation to Patient Safety

Despite past efforts in anesthesiology to improve safety, such as the Closed Claims Project and ASA Standards, Guidelines and Statements, patients continue to be harmed by practitioners' failure to act in accordance with specific management guidelines and/or by a variety of individual or team errors.[30–37]† The simulation courses directly address events of high acuity and consequence, which are associated with mortality and morbidity.[31,33] In particular, the MOCA simulation program requires prioritization of teamwork in crisis situations involving cardiovascular compromise and hypoxemia.

The field of anesthesiology has decades of experience with simulation. The combination of compelling scenarios encountered in a realistic clinical environment, coupled with postevent debriefing, creates an educational stimulus to trigger practitioner reflection and improve patient safety.[38–41]

† American Society of Anesthesiologists Standards, Guidelines, Statements, and Other Documents Web site. Available at: https://www.asahq.org/For-Members/Standards-Guidelines-and-Statements.aspx. Accessed April 6, 2014.

Table 5. Multivariable Analysis with Completion as Outcome

Predictor Variable*	Reference	Comparator	Odds Ratio	95% CI	*P* Value†
Measurability	No	Yes	1.57	0.79–3.08	0.591 (NS)
Experience	1 yr	Per additional year	0.95	0.90–1.01	0.276 (NS)
Total number of target categories per plan‡	None	Per additional target	1.29	1.06–1.57	0.036

* The predictors *center* and *setting* were dropped from the multivariate analysis since $P > 0.20$ in the univariate analysis. † A Bonferroni correction was made to account for multiple comparisons. ‡ Target categories include self, other anesthesia providers, non-anesthesia physicians (*e.g.*, surgeons), and non-anesthesia non-physicians (*e.g.*, nurses, pharmacists).

NS = not significant.

Lessons Learned

From the experience of reviewing participants' practice improvement plans, we learned a number of lessons that will help refine the MOCA Simulation Program. From the outset, we intentionally gave participants considerable latitude in creating their plans to foster creativity and to avoid unduly directing the process. However, it was apparent that not all participants had prior experience in creating improvement plans. Seeing plans that lacked specificity, we learned that it may be necessary to practice plan development during the course. Some sites use the mnemonic *SMART* (specific, measurable, attainable, realistic, and timely) to guide participants in generating high-quality plans.[42] The fact that the courses stimulated a high degree of practice improvement effort among 634 representative participants spread across 29 U.S. simulation centers suggests that the individual programs collectively achieved the mission of facilitating practice change.

Although our analysis suggests that simulation-based training is stimulating reflection and practice improvement, our analytical approach has limitations. Although self-reporting is the standard for part 4 MOC in other specialties and for follow-up of CME activities, it is impossible to know how accurate the reports are. The word counts of the plans and follow-up suggest that many participants made more than a cursory effort. Many participants described implementing compelling plans that exceeded the scope of the plan's initial description.

Because all of the participants in this analysis enrolled in a simulation course, there is no control group, which limits the ability to attribute causality to the intervention. Whether educational methodologies other than simulation would have achieved similar results, with less effort (or expense), is unclear and beyond the scope of this article.

Allowing participants to describe their plans using open text fields permitted richness in detail that might not be possible using a more structured reporting form (checklist or dropdown menu). In some instances, participants packed substantial meaning into a short report (table 2, item 1). In other instances, the lack of structured follow-up resulted in extreme brevity (*e.g.*, "yes") and vagueness. Had we used structured forms to categorize the individuals affected by the plans (the plans' "targets"), it might have biased the results.

In addition, our coders could have misinterpreted plan categories, subcategories, targets, completion, and measurability during their assessments. Nonetheless, the high agreement between coders suggests reliable interpretations.

Importantly, the impact of the improvements on actual patient care or patient outcomes is unknown, which is typical for most educational programs. It would be very difficult or even impossible to determine whether practice improvement plans triggered by the MOCA simulation requirement produce significant change in patient outcome after uncommon events.

In conclusion, we have characterized some aspects of the perceived impact of a new program that uses simulation as a stimulus for practice improvement. The impact of the program, as determined by the fraction of participants who reported having implemented practice change, appears to be substantial. Future work will help delineate the barriers and enablers to plan implementation. Ultimately, if possible, the impact of resulting changes on patient outcomes should be assessed.

