



American Journal of Anesthesia & Clinical Research

Research Article

Anesthesiology Resident Preparedness for Practice Perceptions - A National Survey -

Eric R Simon*, Michael C Trawicki and Richard E Galgon

Department of Anesthesiology, University of Wisconsin, 600 Highland Avenue, Madison, WI 53792, USA

***Address for Correspondence:** Eric R Simon, Department of Anesthesiology, University of Wisconsin, 600 Highland Avenue, Madison, WI 53792, USA, Tel: +160-826-381-00; E-mail: esimon@uwhealth.org

Submitted: 31 July 2019; **Approved:** 06 August 2019; **Published:** 09 August 2019

Cite this article: Simon ER, Trawicki MC, Galgon RE. Anesthesiology Resident Preparedness for Practice Perceptions - A National Survey. Am J Anesth Clin Res. 2019;5(1): 06-0013.

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ABSTRACT

Background: The transition from resident physician to independent practitioner is an important period for young physicians. Optimally, they would feel well prepared to independently care for all patients presenting to them for anesthesia, however, this is unlikely.

Methods: A survey was emailed to all accredited anesthesiology residency program coordinators in April 2018 for further distribution to their CA3 residents. The survey collected data on the resident's perception of his or her preparedness to manage a variety of anesthesia cases, patients with comorbid conditions, and ethical issues as well as perform various procedures.

Results: The survey was distributed to 340 CA3 residents across the United States and 93 surveys were returned for a response rate of 27.4%. More than 90% of residents feel comfortable providing anesthesia for basic surgeries across many surgical subspecialties. However, >40% of residents feel uncomfortable providing anesthesia for a variety of complex surgeries. Regarding airway management, 100% of residents feel extremely comfortable performing laryngoscopy for tracheal intubation, however < 30% feel comfortable performing more complex airway techniques. There are also other various advanced technical procedures where >40% of surveyed residents feel uncomfortable, including placing a bronchial blocker and performing paravertebral blocks. Regarding the business of anesthesiology, nearly 70% of residents graduate feeling uncomfortable with anesthesia billing regulations and >50% graduate feeling unprepared to review an employment contract.

Conclusions: Residents overall feel comfortable providing anesthesia for the majority of surgeries that they will likely encounter in independent practice. However, our data shows that there are areas where improvements still ought to be made. There is clearly a need for residency programs to continuously evaluate their residents' clinical experiences and supplement them with additional learning activities.

INTRODUCTION

The transition from resident physician to attending physician (or independent practitioner) is an important period of time for young physicians. Optimally, they would feel well prepared to independently assess and care for all patients presenting to them in their specialty of training. However, this is unlikely, as patients with rare and complex conditions are, by definition, limited and may not have presented for assessment and care during the resident physician's years of training; individual residency programs likely vary in their abilities to prepare residents for independent practice; and resident physicians practice under the oversight and tutelage of an attending physician, which adds a layer of comfort for the resident physician.

To date, limited information on residents' perceptions of preparedness for independent practice has been gathered. A 1991 survey of young physicians found that 80% of those who responded thought their professional medical education did a "good" or "excellent" job of training them for independent clinical practice, however many still felt unprepared for a variety of conditions they would encounter in their clinical practice [1]. In addition, surveys of physicians in various specialties, including pediatrics [2,3], general preventative medicine [4], rural practice [5], and neurosurgery [6], found similar results, that some of these physicians were underprepared for specific tasks and patient conditions for which residency ideally should have prepared them.

Within anesthesiology, data regarding residents' perceptions of preparedness for independent practice has been even more scarce. Prior to the current study, the only published data that specifically included anesthesiology residents was a 1998 national survey of residents in their final year of training, which showed that more than 90% of these anesthesiology residents felt prepared to administer general anesthesia for patients with complex illnesses, administer anesthesia for cardiac surgery, perform spinals and epidurals, manage acute pain, manage both pre-operative and post-operative patients, and communicate with referring physicians [7]. However, less than 70% of the anesthesiology residents felt prepared to manage chronic pain, participate in quality assurance, collaborate with non-physician caregivers, and practice in managed care [7]. Therefore, the specific

aims of the current study were 1) to characterize residents' perceptions regarding their preparedness to manage specific anesthetic plans for a wide variety of surgical cases, 2) to characterize residents' perceptions regarding their preparedness to perform various technical procedures related to the anesthetic care of a wide variety of patients, and 3) to characterize residents' perceptions regarding their preparedness to provide anesthesia in the setting of various social, ethical, and legal challenges.

