

Fellowships Represent a Logical Target for Cultivating Research in Academic AnesthesiologyJEAN DANIEL ELOY, MD
MOLLY D. AMIN, MD
ANNA A. PASHKOVA, BA
PETER F. SVIDER, BA
KEVIN M. MAURO
JEAN ANDERSON ELOY, MD, FACS**Abstract**

Background The need for greater emphasis on research contributions in academic anesthesiology has been widely recognized in recent years. Some propose increasing integration of research, including dedicated research time, into ACGME requirements for residency and fellowship training experiences. The *h-index*, an effective measure of research productivity that takes into account relevance and impact of an author's contributions on discourse within a field, was used to examine whether there are differences in research productivity between non-fellowship and fellowship-trained faculty in academic anesthesiology departments. This bibliometric was further used to examine differences in subspecialties, and other specialties of medicine.

Methods Research productivity, as measured by the *h-index*, was examined using the Scopus database for 508

academic Anesthesiologists practicing in the various subspecialties.

Results There was no statistical difference in research productivity, as measured by the *h-index*, between non-fellowship and fellowship-trained academic anesthesiologists (2.98±0.32 vs. 2.88±0.31). Critical care anesthesiologists had the highest *h-indices* (5.78±1.11), while regional anesthesia and pain medicine practitioners had the lowest values (1.18±0.32). Unlike in anesthesiology, a sample of physicians from other specialties revealed a statistical difference in *h-index* between non-fellowship and fellowship-trained physicians.

Conclusions Scholarly productivity, as measured by the *h-index* was similar for fellowship and non-fellowship trained anesthesiologists.

Background

There have been calls for increasing research emphasis within academic anesthesiology over the past decade, with one potential strategy for addressing perceived research deficits focusing on targeted recruitment of residents interested in performing research.^{1,2} One study noted that although anesthesiologists comprised 6% of the medical workforce, the proportion of NIH funding allocated to anesthesiology was less than 1%.³ To address this

issue, the authors of that analysis suggested including a mandatory research year in all anesthesiology fellowships. The notion of adding a compulsory research portion to fellowships has been controversial, with some believing it would discourage physicians from pursuing a fellowship, thus limiting exposure to advanced training and perhaps stifling academic careers.^{4,5} Consequently, mandated research time may create a deficit of highly-trained specialists in some already small fields, and such a

Jean Daniel Eloy, MD is in the Department of Anesthesiology at New Jersey Medical School; **Molly D. Amin, MD** is in the Department of Anesthesiology at New Jersey Medical School; **Anna A. Pashkova, BA** is at Robert Wood Johnson Medical School; **Peter F. Svider, BA** is at Robert Wood Johnson Medical School and in the Department of Otolaryngology – Head & Neck Surgery at New Jersey Medical School; **Kevin M. Mauro** is in the Department of Otolaryngology – Head & Neck Surgery at New Jersey Medical School; **Jean Anderson Eloy, MD, FACS** is in the Department of Otolaryngology – Head & Neck Surgery at New Jersey Medical School, the Department of Neurological Surgery at New Jersey Medical School, and the Center for Skull Base and Pituitary Surgery at New Jersey Medical School

Corresponding author: Jean Daniel Eloy, MD, New Jersey Medical School, Department of Anesthesiology, 185 S Orange Ave, MSB Room E 538-B Newark, NJ 07101-1709, Telephone: 973-972-1485, Fax: 973-972-0572

Email address: Jean Daniel Eloy: eloyje@njms.rutgers.edu

No financial support received from foundations, institutions, pharmaceutical or other private companies.

requirement could further exacerbate deficits in research productivity in academic anesthesiology.^{4,5}

The need for fellowship-trained anesthesiologists is not limited to any particular subspecialty. Interestingly, there has been a steady increase in number of fellowship trained anesthesiologist. Pain management was notable to have a total of 4607 practicing physicians in 2016, a 42.9% increase from five years earlier.⁶ Pediatric anesthesiology had 179 fellows matched in 2016, a 20.9% increase also from five years earlier.²⁹

