

Medical Student Perspectives of Clinical Anesthesia Education in the United States: Current Practices and Recommendations

Wu Yin¹, Leslie C. Fowler² and Amy C. Robertson^{3*}

¹Medical Student, Vanderbilt University School of Medicine, USA

²Director of Educational Development and Research, Department of Anesthesiology, Vanderbilt University Medical Center, Vanderbilt University School of Medicine, USA

³Assistant Professor, Department of Anesthesiology, Vanderbilt University Medical Center, Vanderbilt University School of Medicine, USA

*Corresponding author: Amy C. Robertson, Email: amy.robertson@vanderbilt.edu

Received: 03 September 2017; Accepted: 25 September 2017; Published: 29 September 2017

Abstract

Objective: The quality of clinical anesthesia education provided to medical students varies among medical schools in the United States. Furthermore, there is no standardized medical school curriculum for anesthesiology education. The purpose of this study is to determine the educational methods, resources, and evaluation and feedback processes commonly adopted for clinical anesthesia education. The secondary goal of the study is to describe “best practices” and educational methods identified by medical students that may improve the quality of their education.

Materials and Methods: We developed an eight-question survey in which medical students were queried on the current state of clinical anesthesiology education and their perceptions on how best to deliver this education. The target population for the survey consisted of students enrolled in U.S. medical schools interested in anesthesiology as a career. To capture this population, we requested Anesthesia Interest Group (AIG) student leaders from 15 medical schools and the American Society of Anesthesiologists (ASA) Medical Student Component to assist with survey distribution.

Results: A total of 103 responses were received. Textbooks and online videos are the resources most commonly used by medical students to learn anesthesia content. Intraoperative teaching, lecture series, and simulation are the most common teaching modalities. Students reported that “best practices” for teaching anesthesia included intraoperative teaching and simulation. Written examination and formal presentations are the most common methods utilized to assess students. When asked about the frequency of feedback given, students indicated they “sometimes” (41%) and “very often” (35%) received direct feedback. However, nearly 15% of students stated that they “rarely” or “never” received feedback throughout their anesthesia course. Suggestions for improvements include increased exposure to anesthesia, utilizing simulation/hands-on learning, and incorporating structured learning objectives within the curriculum.

Conclusion: Explicit recommendations for medical student resources are needed. Increasing simulations and hands-on learning may enable schools to decrease the gap between current methods and “best practices.” Establishing a formal curriculum and incorporating preferred teaching modalities are important considerations when teaching medical specialties that are not traditionally included in the required clinical experiences of undergraduate medical education.

Keywords: Undergraduate medical education; Education in anesthesia; Curriculum

Abbreviations: LCME: Liaison Committee on Medical Education; IRB: Institutional Review Board; AIG: Anesthesia Interest Group; ASA: American Society of Anesthesiologists; SEA: Society for Education in Anesthesia; WBAs: Workplace-based assessments; EPAs: Entrustable Professional Activities

Introduction

Medical student education within the specialty of anesthesiology varies extensively among schools in the United States [1]. For many medical schools, a designated anesthesiology course or clerkship is not part of the curriculum [2]. According to the Liaison Committee on Medical Education (LCME) Annual Medical School Questionnaire for the 2013-2014 academic year, only 28 out of 140 medical schools in the U.S. had a required clinical experience in anesthesiology [3].

A standardized curriculum for anesthesiology that offers the ideal exposure and quality education for medical students does not exist [4]. In addition, mandatory acquisition of anesthesia-related skills and knowledge has yet to be incorporated into most medical school curricula. Recent studies have explored the impact of exposure to anesthesiology as recruiting tools. Specifically, these studies conclude that early clinical exposure and dedicated preceptorship programs are effective means to increase the number of students interested in anesthesiology [5-7]. However, there is no published data or information specifically describing optimal educational methods for teaching anesthesiology-related course content to medical students.

The purpose of this study is to determine the current curriculum, educational methods, and evaluation and feedback processes commonly adopted by course directors or medical schools for clinical anesthesia education. A secondary goal of the study is to describe educational methods identified by medical students that may improve the quality of anesthesia-related education.

