The Journal of Education in Perioperative Medicine

Review Article

Critical Appraisal of Anesthesiology Educational Research for 2021

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Introduction

Any academic practice must have its foundation in evidence, and practitioners need to remain up to date on the latest research in the field. Anesthesiology medical education is no exception. Medical education in general has pushed for more evidence-based practice, emphasized in projects like Best Evidence in Medical Education (BEME), which is a collection of guides for the best available evidence in medical education on a variety of topics.[1] It is with a solid foundation in evidence that we can push innovations that have a greater chance for success.

This critical appraisal, in its fifth year, provides a summary of high-quality articles published in 2021 with the intent of helping foster evidence-based practice in anesthesiology education.[2-5] In addition to providing a list of rigorously designed and executed studies, the chosen articles highlight innovations in the field and are screened for relevance, increasing the utility of this initiative for busy clinicians and educators while inspiring new avenues of research.

Materials and Methods

Article Identification

The methods used for this appraisal closely follow the methods for the Critical Appraisal of Anesthesiology Educational Research for 2019 and 2020. For those iterations of the critical appraisal initiative, we modified the methodology to equally weigh articles that scored highly on the rubric and other articles that score well on the overall quality question. This decision allowed for articles with research designs that, while rigorous, did not score as highly because of a bias toward an experimental design in the assessment tool. Much of the description of the methodology for this study is added here verbatim from those articles with some additional modifications described as follows.

To identify all articles in anesthesiology education published during the period for this project, we conducted 2 searches. The first search used keywords (Supplemental Online Material, Appendix A) to find all articles published, regardless of the journal, in anesthesiology education. The second search pulled all articles, regardless of the topic, published in high-impact factor anesthesiology journals and medical education journals. This second search was meant to capture any articles that were not found through the keyword search. This list only includes articles that were not included in the first keyword search.

For the keyword search, a medical librarian (M.P.M.) searched 3 Ovid MEDLINE databases (MEDLINE, In-Process & Other Non-Indexed Citations, Epub Ahead of Print), Embase.com, ERIC (via FirstSearch), PsycINFO (via EBSCOhost), and PubMed. These databases were selected to cast a suitable net over the health sciences, education, and psychology literature. Each search consisted of a set of anesthesiology and education terms. Appropriate controlled terms were used in MEDLINE, Embase, PubMed, and ERIC, and supplemented with a search of article title and abstract keywords. The PsycINFO search relied entirely on article title and abstract. A secondary approach to capture relevant studies involved searches of PubMed that targeted (1) education papers published in anesthesiology journals and (2) anesthesiology-related papers published in medical education journals. All final searches were conducted on May 30, 2023. Animal and non-English studies were excluded from the search results, and all searches were limited to publication year 2021 with 2022 publications pre-printed in 2021 excluded. The Ovid MEDLINE search is available in Table 1. All reproducible searches are included in Appendix A. Endnote X20 (Clarivate Analytics) was used to remove duplicates.

In addition, we simultaneously conducted a manual review of the highest impact factor journals in both the fields of anesthesiology and medical education, as identified in Journal Citation Reports (Clarivate Analytics) and accessed through PubMed, to ensure that our searches did not exclude relevant articles. Medical education journals included *Academic Medicine, Medical Education, Advances in Health Sciences Education, Medical Teacher*, and *Simulation*

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in Healthcare. For anesthesiology, the list included *Anesthesiology, Anesthesia & Analgesia, British Journal of Anaesthesia*, and *The Clinical Journal of Anesthesia*. We also included *The Journal of Education in Perioperative Medicine* because of its focus on medical education in anesthesiology.

Inclusion and Exclusion Criteria

We adapted to modified inclusion and exclusion criteria used by Heitz et al[6] in the critical appraisal of research in education in emergency medicine and in previous years' critical appraisals of research in anesthesiology education.[2-5] We included all levels of learners (students, residents/fellows, and practicing clinicians) and articles applicable to physicians, nurses, and other providers in the field of anesthesiology. Studies were defined as hypothesis-testing investigations, evaluations of education interventions, or explorations of educational problems. Publications were excluded if they were (1) not studies (editorials, commentaries), (2) short reports lacking enough information to be evaluated, (3) not relevant to anesthesiology learners, (4) single-site survey studies, or (5) studies examining outcomes limited to an expected learning effect without a comparison group.

Data Collection

This project used 2 review phases for articles. First, 4 of the authors reviewed all abstracts from the original database searches to determine which abstract should be included and which full text should be reviewed and scored by at least 3 members of the author team. To create the list of articles to be included in the full-text review and scoring, 2 authors (L.Z., A.B.) reviewed all abstracts and applied the inclusion and exclusion criteria. Abstracts unrelated to education or anesthesiology were excluded without further review. This included abstracts focused on clinical topics such as patient education and clinical research. All other abstracts were also divided into 2 separate lists. Two additional authors (F.C., R.M.) were each assigned 1 list and independently applied the inclusion and exclusion criteria to their assigned abstracts. If the initial reviewers (L.Z. or A.B.) and the second reviewer (R.M. or F.C.) agreed that the article should be excluded, the article was excluded. Differences of opinion were reconciled by a third reviewer (L.Z., A.B., F.C., or R.M.) who was not initially assigned the abstract. The list of articles and abstracts was maintained in a Microsoft Excel for Microsoft 365 database.

Scoring

The quantitative and qualitative scoring rubrics developed by Heitz et al[6] were used to score each article. In addition, our scoring process used an "overall quality" question that asked about the reviewers' overall impressions of the articles. All authors who reviewed articles were trained for previous versions of this article and we communicated via email and conference calls. In addition, 2 authors (F.C., L.Z.) met via video conference to review each article to determine the appropriate categories for setting, study topic, study purpose, and learner group. The categories and the options under each category were selected based on the initial study by Heitz et al,[6] a review of the top-cited articles in anesthesiology education, data collected from previous years' critical appraisal articles, and an iterative review of all articles included in this review. These additional questions and the questions for coding can be found in the Supplemental Online Material, Appendix B. Two authors (R.M., L.Z.), who have expertise in qualitative research methods, scored all qualitative articles and agreed on all scoring. Tables 2 and 3 show the scoring rubrics used for the quantitative and qualitative articles, respectively. Both rubrics allowed for scores ranging from 1 to 25 to make the scores comparable despite the difference in study type. In addition, a final question asked reviewers to rate each article on a scale from 1 to 10. This holistic assessment was intended to capture the reviewers' overall impressions of the article based on their expert opinions (see Tables 2 and 3). Reviewers were asked to ignore the rubric for this holistic impression assessment and focus on articles they think educators would want to read.