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Competing Interests

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References

1. McIvor W, Burden A, Weinger MB, Steadman R: Simulation for maintenance of certification in anesthesiology: The first two years. J Contin Educ Health Prof 2012; 32:236–42
2. Gaba DM, Fish KJ, Howard SK: Crisis Management in Anesthesiology, 1st edition. New York, Churchill Livingstone, 1993, pp 5–29
3. Weller J, Henderson R, Webster CS, Shulruf B, Torrie J, Davies E, Henderson K, Frampton C, Merry AF: Building the evidence on simulation validity: Comparison of anesthesiologists' communication patterns in real and simulated cases. Anesthesiology 2014; 120:142–8
4. Weinger MB, Burden AR, Steadman RH, Gaba DM: This is not a test!: Misconceptions surrounding the maintenance of certification in anesthesiology simulation course. Anesthesiology 2014; 121:655–9
5. Drazen JM, Weinstein DF: Considering recertification. N Engl J Med 2010; 362:946–7
6. Iglehart JK, Baron RB: Ensuring physicians' competence—Is maintenance of certification the answer? N Engl J Med 2012; 367:2543–9
7. Shershneva MB, Wang MF, Lindeman GC, Savoy JN, Olson CA: Commitment to practice change: An evaluator's perspective. Eval Health Prof 2010; 33:256–75
8. Wakefield J, Herbert CP, Maclure M, Dormuth C, Wright JM, Legare J, Brett-MacLean P, Premi J: Commitment to change statements can predict actual change in practice. J Contin Educ Health Prof 2003; 23:81–93
9. Wakefield JG: Commitment to change: Exploring its role in changing physician behavior through continuing education. J Contin Educ Health Prof 2004; 24:197–204
10. Marinopoulos SS, Dorman T, Ratanawongsa N, Wilson LM, Ashar BH, Magaziner JL, Miller RG, Thomas PA, Prokopowicz GP, Qayyum R, Bass EB: Effectiveness of continuing medical education. Evid Rep Technol Assess (Full Rep) 2007; 149:1–69
11. Corbin J, Strauss A: Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, 3rd edition. Thousand Oaks, Sage, 2007, pp 159–94
12. Patton MQ: Enhancing the quality and credibility of qualitative analysis. Health Serv Res 1999; 34(5 Pt 2):1189–208
13. Bradley EH, Curry LA, Devers KJ: Qualitative data analysis for health services research: Developing taxonomy, themes, and theory. Health Serv Res 2007; 42:1758–72
14. Chung F, Subramanyam R, Liao P, Sasaki E, Shapiro C, Sun Y: High STOP-Bang score indicates a high probability of obstructive sleep apnoea. Br J Anaesth 2012; 108:768–75
15. Bhandari M, Montori V, Devereaux PJ, Dosanjh S, Sprague S, Guyatt GH: Challenges to the practice of evidence-based medicine during residents' surgical training: A qualitative study using grounded theory. Acad Med 2003; 78:1183–90
16. Spivey BE: Continuing medical education in the United States: Why it needs reform and how we propose to accomplish it. J Contin Educ Health Prof 2005; 25:134–43
17. Mansouri M, Lockyer J: A meta-analysis of continuing medical education effectiveness. J Contin Educ Health Prof 2007; 27:6–15
18. Davis D, O'Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A: Impact of formal continuing medical education: Do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? JAMA 1999; 282:867–74
19. Purkis IE: Commitment for changes: An instrument for evaluating CME courses. J Med Educ 1982; 57:61–3
20. Dolcourt JL: Commitment to change: A strategy for promoting educational effectiveness. J Contin Educ Health Prof 2000; 20:156–63
21. Mazmanian PE, Daffron SR, Johnson RE, Davis DA, Kantrowitz MP: Information about barriers to planned change: A randomized controlled trial involving continuing medical education lectures and commitment to change. Acad Med 1998; 73:882–6
22. Martin KO, Mazmanian PE: Anticipated and encountered barriers to change in CME: Tools for planning and evaluation. J Contin Educ Health Prof 1991;11:301–18
23. Domino FJ, Chopra S, Seligman M, Sullivan K, Quirk ME: The impact on medical practice of commitments to change following CME lectures: A randomized controlled trial. Med Teach 2011; 33:e495–500
24. Lockyer JM, Fidler H, Ward R, Basson RJ, Elliott S, Toews J: Commitment to change statements: A way of understanding how participants use information and skills taught in an educational session. J Contin Educ Health Prof 2001; 21:82–9
25. Curry L, Purkis IE: Validity of self-reports of behavior changes by participants after a CME course. J Med Educ 1986; 61:579–84
26. Weller J, Wilson L, Robinson B: Survey of change in practice following simulation-based training in crisis management. Anaesthesia 2003; 58:471–3
27. Weller J, Morris R, Watterson L, Garden A, Flanagan B, Robinson B, Thompson W, Jones R: Effective management of anaesthetic crises: Development and evaluation of a college-accredited simulation-based course for anaesthesia education in Australia and New Zealand. Simul Healthc 2006; 1:209–14
28. Hagen MD, Ivins DJ, Puffer JC, Rinaldo J, Roussel GH, Sumner W, Xu J: Maintenance of certification for family physicians (MC-FP) self assessment modules (SAMs): The first year. J Am Board Fam Med 2006; 19:398–403
29. Galliher JM, Manning BK, Petterson SM, Dickinson LM, Brandt EC, Staton EW, Phillips RL, Pace WD: Do professional development programs for Maintenance of Certification (MOC) affect quality of patient care? J Am Board Fam Med 2014; 27:19–25
30. Cheney FW: The American Society of Anesthesiologists Closed Claims Project: What have we learned, how has it affected practice, and how will it affect practice in the future? Anesthesiology 1999; 91:552–6
31. Cheney FW: The American Society of Anesthesiologists closed claims project: The beginning. Anesthesiology 2010; 113:957–60
32. McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, Kerr EA: The quality of health care delivered to adults in the United States. N Engl J Med 2003; 348:2635–45
33. Porter ME, Teisberg EO: How physicians can change the future of health care. JAMA 2007; 297:1103–11
34. Forrest JB, Cahalan MK, Rehder K, Goldsmith CH, Levy WJ, Strunin L, Bota W, Boucek CD, Cucchiara RF, Dhamee S, Domino KB, Dudman AJ, Hamilton WK, Kampine J, Kotrly KJ, Maltby JR, Mazloomdoost M, MacKenzie RA, Melnick BM, Motoyama E, Muir JJ, Munshi C: Multicenter study of general anesthesia. II. Results. Anesthesiology 1990;72:262–8