MATERIALS AND METHODS

This national survey of Clinical Anesthesiology year 3 (CA3) residents within the United States was reviewed by the University of Wisconsin-Madison Institutional Review Board (IRB) and an exemption was granted (protocol # 2017-0412). Survey procedures and design were developed by the study team in conjunction with the University of Wisconsin-Madison IRB.

Contact information for all 141 Accreditation Council for Graduate Medical Education (ACGME) accredited residency program coordinators was obtained from a University of Wisconsin mailing list and verified using the Fellowship and Residency Electronic Interactive Database Access System maintained by the American Medical Association. A link to the electronic survey was emailed to all anesthesiology residency program coordinators within the United States in April 2018 for further distribution to all of the CA3 residents in their program. The program coordinators were asked to respond directly to the study team with the number of CA3 residents in their program to whom they forwarded the email. Two reminder emails were sent at two week intervals during April 2018.

In addition to minimal background biographical information (gender, age, race, state of residency training program, and career plans after graduation), the survey collected data on the resident's perception of his or her preparedness to manage a variety of anesthesia cases, patients with comorbid conditions, and ethical issues, as well as perform various anesthesia-related procedures. A total of 104 questions within 24 categories were included in the survey (Table 1). The categories were chosen based on the limited previous data available in the literature and expanded in an effort to cover



Table 1: Pooled survey responses

How comfortable do you feel providing anesthesia for the following procedures?					
Procedure	n	1	2	3	4
Emergency laparoscopic appendectomy	82	97.6	2.4	0	0
Open pancreaticoduodenectomy	82	76.8	23.2	0	0
Resection of a pheochromocytoma	82	23.2	45.1	28.1	3.7
Total laryngectomy with a free flap	81	59.3	32.1	6.2	2.5
Awake tracheostomy	80	51.3	33.8	13.8	1.3
Airway surgery requiring the use of a laser	81	71.6	24.7	2.5	1.2
Airway surgery requiring jet ventilation	81	39.5	29.6	19.8	11.1
Robotic hysterectomy	81	98.8	1.2	0	0
Ruptured ectopic pregnancy	80	80	16.3	3.8	0
Dilation and curettage with hemodynamic instability	80	80	16.3	2.5	1.3
Nonobstetric surgery in a pregnant patient at 24 weeks gestation	80	57.5	28.8	12.5	1.3
Emergency ascending aortic dissection repair in a patient with evidence of cardiac tamponade, new diastolic murmur, new ST segment changes, and evidence of new right-sided weakness	82	7.3	34.2	32.9	25.6
Coronary artery bypass grafting with preserved ejection fraction	82	67.1	26.8	4.9	1.2
Coronary artery bypass grafting in a patient with a 95% left anterior descending lesion, recently inserted intra-aortic balloon pump, and with an ejection fraction of 35%*	82	20.7	45.1	23.2	11
Atrial fibrillation ablation in the electrophysiology lab	81	55.6	34.6	9.9	0
Extracranial to intracranial bypass	81	32.1	40.7	17.3	9.9
Craniotomy and tumor removal	81	87.7	11.1	1.2	0
Anterior cervical discectomy and fusion	81	93.8	6.2	0	0
Anterior communicating artery aneurysm clipping*	81	51.9	42	6.2	0
Retinal surgery	81	61.7	22.2	14.8	1.2
Cataract surgery	81	71.6	19.8	7.4	1.2
Acute globe rupture	81	51.9	28.4	17.3	2.5
Pyloromyotomy*	80	46.3	37.5	16.3	0
Myringotomy and tubes	80	85	15	0	0
Hypospadias repair with a caudal block adjunct	80	48.8	38.8	11.3	1.3
Pediatric diagnostic rigid bronchoscopy	79	50.6	39.2	8.9	1.3
Adult rigid bronchoscopy	80	72.5	26.3	1.3	0
Video assisted thoracoscopic surgery with lobectomy	79	86.1	11.4	1.3	1.3
Ivor Lewis Esophagectomy*	80	57.5	30	10	2.5
Pneumonectomy	80	55	31.3	12.5	1.3
Pancreas transplant	79	35.4	21.5	17.7	25.3
Lung transplant	79	8.9	22.8	30.4	38
Liver transplant	79	21.5	35.4	24.1	19
Kidney transplant	79	86.1	3.8	2.5	7.6
Thoracic endovascular aortic repair	77	52	36.4	9.1	2.6
Open thoracoabdominal aortic aneurysm repair	77	29.9	28.6	33.8	7.8
Open abdominal aortic aneurysm repair*	77	50.7	27.3	16.9	5.2
Carotid endarterectomy	77	75.3	20.8	2.6	1.3
Procedures outside the operating room such as magnetic resonance imaging (MRI), neuroangiography, or interventional radiology	81	58	38.3	3.7	0
Placing and managing a double lumen endotracheal tube	82	80.5	18.3	1.2	0
Placing and managing a bronchial blocker	81	19.8	39.5	29.6	11.1