In keeping with the process established in 2019 and 2020, the top articles were determined based on the full scoring rubric and the reviewers' overall impression score. This allowed for the inclusion of articles that our authors, all experts in anesthesiology education, found to be important to the literature, but did not score highly on the rubric because of their study design. Authors for this article have a terminal degree in either education or must be an anesthesiologist involved in medical education.

Included quantitative articles were randomly assigned to 3 reviewers. Each reviewer independently scored on average 26 to 27 articles. Qualtrics (2024) captured all scoring data, which then was exported into Microsoft Excel for Microsoft 365 for analysis. Mean scores were calculated through Excel and the articles with the top mean scores were selected. Interrater reliability was assessed with intraclass correlation coefficient (ICC) using a 2-way random-effect model using R (R Core Team, 2021). Because this study did not involve human subjects, institutional review board approval was not sought.

Results

The initial keyword search criteria identified 1141 citations, with manual search of all articles from the selected journals leading to 1497 more that needed to be reviewed using the inclusion criteria. Most articles were not about anesthesiology medical education, with articles on clinical science or education research not about anesthesiology. This left only 67 articles that were specifically about anesthesiology education research. These included 61 quantitative articles and 6 qualitative articles for review. See the Supplemental Online Material, Appendix C, for the full list of articles. Analysis for interrater reliability found an average measure of absolute agreement ICC = 0.87 (95% confidence interval [CI], 0.80-0.92) for the rubric score, and ICC = 0.48 (95% CI, 0.21-0.67) for the overall score.

Trends identified included learning procedures and nontechnical skills, assessment continued to be a heavily represented topic, even though the degree of representation changed from previous years. Table 4 summarizes the characteristics of these 61 papers. Table 5 summarizes the scores of the quantitative and qualitative articles.

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To facilitate easy access to the top-rated articles, an annotated bibliography of the top 13 quantitative and 2 qualitative papers based on the rubric and the overall score is included as follows.

Birnbach et al, Preparing Anesthesiology Residents for Operating Room Communication Challenges: A New Approach for Conflict Resolution Training[7]

Description

This study explores the impact of a conflict resolution course on resident ability to handle and deescalate conflicts, particularly in challenging interactions with surgeons in high-stakes environments. Using a simulated operating room scenario, residents, some who had completed the course and some who had not, were evaluated on their responses to potential confrontations. Results indicate a significant improvement in conflict resolution skills among residents who completed the course, with 93.3% effectively deescalating situations compared with only 20% among those who had not taken the course. In addition, course participants were more likely to address the confrontational scenario actively.

Significance

This study highlights the positive impact conflict resolution training can have in improving communication and managing conflicts in high-stress medical settings. The use of simulation in the course offers insight into ways to engage learners in conflict resolution training.

Blanchard et al, Comparing Traditional, Immersive Simulation With Rapid Cycle Deliberate Practice in Postgraduate Year 2 Anesthesiology Residents[8]

Description

This study compared the effects of rapid cycle deliberate practice (RCDP) versus traditional training in anesthesiology residents on Emergency Cardiovascular Care (ECC) and communication skills. Twenty-one residents were randomly assigned to the 2 groups for training, followed by individual simulations and a survey. Results showed no significant difference in ECC performance during the simulation between groups. However, the traditional training group reported higher satisfaction and self-confidence learning in 5 areas.

Significance

The study suggests that although both methods are effective for skill development, traditional training may offer higher learner satisfaction, indicating the need for further exploration of RCDP's role in medical education.

Castanelli et al, How Trainees Come to Trust Supervisors in Workplace-based Assessment: A Grounded Theory Study[9]

Description

This study was to determine how trust influences observed trainee behavior in workplace-based assessments. Semistructured interviews were used to gain understanding of how trainees come to trust supervisors in medical education settings. Constructivist grounded theory methods were used, and investigators identified a spectrum of initial trust to dynamic trust. Trainees who perceived their supervisors as more invested in their development tended to have greater trust.

Significance

This work adds to the literature around the concept of "assessment for learning" and highlights actions supervisors can take to build trust with trainees. Learners who feel trust are more willing to take risks and show up authentically, which can aid in better learning and patient care outcomes.

Chuan et al, Education in Regional Anaesthesia Collaboration (ERAC) Group, Using Psychometric Ability to Improve Education in Ultrasound-Guided Regional Anaesthesia: A Multicentre Randomised Controlled Trial[10]

Description

This study sought to understand whether performance at an ultrasound-guided needling task by novices with low visuospatial ability could be improved with deliberate practice training relative to discovery learning. Participants included 140 medical students from 5 medical centers. The authors found that deliberate practice education improved proficiency but not efficiency in ultrasound-guided needling skills.

Significance

This study adds an interesting dimension to the conversation on procedural skills training. The findings have the potential to inform the teaching of ultrasound-guided needling skills in a variety of settings.

Ciceron et al, Individual Versus Collective Debriefing After Interprofessional Training Course Simulation: The Randomised DEBRIEF-SIM Trial[11]

Description

This randomized controlled trial compared collective debriefing with an individual debriefing to improve learning outcomes after a simulation session. The authors studied changes in technical and nontechnical performance before and after simulations and saw no difference between scores. In addition, the collective debrief was time efficient.

Significance

High-quality simulation education requires significant resources. Interventions to improve efficiency can help programs conserve these resources. Although collective debriefing is common in medical education, this study provides evidence that it can lead to appropriate education. Although this study did look at performance changes, the impact of collective debriefing on the learners may be influenced by the group dynamics and relationship with the facilitator and other learners.

Ferschl et al, Implementation and Assessment of a Visiting Scholar Exchange Program in Pediatric Anesthesiology to Promote Junior Faculty and Fellow Professional Development[12]

Description

This study reports on implementation, evaluation, and early outcomes of the Visiting Scholars in Pediatric Anesthesia Program (ViSiPAP). ViSiPAP is an innovative faculty exchange program that supports academic development of junior faculty and fellows. Fifty-three faculty and 20 fellows from 17 institutions participated from 2017 to 2020. Participants rated the impact of ViSiPAP as overwhelmingly positive and agreed the program should be continued. A follow-up survey looking at promotion showed that 69% of faculty

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respondents were up for promotion, 84% agreed their ViSiPAP presentation helped promotion, and 77% made valuable connections to support their promotion packet.

