

RESEARCH

Open Access



Understanding characteristics of internal medicine residents matching into pulmonary critical care medicine fellowships

Benjamin R. Stultz¹, Thomas J. Beckman¹, Andrew J. Halvorsen¹, Michael W. Cullen² and Diana J. Kelm^{3*}

Abstract

Background Internal medicine (IM) residents face significant challenges when pursuing subspecialty fellowships. This study determined the factors that differentiate IM residents entering pulmonary and critical care medicine (PCCM) fellowships from those pursuing other careers.

Methods We completed a retrospective study of 12 classes of IM residents at a single institution completing residency between 2010 and 2021. Data included pre-residency characteristics, global residency performance, and PCCM-specific experiences. Logistic regression models examined associations between these variables and the primary outcome of matching into a PCCM fellowship within one year of completing IM residency.

Results Among 522 residents, 10.3% matched into PCCM. Completing a pulmonary elective significantly increased the odds of matching into PCCM (OR 7.78, 99% CI 3.10–19.53, $p < 0.0001$). Residents who match into PCCM were more likely to have < 3 publications than $3 +$ (OR 3.51 (1.20–10.25), $p = 0.003$). A stated intent to enter PCCM was positively associated with matching into PCCM in the univariable, but not the multivariable, model.

Conclusions Matriculating into PCCM fellowship was significantly associated with completing a pulmonary elective during residency. PCCM-bound residents were less likely to achieve high numbers of publications, suggesting these residents' preferences for clinical learning and practice over scholarship. This study provides insights into characteristics of residents who match into PCCM and guides mentors as they counsel residents considering PCCM.

Keywords Pulmonary critical care medicine, Resident characteristics, Resident mentoring, Fellowship match

Introduction

Approximately 6,000 internal medicine (IM) residents apply for a subspecialty fellowship yearly. With 5,000 fellowship positions available, one in six will not match.[1]

Residents often develop career interests before residency training,[2–4] and early exposure to specialty rotations may further impact their career decisions.[5, 6] Alternatively, some residents' career choices may evolve later in training.[7] IM residents who pursue fellowship training may have higher general medical knowledge than those who do not[8]; however, some competitive subspecialties may require early specialization leading to decreased general medical knowledge.[9] Scholastic accomplishments such as Alpha-Omega-Alpha (AOA) membership, scholarship, and class rank have been shown to predict future performance in training;[10–16] yet, resident publications may be a poor predictor of fellowship publications.[17] Recently, authors identified relationships

*Correspondence:

Diana J. Kelm
Kelm.Diana@mayo.edu

¹ Department of Internal Medicine, Mayo Clinic, Rochester, MN, United States

² Department of Cardiovascular Medicine, Mayo Clinic, Rochester, MN, United States

³ Division of Pulmonary and Critical Care Medicine, Mayo Clinic, 200 First St SW, Rochester, MN 55905, United States



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

between IM residents' medical knowledge, early career intentions, rotation evaluations, and pre-residency characteristics and matriculation into cardiology fellowships. [9].

Pulmonary and Critical Care Medicine (PCCM) is the second largest IM fellowship in the US with 629 training positions. More than 80% of intensivists are IM-trained. [1, 18] This fellowship has become competitive with a 24.8% unmatched rate between 2004 and 2019.[19] As the US population ages, projections suggest a shortage of critical care providers in the US.[20–22] Trainees pursuing PCCM must develop confidence leading multidisciplinary teams during stressful situations, demonstrate empathy with distressed patients and family members, and learn psychomotor skills for numerous bedside procedures.[23] Considering the growing importance of work-life balance on IM resident career selection,[24] residents may feel disinclined to pursue careers in PCCM.[25].

No studies have demonstrated how residents matching into PCCM fellowships differ from their peers. Furthermore, understanding unique characteristics of residents who match into PCCM should help mentor residents with interests in PCCM, assist with attracting residents into PCCM, and alert PCCM fellowship program directors regarding features of successful applicants. This study sought to compare IM residents entering PCCM fellowships with other IM residents based on standardized measures of performance, stated career interests on electronic residency application service (ERAS) personal statements, and exposures to PCCM rotations.