Materials and Methods

Institutional Review Board (IRB) approval was obtained from Vanderbilt University Medical Center. The study was given IRB exempt status. An eight-question survey queried medical students on the current state of clinical anesthesiology education and their perceptions of how best to deliver this education. Specifically, the survey was designed to elicit information from medical students pertaining to the following: (1) modalities and resources used by their medical school to teach clinical anesthesiology; (2) “best practices” for teaching anesthesiology; (3) evaluation and feedback methods commonly used during anesthesiology electives; and (4) suggestions to improve anesthesia-related education. Faculty anesthesiologists who are members of the Society for Education in Anesthesia (SEA) Medical Student Education Committee assisted with survey question generation and identification of the four major themes described above. Survey questions are provided in Appendix A.

The target population for the survey consisted of students enrolled in U.S. medical schools interested in anesthesiology as a career. To capture this population, we attempted to identify students who were members of the Anesthesia Interest Group (AIG) at their respective medical schools and student members of the American Society of Anesthesiologists (ASA) Medical Student Component. The Society for Education in Anesthesia (SEA) Medical Student Education Committee requested members of this society to provide contact information for AIG student leaders from their respective medical schools. This committee received contact information from 15 medical schools. After contacting the individual AIG student leaders for each of these

15 medical schools, all agreed to distribute the survey via email to their respective student members. Appendix B lists the medical schools that distributed the survey to their AIG student members.

In an attempt to increase medical student recruitment for this study, we contacted the ASA Medical Student Component for inclusion of medical student members. The ASA declined to provide contact information for individual student members. However, after approval from the ASA Governance Support Unit, the ASA agreed to directly send a link to the survey via email to each member of the ASA Medical Student Component.

Survey data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at Vanderbilt University School of Medicine [8]. REDCap is a secure, web-based application designed to support data capture for research studies, providing: 1) an interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for data downloads to statistical packages; and 4) procedures for importing data from external sources. Because the ASA and AIG leaders did not provide us with the total number of medical students who received the email link for the survey, a response rate could not be calculated.

Surveys targeting the AIG members were distributed via email to the AIG student leaders between February 2016 and April 2016. For members of the ASA Medical Student Component, an email describing the purpose of the survey along with the survey link was sent directly from the ASA in April 2016. A reminder email from the ASA was sent three weeks later to help accrue additional responses.

Results

A total of 103 surveys were completed. However, the actual response rate is unknown. This is due to the fact that the AIG student leaders emailed the survey link directly to the student members. Similarly, the survey link was emailed by the ASA directly to the ASA Medical Student Component members. The ASA did not provide us with the total number of medical students who comprise the ASA Medical Student Component. Thus, the exact number of students receiving the survey link is not known. Interestingly, a small number of survey respondents did not answer every question. Therefore, the response rate by the 103 medical students varies for each question. Students were also able to select more than one answer for several of the questions.

Students were asked to specify the types of resources (textbooks, online videos, websites, student guide, institution-specific resources) used to learn about or prepare for their anesthesiology course. After selecting the modalities used, a follow-up question prompted students to specify the title of the resource. Textbooks and online videos, used by 79% and 40% of survey respondents respectively, are the most popular resources to learn anesthesia content (Table 1). *Basics of Anesthesia* by Ronald D. Miller is the most commonly used textbook, as indicated by 76% of students who chose to study from textbooks (Table 2). Of the 78 students who selected textbooks as a resource, 26 (33.3%) indicated two or more textbooks were used. With regard to online videos, New York School of Regional Anesthesia video series is the most popular. Of the online student guides and PDFs, *A Medical Student's Anesthesia Primer* by Roy G. Soto is the most commonly used by the surveyed students (Table 3). When asked to describe institutionally specific resources, students mostly stated the resources were school-created lectures, videos, and online presentations.

To gain an understanding of educational modalities, students were asked how their medical schools teach clinical anesthesia. Most schools use multiple teaching methods, with intraoperative teaching (74%), lecture series (56%), and simulation (51%) being the most common (Table 4). Interestingly, 8 of the 99 students who answered the question

Table 1: Educational resources.

