The Journal of Education in Perioperative Medicine

Perspective

The Case for Modernizing the Third-Year Clinical Anesthesiology Residency Curriculum

Sheldon Goldstein, MD
Andre Bryan, MD, MBA
Angela K. Vick, MD
Tracey Straker, MD, MS, MPH, CBA, FASA
Sujatha Ramachandran, MD

Introduction

Advances in anesthesiology over 50 years contributed to the decision to add a required third year of clinical anesthesia (CA) residency training in 1989. Cardiac anesthesiologists with expertise in transesophageal echocardiography (TEE) provide improved monitoring, including surgical guidance. Increased survival of very low birth weight infants increased the need for anesthesiologists who are skilled with these fragile patients. Older, high-risk obstetric patients and complex neurointerventional procedures increased the need for anesthesiologists with special expertise to care for obstetrical and neurosurgical patients. This increased subspecialty knowledge could not be imparted to trainees in 1 rotation; 2 rotations became necessary for generalist anesthesiologists to learn the skills of each subspecialty.

Thirty-two years have passed since the increased training requirement. Since current graduating residents are expected to obtain knowledge in new domains, perform new skills not contemporary in 1989, and apply them to an older and sicker population, we suggest that the residency curriculum be updated for the 21st century.

Increased Age and Severity of Illness

By 2030, 21% of the population is projected to be aged ≥ 65,[1] and since addition of the third year of CA residency (CA-3 year) in 1989, the prevalence and severity of general medical illnesses have increased substantially. Among states taking part in the Behavioral Risk Factor Surveillance System in 1990, 10 had an obesity prevalence < 10% and none had a prevalence ≥ 15%.[2] It is estimated that by 2030, 78% of adults in the US will be overweight and almost 50% will be obese.[3] Hypertension, the leading risk factor for cardiovascular disease, is present in approximately 50% of patients aged ≥ 50.[4] In a survey of US adults between 2011 and 2016, the crude prevalence of diabetes was 14.6% (95% confidence interval, 13.6%-15.7%) and that of undiagnosed diabetes was 4.6% (95% confidence interval, 3.9%-5.3%).[5] In a population-based study, moderate or severe valvular heart disease was present on echocardiography (ECHO) in 13.3% of patients aged ≥ 75 in 2006,[6] and the increasing age of the population will result in a substantial increase in heart disease.[7] Older people have an increased incidence of diastolic heart failure, coronary artery disease, and cognitive decline. Furthermore, heart failure in older people is often accompanied by frailty, cachexia, sarcopenia, and polypharmacy.[8] Nearly 80% of people with heart failure are frail.[9] Frailty increases with age alone, and preoperative frailty is associated with increased morbidity and mortality in major abdominal,[10,11] vascular,[12] and cardiac surgery.[13] Over 800 000 adults in the US have congenital heart disease,[14] more than the number of children with congenital heart disease. Patients with left or right ventricular assist devices present for noncardiac surgery and procedures and may need to be cared for by noncardiac anesthesiologists in some centers. New antimicrobial drugs, pharmacotherapeutic agents and ventilatory modalities, as well as improved care of patients with sepsis, have improved the survival of people who are critically ill. It is clear that today's graduating residents care for a population with far more comorbidities than in 1989.

Increased Numbers of Devices and Techniques

The laryngeal mask airway was reported in 1983.[15] Multiple extraglottic airway devices followed.[16,17] The Bullard laryngoscope was reported in 1990,[18] and 13 video laryngoscopes have been introduced into practice since.[19-21] It is fairly easy to learn to use these devices. Still, each is unique, and anesthesiologists must learn about complications such as palatopharyngeal wall and tonsillar pillar perforation. Since extraglottic airway devices and video laryngoscopes were just being introduced in the US in 1989, they are additional devices for which residents need to achieve competency. Finally, although it was taught only occasionally in 1989, residents are now expected to be proficient in fiberoptic intubation upon graduation.

In 1989 graduates were encouraged to perform nerve blocks, yet the ability to do so was limited to programs where such expertise existed, and some programs did not provide thorough training in performance of regional nerve blocks for surgical anesthesia. Today, graduates are

continued on next page

continued from previous page

expected to be proficient in performance of several regional blocks with ultrasound (US) guidance. The Accreditation Council for Graduate Medical Education (ACGME) anesthesiology requirements describe 4 types of vascular access and 8 nerve blocks, tested on the Anesthesiology Objective Structured Clinical Examination.

Education related to new airway and regional devices, as well as techniques, has increased since 1989. However, we believe the total increase in knowledge and skills beyond airway management and regional anesthesia added since 1989 has not been adequately addressed.