Methods

This study's methods reflect a modification of a prior study from our group focused on internal medicine residents entering cardiology fellowships. [9] While methodological approaches of the current and prior studies are similar, we have revised the methods section to reflect changes relevant to the current study.

This study included residents who matched to the Rochester, Minnesota Mayo Clinic categorical IM residency from 2007 to 2018; thus completing residency between 2010 and 2021. Those who completed residency in under 3 years or left the program were excluded. The primary outcome was matching into PCCM fellowship within a year of completing residency to account for those who completed a chief medical resident year and those who delayed fellowship match for 1 year. Residents who matched into PCCM were compared to all other graduating residents.

Performance, career intent, and PCCM exposure were compared with pre-residency variables, characteristics of PCCM experiences, and global performance markers

during residency. Only information available by the time of fellowship applications was included. After 2011, the fellowship match moved from June of PGY2 year to December of PGY3 year. As such, residents entering between 2007–2009 had data through the first half of PGY2; residents starting after 2009 had data included through the end of PGY2.

Pre-residency variables included declaration of PCCM intent, United States Medical Licensing Examination (USMLE) Step 1 and Step 2 Clinical Knowledge scores, pre-residency PubMed® publications (noting first author), AOA membership, and *US News & World Report* (USNWR) medical school research ranking.[26] Study team members (MC, TB, DK) reviewed personal statements for declaration of a PCCM subspecialty intent.

Data on resident PCCM experiences included previously validated faculty assessments for required PCCM rotations.[27, 28] We differentiated the timing of a resident's first PCCM experience into the first versus second half of the PGY1 year, and assessed the choice to complete an elective pulmonary rotation. Similar to other evaluations, PCCM evaluation scores were deemed "highly professional" if in the top 20th percentile of their class. [8, 20] The percentile score on PCCM-specific content areas of the ITE was included as a measure of PCCM knowledge. Our analysis incorporated data from any PCCM rotations completed by the time of fellowship application for each resident in the study.

Residency clinical performance was assessed with rotation evaluations and mini-clinical evaluation exercise (mini-CEX) scores completed prior to fellowship application.[29, 30] Clinical evaluations were considered "highly professional" if in the top 20th percentile of their class. [31] In-training examination (ITE) was included as a marker of medical knowledge.[32, 33] These scores were restricted to the PGY2 year in order to ensure variance inflation factor (VIF) < 3 for all covariates in the multiple logistic regression model. The total number of PubMed®-indexed publications during residency served as a reflection of academic performance. This is the only variable with data across a resident's entire residency rather than up to the time of fellowship application. Publications were analyzed as discrete variables with odds ratios calculated for zero publications vs. one, two, or greater than or equal to three publications during residency.

REDCap (Research Electronic Data Capture) data tools, hosted at Mayo Clinic, was used to collect and manage study data abstracted from residency application materials. [34] This is a secure, web-based application designed to support research study data capture. One author (AJH), who has no evaluative role within the residency, merged data. After merging data by resident,

the data was deidentified prior to analysis to protect confidentiality.

Independent variables distribution was reported as mean (standard deviation) for continuous variables and n (%) for categorical variables. Relationships between independent variables and the binary primary outcome variable were assessed using logistic regression models. We visually examined functional form for continuous-valued covariates using Loess plots and objectively by Hosmer & Lemeshow goodness-of-fit tests, with those deviating from the assumption of linearity in the logit categorized by logical breakpoints. Potential multicollinearity among covariates was assessed using the VIF, with the highest VIF-valued covariate being excluded and re-assessing until all VIF < 3. A multivariable logistic regression model for the primary outcome adjusted for all modifiable covariates simultaneously. The threshold for statistical

significance was set at $\alpha=0.01$. All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC). The Mayo Clinic Institutional Review Board (IRB) and Internal Medicine Residency Education Group (IMREG) approved this study. The IRB and IMREG groups served as the ethics committees that waived the need for informed consent.

Results

Over this study period, 550 residents matched into the categorical program. Twenty-eight of them did not complete the program or graduated after only 2 years, leaving 522 residents for inclusion. Much of this population has been previously described.[9] We identified no significant differences in demographic or pre-residency characteristics between those included and excluded from our study (Table 1).