Educational Resource	N = Total Responses
Textbooks	79 (79.6%)
Online Videos	39 (39.8%)
Online Student Guides / PDFs	31 (31.6%)
Websites	28 (28.6%)
Institutional Specific Resources	26 (26.5%)
Total number of students who responded	98 (95.1%)

Table 2: Textbooks.

Textbook	N = Total Responses
Basics of Anesthesia by Miller	59 (75.6%)
Anesthesia Secrets by Duke	61 (26.9%)
NMS Clinical Manual of Anesthesia by Glidden	2 (2.6%)
Other	
• Clinical Anesthesiology (by Morgan and Mikhail)	• 26 (33.3%)
• Anesthesia Student Survival Guide (by Ehrenfeld, Urman, Segal)	• 13
• Clinical anesthesia	• 4
• Pocket Anesthesia	• 3
• Respiratory Physiology	• 2
• Essential Clinical Anesthesia (by Vacanti)	• 1
• Anesthesiology (by Butterworth)	• 1
• Ottawa Anesthesia Primer (by Sullivan)	• 1
• Basic Clinical Anesthesia	• 1
• Procedures of the Massachusetts General Hospital	• 1
• Atlas of Peripheral Nerve Blocks	• 1
• Anesthesiology Unplugged	• 1
• Stoelting Pharmacology	• 1
Total number of students who responded	78 (75.7%)

Table 3: Additional educational resources.

Resource	N = Total Responses
Online Videos:	
New York School of Regional Anesthesia	12 (33.3%)
NEJM Multimedia- Pulmonary/Critical Care section	11 (30.6%)
Yale School of Medicine Anesthesiology Educational videos	7 (19.4%)
Other	15 (41.7%)
• YouTube	• 8
• Institution specific videos	• 7
Total number of students who responded	39 (37.9%)
Online Student Guides / PDFs:	
A Medical Student's Anesthesia Primer by Roy G. Soto	11 (40.7%)
The Medical Student's Anesthesia Pocketbook	9 (33.3%)
Other (UpToDate and Pubmed)	10 (37.0%)
Total Number of students who responded	31 (30.1%)

Table 4: Educational techniques used to teach anesthesiology.

Educational Technique	N = Total Responses
Intraoperative Teaching	73 (73.7%)
Lecture Series	55 (55.6%)
Simulation	50 (50.5%)
Online modules/Flipped classroom model	14 (14.1%)
PBLDs (Problem Based Learning Discussions)	5 (5.1%)
Other (Received no formal teaching)	8 (8.1%)
Total Number of students who responded	99 (96.1%)

commented that they received no teaching and were left to their own devices to learn anesthesia-related content.

Students were subsequently asked about “best practices” for teaching anesthesia. Overwhelmingly students believe that intraoperative teaching and simulation are the best methods to teach anesthesia, as indicated by 85% and 83% of students respectively. Lecture series were also considered “best practice” by 50% of students (Table 5). Students were asked how lecture topics should be determined. Responses included a combination of predetermined topics (formal lecture series) and topics decided by the resident or faculty member with whom they were working.

The most common method used to assess performance in an anesthesia clinical course is written examination as indicated by 61% of survey respondents. Formal presentations are also used as a form of assessment according to 25% of the students. Twenty-one percent of respondents indicated that their medical school utilizes milestone-based assessments (Table 6). Interestingly, four of the 98 responders stated they were not assessed while two commented that the anesthesia course was “relaxed.” The setting in which student performance was assessed during the anesthesia course was primarily the operating room as indicated by 83% of students. Other settings where assessment occurred include classroom (34%), post-operative care unit (20%), preoperative clinics (18%), and simulation lab (18%) (Table 7).

Of the 103 respondents, 55% reported that feedback was provided via both written and verbal communication. Approximately 25% of students received only verbal feedback while 11% received only written feedback. Almost 9% stated they received no feedback during their rotation (Table 8). When asked about the frequency of feedback given, students indicated they “sometimes” (41%) and “very often”

Table 5: “Best Practices” for teaching anesthesiology.