The Accreditation Council for Graduate Medical Education (ACGME, Chicago, IL) currently accredits five anesthesiology fellowships: adult cardiothoracic anesthesiology, critical care medicine, obstetric anesthesiology, pain medicine, and pediatric anesthesiology. In the interest of maintaining inquiry and scholarship, ACGME program requirements emphasize attention to research and scholarly activity in each of these subspecialties as well as in general anesthesiology. Scholarship is specifically defined through the following three categories by the ACGME: (1) Discovery, highlighting publication of original research in a peer-reviewed journals (2) Dissemination, focusing on the distribution of information through review articles or textbook chapters (3) Application, in which information is taught

through case reports or clinical series at professional and scientific conferences.

Specialty-specific requirements with regards to scholarly participation are similar. The ACGME requirement for cardiothoracic, critical care, and pediatric anesthesiology mandates “an active research component must be included in each program.”⁷⁻⁹ Obstetric anesthesiology is the only specialty that mandates a required time period for research, stating that three months of research or other scholarly activity must be included.¹⁰ Pain medicine and general anesthesiology requirements simply state that physicians “should participate in scholarly activity.” The requirements of anesthesiology residencies include an academic assignment that may be fulfilled by a grand rounds presentation and manuals for teaching or clinical practice as well as the scholarly projects described above.¹¹

Research productivity is a significant component in the determination of appointment and promotion within academic anesthesiology.² While other factors, such as clinical service and educational contributions, play an important role in the process, evaluation of scholarly contributions remains important.¹²⁻¹⁷ Several components are commonly used to measure research productivity, such as number of publications or number of citations.^{16,17} However, these numbers may not adequately assess research impact. The absolute number of an individual’s publications does not reflect the value, relevance, or impact of a faculty member’s scholarly contributions. The number of times a physician’s publications may have been cited in the literature can be skewed by one highly influential paper among many less significant publications. The *h-index* is one easily calculable and objective measure that gauges the production of meaningful research to account for these factors.¹⁷

Defined by Dr. J.E. Hirsch in 2005, the *h-index* is a bibliometric defined as the number of publications an author has (*h*) that has each been cited a minimum of *h* times.¹⁷ Thus, if an author has 50 publications, but only 9 have been cited at least 9 times each, the author has an *h-index* of 9, disregarding the 41 publications that have a lower citation index. This inclusion criteria of published work emphasizes the importance of consistently meaningful scholarly output as opposed to sheer volume of production with a limited number of quality publications.

There has been no objective evaluation of the impact of fellowship training on research productivity in academic anesthesiology. The objectives of this analysis were to examine this impact with a comprehensive comparison to non-fellowship-trained faculty members, and further compare the various fellowships to gain insight into the emphasis on research within each of these subspecialties. Lastly, a further comparison of fellowship versus non-fellowship trained academic physicians using the *h-index* in other medical specialties was performed.

Methods

Using a random number generator, 20 anesthesiology departments were selected from the American Medical Association's Fellowship and Residency Electronic Interactive Database (FREIDA, Chicago, IL). Listings of faculty were obtained from the individual online sites of these departments. Clinical fellowship data was obtained from online faculty listings; three departments that did not provide this information were excluded from analysis. Instructors, adjuncts, voluntary, part-time, and non-academic faculty were excluded from this analysis.

The *h-index* was provided for each of the 508 faculty members in this analysis using the Scopus database (<http://www.scopus.com>, Elsevier, Amsterdam, NL), and faculty members were organized into the following categories: non-fellowship-trained, critical care, obstetric

anesthesia, cardiothoracic anesthesiology, neuroanesthesia, pediatric anesthesiology, regional anesthesia and pain medicine, or multiple fellowships. The database had been used in prior analyses evaluating *h-index* in a variety of specialties, including studies among anesthesiologists.^{18,20,22,25}

Further examination of the impact of fellowship training was performed for a sample of several other specialties with a similar impact to ensure adequate power. A random number generator was used to choose programs in internal medicine, pediatrics, and otolaryngology. Departments in each of these specialties were added until at least 150 academic physicians per specialty were included. All data was collected in July and August 2012.