Significance

ViSiPAP has early data supporting success as a professional development program for academic productivity, promotion, and retention in an academic career, in addition to participant well-being.

Friedman et al, Investigating Faculty Assessment of Anesthesia Trainees and the Failing-to-Fail Phenomenon: A Randomized Controlled Trial[13]

Description

This randomized controlled trial took a convenience sample of faculty and asked them to rate the recorded performance of learners in either high-stakes or low-stakes assessments. The study showed that some faculty did not give a failing grade despite the performance containing several critical clinical mistakes constituting a clear failing performance.

Significance

This study demonstrates that there is a reluctance to fail residents, which has implications for patient safety and competency-based progression. This highlights a weakness in the current system for medical education. Further research into why faculty do not provide failing scores is needed to determine what kinds of interventions are needed to ensure more accurate assessments.

Hastings et al, Predicting Trainee Clinical Success From Performance at Simulated Endotracheal Intubation[14]

Description

This prospective, observational study compared early trainees' performance with intubation in a simulation environment with their performance in subsequent intubations in the clinical environment. Metrics of intubation during simulation, such as duration of laryngoscopy, quantity of dental force, and overall success, predicted subsequent first-pass success of patient intubation with a high degree of correlation.

Significance

Intubation is a procedure that involves significant risk to the patient and requires substantial faculty supervision. Knowing which trainees should be the focus for additional supervision and training may reduce the risk to patients while maximizing faculty teaching effort efficiency.

Huang et al, A Novel Approach to Emergency Airway Simulation Using a 3D-printed Cricothyrotomy Task Trainer[15]

Description

The objective of this randomized controlled single-institution trial was to compare 2 methods of teaching surgical cricothyrotomy to anesthesiology residents. The authors developed a 3-dimensional (3D) printed cricothyrotomy task trainer and compared results of residents training on this device versus a porcine model. Results found that the 3D model was noninferior to the porcine model to teach surgical cricothyrotomy. Participants in both groups increased their confidence in ability to perform the skill, and those using the 3D model showed significantly faster post-practice times to complete the cricothyrotomy.

Significance

Cricothyrotomy is a life-saving skill necessary in the training of anesthesiology residents; however, attaining competency can be challenging because of low incidence. Effective methods to teach this skill are necessary to ensure resident exposure and proficiency. As 3D modeling becomes more common, this study provides a foundation to explore customizing it for use in other challenging airway scenarios.

Ju et al, A Vicious Cycle of Bias: Residents' Perceptions of Leadership in Health Care[16]

Description

This study explores the development of leader prototype formation in residents. Through semistructured interviews and observation of a simulated resuscitation led by a male or female nurse practitioner (NP), the study uncovers that residents overwhelmingly perceive male physicians as ideal team leaders. The findings identify a cycle in which biases against female and NP leaders diminish acceptance, impacting confidence and performance, thus perpetuating existing biases.

Significance

The finding that residents described male physicians as the ideal leader is worth further exploring. The authors propose interventions that can be applied to a variety of settings to help mitigate the bias they found in leadership prototype.

Kraus et al, Pregnancy and Motherhood for Trainees in Anesthesiology: A Survey of the American Society of Anesthesiologists[17]

Description

This paper presents the results of a survey of active female resident, fellow, and physician members of the American Society of Anesthesiologists focused on childbearing experiences during residency and fellowship. Survey results identified challenges faced by female anesthesiologists who had pregnancies during training, including inadequate maternity leave, deficient access to lactation facilities at work, and negative culture surrounding pregnancy during training.

Significance

This paper provides insight into the experiences of childbearing during training, an important topic for program directors, chairs, and others involved in graduate medical education roles. Results may be used to inform initiatives to support trainees during and after pregnancy at the department, institutional, or specialty levels.

Robertson et al, Efficacy of an Online Curriculum for Perioperative Goals of Care and Code Status Discussions: A Randomized Controlled Trial[18]

Description

The objective of this bi-institutional randomized controlled trial was to compare 2 methods of teaching anesthesiology residents to conduct perioperative goals of care (GOC) and code status (CS) discussions. The authors created an online video curriculum and compared learning gains with residents reading journal articles on the subject. On pre- and post-objective structured clinical examinations

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with standardized patients, use of the video curriculum resulted in residents performing significantly better in simulated GOC discussions and moderately better in CS discussions.

Significance

Teaching residents to conduct GOC and CS discussions may be improved by using a formal video curriculum. The development and validation of additional digital education tools for anesthesiology residents is a promising area for future study.

Saddawi-Konefka et al, Doing More With Written Feedback: Improving Learner Satisfaction and Reflection With the LEAF (Learner-Engaged Analysis of Feedback) Method[19]

Description

This study compared the satisfaction of residents with written feedback and evaluations when given with and without a framework and method for contextualizing the feedback to understand the significance. The framework was created using qualitative analysis of all residents' feedback to create a "typical" learner profile. The LEAF method includes a meeting with a coach to evaluate the resident's personal feedback and compare with that developed standard to enhance self-assessment.

Significance

Feedback to residents may be more impactful when given with appropriate context and benchmarking. This study is unique because it required no additional faculty development or change in feedback acquisition, only an improvement in interpretation and coaching.

Tomobi et al, Evaluating Rapid-cycle Deliberate Practice Versus Mastery Learning in Training Nurse Anesthetists on the Universal Anaesthesia Machine Ventilator in Sierra Leone[20]

Description

This randomized study explored whether RCDP or mastery learning (ML) is more effective for training nurse anesthetists on the Universal Anaesthesia Machine Ventilator in Sierra Leone. Results demonstrated that performance scores on the checklists for 3 different scenarios did not differ significantly between the 2 groups.

Significance

This study helps to fill a gap regarding the effectiveness of RCDP and ML in low-resource settings with implications for curriculum design where resource limitations may have an impact on educational approach.

Urman et al, The Effect of Emergency Manuals on Team Performance During Two Different Simulated Perioperative Crises: A Prospective, Randomized Controlled Trial[21]

Description

This study examined whether having access to an emergency manual during perioperative crises enhances or detracts from team performance. A total of 304 anesthesiologists from 4 academic medical centers participated in the study. The authors found that emergency manual availability had a negligible effect on performance scores. In addition, many teams struggled to effectively incorporate the manual into the patient care process.

