



The Journal of Education in Perioperative Medicine

ORIGINAL RESEARCH

Critical Appraisal of Anesthesiology Educational Research for 2018

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INTRODUCTION

Only through a review of practice can we reflect and improve.¹ As medical educators, we are committed to the growth of the field of medical education in anesthesiology and want to facilitate a reflection of our research practices. We believe that a yearly critical appraisal of all the research published will help the field reflect and grow. By reviewing all relevant articles and highlighting those of the highest quality, we give those interested in the field of anesthesiology education, not only the opportunity to read those articles and possibly implement new practices, but also a chance to think about the field as a whole and how we can improve. In addition, as we discussed in 2017,² putting the highest-quality research in the hands of practitioners might encourage the implementation of evidence-based interventions. Like in medicine itself, grounding educational practice in evidence is something toward which we all strive.^{2,3} Highlighting the findings the field of anesthesiology education has produced over the last year is another way to promote these ideas and practices.

As noted in our previous review of the literature, the purpose of this study is to review and appraise all of the studies published in 2018 on medical education in anesthesiology and to provide summaries of the top medical education research articles in the field.² This is the second article of this series. The first was focused on a critical appraisal of the medical education research in

anesthesiology for 2017.² We hope that this project continues on an annual basis, highlighting high-quality research and trends in anesthesiology education and educational research.

MATERIALS AND METHODS

Article Identification

These methods replicate those of the first critical appraisal in this series published in 2017.² Much of the description of the study methodology has been added here verbatim to allow readers to easily evaluate the methods. Where appropriate, the methods have been updated to reflect the slight changes made in methodology since the first iteration of this project.

To identify all articles in anesthesiology education, a medical librarian (MM) 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 searches were initially run on April 23, 2019 to allow time for studies published in 2018 to be indexed in each database. Animal and non-English studies were excluded from the search results, and all searches were limited to publication year 2018 with 2019 publications preprinted in 2018 excluded. The Ovid MEDLINE search is available in Table 1. All reproducible searches are included in the Appendix A. Endnote X8 (Clarivate Analytics, Philadelphia, Pennsylvania) was used to remove duplicates.

In addition, on July 31, 2019, we 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 any relevant articles. For medical education, the list included *Academic Medicine*, *Medical Education*, *Advances in Health Sciences Education*, *Medical Teacher*, and *Simulation in Healthcare*. For anesthesiology, the list included *Anesthesiology*, *Anesthesia & Analgesia*, and *British Journal of Anaesthesia*. In this manual search, we also included the *Journal of Education in Perioperative Medicine* because of its focus on medical education in anesthesiology.

Inclusion and Exclusion Criteria

We followed the same inclusion and exclusion criteria used by Heitz et al. in the

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critical appraisal of research in education in emergency medicine manuscript and in last year's critical appraisal of anesthesiology education literature manuscript.^{2,4} We included all levels of learners (students, residents/trainees, and practicing clinicians) and articles applicable to both physicians and nurses in the field of anesthesiology. Studies were defined as hypothesis-testing investigations, evaluations of education interventions, or explorations of educational problems.⁴ Publications were excluded if they were: (1) not studies (editorials, commentaries); (2) short reports that lacked enough information to be evaluated; (3) not relevant to anesthesiology learners; (4) single-site survey studies; or (5) studies that examined outcomes limited to an expected learning effect without a comparison group.⁴

Data Collection

To create the list of articles to be included in the critical appraisal, one author (LZ) reviewed all abstracts and applied the inclusion and exclusion criteria. All abstracts were also divided into 2 separate lists. Two additional authors (AG, FC) were each assigned 1 list and independently applied the inclusion and exclusion criteria to their assigned abstracts. If the initial reviewer (LZ) and the second reviewer (AG or FC) agreed that the article should be excluded, the article was excluded. Differences of opinion were reconciled by a third reviewer, (AG or FC) who was not initially assigned the abstract. The list of articles and abstracts were maintained in a Microsoft Excel 2010 database.

Scoring

The quantitative and qualitative scoring rubrics developed by Heitz et al. were used to score each article. Because all authors who participated in the 2017 review also participated in this review, only a brief retraining of how to use the tool was conducted via conference call. In addition, the 3 lead authors (AG, FC, LZ) were each assigned a list of articles to document funding, setting, study topic, study purpose, and learner group. The categories and options under each category were selected based on the initial study by Heitz et al. and a review of the top-cited articles in anesthesiology education.^{4,5} These additional questions and the

questions for coding can be found in Appendix B. Two authors (AG, LZ), who have expertise in qualitative research methods, scored all qualitative articles. Each item was discussed and the 2 authors (AG, LZ) agreed upon scoring. Table 2 and Table 3 show the scoring rubrics used for the quantitative and qualitative articles respectively. Both rubrics allowed for scores ranging from 1 to 25, with a highest possible score set to 25 to make the scores comparable despite the difference in study type.