Statistical Analyses

Student's *t*-tests and one-way ANOVAs were performed where appropriate. A threshold for significance was set at $p < 0.05$.

Results

There was no statistical difference in research productivity, as measured by the *h-index*, between individuals with or without fellowship training (*t*-test, $p = 0.41$) (**Figure 1**). Upon further organization of fellowship-trained faculty into their specific fellowship categories, critical care anesthesiologists had the greatest research productivity (**Figure 2**), which was significantly greater than each of the other subspecialties ($p < 0.05$) except obstetric anesthesiologists ($p = 0.12$). Anesthesiologists with fellowship training in regional anesthesia and pain medicine had less research productivity than other specialties ($p < 0.05$) except neuroanesthesia ($p = 0.09$).

Unlike anesthesiology, fellowship-trained faculty in the sample of academic physicians from other specialties had greater research productivity (**Figure 3**), as measured by the *h-index*, with these differences reaching statistical significance within internal medicine ($p < 0.0001$) and pediatrics ($p = 0.03$).

Discussion

This analysis considered 508 anesthesiologists from 20 departments across the nation, 47% of which had fellowship training. There was no difference in research productivity of anesthesiologists with (h-index 2.88) and without (h-index 2.98) fellowship training ($p=0.41$). This may be in part due to limited interest of the candidates.⁴ One academic anesthesiologist previously noted in a published letter, referring to research in anesthesiology, that “a psychological profile of an anesthesiologist is characterized by the need for immediate gratification rather than gratification from long-term efforts which may seem relatively fruitless for a certain period of time.”¹⁹

An important factor to consider is the relatively few practicing physicians in anesthesiology subspecialties; for example, there were 42,708 practicing general anesthesiologists versus 1547 practicing pain management specialists in 2011.⁶ In the smaller subspecialty community, publications may have a smaller audience, and each paper will be read, and thus cited, less often, with lower *h*-indices for authors. Furthermore, the low *h*-index could be in part because of relatively low impact of anesthesia journals compared to other fields of medicine.

Critical care anesthesiologists had statistically higher mean *h*-indices than all other practitioners except for obstetric anesthesiologists. This finding may reflect a greater number of critical care anesthesiologists than other subspecialty practitioners. Since careers in critical care medicine may be arrived at through multiple pathways, including residencies in surgery, anesthesiology, pediatrics, and internal medicine, there is a larger audience for critical care anesthesiology authors, allowing for more citations and, thus, a higher *h*-index.

The field of regional anesthesiology and acute pain medicine had the lowest *h*-index, for which several explanations are offered. The smaller size of the field leads to fewer academic faculty that can serve as role models for research; with fewer mentors and decreased meaningful

scholarly output by departments, newly trained fellows are less likely to explore and pursue research opportunities.^{1,19}

When comparing fellowship versus non-fellowship trained physicians in pediatrics, otolaryngology, and internal medicine we found greater research productivity with higher *h*-indices in the fellowship trained group within internal medicine and pediatrics. Morrison et al. performed a national survey within pediatric critical care medicine fellowship and found that within the three-year fellowship median dedicated research time was 12 months (range 12-14 months).²⁶ Recently published training guidelines for pediatric cardiology fellowship states “it is recognized that a significant proportion (>12 months) of the 3-year training program should be dedicated to scholarly activities and research training.”²⁷ Allocating a minimum of 33% of total fellowship training time within pediatrics to research activities is a reason why fellowship trained pediatricians see a significant higher *h*-index and publications rates compared to non-fellowship trained pediatricians.²⁸ Similar results were seen with fellowship trained internists. Interestingly, fellowships in anesthesiology are only one year in duration as compared to fellowships for internal medicine and pediatrics. The length of fellowship can impact scholarly productivity. Longer fellowship programs usually have dedicated time for research, which is not typical for fellowships in anesthesiology.