Table 1 Demographics of residents and pre-residency attributes

	Eligible (N= 550)	Excluded (N= 28)	Included (N = 522)	P Value
Gender				> .99
Male	336 (61.1%)	17 (60.7%)	319 (61.1%)	
Female	214 (38.9%)	11 (39.3%)	203 (38.9%)	
Medical School Type	<i>*152 unique</i>		<i>*147 unique</i>	0.11
U.S. Public	329 (59.8%)	15 (53.6%)	314 (60.2%)	
U.S. Private	180 (32.7%)	8 (28.6%)	180 (32.7%)	
International	32 (5.8%)	4 (14.3%)	28 (5.4%)	
Canadian	5 (0.9%)	1 (0.0%)	5 (1.0%)	
Osteopathic	4 (0.7%)	2 (3.6%)	3 (0.6%)	
Age, years	27.3 (2.7)	28.6 (3.4)	27.2 (2.6)	0.03
PCCM Career Intent				0.62
No	532 (96.7%)	27 (96.4%)	505 (96.7%)	
Yes	18 (3.3%)	1 (3.6%)	17 (3.3%)	
USNWR Top 50				> .99
No	351 (63.8%)	18 (64.3%)	333 (63.8%)	
Yes	199 (36.2%)	10 (35.7%)	189 (36.2%)	
AOA member				0.66
No	402 (73.1%)	22 (78.6%)	380 (72.8%)	
Yes	148 (26.9%)	6 (21.4%)	142 (27.2%)	
Publication				> .99
No	353 (64.2%)	18 (64.3%)	335 (64.2%)	
Yes	197 (35.8%)	10 (35.7%)	187 (35.8%)	
First Author				0.60
No	461 (83.8%)	25 (89.3%)	436 (83.5%)	
Yes	89 (16.2%)	3 (10.7%)	86 (16.5%)	
USMLE				
Step 1	238.8 (15.7)	236.1 (17.3)	239.0 (15.6)	0.39
Step 2 CK	249.9 (14.8)	245.2 (14.6)	250.1 (14.8)	0.09

PCCM Pulmonary and Critical Care Medicine, USNWR United States News and World Report, AOA, Alpha Omega Alpha, USMLE United States Medical Licensing Examination

Summaries of the study variables, for the entire population and the PCCM-matched cohort, are seen in Table 2. Of the 522 included residents, 54 (10.3%) matched into PCCM. 187 (35.8%) residents had a publication at the time of residency application including 86 (16.5%) with

a first author publication. One-hundred and eighty-nine (36.2%) graduated from a top 50 medical school as ranked by USNWR, and 142 (27.2%) were AOA members. Seventeen (3.3%) declared an intent to pursue PCCM in their residency application personal statement.