Each quantitative article that met inclusion criteria was randomly assigned to 3 of the 7 author raters, resulting in each author independently scoring on average 14 articles. Qualtrics (2019) was used to capture all scoring data, which then was exported into Excel 2010 for analysis. Mean scores were calculated through Excel 2010, and the articles with the top 10 mean scores were selected. Interrater reliability was assessed with intraclass correlation coefficient using a one-way random-effect model in SPSS 25.0 (IBM Corp, Armonk, New York). Because this study did not involve human subjects, institutional review board approval was not sought.

RESULTS

The initial search criteria identified a total of 888 unique citations. Thirty-six quantitative and 2 qualitative articles met the inclusion criteria. For the manual review, 1404 unique citations were identified, but only 3 additional articles (1 quantitative and 2 qualitative) met the inclusion criteria. See Appendix C for full list of articles included in the critical appraisal. Intraclass correlation coefficient found an average measure of $ICC_{(1)} = 0.76$ (95% CI: 0.57, 0.87) for all quantitative study articles scored. Table 4 summarizes the characteristics of these 41 papers.

The mean score for all 38 quantitative articles included was 17.66 out of a possible 25 points with the score for articles ranging from 12.33 to 22.33. We originally intended to identify the top 10 quantitative articles but included 11 because 3 articles finished in ninth position with an identical score of 19.67. The top 11 scored articles had a mean score of 20.42 with scores ranging from 19.67 to 22.33.

Of the 3 qualitative papers, 1 article received a score of 21 to qualify it for inclusion in the

top list. The average score for the qualitative papers was 15.67 with scores ranging from 13 to 21. In order to facilitate easy access to the top-rated articles, an annotated bibliography of the top 11 quantitative papers and the top qualitative paper is listed below in alphabetical order by first author.

Arzalier-Daret S, Buleon C, Bocca ML, et al. Effect of sleep deprivation after a night shift duty on simulated crisis management by residents in anaesthesia. A randomised crossover study. *Anaesth Crit Care Pain Med.* 2018;37(2):161-6.⁶

Description. Using high-fidelity simulation, this study assessed the performance of randomly assigned residents who were either sleep deprived after a night shift or rested after a night of sleep. As has been shown in previous studies, sleep deprivation negatively affects the performance of the resident.

Significance. While this study further demonstrates the negative impact of sleep deprivation, it does not offer solutions, which is a limitation. This study is another reminder that we need to consider changes to the working schedules of all health care providers if the schedule could potentially be a source of patient harm.

Benzon HA, De Oliveira G, Suresh S. Pediatric Anesthesiology Fellows' Perception of Quality of Attending Supervision and Medical Errors. *Anesth Analg.* 2018;126(2):639-43.⁷

Description. This survey of pediatric anesthesiology fellows detected a high rate of self-reported medication errors but did not see an association between these errors and supervision as was hypothesized.

Significance. Providing safe care while teaching trainees is a central priority for medical education. While this study did not show a connection between the perception of the quality of attending supervision and medical errors, it is important for educators to continue this line of inquiry to help make care safer for patients.

Blanie AG, Roulleau P, Figueiredo S, Benhamou D. Impact of learners' role (active participant-observer or observer only) on learning outcomes during high-fidelity simulation sessions in anaesthesia: A single center, prospective and randomised

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study. *Anaesth Crit Care Pain Med.* 2018;37(5):417-22.⁸

Description. Using a prospective randomized design, this study showed that knowledge acquisition and satisfaction were higher for learners who actively participated in high-fidelity simulation when compared with those who only observed the simulation. This suggests that while both groups had improved learning outcomes, actively involved learners may have slightly better outcomes.

Significance. As demands on medical education increase, the ways in which we use our limited resources are under scrutiny. Having some learners participate only as observers in high-fidelity simulation would be a way to ration resources. While this study shows there is a benefit to observing, the fact that there were additional benefits for active participants may dissuade some programs from using observer-only roles for learners.

Blum RH, Muret-Wagstaff SL, Boulet JR, et al. Harvard Assessment of Anesthesia Resident Performance Research, Group. Simulation-based Assessment to Reliably Identify Key Resident Performance Attributes. *Anesthesiology.* 2018;128(4):821-31.⁹

Description. This study performed an assessment of key resident performance attributes at 3 different institutions using high-fidelity simulation. The study showed that the tool created was reliable and could distinguish between experienced and novice trainees.

