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ORIGINAL RESEARCH

## Assessing the Efficacy of an Online Preoperative Evaluation Course for PGY-1 Anesthesiology Residents

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### INTRODUCTION

The requirements of the American Board of Anesthesiology (ABA) staged examination system, ACGME milestones assessments<sup>[1, 2]</sup>, and educational requirements are at odds with restricted resident work hours<sup>[3-5]</sup> and all create pressure to fit more education into a limited timeframe. Residency training in anesthesiology requires a fundamental clinical skills year (PGY-1) prior to starting clinical anesthesia training<sup>[6]</sup>. There is not a standard curriculum for the PGY-1 year, but its purpose is to prepare anesthesiology residents with medical knowledge readying them to manage patients' perioperative conditions when they present for care by an anesthesiologist. Studies that have assessed the perioperative care knowledge base of anesthesiology residents, revealed lower than expected knowledge scores<sup>[7-9]</sup>.

Mechanisms to meet enhanced educational needs without increasing the duration of training are needed<sup>[10-12]</sup>. Innovations in education may help compensate for lost educational time or rotation timing to enhance acquisition of skills pertinent to several of the milestones. Acquisition of fundamental anesthesia-related knowledge prior to commencing anesthesiology training may ease the transition from the PGY-1 to PGY-2 year. Therefore, we developed an online course to be administered during the PGY-1 year.

We are unaware of any studies in the literature that describe the impact of an online PGY-1 educational program on anesthesiology resident knowledge base, anxiety, or perceived preparedness. The purpose of this study was to assess the impact of a compre-

hensive, longitudinal online, asynchronous, multimodal educational intervention on PGY-1 residents using objective data and subjective survey questionnaires. We hypothesized that residents who received the intervention would show improvement on standardized test scores as compared with the control group. We also hypothesized that these residents would demonstrate less anxiety and improved perceived preparedness scores on their questionnaires as they approached the beginning of their formal training in anesthesiology.

### METHODS

#### *Study Design*

The protocol for this prospective study was approved by the Johns Hopkins University School of Medicine Institutional Review Board, which waived the need for written informed consent. Resident participants were notified that there was a voluntary research component to the course. The course was rolled out and studied over a 3 year period. Residents who started in July 2010 received no intervention and served as the control group. The following year, we initiated the course with a single pilot module administered in the spring of 2011 to PGY1 residents starting that July. The pilot was employed to gather feedback and further refine the curriculum. All PGY1 residents admitted to the program in July 2012 were eligible to participate in the intervention. Participants in the intervention group were advised that completion of course modules was voluntary.

#### *Curriculum Design*

The Johns Hopkins Preoperative Evaluation and Anesthesia Course was designed as an 8-module curriculum for the program's PGY-1 residents. Our needs assessment was based on evidence from the 4 following sources:

1. Our PGY-2 residents expressed anxiety about their transition to clinical anesthesia training and preparation for their new role.
2. The paper by Adesanya and Joshi<sup>[8]</sup> describe lower-than-expected perioperative care knowledge.
3. Our PGY-2 Anesthesia Knowledge Test-0 (AKT, Metrics Associates, Chelmsford, MA) scores were below the national mean.
4. The important role of anesthesiologists in perioperative care<sup>[13]</sup>.

The 5 main goals of the course are:

1. To teach PGY-1 residents the basics of preoperative evaluation and some basic principles of anesthesiology.
2. To reduce residents' anxiety on performing a preoperative evaluation when starting their PGY-2 year.
3. To reduce residents' anxiety and improve fluency in the preoperative planning and discussion with faculty and patients.
4. To allow PGY-1 residents to build relationships with their anesthesia classmates.
5. To create a connection with the Johns

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Hopkins anesthesia residency program despite PGY-1 training in other hospitals or cities.