Performing both direct and indirect laryngoscopy for intubation	82	100	0	0	0
Performing a retrograde intubation	82	6.1	8.5	32.9	52.4
Performing an awake fiberoptic intubation for an unstable patient/impending airway collapse, such as angioedema*	82	32.9	45.1	20.7	1.2
Performing a nasal intubation	82	81.7	17.1	1.2	0
Performing a cricothyrotomy to achieve emergency airway access	82	6.1	22	37.8	34.2
Exchanging a supraglottic airway device for an endotracheal tube	82	59.8	37.8	1.2	1.2
Transversus abdominis plane block	80	68.8	25	5	1.25
Thoracic epidural	80	75	18.8	3.8	2.5
Supraclavicular brachial plexus block	80	83.8	13.8	2.5	0
Single shot femoral nerve block	80	93.8	3.8	2.5	0
Proximal sciatic nerve catheter placement	80	28.8	40	21.3	10
Multiple, bilateral paravertebral blocks*	80	23.8	15	31.3	30
Lumbar epidural	80	98.8	1.3	0	0
Combined spinal epidural	80	91.3	7.5	1.3	0
Managing an emergent Cesarean section for a patient with placenta previa and likely placenta accreta	81	63	28.4	6.2	2.5
Managing an urgent Cesarean section for a patient with pre-eclampsia with severe features*	81	74.1	21	3.7	1.2
Managing an epidural for a vaginal delivery in a healthy patient	81	98.8	1.2	0	0
Evaluating and treating a postpartum patient with a suspected post dural puncture headache	81	87.7	9.9	2.5	0
Managing the airway of a trauma patient with an unstable cervical spine and a high aspiration risk	77	52	37.7	10.4	0
Managing a patient with penetrating or blunt trauma to the chest including advanced airway techniques to allow for one lung ventilation	77	40.3	44.2	13	2.6
Managing a patient with penetrating or blunt abdominal trauma including the treatment of hemorrhagic and distributive shock states*	77	52	39	9.1	0
Managing a patient with massive hemorrhage requiring massive transfusion protocol including major vascular injury associated with organ malperfusion, such as spinal cord injury	77	46.8	41.6	9.1	2.6
Diagnosing and managing wide complex tachycardia	76	54	39.5	5.3	1.3
Diagnosing and managing unstable bradycardia	76	64.5	30.3	5.3	0
Diagnosing and managing narrow complex tachycardia	75	52	42.7	5.3	0
Diagnosing and managing ventricular fibrillation arrest	76	69.7	25	4	1.3
Diagnosing and managing pulseless electrical activity arrest	76	69.7	25	5.3	0
Being the team leader and running a code	76	52.6	34.2	11.8	1.3
Optimizing a patient with a history of heart failure, hypertension, diabetes, and chronic obstructive pulmonary disease who is scheduled to undergo an elective total hip arthroplasty	74	66.2	28.4	5.4	0
Managing and counseling a patient currently on dual anti-platelet therapy scheduled to undergo a radical cystectomy with ileal conduit	74	54.1	39.2	6.8	0