Significance. The major part of the work of residency programs is to assess the competency of residents and only graduate residents who reach a certain level of competence. However, certain skills, like those used in emergency situations, are rarely evaluated in residency. This assessment could be used to establish competency and identify gaps in performance that residents need to address.

de Oliveira Filho GR, Mettrau FAC. The Effect of High-Frequency, Structured Expert Feedback on the Learning Curves of Basic Interventional Ultrasound Skills Applied to Regional Anesthesia. *Anesth Analg.* 2018;126(3):1028-34.¹⁰

Description. This study used a randomized control design to compare the effect of high-frequency, structured expert feedback with self-directed learning. The high-frequency, structured feedback was described as participants receiving feedback after every trial on specific aspects of their performance as delineated by a standardized checklist.

Significance. This study adds to other investigations that have demonstrated the benefits of high-frequency, structured feedback. While this type of feedback is more resource-intensive and requires more time for training sessions, programs may want to consider the educational benefits in using this technique.

Hastings RH, Kedarisetty S, Johnson JM, et al. Manikin Laryngoscopy Motion as a Predictor of Patient Intubation Outcomes: A Prospective Observational Study. *J Educ Perioper Med.* 2018;20(1).¹¹

Description. This study sought to use motion parameters during laryngoscopy in a mannequin to differentiate between experienced and novice professionals and to predict successful intubations in patients. The study showed that the motion used by trainees could help determine readiness for intubating patients with indirect supervision.

Significance. This study used a novel method for assessing residents' procedural skills in simulation. Because the use of motion sensors is an objective assessment of the resident's performance, this method has the potential to be added to the current assessments used to determine readiness for practice and potentially improve patient safety.

Kallidaikurichi Srinivasan K, Gallagher A, O'Brien N, et al. Proficiency-based progression training: an 'end to end' model for decreasing error applied to achievement of effective epidural analgesia during labour: a randomised control study. *BMJ Open.* 2018;8(10):e020099.¹²

Description. This study used a randomized control design to assess the effectiveness of using proficiency-based progression (PBP) training to teach novice anesthesiology trainees how to place labor epidurals. Epidural failure rate from the first 10 labor epidurals performed by participants on actual patients showed those who participated in

the PBP training had a lower incidence of epidural failures compared with the group that received simulation-only training.

Significance. In PBP, the learner is required to demonstrate a proficiency benchmark in procedure performance before progressing to the next step in the process. While this study had a small sample size, it was able to use patient outcomes of epidurals performed on patients to assess the effectiveness of PBP compared with simulation-only training.

Kaplan SJ, Seabott HM, Cunningham EB, et al. Resident Wellness and Social Support: Development and Cognitive Validation of a Resident Social Capital Assessment Tool. *J Surg Educ.* 2018;75(2):313-20.¹³

Description. In this study, the authors describe the development and validity evidence for an instrument to measure social capital in residents. Using a Delphi process and focus groups, the authors created a tool to measure social capital and then used cognitive interviews to revise the tool.

Significance. With burnout, depression, and suicide on the rise for physicians, the medical community is looking for ways to improve wellness. Social capital is an important factor in resident wellness, and an instrument that could assess social capital might aid programs in identifying and intervening with at-risk residents. In addition, this assessment could be used to measure the effectiveness of interventions created to improve social capital for residents.

Laszlo CJ, Szucs Z, Nemeskeri A, et al. Human cadavers preserved using Thiel's method for the teaching of fibreoptically-guided intubation of the trachea: a laboratory investigation. *Anaesthesia.* 2018;73(1):65-70.¹⁴

Description. This study compared using a human cadaver to teach fiber optic-guided intubation of the trachea versus using a mannequin. It suggests that while training led to a decrease in the time to intubate for both groups, there was a greater decrease in time for the human cadaver group.

Significance. The increase in fidelity in using a cadaver versus a mannequin coupled with

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the decrease in time to intubation demonstrated through this study suggests benefits to using a human cadaver for teaching some procedures. While acquisition, preparation, storage, and maintenance might be a barrier, the authors posit that the cost of human cadavers is much less than some mannequins and that universities may have the resources already in place to prepare and store cadavers for the purpose of learning procedures.

Lilot M, Evain JN, Bauer C, et al. Relaxation before debriefing during high-fidelity simulation improves memory retention of residents at three months. *Anesthesiology*. 2018;128(3):638-49.¹⁵

Description. The stress related to participating in simulation scenarios can influence learners' ability to remember key education points, which is the purpose of the intervention. The authors used a randomized control design and showed that using a 5-minute standardized relaxation break immediately before debriefing after the simulation session led to improved recall of critical messages.