Significance

This study provides nuanced insight into emergency manual use in situations that do not correlate directly with the text, adding an important dimension to the conversation on emergency manual use in the operating room.

Discussion

This critical appraisal of the medical education literature continues to show some of the same trends while deviating from others over its iterations. Although learning procedures have remained a constant topic of interest, 2021 showed fewer of these types of studies, making up only 13% (n = 9) of the total number of articles included this year (34% in 2020 and 21% in 2019, $P = .002$). In addition, we observed more articles that focused on nontechnical skills (24%, n = 16) than in previous years (13% in 2020 and 10% in 2021, $P = .016$). We think this is a positive evolution in study topics, because nontechnical skills are inherently more challenging to teach and assess than procedural skills due to their abstract nature, subjectivity in assessment, and the influence of individual personality.[22]

A variety of studies examined assessment, but from 3 different points of view.[9,13,19] Many assessment studies traditionally focus on how to assess learners, the validity and reliability of the process, and tend to emphasize procedural skills.[2] In addition, a key component of the validity and reliability of assessment is removing bias and making assessment the same despite who conducts it. This is possibly another reason assessment of procedural skills is overemphasized, because it is easier to create an objective list of observable tasks that need to be completed to correctly perform the procedure. However, Castanelli et al[9] and Friedman et al[13] focus on emotional aspects of assessment. The former looked at how trust is built through the lens of workplace assessment and the latter looked at the failure-to-fail phenomenon, which investigated how unlikely faculty are to fail learners despite critical mistakes. Although we have seen many articles that have attempted to objectively assess performance, these 2 articles note that there are relationships and emotional contexts to assessment that must be addressed directly for any assessment to maintain validity. Even though the failure-to-fail study used a validated assessment tool and the faculty did not have a relationship with the learner, thus mitigating some source of bias, the results were still affected by the faculty's emotion. Even the study by Saddawi-Konefka et al,[19] which looked at a mechanism for analysis of written feedback, addressed how the feedback is organized and delivered to allow learners to infer from written feedback. This was not a straightforward, objective approach in which one only looks at what was specifically addressed, but rather interprets further meaning into the written comments. This is a welcomed sophistication to the typical assessments that strive for objectivity and are devoid of emotional and relational considerations.

Two studies focused on implications of gender issues in anesthesiology. The national survey study by Kraus et al[17] identified common struggles women anesthesiology trainees face in attempting to balance work and motherhood, pointing to the need for policy changes as well as

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evaluating the impact of such changes. Ju and van Schaik[16] focused on the issue of gender bias when imagining ideal leaders. With women making up more than 50% of graduating medical school classes and only a fraction choosing anesthesiology as their specialty, we are seeing studies that reflect the need for further work in these areas.[23]

There are limitations to this study. Because this is a critical appraisal, the opinions of our experts play a role in which studies are included and excluded. Although we have defined what we are assessing in each article, expert reviewers may have differing opinions on what is valuable. In addition, the objective tool we used to rate each article favors certain study designs. For example, there are specific questions about pre-/post-tests, which means that survey articles or control groups without a pre-/post-design will score lower. We continued to use this tool despite its bias to maintain the same data collection process from year to year, allowing the team to compare data from year to year. The addition of the overall ranking score allowed us to highlight high-quality studies that use methods other than random assignments and control groups to help address this bias.

Conclusion

In this fifth iteration of the critical appraisal of anesthesiology education literature, we continued to refine our review and critique processes. In 2021, we observed a slight decline in articles focused solely on learning procedures, as well as an increase in articles highlighting nontechnical skills. We also observed more nuances in the literature around assessment in education, a welcome trend. To better understand the state of research in anesthesiology education, our next step would be to review 5 years of data from this same tool. This will help anesthesiology education researchers better understand what gaps might exist in our current studies and what topics, study designs, and other characteristics describe the current state of research in anesthesiology education. We believe that the description of anesthesiology education literature can help inform opportunities for targeting funding and research training.

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Sources of support: *This study was funded internally through each department of the authors.*

Abstract

Background: Based on a review of anesthesiology education articles published in 2021, the authors conducted a critical appraisal to describe trends in the literature, highlight innovations in the field, and identify high-yield articles for clinician educators in anesthesiology.

Methods: After a database search (3 Ovid MEDLINE databases, Embase.com, ERIC [via FirstSearch], PsycINFO [via EBSCOhost], and PubMed), abstracts were screened by 2 independent reviewers based on inclusion criteria. Articles representing publications in both anesthesiology-specific journals and general medical education journals were included via manual search. Three randomly assigned raters reviewed and scored each quantitative article using a rubric. Two raters scored qualitative studies using a separate rubric designed for qualitative studies. Each article also received an overall quality rating used to create an additional list of recommended articles.

Results: The database search identified 1141 articles and an additional manual search identified 1497 articles. Of these, 67 articles met the inclusion criteria (61 quantitative, 6 qualitative). This article reports and summarizes the top 13 quantitative articles and top 2 qualitative papers.

Conclusions: This year we did not see as many articles describing curriculum to teach learners procedures, a topic heavily present in previous years. Also, analysis revealed an increase in articles focused on nontechnical skill education and a trend toward how to assess learner performance. Finally, 2 articles focused on gender issues in anesthesiology, an emerging area of interest.

Keywords: Medical education, bibliometric, anesthesiology, literature review, research

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Tables

Table 1. *Database Search Used in Ovid MEDLINE*

1	(exp anesthesiology/ or exp anesthetists/ or (anesthe* or anaesthe*).tw.) and (exp education/ or education.sh. or (academic* or class or classes or course* or curricul* or educat* or fellow or fellows or fellowship or instruct* or intern or interns or internship or learn or learner or learning or lesson* or resident or residents or residenc* or school* or student* or teach* or train* or workshop*).ti.) and english.la.
2	limit 1 to yr="2021"