Table 2 Logistic regression analyses

Pre-Residency Characteristics	N (%)	(N = 522)		Matched to PCCM (N = 54)		Bivariate Logistic Regression		Multiple Logistic Regression	
		N (% of)	p value	OR (99% CI)	p value	OR (99% CI)	p value		
Research publications, total	≥ 1	187 (35.8%)	17 (31.5%)	0.55	0.805 (0.364–1.1782)	0.48	1.134 (0.401–3.202)	0.76	
	0	335 (64.2%)	37 (68.5%)	-	-	-	-	-	
Research publications, 1st author	≥ 1	86 (16.5%)	4 (7.4%)	0.08	0.377 (0.095–1.489)	0.07	0.260 (0.048–1.403)	0.04	
	0	436 (83.5%)	50 (92.6%)	-	-	-	-	-	
PCCM stated intent	Yes	17 (3.3%)	6 (11.1%)	0.005	5.195 (1.328–20.330)	0.002	4.282 (0.851–21.551)	0.02	
	No	505 (96.7%)	48 (88.9%)	-	-	-	-	-	
USNWR Top 50 medical school	≤ 50	189 (36.2%)	21 (38.9%)	0.66	1.136 (0.531–2.431)	0.67	0.999 (0.386–2.587)	> .99	
	> 50	333 (63.8%)	33 (61.1%)	-	-	-	-	-	
AOA member	Yes	142 (27.2%)	11 (20.4%)	0.26	0.658 (0.265–1.635)	0.24	0.367 (0.119–1.136)	0.02	
	No	380 (72.8%)	43 (79.6%)	-	-	-	-	-	
		Mean (SD)	Mean PCCM vs. Not						
USMLE Step 1 Score		238.7 (15.6)	239.1 vs. 239.0	0.96	1.000 (0.977–1.024)	0.96	0.998 (0.958–1.040)	0.89	
USMLE Step 2 Clinical Knowledge Score		250.1 (14.8)	251.1 vs. 250.0	0.57	1.005 (0.980–1.031)	0.60	1.008 (0.965–1.054)	0.63	
PCCM Rotation Characteristics		N (%)	N (% of)						
PCCM Elective	Yes	86 (16.5%)	26 (48.2%)	0.001	6.314 (2.875–13.868)	< .0001	7.782 (3.102–19.525)	< .0001	
	No	436 (83.5%)	28 (51.9%)	-	-	-	-	-	
Timing of first PCCM experience	1st Half	254 (48.7%)	24 (44.4%)	0.57	0.828 (0.393–1.743)	0.51	0.675 (0.287–1.587)	0.24	
	2nd Half	268 (51.3%)	30 (55.6%)	-	-	-	-	-	
PCCM clinical evaluations top 20%	Yes	103 (19.7%)	12 (22.2%)	0.59	1.184 (0.484–2.897)	0.63	1.412 (0.464–4.292)	0.42	
	No	419 (80.3%)	42 (77.8%)	-	-	-	-	-	
		Mean (SD)	Mean PCCM vs. Not						
PGY2 ITE PCCM percentile		62.4 (24.6)	67.8 vs. 61.8	0.06	1.010 (0.994–1.027)	0.09	1.012 (0.991–1.034)	0.14	
Global Residency Performance		N (%)	N (% of)						
Publications during residency	3+	204 (39.1%)	9 (16.7%)	0.0007	0.257 (0.081–0.815)	0.003	0.236 (0.064–0.876)	0.003	
	2	103 (19.7%)	18 (33.3%)	-	1.180 (0.433–3.216)	-	1.243 (0.388–3.983)	-	
	1	123 (23.6%)	13 (24.1%)	-	0.658 (0.227–1.906)	-	0.509 (0.151–1.713)	-	
	0	92 (17.6%)	14 (25.9%)	-	-	-	-	-	
Mini-CEX evaluations top 20%	Yes	104 (19.9%)	7 (13.0%)	0.21	0.570 (0.193–1.684)	0.18	0.445 (0.121–1.629)	0.11	
	No	418 (80.1%)	47 (87.0%)	-	-	-	-	-	
Clinical evaluations top 20%	Yes	106 (20.3%)	12 (22.2%)	0.72	1.137 (0.465–2.779)	0.71	1.437 (0.450–4.591)	0.42	
	No	416 (79.7%)	42 (77.8%)	-	-	-	-	-	
		Mean (SD)	Mean PCCM vs. Not						
PGY2 ITE overall percentile		79.7 (18.3)	80.1 vs. 79.7	0.85	1.001 (0.981–1.022)	0.86	0.996 (0.962–1.031)	0.75	

PCCM Pulmonary and critical care medicine, USNWR United States News and World Report, AOA Alpha Omega Alpha, USMLE United States Medical Licensing Examination, PGY2 Post-graduate year 2, ITE In training exam CEX Clinical evaluation exercise

Mean (SD) USMLE scores for Step 1 were 238.7 (15.6) and for Step 2 CK were 250.1 (14.8). Eighty-six (16.5%) of the residents studied completed a pulmonary elective rotation prior to fellowship application. During their residency, 204 (39.1%) authored ≥ 3 publications. The mean percentile (SD) on the PGY-2 ITE was 79.7 (18.3) overall and 62.4 (24.6) for the PCCM portion of the exam.