Significance. Educators are often looking for ways to improve recall of important key points. Simulation is a resource-intensive educational methodology. If a 5-minute relaxation break can improve recall of the education, other programs could consider implementing such a break to lead to a more effective session. In addition, this study provides evidence that relaxation can be an important component to improved performance.

Sargeant J, Lockyer JM, Mann K, et al. The R2C2 Model in Residency Education: How Does It Foster Coaching and Promote Feedback Use? *Acad Med*. 2018;93(7):1055-63.¹⁶

Description. In this qualitative study, the authors assessed the effectiveness of a feedback model called R2C2 across different residency programs. The R2C2 model was reported to be effective in fostering a productive, reflective feedback conversation focused on resident development and in facilitating the collaborative development of a change plan.

Significance. The R2C2 model consists of four phases: relationship building, explor-

ing reactions to the feedback, exploring understanding of feedback content, and coaching for performance change. This study further demonstrated not only that the model can be effective, but also the context where the model can work, which can influence a more targeted implementation plan.

Zhou Y, Sun H, Macario A, et al. Association between performance in a maintenance of certification program and disciplinary actions against the medical licenses of anesthesiologists. *Anesthesiology*. 2018;129(4):812-20.¹⁷

Description. The value of participating in maintenance of certification programs is unknown. This study demonstrated that completing maintenance of certification program requirements in a timely fashion was associated with a lower incidence of license actions against the physicians. However, the introduction of maintenance of certification requirements was not associated with a significant change in the rate of license action.

Significance. Because of the time and expense of maintenance of certification, it is important for studies to assess the benefit and effectiveness of such programs. Because this study did not demonstrate a change in the rate of license action after the introduction of time-limited certification, participation in maintenance of certification may only act as a surrogate marker that a physician who completes the program is less likely to be disciplined by a state licensing agency.

DISCUSSION

As the second installment of this endeavor, this paper adds to the yearly assessment of anesthesiology education literature from 2018. Hopefully, this project will lead to the evaluation of trends in anesthesiology education research and inform the future direction of research in this area.

In last year's review, we noted that among the papers reviewed less than 20% (12) used random assignment to groups, and only 24% (15) of the studies reviewed included a power analysis.² This year, we noticed a similar trend with 28% (11) of manuscripts reviewed including random assignment of participants, and 36% (14) including a power analysis. Though random assignment to

experimental and control groups or a power analysis may not always be appropriate or needed depending on study design and research methodology, this trend may signal a need for more rigorous design and data analysis strategies in anesthesiology education research.

The mean scores for the quantitative articles were very similar for the top articles this year (20.42) and last year (20.43), while the mean scores for qualitative articles were drastically different from this year (15.67) and last year (5.38). Because there were so few qualitative articles included (3 this year and 3 last year), the variability in quality might be due to lack of representation. While it is too early to tell if this is a trend, it may show that researchers are choosing relatively similar study designs based on published work, which would account for the similarity of the scores for quantitative articles and the lack of representation for qualitative articles.

This year we attempted to further define trends in the field by adding different elements of analysis to our review. New data collected included: Funding source, population targeted in the study, the primary setting of the study, the purpose of the study, and the study topic. While the data are only captured for this year, a few themes emerged. Sixty-seven percent of all studies and 83% of the highlighted studies targeted resident education, highlighting a major focus on graduate medical education within the literature. While residency education is important, there are many other opportunities for study within the field of anesthesiology education beyond resident education. We encourage those with an interest in anesthesiology education to consider potentially investigating research questions related to medical student education within anesthesiology, continuing medical education, faculty development, and nurse anesthetist education.

About 30% of studies (28% of all studies and 33% of highlighted studies) reviewed in this year's data analysis received external funding. Funding did not appear to influence the inclusion of the study in the highlighted group of high-quality articles. While rigorous social science research can be costly, the cost to implement innovative

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single-site or pilot studies is much lower, and still can yield interesting results, which may be why funding did not influence the likelihood of inclusion in the highlighted list. Additionally, this could reflect a relative lack of funding opportunities to study anesthesiology education specifically. Increased funding could influence the quality, depth, breadth, and scope of research in anesthesiology education.

The most commonly stated purposes of the studies reviewed this year were: Assessments of learners, program evaluations, and studies of teaching methods. It is of note that while 26% of all studies reviewed were program evaluations, only 1 of those studies was included in the highlighted group.¹⁶ This further demonstrates that while program evaluation is common in medical education research, it may lack the rigor necessary to make it more effective. We encourage those pursuing research in anesthesiology education to make their work more generalizable through the use of theory, increased sample sizes when appropriate, and multi-institutional sampling strategies. Additionally, opportunities exist to examine questions that go beyond evaluating education interventions, including studies of learning environments or the organizations and institutions in which teaching and learning activities take place. Further, opportunities exist to test and apply theories from other subspecialties of education, such as higher and adult education.