Educational Technique	N = Total Responses
Intraoperative Teaching	84 (84.8%)
Simulation	82 (82.8%)
Lecture Series	49 (49.5%)
Online modules/Flipped classroom model	31 (31.3%)
PBLDs	12 (12.1%)
Other	3 (3%)
Total Number of students who responded	99 (96.1%)

Table 6: Method(s) of assessment.

Assessment Method	N = Total Responses
Written examination	57 (60.6%)
Formal presentation (case-based or evidence-based)	23 (24.5%)
Milestone-based assessment	20 (21.3%)
Oral examination	11 (11.7%)
Other (not assessed or “relaxed” course)	6 (6.1%)
Total Number of students who responded	98 (95.1%)

Table 7: Settings where assessment occurred.

Setting	N = Total Responses
Operating room	81 (82.7%)
Classroom	33 (33.7%)
Post operative care unit	20 (20.4%)
Preoperative clinic	18 (18.4%)
Simulation lab	18 (18.4%)
Other	4 (4.1%)
Total Number of students who responded	98 (95.1%)

Table 8: Type of feedback.

Feedback	N = Total Responses
Both written and verbal	57 (55.3%)
Verbal	26 (25.2%)
Written	11 (10.7%)
I did not receive feedback	9 (8.7%)
Total Number of students who responded	103 (100%)

Table 9: Frequency of feedback.

Frequency	N = Total Responses
Always	9 (8.7%)
Very Often	36 (35.0%)
Sometimes	42 (40.8%)
Rarely	9 (8.7%)
Never	7 (6.8%)
Total Number of students who responded	103 (100%)

(35%) received direct feedback. However, nearly 15% of students stated that they “rarely” or “never” received feedback throughout their anesthesia course (Table 9).

Students were requested to offer suggestions on how medical student anesthesiology education could be improved. A total of 40 free text comment responses were collected. Comments were analyzed independently by the authors and categorized into three main groups. The most universal response supported an increase in exposure to anesthesia as indicated by 44% of the responses. One student commented, “We only get one week during all of 3rd year. I will be taking additional anesthesia electives as a 4th year, but any student interested in the specialty is taking a bit of a leap of faith considering our limited exposure.” Additionally, nearly 25% of student responses proposed including additional simulation and hands-on experience. Finally, students desired more structured learning objectives and greater consensus regarding which educational resources to use.

Discussion

Despite the overwhelming popularity of textbooks and online videos, the survey results demonstrated a wide range of available resources for students to learn anesthesia-related content. Comments indicated that the variety leads to uncertainty regarding the most appropriate resource for the beginner level medical student. Explicit recommendations for books, guides, or video series may help students navigate through the different resources, and choose a suitable and effective educational tool.

When asked about how their respective medical schools taught anesthesia clinical courses, common modalities included intraoperative teaching, followed by lecture series and simulation. Additionally, students reported that “best practices” for teaching anesthesia included intraoperative teaching and simulation. Many students believed that simulation and hands-on learning are crucial to anesthesiology education, as indicated in the comments for both best practices and suggestions to improve anesthesiology education.

Several studies have described the use of simulation to teach anesthesia-related concepts to medical students, primarily in the clinical years [9-11]. Simulation requires dedicated scheduled time for faculty and students, which often poses a challenge. Conversely, hands-on learning experiences for students in the clinical environment can be exceedingly diverse, with variability in both quality and quantity. Innovative educational technologies, such as online modules and web-based multimedia, may provide an alternative to the drawbacks of both simulation and hands-on learning. For example, Fingeret et al. [12] described a technology-based tool utilized during a surgery clerkship which

Table 10: Sample curriculum.