35. Lee LA, Domino KB: The Closed Claims Project. Has it influenced anesthetic practice and outcome? Anesthesiol Clin North America 2002; 20:485–501
36. Oken A, Rasmussen MD, Slagle JM, Jain S, Kuykendall T, Ordonez N, Weinger MB: A facilitated survey instrument captures significantly more anesthesia events than does traditional voluntary event reporting. Anesthesiology 2007; 107:909–22
37. Studdert DM, Mello MM, Gawande AA, Gandhi TK, Kachalia A, Yoon C, Puopolo AL, Brennan TA: Claims, errors, and compensation payments in medical malpractice litigation. N Engl J Med 2006; 354:2024–33
38. Fanning RM, Gaba DM: The role of debriefing in simulation-based learning. Simul Healthc 2007; 2:115–25
39. Gaba DM: The pharmaceutical analogy for simulation: A policy perspective. Simul Healthc 2010; 5:5–7
40. Murray DJ, Boulet JR, Avidan M, Kras JF, Henrichs B, Woodhouse J, Evers AS: Performance of residents and anesthesiologists in a simulation-based skill assessment. Anesthesiology 2007; 107:705–13
41. Rudolph JW, Simon R, Raemer DB, Eppich WJ: Debriefing as formative assessment: Closing performance gaps in medical education. Acad Emerg Med 2008; 15:1010–6
42. Reed VA, Schifferdecker KE, Turco MG: Motivating learning and assessing outcomes in continuing medical education using a personal learning plan. J Contin Educ Health Prof 2012; 32:287–94

Appendix 1. Post Simulation Commitment to Change Form

ABA Diplomate Online Evaluation of MOCA® Simulation Training

Name: Email Address:
ASA Member* Number: ABA Identification Number (ABAIDN):
Address: Preferred Contact Phone:
Years in Practice: Subspecialty (if applicable):
Practice Setting (check one): Community Academic Military Other:

Are you enrolled in the American Board of Anesthesiology's Maintenance of Certification program? ☐Yes ☐No

*If a member of the American Society of Anesthesiologists. Membership is not a requirement.