The Clinical Base Year

The clinical base year fosters development of foundational clinical skills. It exposes residents to common diseases such as hypertension, diabetes, asthma, and coronary artery disease, permitting them to achieve facility in caring for patients with those diseases. It also exposes them to patients who run the gamut from stable to unstable to critically ill. This is valuable time spent, because anesthesia residents must learn to distinguish between patients in these categories. Beyond the question of whether it is wise to shorten the internship, it seems unlikely that the ACGME would curtail primary-care exposure that it has judged necessary since 1939. However, some modification of the clinical base year might be possible to better align with the goal of training modern-day anesthesiologists. Possibilities include a point-of-care US (POCUS) rotation with emphasis on transthoracic echocardiography (TTE) and assessment of lung function in critical care areas, and 2 to 3 months of direct anesthesia care. The amount of time dedicated to such rotations would need to be negotiated with medical and surgical services which rely on anesthesia residents to fulfill their staffing needs. Since we cannot be certain what level of control directors of anesthesia programs will have during the clinical base year in the future, the bulk of our suggestions focus on the CA-3 year.

Suggestions to Modernize the Residency Curriculum

The ACGME requires 2 months each in cardiac, pediatric, obstetric, and neuro-anesthesia, 4 months in critical care, and 3 months in pain. With additional requirements (Table 1), this foundation of the curriculum requires 16 months to complete. The ACGME anesthesiology requirements, just a 4.5-page document in 1989, grew to 63 pages by 2020.[22] Although a fair amount of text is devoted to background and intent, still, 25 new topics and skills were added from 1989 to 2020 (Table 2).

We suggest that the curriculum be modified to improve education for these new requirements for which rotations have not been added. Although in-training examination scores show large increases during the CA-1 and CA-2 years, they rise only a small amount during the CA-3 year.[23] Our suggested modifications would address gaps in education related to the 25 new requirements, and might increase knowledge gained during the CA-3 year. We label these modifications Advanced Training Rotations (ATRs) to differentiate them from existing rotations with basic goals in the same area. ATRs would mostly be incorporated into the CA-3 year (Table 3), but some might be shifted to other years. They would be designed to enhance knowledge in a specific area. ATRs should be taught in parallel with clinical rotations, since the material will likely be better retained in association with clinical cases. They would be designed to increase resident knowledge or skills in specific areas while providing clinical care. In addition to reading the night before about patients' comorbidities and the procedures they will undergo, residents will read material related to the focus of each respective ATR. Depending on the existing curriculum at each program, ATRs might require the creation of several advanced lectures by faculty, but self-study by residents would be the primary method to improve knowledge. This is in line with the stated ACGME outcome that residents develop a commitment to lifelong learning.

In Table 2 we list the 25 requirements added since 1989, numbered not in chronological order of their addition but rather in an order that facilitates a discussion of them and methods to teach them. The need to engage in active listening (requirement 1) describes the foundation of the doctor-patient relationship. This rapport should be taught beginning in medical school and should not require additional time. Still, it serves as a reminder to faculty to model such behavior. Requirement 2 (2 months of obstetric, cardiac, and pediatric anesthesia) is self-explanatory, part of the 16 months of fixed training requirements (Table 1). Requirements 3 (clinical experience with interventional pain procedures) and 4 (experience in 40 patients in which peripheral nerve blocks are used) are satisfied during pain rotations added in requirement 5 (3 months of pain rotations). Requirement 6 (use of electroencephalography or processed electroencephalographic monitoring) can be fulfilled during 2 required months of neuro-anesthesia, as those modalities are often performed in these cases. Airway management is a linchpin of anesthesia practice, and although the techniques listed in requirement 7 (a broad spectrum of airway techniques including laryngeal mask airways, fiberoptic intubation, and lung isolation techniques—double lumen tubes, bronchial blockers, and Univent tube) are performed often during general and thoracic cases, many programs have added an airway rotation to allow residents to focus on airway techniques and achieve proficiency in fiberoptic intubation. We believe requirements 8 (take part in an educational program in substance abuse as it relates to physician well-being), 9 (residents must be educated regarding self-care, in particular as it relates to risk of burnout and depression), and 10 (undergo education in recognition and management of exhaustion and sleep deprivation), which focus on well-being and self-care, can be taught in the classroom via formal lectures or problem-based learning discussions. Regardless which methods are used, self-care should not require more than several hours annually. In summary, we believe that ACGME requirements 1 through 10 can be taught during rotations added since 1989, or with several hours of devoted time. In contrast, it is our opinion that requirements 11 through 17 and 19 through 25 require additional education beyond what was taught in 1989. To satisfy this need, we suggest the development of ATRs, 4 of which we recommend be required.

Discussion of quality improvement (QI) increased in the 1960s and 1970s,[24] followed by a 1991 study reporting an adverse event in 3.7% (95% confidence interval, 3.2%-

continued on next page

continued from previous page

4.2%) of 30 121 hospitalizations in 51 New York state hospitals.[25] Subsequently, on December 1, 1999, the Institute of Medicine published "To Err Is Human," a report[26] estimating that 44 000 to 98 000 people die annually from medical errors in the United States. Reports such as these led to increased focus on QI. The ACGME Practice-based Learning and Improvement competency and Systems-based Practice competency are satisfied via requirements 11 (systematically analyze practice using quality improvement methods) and 12 (must take part in education on patient safety).