Bivariate logistic regression found a positive association with declaring PCCM in residency personal statements ($p=0.002$); however, it was no longer significant in the multivariable model after accounting for all other modifiable independent variables (OR 4.28 (0.85–21.55); $p=0.02$). Multivariable logistic regression found completion of a pulmonary elective rotation was significantly associated with matching into a PCCM fellowship (odds ratio (OR) 7.78, 99% confidence interval (CI) 3.10–19.53, $p<0.0001$). PCCM matriculants were more likely to have <3 publications than $3+$ publications (OR 3.51 (1.20–10.25), $p=0.003$).

Discussion

We endeavored to understand how residents who match in PCCM fellowship differ from their peers. Completing a pulmonary elective was significantly associated with matching into PCCM. Such PCCM electives are essential for residents advancing their skills in managing PCCM patients, meeting faculty members, and obtaining letters of recommendation. Additionally, it is likely that, in many cases, these elective rotations alter residents' pre-existing career plans.

Matriculants into PCCM in this study were more likely to have <3 publications than ≥ 3 publications. Our institution trains many residents pursuing cardiology, gastroenterology, or hematology/oncology fellowship training and we believe that these highly competitive groups are more likely to have ≥ 3 publications. Supporting this, a recent similar study at our institution found that twice as many residents matched into cardiology than PCCM and that those pursuing cardiology fellowship had more publications during residency than their peers.[9] In the current study, the average number of publications in the PCCM-matched group was 1.56, indicating that residents choosing PCCM are more focused on clinical skill enhancement than research. Furthermore, PCCM fellowships may place less emphasis on publications when ranking applicants for selection.

Adjusted analysis did not reveal significant associations between stated career intent in personal statements with matching into PCCM. Many programs may place lesser emphasis on the personal statement vis-a-vis selection decisions; however, this same association was significant in previous research and deserves further study in the field of PCCM. [9, 35, 36].

Strengths of this study include large sample size over a long timeframe and inclusion of both subjective and objective variables. Limitations include the single institution as a large academic medical center, which may reduce generalizability. That said, the study cohort included diverse residents from over 140 different medical schools. This study incorporated residents who trained before the Covid-19 pandemic, which potentially constrains conclusions about fellowship selection since the pandemic. Finally, this was a purely quantitative study; therefore, future qualitative research should examine reasons why residents choose to enter PCCM and other specialties.

To our knowledge, this is the first study on characteristics of residents who match into PCCM fellowship training. This study identified the importance of PCCM elective rotations during residency training on entering PCCM fellowships. While scholarship is an important feature among all fellowship applicants, this study suggests that residents entering PCCM training may place greater emphasis on clinical skills enhancement, and that PCCM program directors may focus more on other qualities, such as clinical experience. These findings should assist in mentoring residents who select careers in PCCM. These results can offer valuable guidance to trainees as they prepare for fellowship applications and prioritize their tasks. By providing general benchmarks, trainees may also be motivated to engage more actively in research by recognizing its differentiating value. Future research should further explore the potential value of personal statements and expressions of career intent, potentially through qualitative inquiry, to better understand the motivation and characteristics of residents who match into PCCM.

Conclusions

We found that completion of a pulmonary elective in residency was significantly associated with matching into PCCM. Additionally, PCCM-bound residents were less likely to achieve high numbers of publications suggesting a preference for clinical exposure over scholarship. This data may help provide insight into residents who match in PCCM and aid in mentoring these residents.

Abbreviations

IM	Internal Medicine
PCCM	Pulmonary and critical Care Medicine
AOA	Alpha omega alpha
ERAS	Electronic residency application service
USMLE	United States medical licensing examination
USNWR	United States news and world report
Mini-CEX	Mini clinical evaluation exercise
ITE	In training exam
ACGME	Accreditation counsel for graduate medical education
MICU	Medical Intensive Care Unit
REDCap	Research electronic data capture

VIF Variance inflation factor
 IRB Institutional Review Board
 IMREG Internal Medicine Residency Education Group

Acknowledgements

Not applicable.

Authors' contributions

BS aided in design, data acquisition, and drafted the work. TB, MC, and DK aided in design and data acquisition. AH aided in design, data analysis, interpretation of data, and prepared Tables 1–2. All authors approved this submitted version and agreed to be personally accountable for their contribution.