Course Specific Learning Objectives	<p>Pre-anesthetic management:</p> <ul style="list-style-type: none"> • Demonstrate an appreciation of pertinent considerations in the preoperative evaluation of the patient by conducting a focused pre-anesthetic history and physical and identifying pertinent factors that may influence perioperative management (age, nature of surgical procedure, comorbidities). • Assign appropriate ASA physical status • Determine components of a clinically safe and appropriate anesthetic plan • Demonstrate knowledge of the pharmacology and pharmacokinetics of preanesthetic medications <p>Intraoperative management:</p> <ul style="list-style-type: none"> • Observe and verbalize proper procedure for induction of anesthesia • Perform airway management skills during uncomplicated induction of general anesthesia • Discuss indications, technique, and complications of endotracheal intubation versus placement of laryngeal mask airway (LMA) • Verbalize an understanding of the principles of routine intraoperative monitoring and indications for invasive methods of hemodynamic monitoring • Discuss appropriate intraoperative fluid and electrolyte therapy • Describe the pharmacology of agents used for maintenance of general anesthesia • Recognize potential intraoperative complications and discuss appropriate treatment (i.e. dysrhythmias, myocardial ischemia, hypoxia, endobronchial intubation, hemorrhage) <p>Postoperative management:</p> <ul style="list-style-type: none"> • Verbalize common complications encountered in the PACU • Discuss interventions for postoperative pain management including multimodal therapy, epidural catheters, and non-narcotic medications <p>Regional anesthesia:</p> <ul style="list-style-type: none"> • Identify benefits, indications, and contraindications of regional anesthetic techniques • Recognize relevant anatomy for various regional and neuraxial anesthetic techniques • Demonstrate knowledge of local anesthetic pharmacology • Describe therapeutic steps necessary to prevent or treat local anesthetic toxicity
Educational Activities	<p>Clinical experience</p> <ul style="list-style-type: none"> • Operating Room - Students are expected to contact their assigned resident to discuss cases for the next day, familiarize themselves with the patient's medical history and scheduled surgical procedure, and assist with setting up the operating room prior to the first case of the day. Participating in the anesthetic care of patients will emphasize anesthesia-related pharmacology, physiology, and clinical reasoning skills associated with intraoperative management. • Perioperative Consult Service – Activities will focus on preoperative and postoperative care of patients on Enhanced Recovery After Surgery (ERAS) protocols as well as regional anesthesia techniques. • Obstetrical Anesthesiology – Educational activities will focus on learning neuraxial anesthesia and the care of obstetrical patients undergoing anesthesia for cesarean section. • Pediatric Anesthesiology – Students will participate in the anesthetic care of pediatric patients with a focus on anesthesia-related pharmacology, physiology, and clinical reasoning skills associated with intraoperative management. <p>Intraoperative discussions with residents and faculty</p> <p>Didactics given by anesthesiology faculty, fellows, and residents</p> <p>Weekly departmental grand rounds</p> <p>Weekly simulation sessions focusing on routine induction of general anesthesia and potential intraoperative complications.</p> <p>Self-directed learning, using the following recommended resources:</p> <ul style="list-style-type: none"> • Miller: <i>Basics of Anesthesia</i>, 7th edition • Videos - New York School of Regional Anesthesia and NEJM Multimedia- Pulmonary/Critical Care section • Online student guide - A Medical Student's Anesthesia Primer by Roy G. Soto
Feedback and Assessment	<p>The final grade will be comprised of performance in six competency domains. Work-placed based assessment of these specific competencies will include the following:</p> <ul style="list-style-type: none"> • Patient care – differential diagnosis, diagnostic workup, self-knowledge of limits, plan and assessment • Medical knowledge • Interpersonal communication – rapport with patients and families, content of presentations to colleagues • Practice-based learning and improvement – receptivity to feedback • Professionalism – professional demeanor, honesty/trustworthiness • Systems-based practice – initiative and contribution, prioritization <p>Verbal formative feedback will be provided daily by the faculty and/or resident.</p> <p>Mid-course written feedback will summarize performance and identify potential areas of focus for improvement.</p> <p>At the end of the course students will provide a 20-minute oral case presentation (mandatory). The presentation will focus on the anesthetic care of a patient in which they participated during the rotation. Assessment will be based upon the following criteria:</p> <ul style="list-style-type: none"> • Preoperative evaluation (pertinent PMH, physical exam findings, laboratory values, additional diagnostic testing, ASA classification, anesthetic plan) • Intraoperative management (induction of anesthesia, airway management, invasive monitoring, maintenance of anesthesia, emergence) • Postoperative care (postop disposition, follow-up visit(s), patient's satisfaction with anesthesia care) • Complexity of case • Discussion of challenging management issues or unexpected outcomes (i.e. intubation of patient with mandibular fracture, unexpected hypotension, extubation of patient with reactive airway disease) <p>A final written exam consisting of 50 multiple-choice questions based upon the course specific learning objectives.</p>