Counseling a patient pre-operatively and developing an anesthetic plan for a patient with a family history of malignant hyperthermia	74	82.4	13.5	4.1	0
Counseling a patient on smoking cessation	74	79.7	14.9	5.4	0
A post-op patient with hypoxemia following a general anesthetic for a biliary duct leak repair	71	47.9	45.1	7	0
A post-op patient who has new complete right sided paralysis after awakening following a laparoscopic cholecystectomy	71	33.8	46.5	15.5	4.2
A patient who develops stridor immediately upon arrival to the post-anesthesia care unit following thyroid surgery*	71	52.1	42.3	5.6	0
A post-op patient who develops new ST segment elevations in the lateral leads following non-cardiac surgery	72	54.2	38.9	6.9	0
Managing a 27 year old male with status asthmaticus requiring mechanical ventilation in the intensive care unit	72	43.1	51.4	5.6	0
Managing a 69 year old male with septic shock secondary to a urinary tract infection in the intensive care unit	72	72.2	20.8	5.6	1.4
Managing a 57 year old male with an upper gastrointestinal bleed in the setting of end stage liver disease in the intensive care unit	72	34.7	54.2	9.7	1.4
Managing a 42 year old female with acute respiratory distress syndrome and persistent hypoxemia requiring mechanical ventilation in the intensive care unit*	72	48.6	41.7	9.7	0
Using ultrasound for placing an internal jugular central line	72	95.8	2.8	1.4	0
Using ultrasound for lung assessment (eg. pneumothorax, pleural effusion, tracheal tube position)*	72	11.1	29.2	43.1	16.7
Using ultrasound for performing a limited transesophageal echocardiogram (eg. volume status, wall motion)	72	54.2	27.8	6.9	11.1
Managing local anesthetic systemic toxicity	72	44.4	43.1	9.7	2.8
Managing malignant hyperthermia	72	40.3	43.1	11.1	5.6
Managing a massive aspiration	72	44.4	41.7	12.5	1.4
Managing an airway fire	72	44.4	40.3	11.1	4.2
Managing an anesthetic for a 29 year old homosexual male	71	97.2	1.4	1.4	0
Managing an anesthetic for a 24 year old transgender female	71	93	4.2	2.8	0
Managing an anesthetic for a 46 year old African American male	71	98.6	1.4	0	0
Managing an anesthetic for a 32 year old Asian female	70	98.6	1.4	0	0
Managing an anesthetic for a 35 year old male who is a prisoner	71	93	5.6	1.4	0
Managing an anesthetic for a 52 year old female with a pre-operative hemoglobin of 6.8 g/dL who is a Jehovah's witness and undergoing an open total abdominal hysterectomy	71	52.1	29.6	18.3	0
Legend					
* Question selected a priori for analysis					
n = number of responses					
1 = extremely comfortable (%)					
2 = somewhat comfortable (%)					
3 = somewhat uncomfortable (%)					
4 = extremely uncomfortable (%)					
I understand and am comfortable with anesthesia billing rules and regulations	72	4.2	26.4	41.7	27.8

I feel well prepared to supervise anesthetists in an anesthesia team model*	72	34.7	51.4	11.1	2.8
I feel well prepared to review and negotiate an employment contract	72	8.3	37.5	30.6	23.6
I feel competent that I can recognize and approach a colleague who appears to be impaired from drugs or alcohol	72	22.2	63.9	13.9	0
Legend					
*Question selected a priori for analysis					
n = number of responses					
1 = extremely agree (%)					
2 = somewhat agree (%)					
3 = somewhat disagree (%)					
4 = extremely disagree (%)					

as much of the broad field of anesthesiology as reasonably possible given the time constraints of the survey (estimated completion time of 10 minutes). The specific questions within each category were formulated in consultation with faculty anesthesiologists who had special professional interests within that category. The survey was piloted on internal residents prior to distribution. Administration of the survey, response monitoring, data collection, and analysis was done using the University of Wisconsin-Madison Qualtrics Survey Hosting Service (Qualtrics, April 2017 version, Provo, UT).

STATISTICAL ANALYSIS

Thirteen questions were selected a priori for statistical analysis in an attempt to limit the problem of multiple comparisons (Table 2). These questions were selected by the research team because of their core educational meaning and value. Differences in responses

Table 2: Survey questions selected a priori for statistical analysis.

How comfortable do you feel providing anesthesia for the following procedures?	Coronary artery bypass grafting in a patient with a 95% left anterior descending lesion, recently inserted intra-aortic balloon pump, and with an ejection fraction of 35%
	Anterior communicating artery aneurysm clipping
	Pyloromyotomy
	Ivor Lewis Esophagectomy
	Open abdominal aortic aneurysm repair
How comfortable do you feel performing the following procedures?	Performing an awake fiberoptic intubation for an unstable patient/impending airway collapse, such as angioedema
How comfortable do you feel performing the following tasks?	Multiple, bilateral paravertebral blocks
	Managing an urgent Cesarean section for a patient with pre-eclampsia with severe features
	Managing a patient with penetrating or blunt abdominal trauma including the treatment of hemorrhagic and distributive shock states
	A patient who develops stridor immediately upon arrival to the post-anesthesia care unit following thyroid surgery
	Managing a 42 year old female with ARDS and persistent hypoxemia requiring mechanical ventilation in the ICU
	Using ultrasound for lung assessment (eg. pneumothorax, pleural effusion, tracheal tube position)
	I feel well prepared to supervise anesthetists in an anesthesia team model