Table 2. *Quantitative Scoring Rubric*

Domain	Item	Item Score	Max Score 25
Introduction ***(select all that apply)***			3
	Appropriate description of background literature	1	
	Clearly frame the problem	1	
	Clear objective/hypothesis	1	
Measurement 1. Methodology ***(select one)***			2
	Has no pre-test or post-test	1	
	Has a post-test only (if has a pre-test do NOT select)	1	
	Has a pre-test and a post-test	2	
2. Groups ***(select all that apply)***			2
	Both experimental and control group	1	
	Random assignment to groups	1	
Data Collection 1. Institutions ***(select one)*** *Number of institutions refers to origin of study participants (not study authors)*			2
	1 institution	0	
	2 institutions	1	
	3 or more institutions	2	
2. Response Rate ***(select one)*** • *Response rate is the proportion of those eligible who completed follow-up assessment.* • *Use "N/A" only if a response rate truly does not apply (eg, data obtained from a medical record or professional organization database).*			2
	< 50% or not reported	0	
	50%-74%	1	
	≥ 75%	2	
	N/A	0	
Data Analysis			
1. Appropriateness ***(select one)*** *Considered "0" if there is statistical error or if authors failed to analyze data*			1
	Data analysis inappropriate for study design/type of data	0	
	Data analysis appropriate for study design and type of data	1	

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Tables *continued*

2. Sophistication ***(select all that apply)*** (*Any test of statistical inference is considered "beyond descriptive.")*			2
	Descriptive analysis only	0	
	Beyond descriptive analysis	1	
	Includes power analysis	1	
Discussion ***(select all that apply)***			3
	Data support conclusion	1	
	Conclusion clearly addresses hypothesis/objective	1	
	Conclusions placed in context of literature	1	
Limitations ***(select one)***			2
	Limitations not identified accurately	0	
	Some limitations identified	1	
	Limitations well addressed	2	
Innovation of Project ***(select one)***			2
	Previously described methods	0	
	New use for known assessment/intervention	1	
	New assessment/intervention methodology	2	
Relevance of Project ***(select one)***			2
	Impractical to most programs	0	
	Relevant to some	1	
	Relevant to many programs	2	
Clarity of Writing ***(select one)***			2
	Unsatisfactory	0	
	Fair	1	
	Excellent	2	
Total			25
Overall, how would you rate this article? This should take into consideration your overall feelings about the article. If you were to recommend that people read something good from this year, would you recommend this article? Is it relevant, well done, innovative?			1-10

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Tables *continued*

Table 3. *Qualitative Scoring Rubric*

Domain	Item	Item Score	Max Score
Introduction ***(select all that apply)***			3
	Appropriate description of background literature	1	
	Clearly frame the problem	1	
	Clear objective/hypothesis	1	
Measurement			3
1. Methodology ***(select all that apply)***			
	Appropriate for study question	1	
2. Sampling of Participants ***(select all that apply)***			
	Appropriate study population	1	
	Enrolled full range of cases/settings beyond convenience	1	
Data Collection 1. Institutions ***(select one)*** *Number of institutions refers to origin of study participants (not study authors)*			3
	1 institution	0	
	2 institutions	1	
	3 or more institutions	2	
2. Sample Size Determination ***(select one)***			
	Appropriate sample size determination	1	
Data Analysis ***(select all that apply)***			5
	Clear, reproducible "audit trail" documenting systematic procedure for analysis	1	
	Data saturation through a systematic iterative process of analysis	1	
	Addressed contradictory responses	1	
	Incorporated validation strategies (eg, member checking, triangulation)	1	
	Addressed reflexivity (impact of researcher's background, position, biases on study)	1	
Discussion ***(select all that apply)***			3
	Data support conclusion	1	
	Conclusion clearly addresses hypothesis/objective	1	
	Conclusions placed in context of literature	1	
Limitations ***(select one)***			2
	Limitations not identified accurately	0	
	Some limitations identified	1	
	Limitations well addressed	2	

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Tables *continued*

Innovation of Project ***(select one)***			2
	Previously described methods	0	
	New use for known assessment/intervention	1	
	New assessment/intervention methodology	2	
Relevance of Project ***(select one)***			2
	Impractical to most programs	0	
	Relevant to some	1	
	Relevant to many programs	2	
Clarity of Writing ***(select one)***			2
	Unsatisfactory	0	
	Fair	1	
	Excellent	2	
Total			25
Overall, how would you rate this article? This should take into consideration your overall feelings about the article. If you were to recommend that people read something good from this year, would you recommend this article? Is it relevant, well done, innovative?			1-10

Table 4. *Trends for All Reviewed Manuscripts in Anesthesiology Education for 2021*

Variable	All Publications (n = 67)		Highlighted (n = 15)	
	%	n	%	n
External Funding	30	20	47	7
Main Setting ***(manuscripts could cover more than 1 group)***				
Data from nonclinical settings (surveys)	46	31	20	3
Simulation	34	23	60	9
Clinical setting	9	6	7	1
Classroom setting	4	3	7	1
Other	1	1	7	1
Purpose of the Study				
Teaching methods	21	14	33	5
Assessment of learner	25	17	13	2
Program/Intervention evaluation	40	27	47	7
Assessment of environment	13	9	13	2
Recruitment	4	3	0	0
Curriculum development	1	1	0	0
Systematic review	0	0	0	0
Clinical reasoning	0	0	0	0
Other	4	3	7	1

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Tables *continued*

Study Design				
Observational	48	32	20	3
Experimental	48	32	80	12
Validation	4	3	0	0
Learner Group ***(manuscripts could cover more than 1 group)***				
Residents	88	59	73	11
Practicing anesthesiologists/physician	39	26	27	4
Medical students	10	7	13	2
Nurses	18	12	7	1
Topic Being Studied ***(manuscripts could cover more than 1 group)***				
Nontechnical skills	24	16	27	4
Learning procedure	13	9	20	3
Curriculum development/evaluation	12	8	0	0
Wellness	12	8	0	0
Assessment/evaluation of learner	10	7	0	0
Recruitment	9	6	0	0
Clinical practice	7	5	20	3
Assessment of environment	7	5	13	2
Feedback	7	5	20	3
Career development	6	4	7	1
Assessment of teaching	4	3	0	0
Professionalism	4	3	0	0
Equity and inclusion	3	2	7	1
Supervision	1	1	0	0
Crisis resource management	1	1	0	0

Table 5. *Score for Quantitative Articles for Scoring Sheet and Reviewers' Impressions*

Score Type	All Articles	Top Articles
	Average Score (Range)	Average Score (Range)
Quantitative		
Scoring sheet	17.60 of 25 (10.33-23.00)	20.82 of 25 (16.67-23.00)
	n = 61	n = 13
Reviewers' impressions	6.07 of 10 (3.33-8.67)	7.38 of 10 (5.72-8.67)
	n = 61	n = 13
Qualitative		
Scoring sheet	14.75 of 25 (11-22)	19.50 of 25 (17-22)
	n = 6	n = 2
Reviewers' impressions	6.75 of 10 (5-9)	9 of 10 (6-9)
	n = 6	n = 2