Eight modules were designed to be administered at a pace of 1 month each. Each module is intended to take no more than 1.5 to 2 hours to complete. The modules are structured to be system-based (Table 1). Topics were based on a faculty consensus of the critical knowledge areas for a PGY-2 resident as well as introductory modules for advanced topics such as Obstetric Anesthesia and Pediatric Anesthesia. Each module consists of a 10-question pretest, a 5 to 7 page written synopsis of the topic, a 15- to 30-minute lecture video, a moderated case-based discussion forum, and a 10-question posttest. Although there was asynchronous participation in the course during each 4-week period, the case-based discussion forum allowed for feedback and interaction with course facilitators and fellow residents as participants logged in multiple times over the course of each module. Groups of current residents along with faculty worked in teams to build the modules. Synopsis documents based on authoritative texts were drafted for the level of a future PGY-2 resident. The pretest and posttest for each module consisted of questions targeting the most essential principles to allow for self-assessment. Each team drafted a relevant clinical case to be used in the discussion forum to allow for knowledge. The module creation process and format was standardized. Creation of each module was led by a senior resident working with junior residents and a senior faculty member nationally recognized as appropriate for the topic. Lectures were given by faculty members and filmed by the course directors. Premiere (Adobe, San Jose, CA) was used for video editing.

The course was administered through the online platform Blackboard (Blackboard, Inc., Washington, DC). Lecture videos were uploaded to an external site, Vcasmo.com (VCASMO, Hong Kong) where PowerPoint (Microsoft, Redmond, WA) slides were synchronized with the video. The final video files were ultimately hosted on Vimeo.com (Vimeo, New York, NY) for streaming.

#### *Outcome Measurement*

All residents entering the program between 2010 and 2012 completed an online survey

(SurveyMonkey, Palo Alto, CA) early in the PGY-1 and again just prior to starting the PGY-2 year. It was designed to survey self-assessed knowledge of and comfort with preoperative evaluation and anesthesia, airway examination, and advising patients regarding coexisting diseases and medications. Anxiety about starting the clinical anesthesia year was also assessed. Additional measures included satisfaction with the course and time spent completing each module. The survey design used a 5-point Likert scale with 5 representing the most favorable result. The surveys were not validated but used a question structure similar to other educational studies. A team consisting of the course directors and senior faculty constructed the survey instrument based on a review of published best practices and sample questions for course evaluation surveys. Multiple targeted survey reminders were sent on a weekly basis to nonresponders to maximize completed surveys and minimize nonresponder bias.

Outcome measures included subjective measures from the presurvey and postsurvey, and objective data from the premodule and postmodule knowledge tests, and AKT scores from day 1 of PGY-2 orientation. United States Medical Licensing Examination (USMLE) Step 1 and Step 2 score data were used to determine any significant baseline test-taking difference between the intervention and control groups.

#### *Statistical Analysis*

Statistical analysis was performed using Prism (GraphPad Software, La Jolla, CA) and PS (Vanderbilt University, Nashville, TN). Independent *t* tests were performed assuming a 2-tailed distribution and a homoscedastic sample based on the Breusch-Pagan test. Confidence intervals were based on an alpha value of 0.05. The Mann-Whitney test was used as appropriate for nonparametric data which were reported as medians and interquartile ranges. Sensitivity analyses were performed to determine the impact of Step 1 and Step 2 scores on AKT scores.

## **RESULTS**

In July 2010, 20 residents started the program and were enrolled as the control group. In July 2012, 25 residents started and were enrolled as the intervention group. Improvement was demonstrated in each of the outcomes measured. Knowledge acquisition

was demonstrated by individual pretest to posttest performance increases, and group performance improvement on the national, standardized Anesthesia Knowledge Test (AKT). Despite being voluntary, 100% of PGY-1 residents in the intervention group participated in the course.

With 25 subjects in the experimental arm using a 2-tailed alpha of 0.05, we had 98.5% power to detect an effect size of 1.0 SD between the pretest and posttest scores on each module<sup>[14]</sup>. With 20 control subjects and 25 experimental subjects using a 2-tailed alpha of 0.05, we had 92.3% power to detect an effect size of 1.0 SD between the AKT-0 scores of the experimental and control group.

Residents in the intervention group showed an improvement of 16.25 to 39.60 percentage points between the pretest and posttest in each of the 8 subjects ( $P < .0001$  in every subject). The results are summarized in Table 2. The greatest improvements were seen in the Pediatric and Obstetric modules. All residents took the AKT on the first day of orientation (Table 3). The intervention group median score was 24 percentile points higher than the control group ( $P = .0488$ ; lower 95% CI, 9.92). The median score was used because of the presence of outliers in each group.