The possibility of using ACGME accreditation guidelines and encouraging programs to become accredited to promote research has also been proposed.⁴ Pagel et al. examined the relationship between ACGME accreditation and *h*-index in cardiothoracic anesthesiologists and found a positive correlation.²⁰ This seems like a logical conclusion, considering that ACGME regulations include guidelines for research and other scholarly work. However, our analysis included programs in both ACGME-accredited and non-accredited specialties and showed that the average *h*-index of neuroanesthesia, a non-accredited fellowship, was not statistically different than other ACGME recognized specialties. If ACGME accreditation has a strong influence on research productivity, it is logical that specialties with

ACGME accreditation have a higher *h-index*. It should be noted that the small sample of neuroanesthesiology fellowship-trained physicians (n=8) may have limited analysis.

While the *h-index* is an excellent tool for measuring the relevance and impact of an author's work, it does have limitations. The *h-index* does not distinguish between types of research performed, such as basic science research versus clinical research.^{16,22} Basic science research may take much longer to produce a meaningful publication than an analysis limited to chart reviews or case reports. Secondly, as previously mentioned, the *h-index* may be influenced by the size of the field, as fewer citations are likely with a smaller audience. Several authors have suggested that the *h-index* is best used within a field rather than to compare among different disciplines of science and medicine for this reason.^{18,23} Another limitation is search error; multiple authors would be remiss not to bring up is the possibility of search error using our methodology; multiple authors with the same name may exist, so there is the potential for publications to have been cited incorrectly. Lastly, age, academic roles, research infrastructure, and

degree of accuracy of faculty listings on websites were not considered for analysis.

A need for more physician-researchers in academic anesthesiology to advance the specialty as a member of the scholarly community has been voiced in recent years.³ A proposed solution includes promoting dedicated research time during fellowship training experiences.³ Our analysis did not find a difference between the research productivity of fellowship trained and non-fellowship trained academic anesthesiologists despite differences noted in other specialties of medicine. Additionally, encouraging research interest early in training, by providing research mentors to medical students, and placing increased emphasis on research when considering residency applicants may promote research in the field.¹ Future study should investigate the impact of scholarship tracking by ACGME's accreditation data system, grant programs such as those offered by the Foundation for Anesthesia Education and Research (FAER), and other interventions that may impact the *h-index*.