included video content of specific procedures containing illustrations and text overlay of indications for surgery, review of pathophysiology and anatomy, post-operative care, and relevant complications. The authors of this study concluded that the web-based operative video platform was associated with improved clinical reasoning and fund of knowledge. Kumar et al. [13] created online modules that incorporated audio, video, and text using screen capture technology to teach key concepts in a critical care rotation. Compared to the traditional curriculum, students participating in this hybrid curriculum demonstrated an improvement in the post-test scores and higher satisfaction scores. Wise et al. [14] utilized a web-based simulation to teach the topic of pulmonary artery catheters to medical students in an anesthesiology clerkship. Results included an increase in student's self-reported understanding of pulmonary artery catheters after using this educational tool. Data also supports computer-based case simulations as an effective method for assessment of higher order performance aspects such as clinical competence and decision-making [15].

Survey data suggests that anesthesiology courses lack clear structure and objectives. In some cases, students desired more direction and formal teaching. Establishing a formal curriculum that includes specific learning objectives and dedicated teaching activities may lend more structure. In addition to enriching the educational experience, a dedicated curriculum may improve recruitment into a specific specialty. Recent studies have demonstrated that a structured anesthesiology educational experience enhanced medical student interest to pursue a career in anesthesiology [5,16].

Written examinations and formal presentations are the most common forms of assessment. The comments did not indicate whether these modalities are effective. However, the absence of feedback in some cases suggests that the overall amount of assessment may be lacking. Two students reported that the course was "relaxed," implying that students may not reach their educational goals due to the absence of assessments. Overall, nearly 10% of students stated that they received no feedback throughout the elective. While a relaxed course itself is not negative, there is potential for reduced learning opportunities and lackluster effort, emphasizing the importance of feedback. Furthermore, insufficient feedback leaves students uninformed of potential areas of improvement and progress towards competency [17].

The LCME requires course directors to provide formative feedback during their experience to allow students to understand and remediate their deficiencies [18]. Finally, as medical education adopts a competency-based framework, workplace-based assessments (WBAs) have become essential to evaluate learners [19]. Anesthesiology course directors should consider providing formative feedback along with developing a formal WBA with specific assessment criteria to provide worthwhile feedback to medical students. Timely and constructive feedback on performance and competence can act as a strong motivating factor in helping students acquire clinical skills, communication skills, and professional attributes [17,20].

Nearly 50% of the free text comments supported an increase in exposure to anesthesia. Many of these comments indicated a desire for this exposure to occur earlier in the curriculum. Previous studies have suggested that exposure to anesthesiology in medical school is likely to increase the number of applicants to anesthesia residency programs as well as improve students' attitudes towards anesthesiologists as physicians [5-7]. Increased exposure to anesthesia also provides an opportunity for students to achieve specific Core Entrustable Professional Activities (EPAs) for Entering Residency. EPA 12 states that medical school graduates should demonstrate competency in performing basic patient care procedures such as bag-mask ventilation and insertion of peripheral intravenous catheter [21]. Anesthesiologists are uniquely suited to teach a variety of pertinent topics beyond the operating room, such as pain medicine, the Perioperative Surgical Home model, and teamwork training [22,23]. Therefore, education

in anesthesiology may have a key role as medical schools revise their curricula to ensure students achieve critical competencies and milestones. An outline for a sample curriculum integrating the different teaching methods favored by the students along with course specific learning objectives, feedback and assessment methods, and clearly defined expectations is illustrated in Table 10.