Part A: Practice Improvement Plan

As a result of the simulation educational activity, what changes in or enhancements to your personal skills or knowledge, processes or systems, or your practice setting would you like to make within the next three months to improve *your practice*? List a minimum of three changes and/or enhancements. The examples below show the recommended level of detail for your descriptions:

1.
2.
3.

Example 1: OR fire preparedness
Our hospital does not have a consistent strategy for dealing with fires in the Operating Room (OR) so I want to educate everyone in the OR on how to prevent an OR fire and how to care for a patient in the event of such a fire.

Example 2: Improving accuracy and precision of team communications
After completing the training I realized that the systems we have in place for calling for help need improvement. I plan to work with my colleagues to install better communication systems.

Example 3: Improving management of potential life threatening emergencies
After completing the training, I realize that our system for managing Malignant Hyperthermia is disorganized and unclear. I plan to work with our OR staff to develop an MH cart, place an MH laminated card in each OR and conduct an in-service training session on mixing Dantrolene.

Example 4: Develop management protocols and differential diagnoses for commonly encountered conditions
During the course we discussed developing a systematic approach to common conditions like hypotension, hypertension, tachycardia, bradycardia and hypoxia. I will make lists of several pathophysiologies and use them during patient care

ABA = American Board of Anesthesiology; ASA = American Society of Anesthesiologists; MH = malignant hyperthermia; MOCA = Maintenance of Certification in Anesthesiology Program; OR = operating room.

Appendix 2. Post Simulation Course 30-, 60-, and 90-day Follow-up E-mail

As a diplomate in the American Board for Anesthesiology's Maintenance of Certification in Anesthesiology Program® (MOCA) you are required to reply to this email to complete your Part 4 requirement for simulation training. **(Please respond via e-mail)**

Your personal improvement enhancements from your evaluation:
1.
2.
3.
4.

Please enter your answers to your **personal improvements** into the table below:

1
2.
3.
4.

For each enhancement you submitted, please answer the following question:
1. Did you successfully implement your personal improvement enhancement (Yes/No/Partially?)
Please describe in detail what was done. See example below.

**If you didn't implement the changes, faced difficulty implementing the changes, or only partially implemented the changes, please explain any barriers you faced.*

Example: Improving accuracy and precision of my communication with the team
After attending the MOCA session, I realized I needed to improve my communication. During the course, I realized that I needed to work to avoid "thin air" requests. I have begun to introduce myself to the people in the ORs and to address requests to a specific person by name. I also ask them to follow up on these requests.

After the course, I met with my Chair and we decided to implement a system to include the WHO Safe Surgery Checklist and Pre-operative Huddles in our Department. I am implementing these programs and will hold Grand Rounds for my Department about closed loop communication. I will also hold an in-service for the OR Staff and the PACU Nurses about closed loop communication.

If there were barriers, this example might conclude:

I returned home from the MOCA course and I have changed my communication to call people by name and to ask them to report back to me after they've completed what I request. I expected to encourage my Department and Operating Room Staff to adopt closed loop communication strategies and have not yet been able to do that. I met with my Department Chair and Nursing Management to discuss implementing the WHO Safe Surgery Checklist and Pre-Operative Huddles. They have asked that we wait to implement this strategy until we move to our new ORs next month. A Grand Rounds for my Department is scheduled and meetings are scheduled with the Chair of Surgery and the Nursing Supervisor after we open our new ORs.

Example: Develop management protocols and differential diagnoses for commonly encountered conditions
I developed lists of causes of hypotension, hypertension, tachycardia, bradycardia, hypercarbia and hypoxia by consulting several textbooks, review articles and other cognitive aids. I had the list printed, laminated, and secured to my anesthesia cart (in my practice, I have my own cart, which I move from room to room to do cases). As an emergency arises I can either ask a colleague to refer to my lists, or have them manage the patient as I consult it. I intend to add more items to each list as I think of or encounter more sources of physiologic changes, and I will add more lists as I consider other episodes of perioperative pathophysiology. There were no barriers encountered in implementing this plan.

Upon receipt of your reply, your portal account will be updated to reflect satisfactory completion of the requirement.