QI incorporates structured review of individual cases or assessments of quality among larger numbers of patients using various methods.[27] This is new knowledge that residents must acquire today that was not taught in 1989. While requirement 11 is taught during preparation of QI presentations, the need to teach QI to residents is vital, and we suggest that a QI ATR led by the QI director might be required, or offered to interested residents. There is overlap between QI and requirement 12, and a curriculum teaching both to residents and faculty has been reported.[28] There is also overlap between QI and research, as research methods are often applied in QI projects, so requirements 13 (the ability to conduct, interpret and apply the results of medical research) and 14 (curriculum must advance residents' knowledge of the basic principles of research, including how research is conducted, evaluated, explained to patients and applied to patient care) could also be taught during a QI rotation. To ensure that informed consent is obtained when projects are under the rubric of research, trainees should be taught to differentiate QI from research. Tools to distinguish QI from research exist.[29] The fact that QI, patient safety, research, and requirement 18 (incorporate considerations of cost awareness) overlap can be used to advantage by incorporating principles of each into 1 ATR.

Most programs provide research opportunities, but few residents devote significant time to research. This is a significant deviation from the first residency in anesthesiology, established by Dr. Ralph Waters at the University of Wisconsin–Madison, which required the entire second of 3 years of residency to be devoted to basic science research.[30] Requirement 13 is limited to knowledge of research, whereas requirement 14 suggests a more in-depth experience, resulting in residents developing the "ability to conduct, interpret and apply the results of medical research". This raises the question of whether we should be doing more. At a minimum, residents should actively contribute to research, either by undertaking their own projects or by joining an ongoing research study. Confirmation that the goals of requirement 14 have been achieved could be proven by residents demonstrating the ability to obtain informed consent, explain data organization in a database, and write an abstract judged acceptable by research faculty. Such requirements do not seem onerous, and a research ATR might influence some to pursue a career in research. The Anesthesiology Residency Review Committee requires research to maintain accreditation, but some programs have few faculty engaged in research. Indeed, some maintain PhD scientists who provide academic productivity to satisfy accreditation requirements while clinical faculty perform minimal research. If a research ATR exposes all residents to research, some might pursue a career that includes research, addressing the concern of a 2003 report that anesthesiology received only 0.9% of National Institutes of Health grants, despite representing 6% of the medical workforce.[31] Although the focus of our suggestions are related to the CA-3 year, research rotations might take place in the CA-2 year, so residents who develop an interest could schedule additional research ATRs during the CA-3 year.

The American Society of Anesthesiologists has published "Starting Out: A Practice Management Guide for Anesthesiology Residents,"[32] which discusses liability, credentialing, clinical practice, and business and legal issues. This 95-page document is best seen as a reference, but some teaching of practice management and floor-runner skills is required. While Six Sigma and LEAN have been applied to improve operating-room (OR) efficiency, we teach Integrated Practice Improvement Solutions, since it is more flexible, was developed specifically for the OR,[33] and has been shown to improve OR efficiency while increasing hospital and anesthesia revenue with no untoward effect on patient safety.[34] Practice management (requirement 15) and OR management including floor-runner skills (requirement 16) seem suited to education within the OR environment. We teach these during a 2-week OR-management/floor-runner rotation, during which residents take part in daily creation of the OR schedule and modification as needs arise, under the supervision of an attending who is skilled in OR efficiency. Neither of these domains was taught in 1989, and we recommend at minimum a 2-week practice-management/floor-runner ATR, though other programs may have other ideas how to teach these domains.

Management and organizational skills (requirement 17) and cost awareness (requirement 18) should be taught to residents not only because they are ACGME requirements but because they make anesthesiologists better OR leaders and more valuable to hospitals. We believe neither of these requires dedicated time to be taught independently, and could be taught during QI, research, or practice-management ATRs.

Even at university programs, use of TEE by anesthesiologists was in its infancy in 1989; but 11 TEE views are tested on the Anesthesiology Objective Structured Clinical Examination, and TTE will be tested beginning in 2022. Despite multiple TEE and POCUS ACGME requirements (19-24), no required rotations have been added. Originally the domain of cardiac anesthesiologists, TEE has detected multiple etiologies of hypotension and cardiac arrest during noncardiac surgery.[35-38] Recognition of its utility during noncardiac surgery was the impetus behind the American Society of Anesthesiologists' request that the National Board of Echocardiography create a basic examination so that noncardiac anesthesiologists could document expertise in TEE. Furthermore, patients sometimes present with hypotension, respiratory insufficiency, and decreased urine output in the postanesthesia care unit, and the etiology of these problems can often be diagnosed with POCUS, which has also been shown to shorten stays in the unit.[39]