Although steps were taken to mitigate bias, this study does have limitations. An informationist (MM) is a part of our team to ensure rigor in search strategies; however, it is possible that the search strategy may have excluded articles published in a journal where the focus is on a field outside of anesthesiology or medical education. Also, we made the decision to only include search terms that would identify articles that mentioned anesthesiology specifically. This might lead to the exclusion of articles about some subspecialties, like critical care and pain medicine, if they do not specifically mention anesthesiology or anesthesiologists. Another inherent potential limitation of a critical appraisal is in the rating of the papers, both from the perspective of the

raters and the tool itself. As with the 2017 critical appraisal,² we participated in rater training and worked to further refine understanding of each criterion included in the rubric through group discussion and consensus. However, there are items in the assessment tool that are subjective. As a result, some bias is expected depending on the background, training, preferences, and values of the different reviewers involved in this project. Despite these potential challenges, the interrater reliability of our assessment was high, demonstrating relative agreement in our individual appraisals of each paper.

While we evaluated quantitative and qualitative studies in relation to studies of the same type, the tool used for this project includes a bias towards interventional designs, as we noted previously.² While we do not believe that this limitation diminishes the worth of this review in identifying high-quality articles overall, we must acknowledge that our tool is somewhat challenged when applied to noninterventional study designs. To help address this bias, we included an overall rating score on a scale from 1 to 10 to allow reviewers to indicate their holistic impressions of the quality of the study. For example, a systematic review of educational interventions regarding end-of-life conversations by Bakke et al. received an average holistic rating of 8 but did not score high enough on the standardized assessment tool's other criteria to make the top-rated article list.¹⁸ To help strengthen the assessment tool for future iterations of this paper, we piloted additional questions that, while not used in this review, could help strengthen the instrument for future publications. These questions can be found in Appendix B.

Future directions for this critical appraisal of the anesthesiology education literature are myriad. In addition to exploring new articles each year, we aim to develop a refined rubric that addresses our identified limitations in terms of study design and methodology. Further, it may be possible to focus critical appraisals on specific topics within the literature such as simulation or resident wellness initiatives as the body of literature in anesthesiology education research grows. Another potential area for exploration could be to track trends in research over time. Will funding play a bigger

role in differentiating higher-quality articles from lower-quality articles in the future? How will the topics and study designs used change over time?

Regardless of future directions, we hope that this critical appraisal is a useful tool for learners and teachers of all kinds within anesthesiology education and that it leads to a greater use of evidence-based practices and improved education outcomes in the future.

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Abstract

Background: Through a critical appraisal of the education research in anesthesiology, this article enables those interested in the field to read the high-quality articles for the past year and possibly implement these evidence-based interventions and concepts into practice. This study reviews and appraises all medical education studies published in 2018 in anesthesiology and summarizes the highest-rated articles evaluated.

Methods: Three Ovid MEDLINE databases, Embase.com, ERIC, PsycINFO, and PubMed were searched followed by a manual review of articles published in the highest impact factor journals in both the fields of anesthesiology and medical education. Abstracts were double-screened and quantitative articles subsequently scored by 3 randomly assigned raters. Qualitative studies were scored by 2 raters. Two different rubrics were used for scoring quantitative and qualitative studies, both allowed for scores ranging from 1 to 25.

Results: A total of 888 unique citations were identified through the search criteria. Of those, 39 articles met the inclusion criteria (36 quantitative and 3 qualitative). The top 11 quantitative papers and the top qualitative paper with the highest scores were reported and summarized.

Conclusions: As the second article to critically review the literature available for education in anesthesiology, we are able to add to this annual series to help further disseminate the articles of the highest quality in anesthesiology education. Because this is only the second year, we can only report on initial suggestions of trends that we hope will help guide future research.