MOCA = Maintenance of Certification in Anesthesiology Program; OR = operating room; PACU = postanesthesia care unit; WHO = World Health Organization.

Appendix 3. Coding Scheme: Categorization of Themes (numbered items 1–8) and Subthemes (lettered items with Roman numeral subclassifications) with Representative Examples

1. **Teamwork/CRM** = Improve my teamwork and Crisis/Crew Resource Management skills
    a. **Communication** = Improve my communication (one person to another person)
        i. Share information/mental model—Voice concerns, succinctly state problem or need, speak up, use two challenge rule, CUS, call-out (*e.g.*, "During the simulation, I found myself not always consistently communicating with the surgeon the gravity of the situation we happened to be in, even though in other situations I was communicating appropriately with other anesthesia providers/help. In the future I'll make some concentrated effort in communicating/educating the other team members involved in the care of the patient regarding my specific concerns.")
        ii. Use directed communication—call people by name; don't just speak into the air
        iii. Use closed-loop communication—check-back; repeat back and confirm task is done
        iv. Clarify roles (*e.g.*, "When a crisis situation arises I will implement the process learnt in the simulation training, assertively clarify roles to have a good outcome")
        v. Debrief—Ask for or give feedback (*e.g.*, "When providing feedback, use the 'I saw, I think, I wonder' approach. This will enable to person receiving feedback to respond to more open-ended questions in an advocacy-inquiry style approach.")
    b. **Help** = Call for help (*e.g.*, "When in difficulty call for help ASAP than wait till things are out of control.")
    c. **Leadership** = Improve my leadership skills
        i. Assume/designate team leader (*e.g.*, "Assign an event leader EARLY in a critical event situation")
        ii. Be assertiveness and authoritative
        iii. Prioritize, delegate tasks and distribute work
        iv. Encourage input from other members
    d. **Followership** = Improve my followership—how to help when I am called for help
    e. **Decision** = Improve my decision making skills
        i. Anticipate and plan—gather information, prepare, brief
        ii. Critical thinking
        iii. Reassess or huddle
    f. **Resource** = Improve my resource utilization—my use of available resources (*e.g.*, "I would take more time and effort to identify sources for help in urgent/emergent situations. This circle of help will allow me to effectively call for help in a timely manner to enhance patient safety.")
        i. Use personnel
        ii. Use equipment
        iii. Use cognitive aids
        iv. Use plans
    g. **Monitor** = Cross monitoring—look out for potential errors and support other team members
    h. **Situation** = Improve my own situation awareness (*e.g.*, "Accepting the realization that even at my advanced years of experience, I can overlook clear and convincing evidence of an impending problem, as one of our very experienced colleagues did during simulation.")
        i. Minimize cognitive errors
        ii. Avoid fixation error
        iii. Maintain big picture
        iv. Step out and rethink
        v. Maintain vigilance
    i. **Relationship** = Foster collegial relationships with others
    j. **Stress** = Manage my stress better
    k. **Other**

Appendix 3. (*Continued*)

2. **Handoff** = Improve handoff and transfer of care (*e.g.*, "Better MD-RN Handoff Reporting")
    a. **Communication** = improve communication during handoffs
        i. Use SBAR—situation, background, assessment, recommendation
    b. **Checklist** = create handoff checklist
    c. **Other**
3. **System** = Plan or implement system-wide improvements (changes that will benefit my partners and others' practice—requires other leaders to buy in to implement, affects others)
    a. **Communication** = Improve communication between departments; start interprofessional dialogue with unit leaders
    b. **Education** = Teach others (colleagues/partners, residents/students, nurses/ancillary staff) —present lecture, engage in discussion or hold training course
        i. Clinical information (*e.g.*, "Lack of perioperative nursing awareness of local anesthetic toxicity treatment associated with blocks and treatment drugs. I plan to do an in-service for our PACU nurses and techs teaching them about block related local anesthetic toxicity and its treatment with specific drugs.")
        ii. Equipment use
        iii. Facility policies/procedures
        iv. Teaching skills
        v. Team training
    c. **Simulation** = Run simulation (*e.g.*, "Would like to start using the simulation resources here at our own facility.")
        i. Mock codes
        ii. Drills (fire, MH, OR disasters, etc.)
    d. **Equipment/Meds** = Ensure equipment or medication availability, organization, readiness (*e.g.*, "I will create a simple cricothyroidotomy kit for each of the three hospitals where I practice consisting of a curved hemostat, scalpel and 5.0 cuffed ETT in a plastic ziplock bag just in case I encounter a situation where I cannot intubate or ventilate the patient.")
        i. Nebulizer-spacer for circuit for inhaler
        ii. Difficult airway cart
        iii. Lipid rescue cart
        iv. Intraosseous needles
    e. **Checklist** = Ensure cognitive aid availability (*e.g.*, Have cognitive aids or check list readily available at my facility, i.e. on all anesthesia carts. At minimum have ACLS and MH checklist available. Also, get a smart phone with apps to have these items readily available.")
        i. MH protocol
        ii. ACLS protocol
        iii. Lipid rescue protocol
        iv. OB Hemorrhage
    f. **Policy** = create policy
    g. **DPP** = Designate point person for institutional responsibilities
    h. **Break** = Give breaks for fatigue or error prevention, fresh look
    i. **Other**