The ACGME requirements state that residents should have "competency in using

continued on next page

continued from previous page

surface ultrasound and transesophageal and transthoracic echocardiography, to guide performance of invasive procedures, and to evaluate organ function and pathology as related to anesthesia, critical care, and resuscitation."[22] They also state that residents need to understand principles and physics of US, and obtain TTE and TEE views of the heart with an understanding of limitations and artifacts. We believe that to teach these ACGME requirements, at least 1 ATR in ECHO/POCUS should be required during residency, and the opportunity afforded for those who are interested to pursue additional training in the CA-3 year. Learning the principles and physics of US and the techniques to obtain ECHO views may require several months of focused effort, depending on the number of exams performed monthly and the level of expertise sought. Residents who perform POC TTE exams throughout their residency, and follow the 2 required cardiac rotations with 2 or 3 ATRs in ECHO/POCUS, could have substantial expertise in TTE and/or TEE at graduation. A second or third elective, library ECHO/US ATR, would have a resident performing ECHO/US exams on a daily basis, but without OR responsibilities, thereby providing time to prepare for a National Board of Echocardiography exam in TEE and/or TTE critical care. The authors know several residents who have successfully completed basic and advanced National Board of Echocardiography ECHO exams during their CA-3 year, so this is achievable. Departments might consider reimbursing residents if they pass such an examination. This compensation would incentivize residents to prepare thoroughly to pass the examination, and while it is a relatively small cost to departments, informing future applicants that residents have passed ECHO examinations would likely facilitate recruitment of higher-quality applicants.

Simulation

Annual simulation experience is an additional ACGME requirement added since 1989. Simulators provide an excellent venue to educate residents in rare or life-threatening scenarios. However, some programs provide residents as little as 2 hours of simulation training annually, an injudicious checking of a box on a form to satisfy an ACGME requirement. This is a wasted opportunity. We propose that all CA-3 residents receive a minimum of 12 to 24 hours of simulation training. Scenarios should include those that are rare, may cause severe harm to patients, or provide little opportunity for education during an actual event due to the necessity for rapid, focused decision making and treatment. Possible scenarios might include fire, malignant hyperthermia, hemolytic transfusion reaction, retained throat pack, venous air embolism, and anaphylaxis, as these are sufficiently rare that most residents will graduate without having ever experienced them.

We suggest the following as a possible format for a required simulation ATR. Each simulation would encompass 15 minutes, followed by a 20-minute faculty-guided debriefing. Forty-five minutes would then be provided for residents to read 1 or 2 review articles or case reports on the topic. Faculty would then deliver a brief presentation, 6 to 8 slides in 10 to 15 minutes, summarizing optimal management of the scenario. We prefer such a format because an immediate faculty-guided debriefing alone, while requiring residents to self-reflect and draw upon their current knowledge of the topic, may not advance their knowledge of it. Subsequent reading of 1 or 2 papers and the summary faculty slides would reinforce the learning experience. How each program schedules sessions could vary. Some might have groups of 4 or 5 attendees attend 1 session monthly, whereas others might have each group take part in 3 scenarios 1 day quarterly. In total, such a format would provide 18 hours of simulation-based education if implemented during the CA-3 year, and 36 hours if implemented during the CA-2 and CA-3 years.

Proposed Modifications Beyond the ACGME Milestones

We propose the development of 3 ATRs unrelated to current ACGME requirements, because we feel they are relevant to modern anesthesia practice. The first is an ATR in patient blood management (PBM). This is not listed among the ACGME requirements, but we recommend that an ATR in PBM be required. The Society for the Advancement of Patient Blood Management defines PBM as "the timely application of evidence-based medical and surgical concepts designed to maintain hemoglobin concentration, optimize hemostasis and minimize blood loss in an effort to improve patient outcome."[40] Anesthesiologists order about half the blood products in a hospital,[41] and likely transfuse more blood products than any other physician specialists. It therefore seems vital that residents learn the domain knowledge of PBM, since application of PBM has been shown to improve patient outcomes and decrease costs.[42] During a required PBM-1 ATR, residents would prepare management plans for cases that include PBM techniques, to be discussed with their attending and applied as appropriate. During an elective PBM-2 ATR, residents could do the same, or rotate with a hematologist or blood banker and perform consultations for patients with bleeding disorders or transfusion challenges or complications.

We suggest offering an elective ATR in advanced cardiac care. Noncardiac anesthesiologists may be called upon to anesthetize patients for endoscopy or emergent noncardiac surgery who have cardiac assist devices in place, or for urgent vascular surgery due to complications arising from such devices. Our recommended ATR would provide graduating residents additional cardiac-related skills without their having to complete a cardiac anesthesia fellowship. Such a rotation might accompany an additional OR cardiac rotation, or a cardiac surgical intensive care unit rotation under supervision of faculty and perfusionists caring for patients supported with cardiac assist devices.