We acknowledge limitations in this study. The survey was not hypothesis-driven, so the data are primarily descriptive. The size of the study population was not large, only 103 students. This is a drawback inherent in voluntary surveys. In addition, the unknown survey response rate limits its generalizability. The recruitment method of engaging the ASA Medical Student Component and AIG leaders with survey distribution introduces a selection bias in that a majority of respondents are likely planning a career in anesthesiology and are not representative of the entire medical student population. Despite these limitations, this is the first study to report medical student perspectives regarding current and best educational practices for teaching clinical anesthesiology.

We are currently working on the creation of a similar survey for distribution to medical schools and anesthesia course directors to identify how many schools offer formal anesthesia-related education, key components of their curriculum, and preferred teaching and feedback / assessment methods. In addition, we intend to compare the perspectives of learners and teachers. Ultimately after obtaining data from our survey to medical schools and course directors, we hope to provide consensus recommendations regarding establishment of a formal curriculum and best practices for teaching clinical anesthesiology to medical students.

Conclusion

Techniques and resources in clinical anesthesia education vary widely within medical schools. Explicit recommendations for books, guides, or video series could help students choose suitable and effective educational resources. Increasing simulations and hands-on learning may enable schools to decrease the gap between current methods and best practices as identified by medical students. New technologies, such as web-based simulation, often appeal to the current generation of learners. Establishing a formal curriculum, incorporating preferred teaching modalities, and utilizing formative feedback processes and WBAs are important considerations as medical education adopts a competency-based framework.

References

1. Tien M, Aiudi CM, Sviggum HP, Long TR. A peer-designed selective in anesthesiology, critical care, and perioperative medicine for first- and second-year medical students. *J Clin Anesth*. 2016; 31:175–181.
2. Wenzel V, Gravenstein N. Anesthesiology mentoring. *Curr Opin Anaesthesiol*. 2016; 29:698–702.
3. LCME Annual Medical School Questionnaire.
4. Rohan D, Ahern S, Walsh K. Defining an anaesthetic curriculum for medical undergraduates. A Delphi study. *Med Teach*. 2009; 31:e1–e5.
5. Murray AM, Wiisanen MT. APEP - Anesthesiology Preceptorship Enrichment Program...A Popular Student Curriculum AND a Recruiting Tool? *J Educ Perioper Med*. 2016; 18:E402.
6. Murray A, Kileny J, LeVan P. APEP-Anesthesiology Preceptorship Enrichment Program: A Curriculum for First and Second Year Medical Students. An Early Look. *J Educ Perioper Med*. 2009; 11:E051.
7. Samra SK, Davis W, Pandit SK, Cohen PJ. The effect of a clinical clerkship on attitudes of medical students toward anesthesiology. *Academic Medicine*. 1983; 58:641-7.
8. Harris PA, Taylor R, Thielke R, Jonathon Payne, Nathaniel Gonzalez, Jose G Conde. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*. 2009; 42:377–381.