Figure 1

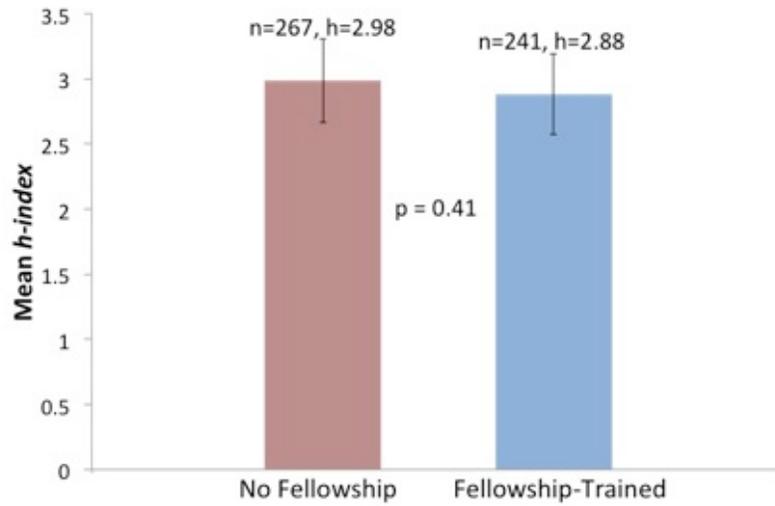


Figure 2

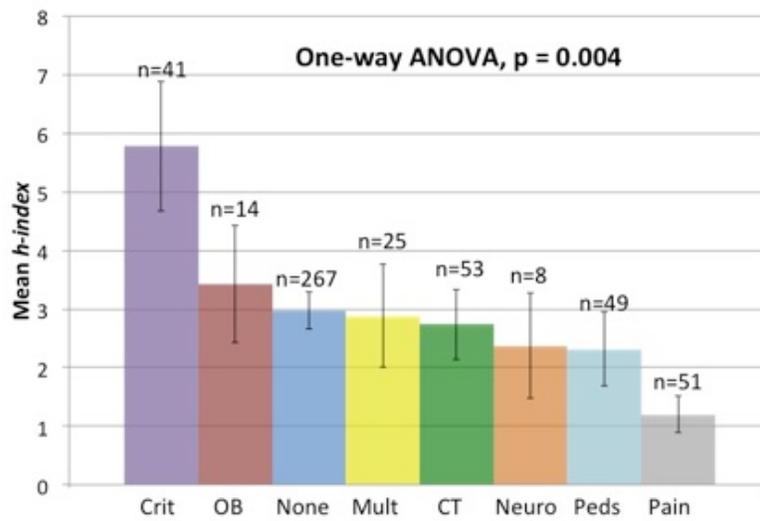
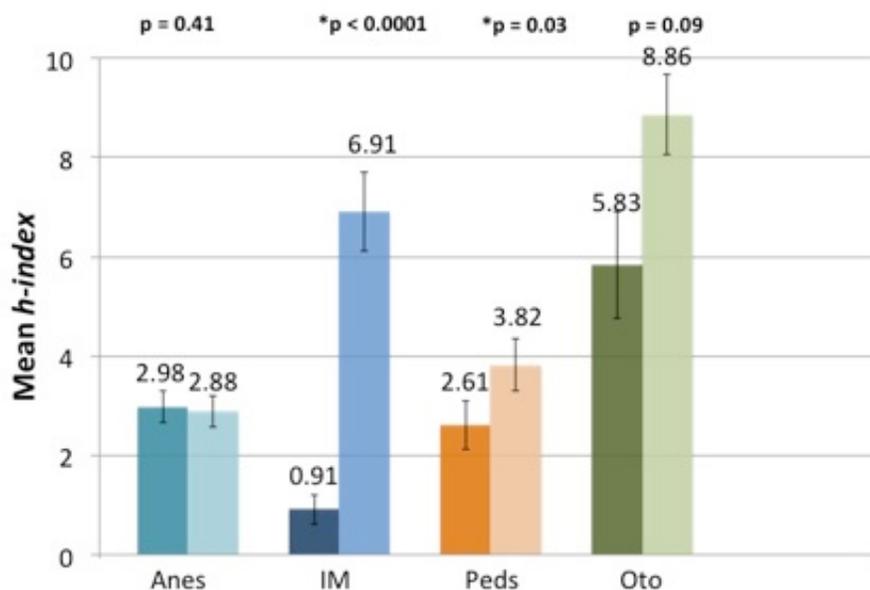


Figure 3



References

- 1 Knight PR, Wartier DC. Anesthesiology residency programs for physician scientists. *Anesthesiology* 2006;104:1-4.
- 2 Reves JG. We are what we make: transforming research in anesthesiology: the 45th Rovenstine Lecture. *Anesthesiology* 2007;106:826-835.
- 3 Schwinn DA, Balsler JR. Anesthesiology physician scientists in academic medicine: a wake-up call. *Anesthesiology* 2006;104:170-178.
- 4 Ilfeld BM, Yaksh TL, Neal JM. Mandating two-year regional anesthesia fellowships: fanning the academic flame or extinguishing it? *Regional anesthesia and pain medicine* 2007;32:275-279.
- 5 Pandit JJ. Royal College recommendations to improve academic anesthesia in the United Kingdom: how they compare with United States proposals. *Anesthesiology* 2006;105:625-626; author reply 628, 629-630.
- 6 AAMC. "Careers in Medicine" <https://www.aamc.org/students/medstudents/cim/> 2016; Accessed Jan 2017.
- 7 Accreditation Council for Graduate Medical Education. ACGME Program Requirements for Graduate Medical Education in Anesthesiology Critical Care Medicine 2001.
- 8 Accreditation Council for Graduate Medical Education. ACGME Program Requirements for Graduate Medical Education in Pediatric Anesthesiology 2004.
- 9 Accreditation Council for Graduate Medical Education. ACGME Program Requirements from Graduate Medical Education in Adult Cardiothoracic Anesthesiology 2006.
- 10 Accreditation Council for Graduate Medical Education. Program Requirements for Graduate Medical Education in Obstetric Anesthesiology 2011.