to these questions were assessed between gender, age, race, region of residency program, and career plans after graduation. Question responses were coded from 1 = extremely comfortable to 4 = extremely uncomfortable. Differences by gender, age (above or below 33 years), and race (white or not white) were analyzed using Mann-Whitney-Wilcoxon tests. Differences by region of residency program and career plans after graduation were analyzed using Kruskal-Wallis tests. Despite the high number of tests, no *p*-value correction was applied at this stage to control Type 1 error. Patients with unavailable (other unspecified or missing) data of either the question or demographic characteristic were excluded from analysis for that particular test. When differences were detected across a variable with more than two categories, pairwise Mann-Whitney-Wilcoxon tests with a false discovery rate *p*-value correction were used to assess pairwise differences. The data analysis for this study was generating using SAS software (SAS Institute Inc., Cary, NC). The responses to the remainder of the questions not selected a priori for analysis were analyzed qualitatively by the research team. All of the results were reviewed by the statistician.

RESULTS

Of the 141 program coordinators that were sent the survey, 27 responded that they were willing to distribute the survey to their CA3 residents (19.1%). These program coordinators were from all across the continental United States with CA3 class sizes ranging from 4-26 residents. The survey was distributed to 340 CA3 residents at U.S. ACGME accredited anesthesiology residencies during April 2018 (their final year of training) and 93 surveys were returned (at least one from all 27 programs who forwarded the survey to residents) for a response rate of 27.4%. Demographics of the residents who responded are shown in table 3.

Survey responses were compiled and are presented in table 1. Statistical analysis was performed on the 13 questions identified a priori (Table 2). Qualitative analysis was performed by the research team on the remainder of the questions.

Across the 13 questions selected a priori for analysis, there were no gender or race differences detected. There was a trend towards greater levels of comfort in performing the tasks and procedures surveyed in those residents planning on going into academic practice compared to those going into private practice or pursuing a fellowship (Table 4). Residents planning on going into academic practice had the highest average level of comfort in 11 of the 13 questions. Specifically regarding using an ultrasound for lung assessment, those residents planning on going into academic practice were more comfortable than those who are planning to pursue a fellowship (mean 1.75 vs 2.84, *p* < 0.05).

There was also a trend towards younger residents (less than 33 years old) feeling more comfortable with the tasks and procedures surveyed than older residents (33 years old or greater). Younger residents felt more comfortable, on average, compared to older residents for all 13 of the questions selected a priori (Table 5), and this difference was statistically significant for managing a patient with Acute Respiratory Distress Syndrome (ARDS) with persistent hypoxemia requiring mechanical ventilation (mean 1.44 vs 1.86, *p* = 0.015). No additional demographic data was collected specifically regarding these older residents.

When comparing across the various regions of the United States, the only statistically significant difference detected was in

Table 3: Demographics of CA3 residents who responded.

	Male	50	64.10%
Gender	Female	28	35.90%
Age (years), mean ± SD		32.3 ± 3.3	
Race	Caucasian	57	69.50%
	African American	3	3.70%
	Asian	10	12.20%
	Other	10	12.20%
	Prefer not to state	2	2.40%
	West	9	11.10%
	Midwest	24	29.60%
Location of Residency Program	Northeast	31	38.30%
	South	17	21.00%
	Fellowship	52	62.70%
Career Plans After Graduation	Academic practice	5	6.00%
	Private practice	26	31.30%

West: AK, AZ, CA, CO, HI, ID, NM, NV, OR, UT, WA, WY, Midwest: IA, IL, IN, KS, MI, MN, MO, MT, ND, NE, OH, SD, WI, Northeast: CT, DC, DE, MA, ME, MD, NH, NJ, NY, PA, RI, VT, South: AR, AL, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA, WV

regards to managing an urgent Cesarean section for a patient with pre-eclampsia with severe features (Table 6). Those residents whose residency program is located in the West Region felt less comfortable, on average, than those residents located in each of the other regions of the country [mean 2.11 (west) vs 1.25 (midwest) vs 1.22 (northeast) vs 1.17 (south), *p* < 0.01].