Funding

None.

Data availability

The datasets generated and/or analysed during the current study are not publicly available due to trainee privacy but are available from the corresponding author on reasonable request.

Declarations

The Mayo Clinic Institutional Review Board (IRB) and Internal Medicine Residency Education Group (IMREG) approved this study. The IRB and IMREG groups served as the ethics committees that waived the need for informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 5 January 2024 Accepted: 30 October 2024

Published online: 20 November 2024

References

- Program NRM. Results and Data: Specialties Matching Service 2020 Appointment Year. Washington, DC: National Resident Matching Program; 2020.
- Bonura EM, Lee ES, Ramsey K, Armstrong WS. Factors influencing internal medicine resident choice of infectious diseases or other specialties: a national cross-sectional study. *Clin Infect Dis*. 2016;63(2):155–63.
- Barsoumian AE, Hartzell JD, Bonura EM, Ressler RA, Whitman TJ, Yun HC. Military internal medicine resident decision to apply to fellowship and extend military commitment. *Mil Med*. 2018;183(7–8):e299–303.
- Jhaveri KD, Sparks MA, Shah HH, Khan S, Chawla A, Desai T, et al. Why not nephrology? A survey of US internal medicine subspecialty fellows. *Am J Kidney Dis*. 2013;61(4):540–6.
- Rohan-Minjares F, Alfero C, Kaufman A. How medical schools can encourage students' interest in family medicine. *Acad Med*. 2015;90(5):553–5.
- Campos-Outcalt D, Senf J. A longitudinal, national study of the effect of implementing a required third-year family practice clerkship or a department of family medicine on the selection of family medicine by medical students. *Acad Med*. 1999;74(9):1016–20.
- West CP, Popkave C, Schultz HJ, Weinberger SE, Kolars JC. Changes in career decisions of internal medicine residents during training. *Ann Intern Med*. 2006;145(10):774–9.
- Ofoma UR, Lehman EE, Haidet P, Yacht AC. Associations between subspecialty fellowship interest and knowledge of internal medicine: a hypothesis-generating study of internal medicine residents. *BMC Med Educ*. 2011;11: 5.
- Cullen MW, Klarich KW, Oxentenko AS, Halvorsen AJ, Beckman TJ. Characteristics of internal medicine residents who successfully match into cardiology fellowships. *BMC Med Educ*. 2020;20(1):238.
- Gross C, O'Halloran C, Winn AS, Lux SE, Michelson CD, Sectish T, et al. Application factors associated with clinical performance during pediatric internship. *Acad Pediatr*. 2020;20(7):1007–12.
- Hamdy H, Prasad K, Anderson MB, Scherpbier A, Williams R, Zwierstra R, et al. BEME systematic review: predictive values of measurements obtained in medical schools and future performance in medical practice. *Med Teach*. 2006;28(2):103–16.
- Chen F, Arora H, Martinelli SM, Teeter E, Mayer D, Zvara DA, et al. The predictive value of pre-recruitment achievement on resident performance in anesthesiology. *J Clin Anesth*. 2017;39:139–44.
- Daly KA, Levine SC, Adams GL. Predictors for resident success in otolaryngology. *J Am Coll Surg*. 2006;202(4):649–54.
- Bhat R, Takenaka K, Levine B, Goyal N, Garg M, Visconti A, et al. Predictors of a top performer during emergency medicine residency. *J Emerg Med*. 2015;49(4):505–12.
- Cullen MW, Reed DA, Halvorsen AJ, Wittich CM, Kreuziger LM, Keddis MT, et al. Selection criteria for internal medicine residency applicants and professionalism ratings during internship. *Mayo Clin Proc*. 2011;86(3):197–202.
- Cullen MW, Beckman TJ, Baldwin KM, Engstler GJ, Mandrekar J, Scott CG, et al. Predicting quality of clinical performance from cardiology fellowship applications. *Tex Heart Inst J*. 2020;47(4):258–64.