To rule out differences in test-taking ability, the USMLE Step 1 and Step 2 scores of the intervention group were compared with the control group. Residents with only NBME or COMLEX examination scores were excluded from analysis and represented 1 to 3 residents in each group. The intervention group Step 1 and Step 2 mean scores were 227.4 ( $n = 25$ ) and 233.3 ( $n = 23$ ) with medians of 223 and 235. The control group Step 1 and Step 2 mean scores were 229.1 ( $n = 20$ ) and 229.7 ( $n = 20$ ) with median scores of 231 on each. There was no statistically significant difference between the 2 groups based on an unpaired *t* test *P* value of .78 and .62 on Step 1 and Step 2, respectively. Sensitivity analyses did not demonstrate any difference from the main analysis when considering Step 1 and Step 2 scores.

Qualitative measures were used to assess improvement in comfort levels after taking the course. Residents were asked to rate agreement with each statement, scaled 1 to 5,

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with 1 representing strongly disagree, 3 being neutral, and 5 indicating strongly agree (Table 4). During the course of the year, the intervention group improved across several subjective measures. When compared with the control group, statistically significant improvement in the intervention group was seen across every measure except perceived preparation to start residency ( $P=.20$ ) (Table 5). The most marked gains were seen in comfort advising about medications ( $P<.0001$ ), understanding the impact of coexisting disease ( $P<.0001$ ), and comfort assessing patient airway ( $P=.002$ ).

The course evaluations were positive. When residents were asked whether they felt the educational activity was worthwhile and added value to their education, the mean rating was a 4.38 with a median score of 5, indicating strong agreement with the statement. Of the 25 residents, 22 residents assigned a rating of 4 or greater to this statement. Residents reported spending an average of 102.5 minutes completing each monthly module. When asked which components of the module residents consistently completed, 96% of the residents reported consistently reading the synopsis for each module (Table 6). Some residents indicated that the interactive case discussion was most likely to be skipped when time was an issue, whereas others indicated high value in the case discussion. This suggested that the multimodal format of the intervention accommodated different learning preferences among the residents. Many residents mentioned that the group email threads related to the course and the case-based discussion forums facilitated the development of relationships with their fellow classmates in advance of their PGY-2 year.

## DISCUSSION

We describe an online preoperative evaluation course for PGY-1 residents. A very high rate of participation in the voluntary course was demonstrated, as well as improved AKT-0 scores, resident reports of improved comfort with components of the preoperative evaluation, and decreased anxiety about starting clinical anesthesia training. Presumably these improvements would provide residents an advantage as they enter their PGY-2 year in terms of increased knowledge base, better context for application of knowledge to clinical decisions, the ability to proceed

with higher level knowledge acquisition at an earlier point in the PGY-2 year and lower stress, improved sense of wellness, and a more favorable learning environment.

Given the varying structures of the PGY-1 year, and the increasing appeal of structured education in light of restrictive duty hours, online-based anesthesiology education has garnered increasing interest among training programs and residents alike<sup>[15-17]</sup>. Although a handful of anesthesiology residencies have introduced online education for PGY-1 residents, a literature search failed to reveal any studies evaluating the efficacy and impact of such education. Future investigations will be needed to determine if this early knowledge advantage results in improved clinical performance.

Our study was limited by the lack of a randomized concurrent control group. Proceeding with a randomized design would have halved the sample size of the intervention group, thereby reducing the power of the study. In light of this limitation, the control group and intervention group were compared on the basis of USMLE scores and found to be equivalent. An additional limitation is that it is not possible for us to say that the effect was due definitively to our online course. The course may provide structured incentive for residents to pursue their own supplementary reading, a desirable secondary effect of the course. The survey instrument used prior to starting the course and upon its completion was based on best practices but was not a validated survey. Therefore, this may reduce the ability of the survey to accurately measure the desired outcomes of reduced anxiety about and increased comfort with the educational material. Finally, when evaluating educational interventions, it can be challenging to assess the impact. Pretests and posttests are commonly used in educational studies<sup>[18]</sup>. However, there are few studies on the degree of correlation with clinical performance<sup>[19]</sup>.