DISCUSSION

The data presented here provides evidence of anesthesiology resident preparedness in core anesthetic domains, however it also provides specific examples of areas where improvements in their education can be made.

It is not surprising, and even reassuring, that no statistically significant differences in the comfort level of anesthesiology residents were detected between gender or race. We did find that those residents going into academic practice felt more comfortable using an ultrasound for lung assessment, younger residents felt more comfortable managing a tenuous patient with ARDS, and residents whose residency program is located in the West region felt less comfortable managing a patient with pre-eclampsia with severe features undergoing a cesarean section. One could hypothesize various reasons for these findings, such as those residents going into academic practice may be more interested in challenging cases requiring advanced techniques and pursue additional opportunities during residency, making them more comfortable with using an ultrasound for lung assessment. Instead, these findings could be confounded by the specific institutions of those residents who responded (large, busy academic centers with significant exposure to complex procedures and techniques compared to small community hospitals) which were not queried in an attempt to maintain anonymity. In order to further evaluate these findings, an additional study with a larger sample size and more specific demographic information could be performed.

Looking qualitatively at the remainder of the data, residents overall felt comfortable managing the anesthetic and performing the



majority of technical procedures that they are likely to encounter in independent practice. This level of perceived comfort should serve as a reassurance that residency programs are adequately preparing residents for independent practice. When comparing our study to the only previously published data describing anesthesiology resident preparedness [7], there are specific areas where anesthesiology residents have already shown improvement. Previously, only 86% of respondents felt prepared to perform “regional blocks,” however more than 93% of residents in our survey felt comfortable performing basic peripheral nerve blocks. It is possible that the more widespread

Table 4 : Differences between residents based on career plans after graduation.

Survey Question	AP	F	PP	p-value
	Mean (SD)	Mean (SD)	Mean (SD)	
CABG in a patient with a 95% left anterior descending lesion, recently inserted intra-aortic balloon pump, and an ejection fraction of 35%	1.75 (0.96)	2.27 (0.92)	2.27 (0.92)	0.547
Anterior communicating artery aneurysm clipping	1.50 (0.58)	1.60 (0.64)	1.46 (0.58)	0.671
Pyloromyotomy	1.50 (0.58)	1.71 (0.74)	1.73 (0.78)	0.888
Ivor Lewis esophagectomy	1.75 (0.50)	1.51 (0.79)	1.65 (0.80)	0.422
Open abdominal aortic aneurysm repair	1.25 (0.50)	1.77 (0.75)	1.88 (1.23)	0.455
Performing an awake fiberoptic intubation for an unstable patient/impending airway collapse, such as angioedema	1.20 (0.45)	1.86 (0.75)	2.12 (0.77)	0.032
Multiple, bilateral paravertebral blocks	2.50 (1.00)	2.71 (1.15)	2.65 (1.20)	0.87
Managing an urgent C-section for a patient with pre-eclampsia with severe features	1	1.38 (0.70)	1.27 (0.45)	0.462
	0			
Managing a patient with penetrating or blunt abdominal trauma including the treatment of hemorrhagic and distributive shock states	1	1.58 (0.65)	1.67 (0.70)	0.143
	0			
A patient who develops stridor immediately upon arrival to the PACU following thyroid surgery	1	1.55 (0.59)	1.64 (0.66)	0.135
	0			
A 42 year old female with ARDS and persistent hypoxemia requiring mechanical ventilation	1.50 (0.58)	1.64 (0.65)	1.61 (0.72)	0.921
Using ultrasound for lung assessment	1.75 [^] (0.50)	2.84 [^] (0.83)	2.43 (0.95)	0.020*
I feel well prepared to supervise anesthesiologists in an anesthesia team model	1.25 (0.50)	1.93 (0.79)	1.65 (0.57)	0.104

AP = Academic Practice
 F = Fellowship
 PP = Private Practice
 Question responses coded from 1-4, where:
 1 = extremely comfortable
 2 = somewhat comfortable
 3 = somewhat uncomfortable
 4 = extremely uncomfortable
[^]p = 0.041 for pairwise difference between AP and F
 * = statistically significant

Table 5: Differences between residents based on age.