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Supplemental Online Material

Appendix A. Database Searches to Identify Best Articles in Anesthesiology Education

Ovid Medline; Ovid Medline In-Process & Other Non-Indexed Citations; Ovid Medline Epub Ahead of Print; Daily and Versions (748 results on March 11, 2022)

1. (exp anesthesiology/ or exp anesthetists/ or (anesthe* or anaesthe*).tw.) and (exp education/ or education.sh. or (academic* or class or classes or course* or curricul* or educat* or fellow or fellows or fellowship or instruct* or intern or interns or internship or learn or learner or learning or lesson* or resident or residents or residenc* or school* or simulation or student* or teach* or train* or workshop*).ti.) and english.la.

2. limit 1 to yr="2021"

Elsevier Embase (646 results on March 11, 2022)

(('anesthesiology'/exp OR 'anesthetists'/exp) AND 'education'/exp OR ((anesthesia*:ti OR anesthesio*:ti OR anaesthesio*:ti) AND (academic*:ti OR class:ti OR classes:ti OR course*:ti OR curricul*:ti OR educat*:ti OR fellow:ti OR fellows:ti OR fellowship:ti OR instruct*:ti OR intern:ti OR interns:ti OR internship:ti OR learn:ti OR learner:ti OR learning:ti OR lesson*:ti OR resident:ti OR residents:ti OR residenc*:ti OR school*:ti OR simulation*:ti OR student*:ti OR teach*:ti OR train*:ti OR workshop*:ti)) OR (((anesthesia* OR anesthesio* OR anaesthesio*) NEAR/5 (academic* OR course* OR curricul* OR educat* OR fellow OR fellows OR fellowship OR instruct* OR intern OR interns OR internship OR learn OR learner OR learning OR lesson* OR resident OR residents OR residenc* OR school* OR student* OR teach* OR train* OR workshop*)):ab)) AND [english]/lim AND [2021-2021]/py NOT ('conference abstract':it OR 'conference paper':it OR 'conference review':it)

FirstSearch ERIC (4 results on March 11, 2022)

(ti: anesthe* OR ti: anaesthe*) or (ab: anesthe* OR ab: anaesthe*) or de: anesthesiology and yr: 2021-2021

EBSCOhost PsycInfo (14 results on March 11, 2022, limited to 2021)

(TI (anesthe* OR anaesthe*) OR AB (anesthe* OR anaesthe*)) AND (TI (academic* OR class OR classes OR course* OR curricul* OR educat* OR fellow OR fellows OR fellowship OR instruct* OR intern OR interns OR internship OR learn OR learner OR learning OR lesson* OR resident OR residents OR residenc* OR school* OR student* OR teach* OR train* OR workshop*))

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Supplemental Online Material *continued*

PubMed - Anesthesia in medical education journals (8 results on March 11, 2022)

(anesthesiology[mh] OR anesthetists[mh] OR anesthesia[tiab] OR anaesthesia[tiab] OR anesthesiology[tiab] OR anaesthesiology[tiab]) AND ("Acad Med"[Journal] OR "Med Educ"[Journal] OR "Adv Health Sci Educ Theory Pract"[Journal] OR "Med Teach"[Journal] OR "Simul Healthc"[Journal]) AND 2021[dp]

PubMed - Education in anesthesiology journals (108 results on March 11, 2022)

(education[mh] OR education[sh] OR academic[ti] OR class[ti] OR classes[ti] OR course[ti] OR courses[ti] OR curricula[ti] OR curriculum[ti] OR educate[ti] OR educated[ti] OR educating[ti] OR education[ti] OR educator[ti] OR educators[ti] OR instructing[ti] OR instruction[ti] OR instructor[ti] OR instructors[ti] OR learn[ti] OR learned[ti] OR learning[ti] OR lesson[ti] OR lessons[ti] OR residencies[ti] OR residency[ti] OR school[ti] OR schools[ti] OR student[ti] OR students[ti] OR teach[ti] OR teacher[ti] OR teachers[ti] OR teaching[ti] OR train[ti] OR trained[ti] OR training[ti] OR trainer[ti] OR trainers[ti] OR workshop[ti] OR workshops[ti]) AND ("Anesthesiology"[Journal] OR "anesthesia and analgesia"[journal] OR "british journal of anaesthesia"[journal] OR "J Educ Perioper Med"[journal]) AND 2021[dp]

PubMed - Journal Table of Contents Handsearch (1477 results on March 11, 2022; 1769 results on June 2, 2023, after adding a new journal)

("acad med"[journal] OR "Adv Health Sci Educ Theory Pract"[journal] OR"anesthesia and analgesia"[journal] OR "anesthesiology"[journal] OR "british journal of anaesthesia"[journal] OR "j clin anesth"[journal] OR "j educ perioper med"[journal] OR "med educ"[journal] OR "med teach"[journal] OR "simul healthc"[journal]) AND 2021[dp] AND hasabstract[text] NOT (editorial[pt] OR letter[pt]) NOT pubstatusaheadofprint

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Supplemental Online Material *continued*

Appendix B. Additional Questions

Questions to Code Articles Reviewed
Funding
None (or internally funded by department)
Yes, please specify
Target Audience: (Select all that apply)
Residents
Medical Students
Practicing Anesthesiologists
Nurse
Other
Non-physician/Non-provider author:*
Yes, first, second, or last
Yes, but not first, second, or last
No
Unclear
Primary Setting:
Simulation
Real-life
Other
Purpose:
Teaching methods
Learner evaluation of programs
Learner assessment
Intervention description
Environment assessment
Other
Topic:
Case management/general practice
Learning procedures
Crisis resource management
Anesthesiology non-technical skills
Professionalism
Resident selection
Interprofessionalism
Other
Competency:*
Patient care
Medical knowledge
Practice-based learning and improvement
Interpersonal and communication skills
Professionalism
Systems-based practice
N/A

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Supplemental Online Material *continued*