Considering the frequent experience residents have with older patients, an ATR in geriatrics is likely not necessary, but we encourage programs to provide directed didactics on best practices for caring for these patients. This might include 2 or 3 lectures focusing on physiology, pharmacokinetics, and pharmacodynamics in older people, and anesthetic management in this at-risk population. A formal geriatrics ATR might be considered as an elective for CA-3 residents who wish to develop expertise and/or perform research in this population.

continued on next page

continued from previous page

ACGME Milestones/ Competency-based Education

The Next Accreditation System was implemented in anesthesiology in July 2014.[43] In 2016, the ACGME instituted milestones to document each resident's progress toward becoming an independent practitioner—that is, competency-based education. The goal of competency-based education is to for learners to achieve the ability to access rules relevant to a task and make decisions about the task, while manually performing the task[44]—a progression of skill development that begins with novice and progresses through advanced beginner, competent, proficient, and eventually expert.[45] Indeed, the improvement that residents demonstrate during training reflects their passage through these stages, although achievement of expert status might not occur until after several years of independent attending practice, or not ever. Some commentators feel that since anesthesia requires complex behaviors incorporating situational awareness, resource management, multitasking, critical decision making, and empathy, checking off residents as competent in small observable behaviors is a reductionist approach.[46] Indeed, many programs have found it challenging to create metrics to assess milestones, and faculty may need to be trained to reliably perform such assessments.[47] Still, competency-based education is gaining traction, and milestones help trainees identify areas in which they need improvement, as well as help educators identify didactic and clinical training deficits that require additional focus. Furthermore, it is expected that milestones will improve with time, with Milestones 2.0 in effect as of July 1, 2021.[47]

The Next Accreditation System suggests innovative education for trainees who complete milestones quickly. Our proposed curriculum dovetails well with this idea, since once milestones have been completed, it leaves room for ATRs that are tailored to each individual and program. A program that judges its existing QI education strong might not require an ATR in QI, but might allow a resident who plans to matriculate in a fellowship in perioperative management to complete such an ATR. Similarly, an innovative big-data ATR could be developed if a resident plans to perform research with big data. Residents who plan to subspecialize could elect an ATR in their chosen subspecialty if they wish to enter fellowship at a more advanced level, or could elect CA-3 ATRs unrelated to their fellowship to round out their education.

The Next Accreditation System has not suggested early graduation, and we believe several considerations make early graduation inadvisable. The first is medicolegal. If a trainee graduates early and a patient cared for by that graduate experiences a bad outcome in the first month of practice, might the training program be held legally liable? We expect that programs would only graduate residents early based upon a clearly defined guideline from the American Board of Anesthesiology, and no such guideline exists. Still, we wonder whether a lawsuit might be brought against a training program if such a scenario unfolded without a guideline in place from the board. A second consideration is staffing. Training programs often have fewer attendings during the latter part of the academic year, since faculty who leave, take ill, or retire are usually replaced only after new graduates enter practice in July or August. Trainees who graduate early and move elsewhere would further strain clinical coverage, which might negatively affect the education of residents still in training, especially at smaller programs. Finally, residents are contractually obligated for the entire CA-3 year. We do not believe they should be relieved of this obligation because they complete milestones more rapidly than their peers. Instead, we suggest that innovative ATRs be offered to these advanced residents.

Summary

Many airway devices, awake intracranial surgery, total intravenous anesthesia, electrophysiologic monitoring, perioperative ECHO, PBM, cardiac assist devices, and extracorporeal membrane oxygenation were rare or nonexistent in 1989. Compared with 1989 graduates, current residents must learn a larger knowledge base, multiple new skills, and new ACGME competencies. Addition of a fourth CA year could be considered, but the logistical and financial challenges would be substantial. A logical alternative is to modify the current curriculum to advance education in new areas. We recommend that at least 1 ATR in QI or research, 1 in ECHO/US, 1 in PBM, and 1 in simulation be required of all residents, although different programs might emphasize different ATRs based on their individual strengths and weaknesses.

In conclusion, we recommend updating the anesthesia residency curriculum to improve education related to the 25 ACGME requirements added since 1989. Our suggested ATRs, designed for residents to focus on learning didactic knowledge in targeted areas during clinical rotations beyond the 16 currently required, present a framework to do so. The expertise displayed by anesthesiologists with advanced education during the CA-3 year will not just improve care of patients but will also raise anesthesiologists' professional standing in the eyes of our surgical colleagues.

References

1. Mather M, Jacobsen LA, Pollard KM. Aging in the United States. *Population Bulletin.* 2015;70(2):3.
2. Centers for Disease Control and Prevention. Obesity trends among U.S. adults between 1985 and 2010. https://www.cdc.gov/obesity/downloads/obesity_trends_2010.pdf. Accessed October 24, 2021.
3. Wang Y, Beydoun MA, Min J, et al. Has the prevalence of overweight, obesity and central obesity levelled off in the United States? trends, patterns, disparities, and future projections for the obesity epidemic. *Int J Epidemiol*. 2020;49(3):810-23.
4. Chow CK, Teo KK, Rangarajan S, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. *JAMA*. 2013;310(9):959-68.
5. Cheng JY, Kanaya AM, Araneta MRG, et al. Prevalence of diabetes by race and ethnicity in the United States, 2011-2016. *JAMA*. 2019;322(24):2389-98.
6. Nkomo VT, Gardin JM, Skelton TN, et al. Burden of valvular heart diseases: a population-based study. *Lancet*. 2006;368(9540):1005-11.
7. Sidney S, Go AS, Jaffe MG, et al. Association between aging of the US population and heart disease mortality from 2011 to 2017. *JAMA Cardiol*. 2019;4(12):1280-6.
8. Coats AJS. Heart failure management of the elderly patient: focus on frailty, sarcopaenia, cachexia, and dementia: conclusions. *Eur Heart J Suppl*. 2019;21(suppl L):L36-8.
9. Vitale C, Spoletini I, Rosano GMC. Frailty in heart failure: implications for management. *Card Fail Rev*. 2018;4(2):104-6.
10. Sandini M, Pinotti E, Persico I, et al. Systematic review and meta-analysis of frailty as a predictor

continued on next page

continued from previous page

of morbidity and mortality after major abdominal surgery. *BJS Open*. 2017;1(5):128-37.