Survey Question	Age < 33	Age ≥ 33	p-value
	Mean (SD)	Mean (SD)	
CABG in a patient with a 95% left anterior descending lesion, recently inserted intra-aortic balloon pump, and an ejection fraction of 35%	2.17 (0.78)	2.35 (1.07)	0.462
Anterior communicating artery aneurysm clipping	1.48 (0.58)	1.64 (0.65)	0.286
Pyloromyotomy	1.67 (0.75)	1.75 (0.72)	0.553
Ivor Lewis esophagectomy	1.43 (0.54)	1.79 (0.99)	0.194
Open abdominal aortic aneurysm repair	1.62 (0.75)	1.97 (1.10)	0.236
Performing an awake fiberoptic intubation for an unstable patient/impending airway collapse, such as angioedema	1.84 (0.72)	1.97 (0.83)	0.446
Multiple, bilateral paravertebral blocks	2.51 (1.18)	2.91 (1.07)	0.137
Managing an urgent C-section for a patient with pre-eclampsia with severe features	1.25 (0.53)	1.42 (0.71)	0.216
Managing a patient with penetrating or blunt abdominal trauma including the treatment of hemorrhagic and distributive shock states	1.51 (0.63)	1.66 (0.71)	0.377
A patient who develops stridor immediately upon arrival to the PACU following thyroid surgery	1.44 (0.59)	1.68 (0.62)	0.091
A 42 year old female with ARDS and persistent hypoxemia requiring mechanical ventilation	1.44 (0.55)	1.86 (0.74)	0.015*
Using ultrasound for lung assessment	2.57 (0.89)	2.77 (0.90)	0.438
I feel well prepared to supervise anesthesiologists in an anesthesia team model	1.74 (0.70)	1.93 (0.79)	0.281

Question responses coded from 1-4, where:
 1 = extremely comfortable
 2 = somewhat comfortable
 3 = somewhat uncomfortable
 4 = extremely uncomfortable
 * = statistically significant

use of ultrasound in current practice has at least partially led to the improved comfort level in peripheral nerve blocks. Paravertebral blocks, which were initially pioneered in 1905 but remained neglected until renewed interest in the 1970s [8], do not have the same level of comfort. This can be expected with newer techniques, however the relatively steep learning curve for paravertebral blocks compared to epidurals suggests that residents may not be getting enough exposure to this particular nerve block for a variety of potential reasons, including the paucity of the block at that particular institution, large resident class size, or presence of regional anesthesiology fellows who may perform these blocks instead.

Residents in our study also showed a higher level of comfort caring for various populations of patients. In the previous study, 46% of residents felt unprepared to care for various populations of patients. However, in the current study, more than 97% of residents felt comfortable providing anesthesia to a diverse set of patients, including those of different genders, races, ethnicities, and sexual orientations.

Despite the overall positive view of residents’ preparedness for

Table 6: Differences between residents based on region of residency program.

Survey Question	MW	NE	South	West	p-value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
CABG in a patient with a 95% left anterior descending lesion, recently inserted intra-aortic balloon pump, and an ejection fraction of 35%	2.00 (0.93)	2.46 (0.79)	1.94 (0.73)	2.67 (1.12)	0.06
Anterior communicating artery aneurysm clipping	1.46 (0.59)	1.52 (0.64)	1.67 (0.59)	1.67 (0.71)	0.624
Pyloromyotomy	1.91 (0.90)	1.67 (0.68)	1.44 (0.51)	1.78 (0.83)	0.396
Ivor Lewis esophagectomy	1.30 (0.47)	1.81 (0.96)	1.44 (0.62)	1.56 (0.73)	0.25
Open abdominal aortic aneurysm repair	1.43 (0.60)	1.96 (0.98)	1.59 (0.71)	1.89 (1.05)	0.256
Performing an awake fiberoptic intubation for an unstable patient/impending airway collapse, such as angioedema	1.88 (0.80)	2.11 (0.79)	1.58 (0.61)	1.89 (0.78)	0.162
Multiple, bilateral paravertebral blocks	2.35 (1.30)	3.04 (0.85)	2.56 (1.10)	2.56 (1.33)	0.255
Managing an urgent C-section for a patient with pre-eclampsia with severe features	1.25 (0.44)	1.22 (0.51)	1.17 (0.38)	2.11 (1.05)	0.009*
Managing a patient with penetrating or blunt abdominal trauma including the treatment of hemorrhagic and distributive shock states	1.38 (0.50)	1.78 (0.70)	1.35 (0.49)	1.67 (0.87)	0.124
A patient who develops stridor immediately upon arrival to the PACU following thyroid surgery	1.50 (0.61)	1.54 (0.59)	1.47 (0.62)	1.62 (0.74)	0.947
A 42 year old female with ARDS and persistent hypoxemia requiring mechanical ventilation	1.35 (0.59)	1.68 (0.69)	1.76 (0.66)	1.62 (0.74)	0.196
Using ultrasound for lung assessment	2.86 (0.91)	2.75 (0.90)	2.24 (0.83)	2.50 (0.76)	0.127
I feel well prepared to supervise anesthetists in an anesthesia team model	1.86 (0.79)	1.96 (0.81)	1.47 (0.62)	2.00 (0.54)	0.125