We believe that our online, multimodal, asynchronous curriculum is well suited to perioperative knowledge content delivery and such a system allows our program to extend anesthesiology education into the PGY-1. Residents reported they did not feel unduly taxed by the time required to complete this course. It also allowed them to

feel a connection with our clinical training program before arriving by getting to know their classmates, who were not training on site, and by becoming more comfortable with anesthesia content.

The latest iteration of our course has migrated to a new digital platform, which supports mobile access from iPads, tablets, and mobile phones. It also offers a more robust backend with built-in statistical functions to validate questions and support research aims. We feel this will further stimulate expansion and improvement of a validated model for educating future residents. Participation remains voluntary at our institution. Advancements in the digital platform also allow us to make the course available to outside institutions and offer feedback such as percentile performance within and across institutions. Therefore, we feel our results would be able to be scaled to all anesthesiology training programs.

Future research should focus on determining if the multimodal approach is necessary to achieve maximum benefit across all residents, or if certain elements provide maximal benefit. Based on resident self-assessed feedback, the synopsis documents and question-answer feedback from pretests and posttests hold the greatest value to residents. However, objective data are needed to measure the benefit of each component. Other programs have performed targeted evaluations to determine the minimum educational content necessary to acquire focused knowledge<sup>[20]</sup>. Such information would allow for streamlining the course and would thereby decrease the cost and effort required in building and updating modules as well as the time commitment by residents to complete the course.

Rather than diluting our efforts through individual educational projects at each institution, it would be mutually beneficial to work collectively on creating a high quality, high impact curriculum that is applicable to residents across all programs. If the primary purpose of residency is to assure a minimum level of competence and knowledge among every graduating resident, then this course platform could help assure that the knowledge objective is met consistently while freeing up more time during resident-faculty interactions to focus on clinical competence.

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## CONCLUSION

We created a successful online curriculum to help our residents improve perioperative knowledge and use of that knowledge to direct preoperative care. This study demonstrated that an online curriculum can impact objective standardized exam scores, as well as improve resident reported comfort performing a preoperative patient evaluation. This curriculum and other online curricula have the potential to positively impact education during the clinical anesthesia years, to facilitate achievement of some anesthesia milestones, and to begin preparation for the ABA Basic Examination.

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## Abstract

**Background:** The impact of an online postgraduate year (PGY-1) education program on anesthesiology resident knowledge base, anxiety, or preparedness has not been described previously. The literature shows resident knowledge of perioperative care is lower than expected.

**Methods:** The Johns Hopkins Preoperative Evaluation and Anesthesia Course was designed as an 8 module, 8 month online academic curriculum for the program's PGY-1 class. Each module includes a pretest, topic synopsis, lecture

video, moderated case discussion and a posttest. All PGY-1 residents entering the program in July 2012 were eligible to participate. Residents starting in July 2010 served as the control group. A survey was administered to measure self-assessed knowledge of and comfort with components of preoperative anesthesia care and perceived anxiety about starting the clinical anesthesia year. Additional outcome measures included performance on the pretest and postmodule tests and Anesthesia Knowledge Test scores from day 1 of Clinical Anesthesia year 1 (CA-1, PGY-2) orientation. Statistical analysis included independent t tests, the Mann-Whitney test, and sensitivity analyses.

**Results:** Residents in the intervention group showed an improvement of 16.25 to 39.60 percentage points between the pretest and posttest in each of the 8 subjects ( $P < .0001$  in every subject). The intervention group median score was 24 percentile points higher on the Anesthesia Knowledge Test as compared with the control group ( $P = .0488$ ; lower 95% CI, 9.92). Significant improvement was also seen across measures including comfort advising about medications ( $P < .0001$ ), understanding of coexisting disease ( $P < .0001$ ), comfort assessing patient airway ( $P = .0002$ ), and anxiety about starting PGY-2 year ( $P = .0116$ ).