9. McIvor WR. Experience with medical student simulation education. *Crit Care Med.* 2004; 32:S66–9.
10. Hallikainen J, Väisänen O, Randell T, Tarja, Tarkkila, Pekka, et al. Teaching anaesthesia induction to medical students: comparison between full-scale simulation and supervised teaching in the operating theatre. *Eur J Anaesthesiol.* 2009; 26:101–104.
11. Lim G, McIvor WR. Simulation-based Anesthesiology Education for Medical Students. *Int Anesthesiol Clin.* 2015; 53:1–22.
12. Fingeret AL, Martinez RH, Hsieh C, Downey P, Nowygrod R. Watch what happens: using a web-based multimedia platform to enhance intraoperative learning and development of clinical reasoning. *Am. J. Surg.* 2016; 211:384–389.
13. Kumar A, Hata S, Bayman EO, Krishnan S. Implementing a Hybrid Web-Based Curriculum for an Elective Medical Student Clerkship in a Busy Surgical Intensive Care Unit (ICU): Effect on Test and Satisfaction Scores. *J Surg Educ.* 2013; 70:109–116.
14. Wise EM, McIvor WR, Mangione MP. Assessing student usage, perception, and the utility of a Web-based simulation in a third-year medical school clerkship. *J Clin Anesth.* 2016; 33:5–13.
15. Ward RC, Muckle TJ, Kremer MJ, Krogh MA. Computer-Based Case Simulations for Assessment in Health Care: A Literature Review of Validity Evidence. *Evaluation & the Health Professions* 2017.
16. Galway UA. Designing an Optimally Educational Anesthesia Clerkship for Medical Students - Survey Results of a New Curriculum. *J Educ Perioper Med.* 2010; 12:E054.
17. Ende J. Feedback in clinical medical education. *JAMA.* 1983; 250:777–781.
18. LCME® Functions and Structure of a Medical School, Standards for Accreditation of Medical Education Programs Leading to the MD Degree.
19. Iobst WF, Sherbino J, Cate OT, Richardson DL, Dath D, Swing SR. Competency-based medical education in postgraduate medical education. *Med Teach.* 2010; 32:651–656.
20. Scharfel SA. Giving feedback - an integral part of education. *Best Pract Res Clin Anaesthesiol.* 2012; 26:77–87.
21. Englander R, Flynn T, Call S, Carraccio C, Cleary L, Fulton TB, et al. Toward Defining the Foundation of the MD Degree: Core Entrustable Professional Activities for Entering Residency. *Academic Medicine.* 2016; 91:1352–1358.
22. Sullivan KR, Rollins MD. Innovations in anaesthesia medical student clerkships. *Best Pract Res Clin Anaesthesiol.* 2012; 26:23–32.
23. King AB, Alvis BD, McEvoy MD. Enhanced recovery after surgery, perioperative medicine, and the perioperative surgical home: current state and future implications for education and training. *Curr Opin Anaesthesiol.* 2016; 29:727–732.

Appendix A: Survey Questions

1. Please indicate the types of educational resources you accessed in order to learn about or prepare for the anesthesiology course. Choose all that apply.

- Textbooks
- Online videos
- Websites
- Online student guides / PDFs
- Institutional resources, please list the institutional resources you utilized (medical school created anesthesiology-specific resources)

2. Please choose the educational techniques used by your medical school to teach anesthesiology. Choose all that apply.

- Lecture series
- Simulation
- Intraoperative teaching
- Online modules / flipped classroom model
- PBLDs
- Other, please explain.

3. Please indicate the “best practices” for teaching anesthesiology to medical students. Choose all that apply.

- Lecture series
- Simulation
- Online modules / flipped classroom model
- PBLDs
- Intraoperative teaching.
- Other, please explain.

4. Please choose the method(s) by which you were assessed during your anesthesiology course.

- Written examination
- Oral examination
- Milestone-based assessment
- Formal presentation (case-based or evidence-based)
- Other, please explain.

5. Please indicate the setting that you were assessed during your anesthesiology course.

- Operating room
- Preoperative clinic

- Simulation lab
- Postoperative care unit
- Other, please explain.

6. Please indicate the frequency of feedback given to you during your anesthesiology course.

- Always
- Very often
- Sometimes
- Rarely
- Never

7. Please choose the type of feedback you received during your anesthesiology course.

- Written
- Verbal
- Both written and verbal
- I did not receive feedback

8. Please share your thoughts regarding how medical student anesthesiology education can be improved.

Appendix B: Medical schools that distributed the survey to Anesthesia Interest Group student member

1. Boston University School of Medicine
2. Feinberg School of Medicine, Northwestern University
3. Harvard Medical School
4. Icahn School of Medicine at Mount Sinai
5. Lewis Katz School of Medicine at Temple University
6. Loma Linda University School of Medicine
7. Mayo Medical School
8. Meharry Medical College
9. Oklahoma State University Medical Center
10. Stanford University School of Medicine
11. University of California San Francisco School of Medicine
12. University of Connecticut School of Medicine
13. University to Florida College of Medicine
14. University of Wisconsin School of Medicine and Public Health
15. Vanderbilt University School of Medicine