References

- 11 Accreditation Council for Graduate Medical Education. ACGME Program Requirements for Graduate Medical Education in Anesthesiology. 2008
- 12 Reed DA, Enders F, Lindor R, McClees M, Lindor KD. Gender differences in academic productivity and leadership appointments of physicians throughout academic careers. *Academic medicine : journal of the Association of American Medical Colleges* 2011;86:43-47.
- 13 Chapman T, Carrico C, Vagal AS, Paladin AM. Promotion as a clinician educator in academic radiology departments: guidelines at three major institutions. *Academic radiology* 2012;19:119-124.
- 14 Beasley BW, Wright SM, Cofrancesco J, Jr., Babbott SF, Thomas PA, Bass EB. Promotion criteria for clinician-educators in the United States and Canada. A survey of promotion committee chairpersons. *JAMA : the journal of the American Medical Association* 1997;278:723-728.
- 15 Atasoylu AA, Wright SM, Beasley BW et al. Promotion criteria for clinician-educators. *Journal of general internal medicine* 2003;18:711-716.
- 16 Svider PF, Choudhry ZA, Choudhry OJ, Baredes S, Liu JK, Eloy JA. The use of the h-index in academic otolaryngology. *Laryngoscope* 2012.
- 17 Hirsch JE. An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences of the United States of America* 2005;102:16569-16572.
- 18 Lee J, Kraus KL, Couldwell WT. Use of the h index in neurosurgery. *Clinical article. Journal of neurosurgery* 2009;111:387-392.
- 19 Gelman S. Anesthesiologist scientist: endangered species. *Anesthesiology* 2006;105:624-625; author reply 628, 629-630.
- 20 Pagel PS, Hudetz JA. Scholarly productivity of united states academic cardiothoracic anesthesiologists: influence of fellowship accreditation and transesophageal echocardiographic credentials on h-index and other citation bibliometrics. *Journal of cardiothoracic and vascular anesthesia* 2011;25:761-765.
- 21 Engqvist L, Frommen JG. The h-index and self-citations. *Trends in ecology & evolution* 2008;23:250-252.

References

- 22 Pagel PS, Hudetz JA. Bibliometric analysis of anaesthesia journal editorial board members: correlation between journal impact factor and the median h-index of its board members. *British journal of anaesthesia* 2011;107:357-361.
- 23 Castillo M. Measuring academic output: the H-index. *AJNR American journal of neuroradiology* 2010;31:783-784.
- 24 "FAER Grant Opportunities." FAER Foundation for Anesthesia Research and Education, 2006. Accessed at <http://faer.org/programs/grants/index.html>.
- 25 Pagel, P., & Hudetz, J. (2011). H-index is a sensitive indicator of academic activity in highly productive anaesthesiologists: results of bibliometric analysis. *Acta Anaesthesiologica Scand*, 9, 1085-1089.
- 26 Morrison, W., Helfaer, M., & Nadkarni, V. (2009). National survey of pediatric critical care medicine fellowship clinical and research time allocation. *Pediatric Critical Care Medicine*, 10(3), 397-399.
- 27 Mahle, W., Murphy, A., Li, J., Law, Y., Newburger, J., Daniels, S.m Bernstein, D., Marino, B., & Ross, R. (2015). Task Force 8: Pediatric Cardiology Fellowship Training in Research and Scholarly Activity. *Circulation*, 132, E107-E113.
- 28 Szilagyi, P., Haggerty, R., Baldwin, C., & Paradis, H. (2011). Tracking the Careers of Academic General Pediatric Fellowship Program Graduates: Academic Productivity and Leadership Role. *Academic Pediatrics*, 11(3), 216 -223.
- 29 Fellowship Match Data. (2016). Retrieved January 18, 2017, from <http://www.nrmp.org/match-data/fellowship-match-data/>