**Conclusions:** We have demonstrated significantly positive impact of a comprehensive, longitudinal online, asynchronous, multimodal educational intervention on PGY-1 residents using objective and subjective data.

**Key Words:** Medical education, Technology, Wellness

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# Figures

**Table 1.** *The 8 Modules*

No.	Module Title
1	Introduction to Preoperative Evaluation
2	Cardiac Disease and Anesthesia
3	Pulmonary Disease and Anesthesia
4	Endocrine, GI, and Renal Disease and Anesthesia
5	Neurologic Disease and Anesthesia
6	Introduction to Obstetric Anesthesia
7	Introduction to Pediatric Anesthesia
8	Prior Anesthetic History and Anesthetic Planning

**Table 2.** *Pretest and Posttest Scores in the Intervention Group*

Module	Pretest (n)	Posttest (n)	P Value
Introduction	71.20±12.69 (25)	97.20±6.14 (25)	<.0001
Cardiac	66.19±12.44 (21)	86.50±12.68 (21)	<.0001
Pulmonary	62.61±16.02 (23)	86.09±8.39 (23)	<.0001
Endocrine, Renal, and GI	68.26±17.49 (23)	96.09±5.83 (23)	<.0001
Neurology	66.19±19.87 (21)	86.19±9.21 (21)	<.0001
Obstetrics	47.50±14.10 (20)	81.00±13.73 (20)	<.0001
Pediatrics	52.80±14.87 (25)	92.40±5.97 (25)	<.0001
Anesthetic History/Planning	78.13±13.77 (16)	94.38±7.27 (16)	<.0001

Data are expressed as mean ± 1 SD.

**Table 3.** *AKT Scores in the Control and Intervention Group*

AKT	Mean	Median	P Value
Control	38.35±27.15	32	
Intervention	53.28±23.95	56	.0488

Data are expressed as mean ± 1 SD.

## Figures

**Table 4.** Survey Results Within Intervention Group

Survey Question	Baseline	Postcourse	P Value
Number of subjects	25	25	
Feel connected to anesthesiology residency <sup>a</sup>	3 (3-4)	4 (4-4)	<.0001
Anxiety about starting PGY-2 year	3 (3-4)	3 (3-3)	.06
Feel prepared to start residency	3 (2-3)	3 (2-3)	.63
Rate anesthesiology knowledge	2 (2-3)	3 (2-3)	.07
Comfort performing preoperative evaluation <sup>a</sup>	2 (2-3)	3 (3-3)	.0005
Comfort assessing patient airway	3 (3-3)	3 (3-3)	.18
Comfort advising about medications <sup>a</sup>	2 (2-3)	3 (3-3)	.001
Understanding impact of coexisting disease <sup>a</sup>	2 (2-3)	3 (3-3)	.002
Comfort discussing assessment with attending	2 (2-3)	3 (2-3)	.09

Questions used Likert scale with 5 representing most favorable result. Median Likert (interquartile range) scores are reported.

<sup>a</sup>P value is significant.

**Table 5.** Survey Results, Intervention vs Control Group

Survey Question	Control	Intervention	P Value
Number of subjects	20	25	
Feel connected to anesthesiology residency	3 (2-4)	4 (4-4)	.02
Anxiety about starting PGY-2 year	2 (2-3)	3 (3-3)	.01
Feel prepared to start residency	2 (2-3)	3 (2-3)	.20
Rate anesthesiology knowledge	2 (1-2)	3 (2-3)	.005
Comfort performing preoperative evaluation	2 (2-3)	3 (3-3)	.0003
Comfort assessing patient airway	2 (2-3)	3 (3-3)	.0002
Comfort advising about medications	2 (1-2)	3 (3-3)	<.0001
Understanding impact of coexisting disease	2 (2-2)	3 (3-3)	<.0001
Comfort discussing assessment with attending	2 (2-2)	3 (2-3)	.001

Questions used Likert scale with 5 representing most favorable result. Median Likert (interquartile range) scores are reported.

**Table 6.** Course Feedback

Completed Activity in at Least 6 of the 8 Modules	n
Pretest	21
Synopsis	24
Video Lecture	14
Case Discussion	3
Posttest	19