11. Parmar KL, Law J, Carter B, et al. Frailty in older patients undergoing emergency laparotomy: results from the UK observational Emergency Laparotomy and Frailty (ELF) Study. *Ann Surg*. 2021;273(4):709-18.
12. Houghton JSM, Nickinson ATO, Morton AJ, et al. Frailty factors and outcomes in vascular surgery patients: a systematic review and meta-analysis. *Ann Surg*. 2020;272(2):266-76.
13. Sepehri A, Beggs T, Hassan A, et al. The impact of frailty on outcomes after cardiac surgery: a systematic review. *J Thorac Cardiovasc Surg*. 2014;148(6):3110-7.
14. Cheema A, Ibekwe S, Nyhan D, Steppan J. When your 35-year-old patient has a sternotomy scar: anesthesia for adult patients with congenital heart disease presenting for noncardiac surgery. *Int Anesthesiol Clin*. 2018;56(4):3-20.
15. Brain AI. The laryngeal mask—a new concept in airway management. *Br J Anaesth*. 1983;55(8):801-5.
16. Hernandez MR, Klock PA Jr, Ovassapian A. Evolution of the extraglottic airway: a review of its history, applications, and practical tips for success. *Anesth Analg*. 2012;114(2):349-68.
17. Gordon J, Cooper RM, Parotto M. Supraglottic airway devices: indications, contraindications and management. *Minerva Anestesiol*. 2018;84(3):389-97.
18. Borland LM, Casselbrant M. The Bullard laryngoscope: a new indirect oral laryngoscope (pediatric version). *Anesth Analg*. 1990;70(1):105-8.
19. Niforopoulou P, Pantazopoulos I, Demestiha T, Koudouna E, Xanthos T. Video-laryngoscopes in the adult airway management: a topical review of the literature. *Acta Anaesthesiol Scand*. 2010;54(9):1050-61.
20. Thong SY, Lim Y. Video and optic laryngoscopy assisted tracheal intubation—the new era. *Anaesth Intensive Care*. 2009;37(2):219-33.
21. Paolini JB, Donati F, Drolet P. Review article: video-laryngoscopy: another tool for difficult intubation or a new paradigm in airway management? *Can J Anaesth*. 2013;60(2):184-91.
22. Accreditation Council for Graduate Medical Education. ACGME program requirements for graduate medical education in anesthesiology. https://www.acgme.org/Portals/0/PFAssets/ProgramRequirements/040_Anesthesiology_2021.pdf. Accessed October 24, 2021
23. Zhou Y, Sun H, Lien CA, et al. Effect of the BASIC Examination on knowledge acquisition during anesthesiology residency. *Anesthesiology*. 2018;128:813-20.
24. Marjoua Y, Bozic KJ. Brief history of quality movement in US healthcare. *Curr Rev Musculoskelet Med*. 2012;5:265-73.
25. Brennan TA, Leape LL, Laird NM, et al. Incidence of adverse events and negligence in hospitalized patients—results of the Harvard Medical Practice Study I. *N Engl J Med*. 1991;324:370-6.
26. Institute of Medicine (US) Committee on Quality of Health Care in America, Kohn LT, Corrigan JM, Donaldson MS, eds. To Err is Human: Building a Safer Health System. Washington (DC): National Academies Press (US); 2000.
27. Goldmann D. Ten tips for incorporating scientific quality improvement into everyday work. *BMJ Qual Saf*. 2011;20(suppl 1):i69-72.
28. Kroker-Bode C, Whicker SA, Pline ER. Piloting a patient safety and quality improvement co-curriculum. *J Community Hosp Intern Med Perspect*. 2017;7(6):351-7.
29. Carter EJ, Usseglio J, Pahlevan-Ibrekic C, et al. Differentiating research and quality improvement activities: a scoping review and implications for clinical scholarship. *J Clin Nurs*. 2021;30(17-18):2480-8.
30. Bacon DR, Ament R. Ralph Waters and the beginnings of academic anesthesiology in the United States: the Wisconsin template. *J Clin Anesth*. 1995;7(6):534-43.
31. Schwinn DA, Balser JR. Anesthesiology physician scientists in academic medicine: a wake-up call. *Anesthesiology*. 2006;104(1):170-8.
32. Semo JJ. Starting Out: A Practice Management Guide for Anesthesiology Residents. American Society of Anesthesiologists, Park Ridge, IL, 2001
33. Chernov M, Pullockaran J, Vick A, et al. Integrated practice improvement solutions—practical steps to operating room management. *J Invest Surg*. 2016;29(5):316-21.
34. Chernov M, Vick A, Ramachandran S, et al. Perioperative efficiency vs. quality of care—do we always have to choose? *J Invest Surg*. 2018;33(3):265-70.
35. Suriani RJ, Neustein S, Shore-Lesserson L, et al. Intraoperative transesophageal echocardiography during noncardiac surgery. *J Cardiothorac Vasc Anesth*. 1998;112(3):274-80.
36. Schulmeyer MCC, Santelices E, Vega R, et al. Impact of intraoperative transesophageal echocardiography during noncardiac surgery. *J Cardiothorac Vasc Anesth*. 2006;20(6):768-71.
37. Fayad A, Shillcutt SK. Perioperative transesophageal echocardiography for non-cardiac surgery. *Can J Anaesth*. 2018;65(4):381-98.
38. Schulmeyer C, Farías J, Rajdl E, et al. Utility of transesophageal echocardiography during severe hypotension in non-cardiac surgery. *Rev Bras Anestesiol*. 2010;60(5):513-21.
39. Ramsingh D, Singh S, Canales C, et al. The evaluation of point-of-care ultrasound in the post-anesthesia unit—a multicenter prospective observational study. *J Clin Med*. 2021;10(11)2389-98.
40. Society for the Advancement of Blood Management. www.sabm.org. Accessed October 30, 2021.
41. Robblee JA, Crosby E. Transfusion medicine issues in the practice of anesthesiology. *Transfus Med Rev*. 1995;9(1):60-78.
42. Leahy MF, Hofmann A, Towler S, et al. Improved outcomes and reduced costs associated with a health-system–wide patient blood management program: a retrospective observational study in four major adult tertiary-care hospitals. *Transfusion*. 2017;57(6);1347-58.
43. Nasca TJ, Philibert I, Brigham T, et al. The next GME accreditation system—rationale and benefits. *N Engl J Med*. 2012;366(11):1051-6.
44. Ebert TJ, Fox CA. Competency-based education in anesthesiology: history and challenges. *Anesthesiology*. 2014;120:24-31.
45. Dreyfus SE. The five-stage model of adult skill acquisition. *Bull Sci Technol Soc*. 2004;24(3):177-81.
46. Weller JM, Naik VN, San Diego RJ. Systematic review and narrative synthesis of competency-based medical education in anaesthesia. *Br J Anaesth*. 2020;124(6):748-60.
47. Ambardekar AP, Walker KK, McKenzie-Brown AM, et al. The anesthesiology milestones 2.0: an improved competency-based assessment for residency training. *Anesth Analg*. 2021;133(2):353-61.