Keywords: medical education, bibliometric, anesthesiology

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Figures

Table 1. Database Search Used in Ovid MEDLINE

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2	limit 1 to yr="2018"

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 pretest or posttest	1	
	Has a posttest only (If has a pretest do NOT select)	1	
	Has a pretest and a posttest	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	

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Figures continued

Table 2 cont. Quantitative Scoring Rubric continued

Data Analysis			
1. Appropriateness (<i>select one</i>) 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	
2. Sophistication (<i>select all that apply</i>) (Any test of statistical inference is considered "beyond descriptive.")			2
	Descriptive analysis only	0	
	Beyond descriptive analysis	1	
	Includes power analysis	1	
Discussion (<i>select all that apply</i>)			3
	Data support conclusion	1	
	Conclusion clearly addresses hypothesis/objective	1	
	Conclusions placed in context of literature	1	
Limitations (<i>select one</i>)			2
	Limitations not identified accurately	0	
	Some limitations identified	1	
	Limitations well addressed	2	
Innovation of Project (<i>select one</i>)			2
	Previously described methods	0	
	New use for known assessment/intervention	1	
	New assessment/intervention methodology	2	
Relevance of Project (<i>select one</i>)			2
	Impractical to most programs	0	
	Relevant to some	1	
	Relevant to many programs	2	
Clarity of Writing (<i>select one</i>)			2
	Unsatisfactory	0	
	Fair	1	
	Excellent	2	
Total			25

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Figures 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			3
1. Institutions (select one) Number of institutions refers to origin of study participants (not study authors)			
	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 <i>audit trail</i> 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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Figures continued

Table 3 cont. Qualitative Scoring Rubric

Innovation of Project (<i>select one</i>)			2
	Previously described methods	0	
	New use for known assessment/intervention	1	
	New assessment/intervention methodology	2	
Relevance of Project (<i>select one</i>)			2
	Impractical to most programs	0	
	Relevant to some	1	
	Relevant to many programs	2	
Clarity of Writing (<i>select one</i>)			2
	Unsatisfactory	0	
	Fair	1	
	Excellent	2	
Total			25

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Figures continued

Table 4. Trends for All Reviewed Manuscripts in Anesthesiology Education for 2018

Variable	All Publications (n = 39)		Highlighted (n = 12)	
	%	n	%	n
External Funding	28	11	33	4
Main Setting				
Simulation	36	14	67	8
Data from nonclinical settings (Surveys, assessment of non-clinical environments)	31	12	25	3
Clinical setting	15	6	8	1
Classroom setting	13	5	0	0
Systematic review	5	2	0	0
Purpose of the Study				
Assessment of learner	39	13	42	5
Program/intervention evaluation	26	10	8	1
Teaching methods	23	9	50	6
Curriculum development	5	2	0	0
Assessment of environment	5	2	0	0
Systematic review	5	2	0	0
Clinical reasoning	3	1	0	0
Study Type				
Experimental	49	19	42	5
Observational	41	16	50	6
Systematic review	5	2	0	0
Validation	5	2	8	1
Learner Group (Manuscripts could cover more than 1 group)				
Residents	67	26	83	10
Practicing anesthesiologists	26	10	17	2
Nurses	18	7	8	1
Medical students	8	3	0	0
Other	5	2	0	0

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Figures continued

Table 4 cont. Trends for All Reviewed Manuscripts in Anesthesiology Education for 2018

Topic Being Studied				
Clinical practice	21	8	0	0
Assessment/evaluation of learner	13	5	25	3
Learning procedure	13	5	25	3
Nontechnical skills	10	4	0	0
Assessment of teaching	10	4	17	2
Wellness	10	4	17	2
Curriculum development/evaluation	8	3	0	0
Assessment of environment	5	2	0	0
Career development	5	2	0	0
Feedback	3	1	8	1
Supervision	3	1	0	0

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Appendix A

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

Ovid Medline; Ovid Medline In-Process & Other Non-Indexed Citations; Ovid Medline Epub Ahead of Print (507 results on April 23, 2019)

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 zzzza 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="2018"

Embase.com (723 results on April 23, 2019)

('anesthesiology'/exp OR 'anesthetists'/exp OR anesthe*.ti,ab OR anaesthe*.ti,ab) AND ('education'/exp OR 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 student*.ti OR teach*.ti OR train*.ti OR workshop*.ti) AND [english]/lim AND [2018-2018]/py NOT ('conference abstract':it OR 'conference paper':it OR 'conference review':it)

ERIC via FirstSearch (2 results on April 23, 2019)

(ti: anesthe* OR ti: anaesthe*) or (ab: anesthe* OR ab: anaesthe*) or de: anesthesiology and yr: 2018-2018

PsycINFO (25 results on April 23, 2019)

1. TI (anesthe* OR anaesthe*) OR AB (anesthe* OR anaesthe*)
2. 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*)

3. 1 AND 2 limited to 2018

PubMed - Anesthesia in medical education journals (11 results on April 23, 2019)

(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 2018[dp]

PubMed - Education in anesthesiology journals (103 results on April 23, 2019)

(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 2018[dp]

PubMed - Journal Table of Contents Handsearch (1653 results on July 31, 2019)