Appendix 3. (*Continued*)

4. **Knowledge** = Improve knowledge via self-study (target is usually self)
   a. **Application** = apply lessons/knowledge learned
   b. **Function/Location** = Review equipment function or location (*e.g.*, "I would like to have an in-depth knowledge and become an expert in the use of the rarely-used but critical, life-saving equipment in the OR area, especially the External Pacemakers. The setup of this critical equipment is often difficult and programming can be non-intuitive." "I would like to find out where our MH carts are stored.")
      i. Anesthesia machine
         1. Function
         2. Set up
         3. Oxygen connection
      ii. OR gas pipelines (O_2 delivery system)
      iii. Difficult airway cart
      iv. Tracheostomies
      v. OR electrical grounding
      vi. Jet ventilation
      vii. Glidescope
      viii. Lipid rescue
      ix. Intraosseous needles
   c. **Guideline** = Review clinical guidelines (*e.g.,* "I will review management of local anesthetic toxicity.")
      i. AHA
         1. ACLS
         2. PALS
         3. NRP
         4. ATLS
      ii. MH
      iii. Local anesthetic toxicity
      iv. Difficult airway
      v. Medications
      vi. Diagnostic studies
      vii. Power failure
      viii. Oxygen failure
      ix. Airway fire
      x. Hypoxia differential
      xi. Hypotension differential
      xii. Patient safety–monitoring
   d. **Literature** = Review literature (*e.g.,* "Daily reading of one at least one anesthesiology related abstract.")
   e. **Policy** = Review policies/procedures at facility (*e.g.,* "Improve my knowledge of OR fire safety; what protocols are in place for proper response to an OR fire, especially in terms of oxygen shut-off, extinguisher location, necessary emergency response activation, and patient transport.")
      i. DNR
      ii. Fire evacuation
      iii. Biohazard/mass casualty
      iv. Trauma protocol (hospital's procedure, not just learning about ATLS)
      v. Massive transfusion protocol
   f. **Ethics** = Review ethics
   g. **Other**

Appendix 3. (*Continued*)

5. **Procedure** = Improve procedural skills (*e.g.,* central line placement, cric placement)
   a. **Access**
      i. Central line placement
      ii. Intraosseous access
   b. **Airway**
      i. Cricothyrotomy/tracheostomy/surgical airway
      ii. Difficult airway
      iii. Bronchial blockers/double lumen tubes
   c. **Echo** = Echocardiography
   d. **Ultrasound** = Ultrasound in general
   e. **Other**
6. **Patient** = Improve my interaction with patients
   a. **Communication**
      i. Error disclosure—use CONES method
      ii. Delivering bad news
      iii. Informed consent
      iv. Educate patient
   b. **Other**
7. **Other** = Anything that does not fit into the above categories

ACLS = advanced cardiac life support; AHA = American Heart Association; ASAP = as soon as possible; ATLS = advanced trauma life support; CONES = context, opening shot, narrative, emotions, strategy/summary; CRM = crisis (or crew) resource management; CUS = concerned, uncomfortable, safety issue/stop; DNR = do not resuscitate; DPP = designated point person; ETT = endotracheal tube; MH = malignant hyperthermia; OB = obstetric; OR = operating room; PACU = postanesthesia care unit; PALS = pediatric advanced life support; NRP = neonatal resuscitation program; SBAR = situation, background, assessment, recommendation.