Theme topic: (Open-ended question)
* We did not report on Non-physician Author and Competency categories because the data collected was not useful. For Non-Physician Author category, almost half of the articles reviewed did not include the degrees of the authors. For the Competency category, many of the articles were not about competencies. For example, articles about the clinical competency committee work or patient dignity where not about a specific competency and therefor the coding was not useful.
Additional Questions Piloted to Enhance Scoring Tool *(Not used for scoring in this review)*
Sampling:
The sampling was not rigorous (small and/or convenience sample)=0
The sampling was rigorous (larger and/or purposeful sample)=1
Study Design
Appropriateness
The study design was inappropriate to answer the research question=0
The study design was appropriate to answer the research question=1
Rigorous
The study design lacked rigor=0
The study design was somewhat rigorous=1
The study design was very rigorous=2

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Supplemental Online Material *continued*

Appendix C. Full List of Articles Included in the Critical Appraisal

Article No.	First Author	Title	Journal	Type
1	Afonso AM	Burnout Rate and Risk Factors among Anesthesiologists in the United States	*Anesthesiology*	Quantitative
2	Arthur ME	Rank and Match Outcomes of In-person and Virtual Anesthesiology Residency Interviews	*J Educ Perioper Med*	Quantitative
3	Birnbach DJ	Preparing Anesthesiology Residents for Operating Room Communication Challenges: A New Approach for Conflict Resolution Training	*Anesth Analg*	Quantitative
4	Bisgaard CH	Early procedural training increases anesthesiology residents' clinical production: a comparative pre-post study of the payoff in clinical training	*BMC Med Educ*	Quantitative
5	Blanchard EE	Comparing traditional, immersive simulation with Rapid Cycle Deliberate Practice in postgraduate year 2 anesthesiology residents	*Adv in Sim*	Quantitative
6	Boselli E	Effects of a training program in medical hypnosis on burnout in anesthesiologists and other healthcare providers: A survey study	*Complement Ther Med*	Quantitative
7	Buleon C	First steps towards international competency goals for residency training: a qualitative comparison of 3 regional standards in anesthesiology	*BMC Med Educ*	Qualitative
8	Caine Richards KA	Estimation of Surgical Blood Loss by Anesthesia and Surgical Trainees: Impact of an Educational Intervention on Interrater Reliability	*AANA J*	Quantitative

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Supplemental Online Material *continued*

9	Carullo PC	The impact of a smartphone meditation application on anesthesia trainee well-being	*J Clin Anesth*	Quantitative
10	Castanelli DJ	How Trainees Come to Trust Supervisors in Workplace-Based Assessment: A Grounded Theory Study	*Anesth Analg*	Qualitative
11	Chen D	Residency program directors' perceptions about the impact of the American Board of Anesthesiology's Objective Structured Clinical Examination	*J Clin Anesth*	Quantitative
12	Chu E	An Equitable Electronic Scheduling System for Anesthesiology Residents: A Quality Improvement Project	*J Educ Perioper Med*	Quantitative
13	Chuan A	Using psychometric ability to improve education in ultrasound-guided regional anaesthesia: a multicentre randomised controlled trial	*Anaesthesia*	Quantitative
14	Ciceron F	Individual versus collective debriefing after interprofessional training course simulation: The randomised DEBRIEF-SIM trial	*Anaesth Crit Care Pain Med*	Quantitative
15	Clunie M	Competence of anesthesiology residents following a longitudinal point-of-care ultrasound curriculum	*Can J Anaesth*	Quantitative
16	Dillon SJ	Does simulation improve clinical performance in management of postpartum hemorrhage?	*Am J Obstet Gynecol*	Quantitative
17	Dillon SJ	How personality affects teamwork: a study in multidisciplinary obstetrical simulation	*Am J Obstet Gynecol MFM*	Quantitative
18	Ende HB	A cluster quasi-randomized controlled trial of an interactive, monthly obstetric anesthesiology curriculum:	*Int J Obstet Anesth*	Quantitative

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Supplemental Online Material *continued*

		impact on resident satisfaction and knowledge retention		
19	Ende HB	Improving ACGME Compliance for Obstetric Anesthesiology Fellows Using an Automated Email Notification System	*Appl Clin Inform*	Quantitative
20	Farina C	The Flipped Classroom With Case-Based Learning in Graduate Nurse Anesthesia Education	*AANA J*	Quantitative
21	Ferschl MB	Implementation and Assessment of a Visiting Scholar Exchange Program in Pediatric Anesthesiology to Promote Junior Faculty and Fellow Professional Development	*J Educ Perioper Med*	Quantitative
22	Finstad AS	Is simulation-based team training performed by personnel in accordance with the INACSL Standards of Best Practice: Simulation--a qualitative interview study	*Adv Simul*	Qualitative
23	Fleming M	Examining the accuracy of residents' self-assessments and faculty assessment behaviours in anesthesiology	*Can Med Educ J*	Quantitative
24	Friedman Z	Investigating faculty assessment of anesthesia trainees and the failing-to-fail phenomenon: a randomized controlled trial	*Can J Anaesth*	Quantitative
25	Goudra B	US Residents' Perspectives on the Introduction, Conduct, and Value of American Board of Anesthesiology's Objective Structured Clinical Examination-Results of the 1st Nationwide Questionnaire Survey	*Anesth Essays Res*	Quantitative
26	Hastings RH	Predicting Trainee Clinical Success From Performance at Simulated Endotracheal Intubation	*Simul Healthc*	Quantitative

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continued from previous page

Supplemental Online Material *continued*

27	Huang J	A Novel Approach to Emergency Airway Simulation Using a 3D-printed Cricothyrotomy Task Trainer	*J Educ Perioper Med*	Quantitative
28	Jans J	Nurse anesthetists' reflections and strategies when supervising master's students	*Nurse Educ Pract*	Qualitative
29	Ju M	A Vicious Cycle of Bias: Residents' Perceptions of Leadership in Health Care	*Acad Med*	Qualitative
30	Kattan E	Simulation-Based Mastery Learning of Bronchoscopy-Guided Percutaneous Dilatational Tracheostomy: Competency Acquisition and Skills Transfer to a Cadaveric Model	*Simul Healthc*	Quantitative
31	Kraus MB	Pregnancy and Motherhood for Trainees in Anesthesiology: A Survey of the American Society of Anesthesiologists	*J Educ Perioper Med*	Quantitative
32	Kushelev M	Perioperative do-not-resuscitate orders: Trainee experiential learning in preserving patient autonomy and knowledge of professional guidelines	*Medicine*	Quantitative
33	Lamiani G	Cultivating Empathy and Soft Skills Among Intensive Care Residents: Effects of a Mandatory, Simulation-Based, Experiential Training	*Ann Transplant*	Quantitative
34	Lee DC	Adaptations in anesthesiology residency programs amid the COVID-19 pandemic: virtual approaches to applicant recruitment	*BMC Med Educ*	Quantitative
35	Lemke R	Associations of form and function of speaking up in anaesthesia: a prospective observational study	*Br J Anaesth*	Quantitative
36	Love ER	Reducing Over-Interviewing in the Anesthesiology Residency Match	*Cureus*	Quantitative