("Anesthesiology"[Journal] OR "anesthesia and analgesia"[journal] OR "british journal of anaesthesia"[journal] OR "J Educ Perioper Med"[journal] OR "Acad Med"[Journal] OR "Med Educ"[Journal] OR "Adv Health Sci Educ Theory Pract"[Journal] OR "Med Teach"[Journal] OR "Simul Healthc"[Journal]) AND 2018[dp] AND hasabstract[text] NOT (editorial[pt] OR letter[pt]) NOT pubstatusaheadofprint

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Appendix B

Appendix B. Additional Questions

Questions to Code Articles Reviewed	
Funding	
<input type="checkbox"/>	None (or internally funded by department)
<input type="checkbox"/>	Yes, please specify
Target Audience: (Select all that apply)	
<input type="checkbox"/>	Residents
<input type="checkbox"/>	Medical students
<input type="checkbox"/>	Practicing anesthesiologists
<input type="checkbox"/>	Nurse
<input type="checkbox"/>	Other
Nonphysician/Nonprovider author:*	
<input type="checkbox"/>	Yes, first, second, or last
<input type="checkbox"/>	Yes, but not first, second, or last
<input type="checkbox"/>	No
<input type="checkbox"/>	Unclear
Primary Setting:	
<input type="checkbox"/>	Simulation
<input type="checkbox"/>	Real-life
<input type="checkbox"/>	Other
Purpose:	
<input type="checkbox"/>	Teaching methods
<input type="checkbox"/>	Learner evaluation of programs
<input type="checkbox"/>	Learner assessment
<input type="checkbox"/>	Intervention description
<input type="checkbox"/>	Environment assessment
<input type="checkbox"/>	Other
Topic:	
<input type="checkbox"/>	Case management/general practice
<input type="checkbox"/>	Learning procedures
<input type="checkbox"/>	Crisis resource management
<input type="checkbox"/>	Anesthesiology non-technical skills
<input type="checkbox"/>	Professionalism
<input type="checkbox"/>	Resident selection
<input type="checkbox"/>	Interprofessionalism
<input type="checkbox"/>	Other

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Appendix B continued

Competency:*	
	Patient care
	Medical knowledge
	Practice-based learning and improvement
	Interpersonal and communication skills
	Professionalism
	Systems-based practice
	N/A
Theme topic: (Open-ended question)	
* We did not report on Nonphysician Author and Competency categories because the data collected was not useful. For Nonphysician Author category, 43% 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 were not about a specific competency and therefore 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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Appendix C

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

Article #	First Author	Title	Journal	Type
1	Arzallier-Daret, S.	Effect of sleep deprivation after a night shift duty on simulated crisis management by residents in anaesthesia. A randomised crossover study	Anaesthesia Critical Care & Pain Medicine	Quantitative
2	Bakke, K. E.	Training surgeons and anesthesiologists to facilitate end-of-life conversations with patients and families: A systematic review of existing educational models	Journal of Surgical Education	Quantitative
3	Beck, S.	For beginners in anaesthesia, self-training with an audio-visual checklist improves safety during anaesthesia induction: A randomised, controlled two-centre study	European Journal of Anaesthesiology	Quantitative
4	Benzon, H. A.	Pediatric anesthesiology fellows' perception of quality of attending supervision and medical errors	Anesthesia & Analgesia	Quantitative
5	Blanie, A.	Impact of learners' role (active participant-observer or observer only) on learning outcomes during high-fidelity simulation sessions in anaesthesia: a single center, prospective and randomised study	Anaesthesia Critical Care & Pain Medicine	Quantitative
6	Blum, R. H.	Simulation-based assessment to reliably identify key resident performance attributes	Anesthesiology	Quantitative
7	Boet, S.	Measuring non-technical skills of anaesthesiologists in the operating room: A systematic review of assessment tools and their measurement properties	British Journal of Anaesthesia	Quantitative
8	Cafferkey, A.	The college of anaesthetists of ireland simulation training programme: A descriptive report and analysis of course participants' feedback	Irish Journal of Medical Science	Quantitative
9	Curry, S. E.	Teaching medical students clinical anesthesia	Anesthesia & Analgesia	Quantitative
10	de Oliveira Filho, G. R.	The effect of high-frequency, structured expert feedback on the learning curves of basic interventional ultrasound skills applied to regional anesthesia	Anesthesia & Analgesia	Quantitative
11	Efstathiou, J. A.	Long-term impact of a faculty mentoring program in academic medicine	PLoS ONE	Quantitative
12	Goldhammer, J. E.	Use of provider debriefing to improve fast-track extubation rates following cardiac surgery at an academic medical center	American Journal of Medical Quality: The Official Journal of the American College of Medical Quality	Quantitative
13	Hastings, R. H.	Manikin laryngoscopy motion as a predictor of patient intubation outcomes: A prospective observational study	The Journal of Education in Perioperative Medicine	Quantitative
14	Hoffman, C. R.	Using operating room turnover time by anesthesia trainee level to assess improving systems-based practice milestones	BMC Medical Education	Quantitative
15	Kallidaikurichi Srinivasan, K.	Proficiency-based progression training: an 'end to end' model for decreasing error applied to achievement of effective epidural analgesia during labour: A randomised control study	BMJ Open	Quantitative