- Prasad V, Rho J, Selvaraj S, Cheung M, Vandross A, Ho N. Can a resident's publication record predict fellowship publications? *PLoS ONE*. 2014;9(3):e90140.
- Napolitano LM, Rajajee V, Gunnerson KJ, Maile MD, Quasney M, Hyzy RC. Physician training in critical care in the United States: update 2018. *J Trauma Acute Care Surg*. 2018;84(6):963–71.
- Richards JB, Spiegel MC, Wilcox SR. Characteristics of Pulmonary Critical Care Medicine and Pulmonary Medicine Applicants and Fellowships. *ATS Sch*. 2020;1(1):67–77.
- Angus DC, Kelley MA, Schmitz RJ, White A, Popovich J Jr. Caring for the critically ill patient. Current and projected workforce requirements for care of the critically ill and patients with pulmonary disease: can we meet the requirements of an aging population? *Jama*. 2000;284(21):2762–70.
- Halpern NA, Pastores SM, Oropello JM, Kvetan V. Critical care medicine in the United States: addressing the intensivist shortage and image of the specialty. *Crit Care Med*. 2013;41(12):2754–61.
- Halpern NA, Goldman DA, Tan KS, Pastores SM. Trends in critical care beds and use among population groups and medicare and medicaid beneficiaries in the United States: 2000–2010. *Crit Care Med*. 2016;44(8):1490–9.
- Kelm DJ, Ridgeway JL, Ratelle JT, Sawatsky AP, Halvorsen AJ, Niven AS, et al. Characteristics of effective teachers of invasive bedside procedures: a multi-institutional qualitative study. *Chest*. 2020;158(5):2047–57.
- West CP, Drefahl MM, Popkave C, Kolars JC. Internal medicine resident self-report of factors associated with career decisions. *J Gen Intern Med*. 2009;24(8):946–9.
- Lorin S, Heffner J, Carson S. Attitudes and perceptions of internal medicine residents regarding pulmonary and critical care subspecialty training. *Chest*. 2005;127(2):630–6.
- Harder B, Comarow A. Hospital quality reporting by US News & World Report: why, how, and what's ahead. *JAMA*. 2015;313(19):1903–4.
- Beckman TJ, Mandrekar JN, Engstler GJ, Ficalora RD. Determining reliability of clinical assessment scores in real time. *Teach Learn Med*. 2009;21(3):188–94.
- Post JA, Wittich CM, Thomas KG, Dupras DM, Halvorsen AJ, Mandrekar JN, et al. Rating the quality of entrustable professional activities: content validation and associations with the clinical context. *J Gen Intern Med*. 2016;31(5):518–23.
- Holmboe ES, Huot S, Chung J, Norcini J, Hawkins RE. Construct validity of the miniclinical evaluation exercise (miniCEX). *Acad Med*. 2003;78(8):826–30.
- Cook DA, Beckman TJ, Mandrekar JN, Pankratz VS. Internal structure of mini-CEX scores for internal medicine residents: factor analysis and generalizability. *Adv Health Sci Educ Theory Pract*. 2010;15(5):633–45.
- Reed DA, West CP, Mueller PS, Ficalora RD, Engstler GJ, Beckman TJ. Behaviors of highly professional resident physicians. *JAMA*. 2008;300(11):1326–33.
- McDonald FS, Zeger SL, Kolars JC. Associations of conference attendance with internal medicine in-training examination scores. *Mayo Clin Proc*. 2008;83(4):449–53.
- Waxman H, Braunstein G, Dantzer D, Goldberg S, Lefrak S, Lichstein E, et al. Performance on the internal medicine second-year residency

- in-training examination predicts the outcome of the ABIM certifying examination. *J Gen Intern Med.* 1994;9(12):692–4.
34. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform.* 2009;42(2):377–81.
 35. Max BA, Gelfand B, Brooks MR, Beckerly R, Segal S. Have personal statements become impersonal? An evaluation of personal statements in anesthesiology residency applications. *J Clin Anesth.* 2010;22(5):346–51.
 36. Taylor CA, Weinstein L, Mayhew HE. The process of resident selection: a view from the residency director's desk. *Obstet Gynecol.* 1995;85(2):299–303.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.