States Included In Each Region: MW = Midwest: IA, IL, IN, KS, MI, MN, MO, MT, ND, NE, OH, SD, WI
 NE = Northeast: CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT
 South: AR, AL, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA, WV
 West: AK, AZ, CA, CO, HI, ID, NM, NV, OR, UT, WA, WY
 Question responses coded from 1-4, where:
 1 = extremely comfortable
 2 = somewhat comfortable
 3 = somewhat uncomfortable
 4 = extremely uncomfortable
 * = statistically significant

independent practice, this study serves to highlight areas where room for improvement still exists. Some of the questions that residents responded feeling uncomfortable are technical skills such as advanced airway or regional anesthetic techniques or perioperative ultrasound use. Perhaps additional workshops with opportunities for residents to practice these advanced techniques would increase the residents' perceived level of comfort.

Many questions where residents responded feeling uncomfortable are advanced surgical operations within anesthesiology subspecialties. The ACGME lists the number of specific cases that an anesthesiology resident must perform prior to graduation [9], however it is unknown whether performing this number of cases leads to residents getting enough experience to feel comfortable as an independent practitioner. Perhaps residents can gain additional experience, rather than makeup a specific knowledge deficit, via simulation center scenarios or presentations of complex surgical cases at conferences.

Indeed, our study has limitations. First, only 27 of 141 residency program coordinators forwarded the survey to their residents, and only 27.4% of those residents responded. It is likely that the length of this survey contributed to the low response rate, and a shorter future survey may improve this. The low response rate could lead to a significant amount of nonresponse bias within the data, resulting in data that is not adequately representative of graduating CA3 residents across the country. It could also lead to a significant level of selection bias, as perhaps certain residents are more likely to respond, such as those who feel more comfortable performing the various anesthetics and procedures or those with the time and motivation to complete the survey. In an effort to maintain anonymity, we did not collect specific demographic data, such as specific residency program, class size, case load, test scores, primary language, or commitments outside of work, which may explain some of the differences observed.

Another important potential limitation is the reliance on residents to assess and report their own comfort level, as it is possible that their self-perceived level of comfort does not correlate with their actual ability. However, self-reported preparedness has been used in previous studies as an indicator of educational quality, including the only previous study specifically looking at anesthesiology residents [1,10]. It is possible that residents are hard on themselves and actually underestimate their level of preparedness, as studies have shown that students tend to underrate their preparedness relative to the assessments of their supervisors [11,12]. While resident perceptions of their preparedness cannot imply competency alone, they are useful indicators of the quality of their educational experiences.

This data could provide the foundation for multiple future studies. Larger studies could validate these results across additional classes of residents. Program directors could also provide these survey questions internally to their own CA3 residents and compare their responses with those obtained in this study. In addition, changes in residents' comfort levels over time could be assessed after specific interventions that are designed to improve the identified gaps in knowledge are implemented. Finally, in future studies, additional areas could be queried, such as performing quality improvement projects, preparation for the new Objective Structured Clinical Exam (OSCE) component of the American Board of Anesthesiology staged exams, or communication, including delivering bad news.

CONCLUSION

Our study shows that most graduating CA3 residents feel prepared for the vast majority of what they are likely to encounter in independent practice. However, our data highlights several areas where improvements still ought to be made. There is clearly a need for residency programs to continuously evaluate their residents' clinical experiences and supplement these experiences with additional learning activities such as lectures, conferences, workshops, and simulations.



ACKNOWLEDGEMENT

Thanks to Jen Birstler, Biostatistician, Department of Biostatistics and Medical Informatics, University of Wisconsin - Madison, for statistical support for this project.

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