continued on next page

continued from previous page

Supplemental Online Material *continued*

37	Love ER	Interview Data Highlight Importance of "Same-State" on Anesthesiology Residency Match	*Anesth Analg*	Quantitative
38	McEvoy MD	Comparison of Two Learning Modalities on Continuing Medical Education Consumption and Knowledge Acquisition: A Pilot Randomized Controlled Trial	*J Educ Perioper Med*	Quantitative
39	Mehta A	Publication misrepresentation among pediatric anesthesiology fellowship applicants: A retrospective single-center cohort study	*Paediatr Anaesth*	Quantitative
40	Miller C	Resident Preparation for the American Board of Anesthesiology Objective Standardized Clinical Examination: A Comparison of Virtual Telesimulation with In-person Simulation	*J Educ Perioper Med*	Quantitative
41	Moll-Khosrawi P	Understanding Why All Types of Motivation Are Necessary in Advanced Anaesthesiology Training Levels and How They Influence Job Satisfaction: Translation of the Self-Determination Theory to Healthcare	*Healthcare*	Quantitative
42	Neves SE	Using Machine Learning to Evaluate Attending Feedback on Resident Performance	*Anesth Analg*	Quantitative
43	Niburski K	Criteria for selection to anesthesia residency programs: a survey of Canadian anesthesia program directors	*Can Med Educ J*	Quantitative
44	Nizamuddin SL	The Influence of the In-person Residency Interview: A Prospective Study	*J Educ Perioper Med*	Quantitative
45	Paige JT	Improvement in student-led debriefing analysis after simulation-based team	*Surgery*	Quantitative

continued on next page

continued from previous page

Supplemental Online Material *continued*

		training using a revised teamwork assessment tool		
46	Patzkowski MS	Medical School Clinical Knowledge Exam Scores, Not Demographic or Other Factors, Associated With Residency In-Training Exam Performance	*Mil Med*	Quantitative
47	Pollard EM	Closing the Mentorship Gap: Implementation of Speed Mentoring Events for Women Faculty and Trainees in Anesthesiology	*Womens Health Rep*	Quantitative
48	Pregnall AM	ACGME Case Log Reminder Does Not Improve Resident Accuracy in Logging Cases	*J Med Syst*	Quantitative
49	Rineau E	Cognitive Aid for Anesthetic Preparation in An Emergency Situation: A Simulation-Based Study	*Healthcare*	Quantitative
50	Robertson AC	Efficacy of an Online Curriculum for Perioperative Goals of Care and Code Status Discussions: A Randomized Controlled Trial	*Anesth Analg*	Quantitative
51	Saddawi-Konefka D	Doing More With Written Feedback: Improving Learner Satisfaction and Reflection With the LEAF (Learner-Engaged Analysis of Feedback) Method	*Acad Med*	Quantitative
52	Saway BF	Mindfulness in the OR: A Pilot Study Investigating the Efficacy of an Abbreviated Mindfulness Intervention on Improving Performance in the Operating Room	*J Surg Educ*	Quantitative
53	Sharpe EE	A cross-sectional survey study of United States residency program directors' perceptions of parental leave and pregnancy among anesthesiology trainees	*Can J Anaesth*	Quantitative
54	Sidi A	Simulation-Based Assessment Identifies Longitudinal Changes in Cognitive Skills in	*J Patient Saf*	Quantitative

continued on next page

continued from previous page

Supplemental Online Material *continued*

		an Anesthesiology Residency Training Program		
55	Spring J	Impact of Gender on Clinical Evaluation of Trainees in the Intensive Care Unit	*Ats Scholar*	Quantitative
56	Stecz P	Stress responses in high-fidelity simulation among anesthesiology students	*Sci Rep*	Quantitative
57	Sun H	Anesthesiology Residents' Experiences and Perspectives of Residency Training	*Anesth Analg*	Quantitative
58	Szmulewicz C	Communication of bad news in relation with surgery or anesthesia: An interdisciplinary simulation training program	*J Gynecol Obstet Hum Reprod*	Quantitative
59	Tanaka P	Milestone Learning Trajectories of Residents at Five Anesthesiology Residency Programs	*Teach Learn Med*	Quantitative
60	Tomobi O	Evaluating Rapid-cycle Deliberate Practice Versus Mastery Learning in Training Nurse Anesthetists on the Universal Anaesthesia Machine Ventilator in Sierra Leone	*J Educ Perioper Med*	Quantitative
61	Urman RD	The effect of emergency manuals on team performance during two different simulated perioperative crises: A prospective, randomized controlled trial	*J Clin Anesth*	Quantitative
62	Wang J	Effect of Online Psychological Intervention on Burnout in Medical Residents From Different Majors: An Exploratory Study	*Front Psychol*	Quantitative
63	Warren J	Trainee doctors' experiences of learning and well-being while working in intensive care during the COVID-19 pandemic: a qualitative study using appreciative inquiry	*BMJ Open*	Qualitative
64	Watkins SC	Tools for Assessing the Performance of Pediatric	*Simul Healthc*	Quantitative

continued on next page

continued from previous page

Supplemental Online Material *continued*

		Perioperative Teams During Simulated Crises: A Psychometric Analysis of Clinician Raters' Scores		
65	Woo JYH	Gender Differences in the Language of LORs Written for Anesthesiology Medical Student Applicants: Analysis of One Program's Recruitment Cycle	*J Educ Perioper Med*	Quantitative
66	Woodworth GE	Development and Pilot Testing of Entrustable Professional Activities for US Anesthesiology Residency Training	*Anesth Analg*	Quantitative
67	Zhou Y	Demographic Trends From 2005 to 2015 Among Physicians with Accreditation Council for Graduate Medical Education-Accredited Anesthesiology Training and Active Medical Licenses	*Anesth Analg*	Quantitative