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Appendix C *continued*

Article #	First Author	Title	Journal	Type
16	Kaplan, S. J.	Resident wellness and social support: development and cognitive validation of a resident social capital assessment tool	Journal of Surgical Education	Quantitative
17	Kenevan, M. R.	The changing characteristics of anesthesiology program directors	The Journal of Education in Perioperative Medicine	Quantitative
18	Lane, M. A.	Supporting clinicians after adverse events: development of a clinician peer support program	Journal of Patient Safety	Quantitative
19	Laszlo, C. J.	Human cadavers preserved using Thiel's method for the teaching of fiberoptically-guided intubation of the trachea: a laboratory investigation	Anaesthesia	Quantitative
20	Leeper, W. R.	Multidisciplinary difficult airway course: an essential educational component of a hospital-wide difficult airway response program	Journal of Surgical Education	Quantitative
21	Lemarie, P.	High-fidelity simulation nurse training reduces unplanned interruption of continuous renal replacement therapy sessions in critically ill patients: The SimHer randomized controlled trial	Anesthesia & Analgesia	Quantitative
22	Lilot, M.	Relaxation before debriefing during high-fidelity simulation improves memory retention of residents at three months	Anesthesiology	Quantitative
23	Marchalot, A.	Effectiveness of a blended learning course and flipped classroom in first year anaesthesia training	Anaesthesia Critical Care & Pain Medicine	Quantitative
24	Nag, K.	Effectiveness of algorithm based teaching on recognition and management of periarrest bradyarrhythmias among interns – A randomized control study	Anaesthesia, Pain and Intensive Care	Quantitative
25	Sakakura, Y.	Biomechanical profiles of tracheal intubation: A mannequin-based study to make an objective assessment of clinical skills by expert anesthesiologists and novice residents	BMC Medical Education	Quantitative
26	Sargeant, J.	The R2C2 model in residency education: how does it foster coaching and promote feedback use?	Academic Medicine	Qualitative
27	Schoenherr, J. R.	Subjective awareness of ultrasound expertise development: individual experience as a determinant of overconfidence	Advances in Health Sciences Education	Quantitative
28	Sidhu, N. S.	Developing and validating a tool for measuring the educational environment in clinical anesthesia	Canadian Journal of Anaesthesia	Quantitative
29	Smith, A.	Undergraduate education in anaesthesia, intensive care, pain, and perioperative medicine: The development of a national curriculum framework	Medical Teacher	Qualitative
30	Speck, R. M.	Academic anesthesiology career development: a mixed-methods evaluation of the role of foundation for anesthesiology education and research funding	Anesthesia & Analgesia	Quantitative

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Appendix C *continued*

Article #	First Author	Title	Journal	Type
31	Tscholl, D. W.	Using an animated patient avatar to improve perception of vital sign information by anaesthesia professionals	British Journal of Anaesthesia	Quantitative
32	Valeberg, B. T.	Nurse anaesthetist students' experiences of patient dignity in perioperative practice-a hermeneutic study	Nursing Open	Qualitative
33	Vasilopoulos, T.	Understanding conflict management styles in anesthesiology residents	Anesthesia & Analgesia	Quantitative
34	Wanderer, J. P.	Implementation and evaluation of the Z-score system for normalizing residency evaluations	Anesthesiology	Quantitative
35	Wands, B. A.	A survey of moral distress in certified registered nurse anesthetists: A theoretical perspective for change in ethics education for advance practice nurses	International Journal of Nursing Sciences	Quantitative
36	Wolpaw, J.	Creation and evaluation of an anesthesiology and critical care podcast	The Journal of Education in Perioperative Medicine	Quantitative
37	Zarifnejad, G.	Does peer education increase academic achievement in first year students? A mixed-method study	Journal of Peer Learning	Quantitative
38	Zhou, Y.	Effect of the basic examination on knowledge acquisition during anesthesiology residency	Anesthesiology	Quantitative
39	Zhou, Y.	Association between performance in a maintenance of certification program and disciplinary actions against the medical licenses of anesthesiologists	Anesthesiology	Quantitative

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