The following authors are in the Department of Anesthesiology, Albert Einstein College of Medicine - Montefiore Medical Center, New York, NY. ***Sheldon Goldstein*** *is an Associate Professor in the Department of Anesthesiology;* ***Angela K. Vick*** *is an Assistant Professor,* ***Tracey Straker is a Professor****, and* ***Sujatha Ramachandran*** *is an Associate Professor.* ***Andre Bryan*** *is an Attending Anesthesiologist in theDepartment of Anesthesiology Somnia Inc., at Nassau University Medical Center, East Meadow, NY.*

Corresponding author: *Sheldon Goldstein, MD, Department of Anesthesiology, Montefiore Medical Center–Albert Einstein College of Medicine, Fourth Floor Silver Zone, 111 E 210th Street, Bronx, NY 10467. Telephone: (718) 920-4187*

Email address: *Sheldon Goldstein: shgoldst@montefiore.org*

Financial Disclosures: *Dr. Goldstein is majority shareholder in Coagulation Sciences LLC. To date, he has received neither salary nor royalties from the company, and the company has no commercial product.*

Conflicts of Interest: *None.*

Keywords: ACGME requirements, curriculum, resident education, anesthesiology residency, milestones, competency-based education

continued on next page

continued from previous page

Tables

Table 1. *Sixteen ACGME Required Foundational Rotations*

Name	Months	Minimum Required Cases
Cardiac/thoracic anesthesia	2	20 cardiac, including 10 on-pump
		20 intrathoracic noncardiac
Pediatric anesthesia	2	100 aged < 12 y
		20 aged < 3 y, including 5 aged < 3 mo of age
Obstetric anesthesia	2	40 patients undergoing vaginal delivery
		20 patients undergoing caesarean section
Neuroanesthesia	2	20 patients, with the majority being open cranium
Chronic pain	1	
Acute pain	1	
Regional anesthesia	1	40 patients undergoing a variety of rotations
Critical care medicine	4 (2 during CBY)	
Preadmission testing and postanesthesia care unit	1 (2 wk of each)	
Additional case requirements	May be fulfilled any time on a general operating room rotation	20 vascular cases
		20 cases with life-threatening pathology

Abbreviation: CBY, clinical base year.

continued on next page

continued from previous page

Tables *continued*

Table 2. *2020 ACGME Anesthesiology Requirements[22] Added Since 1989*

1. Create and sustain a therapeutic relationship with patients, and engage in active listening
2. Requirement of two months of obstetric, cardiac and pediatric anesthesia
3. Clinical experience with interventional pain procedures
4. Experience in 40 patients in which peripheral nerve blocks are used
5. Three months of pain rotations
6. Use of electroencephalography or processed electroencephalographic monitoring
7. A broad spectrum of airway techniques including Laryngeal Mask Airways, Fiberoptic Intubation, and lung isolation techniques (double lumen tubes, bronchial blockers, and Univent tube)
8. Take part in an educational program in substance abuse as it relates to physician well-being
9. Residents must be educated regarding self-care, in particular as it relates to risk of burnout and depression
10. Undergo education in recognition and management of exhaustion and sleep deprivation
11. Systematically analyze practice using quality improvement methods
12. Must take part in education on patient safety
13. The ability to conduct, interpret and apply the results of medical research
14. Curriculum must advance residents' knowledge of the basic principles of research, including how research is conducted, evaluated, explained to patients and applied to patient care
15. Practice management
16. Operating room management including floor runner skills
17. Develop management skills including basic knowledge of organizational culture, decision-making, change management, conflict resolution, and negotiation and advocacy
18. Incorporate considerations of cost awareness
19. Understand the principles of US, including the physics of US and transducer selection, to obtain images with an understanding of limitations and artifacts
20. Obtain standard views of the heart with TEE allowing evaluation of myocardial function, and estimate central venous pressure and gross pericardial/cardiac pathology
21. Obtain standard views of the heart and IVC, with TTE allowing evaluation of myocardial function, estimation of central venous pressure and gross pericardial/cardiac pathology
22. Use of surface US, TEE and TTE to guide performance of procedures and to evaluate organ function and pathology as related to anesthesia, critical care and resuscitation
23. Use US for detection of pneumothorax and pleural effusion
24. Be able to describe above US techniques, views and findings in standard language
25. Required simulation experience annually

Abbreviations: ACGME, Accreditation Council for Graduate Medical Education; IVC, inferior vena cava; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography; US, ultrasound.

continued on next page

continued from previous page

Tables *continued*

Table 3. *Suggested Advanced Training Rotations*

Rotation	Basic Requirements	Documentation of Learning	Clinical Care Assignment During Advanced Rotation
Advanced QI	Take part in QI review of 4 clinical cases	Prepare 1 slide presentation incorporating a QI methodology such as Plan-Do-Study-Act	Any
Advanced Research 1 (clinical)	Assist with clinical research	As required by each program	Any
Advanced Research 2 (clinical or basic science)	Write research abstract Present poster within department	Demonstrate the ability to obtain informed consent Explain data organization in a database Write an abstract judged acceptable by research faculty	Any (clinical care optional, at each program's discretion)
Advanced Practice Management	Complete learning modules related to practice management	Be primarily responsible for running the OR floor for a minimum of 1 wk	Should not be assigned in the OR when running the floor
Advanced ECHO/US (POCUS 1)	Perform 20 POC ECHO exams (some of these exams may be performed on a simulator)	Demonstrate the ability to perform a basic POC TTE exam	Any
Advanced ECHO/US (POCUS 2)	Perform 30 POC ECHO exams Perform 10 lung US exams Perform 10 abdominal US exams (some of these exams may be performed on a simulator)	National Board of Echocardiography exam in critical care echocardiography (optional)	Any (or library POCUS elective without clinical care)
Advanced ECHO/US (TEE 1)	Perform 10 TEE exams (some of these exams may be performed on a simulator)	Demonstrate the ability to obtain the 11 TEE views tested on the Anesthesiology OSCE	OR or cardiac rotation
Advanced ECHO/US (TEE 2)	Perform 20 TEE exams (some of these exams may be performed on a simulator)	National Board of Echocardiography exam in basic TEE or advanced TEE (optional)	OR, cardiac, or ICU (or library TEE elective without clinical care)
Advanced Simulation	Take part in simulation training for 12-24 h during the CA-3 year	As required by each program	Any (simulation sessions to be outside OR time)
Advanced Geriatrics	Write 15 brief patient plans	Brief end-of-rotation quiz	Any
Advanced Cardiac Care	Complete learning modules related to IABP, cardiac assist devices, Impella, and ECMO	Brief end-of-rotation quiz	Cardiac, ICU, or perfusion

continued on next page

continued from previous page

Tables *continued*

Advanced PBM 1	Write 15 brief patient plans	Brief end-of-rotation quiz	OR, cardiac, or transplant
Advanced PBM 2	Write 15 brief patient plans or rotate with a hematologist or blood banker and perform consultations for patients with bleeding disorders or transfusion challenges or complications	Brief end-of-rotation quiz	OR, cardiac, or transplant (or hematology service)

Abbreviations: CA-3, third year of clinical anesthesia residency; ECHO, echocardiography; ECMO, extracorporeal membrane oxygenation; IABP, intraaortic balloon pump; ICU, intensive care unit; OR, operating room; OSCE, Objective Structured Clinical Examination; PBM, patient blood management; POC, point-of-care; POCUS, point-of-care ultrasound; QI, quality improvement; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography; US, ultrasound.