

# Evaluation of the Foundation for Anesthesia Education and Research Medical Student Anesthesia Research Fellowship Program Participants' Scholarly Activity and Career Choices

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## ABSTRACT

**Background:** The Foundation for Anesthesia Education and Research Medical Student Anesthesia Research Fellowship (MSARF) program is an 8-week program that pairs medical students with anesthesiologists performing anesthesia-related research. This study evaluated the proportion of students who published an article from their work, as well as the percentage of students who entered anesthesiology residency programs.

**Methods:** A list of previous MSARF participants (2005 to 2012), site, and project information was obtained. Searches for publications were performed using PubMed. The primary outcome was the publication rate for MSARF projects. The MSARF abstract-to-publication ratio was compared with the percentage of abstracts presented at biomedical meetings that resulted in publication as estimated by a Cochrane review (44%). For students who had graduated from medical school, match lists from the students' medical schools were reviewed for specialty choice.

**Results:** Forty-two percent of the 346 MSARF projects were subsequently published. There was no difference between the MSARF abstract-to-publication ratio and the publication rate of articles from abstracts presented at scientific meetings ( $P = 0.57$ ). Thirty percent ( $n = 105$ ; 95% CI, 25 to 35%) of all the MSARF students were authors on a publication. Fifty-eight percent of the students for whom residency match data ( $n = 255$ ) were available matched into anesthesiology residencies (95% CI, 52 to 64%).

**Conclusions:** The MSARF program resulted in many students being included as a co-author on a published article; the majority of these students entered anesthesiology residency programs. Future research should determine whether the program has a long-term impact on the development of academic anesthesiologists. (ANESTHESIOLOGY 2016; 124:1168-73)

THE number of physician-scientists (researchers with an M.D. or both M.D. and Ph.D. degrees) has been steadily decreasing.<sup>1,2</sup> This decrease in physician-scientists is reflected throughout the research pipeline. The National Institutes of Health (NIH) is a major source for research funding in the United States. There has been a decline in the number and percentage of first-time M.D. applicants for R01-equivalent awards, as well as a decline in the number of physicians in T32 training programs and those with F32 fellowship and career development (K) awards.<sup>2</sup> Anesthesiology has historically been underrepresented in NIH funding<sup>3</sup>; therefore, decreases in the number of physician-scientists will disproportionately affect funded research within our specialty.

Multiple reasons for the shortage of physician-scientists exist. One potential cause is a decreasing pipeline of students interested in research careers. Less than 20% of graduating medical students are interested in research as a career.<sup>1,2</sup>

### What We Already Know about This Topic

- Foundation for Anesthesia Education and Research Medical Student Anesthesia Research Fellowship is a program designed to increase interest among physician-investigators in anesthesiology by pairing medical students with academic anesthesiologists to perform anesthesia-related research
- The efficacy of the program was evaluated to determine the rate of publication success and enrollment into anesthesiology residency programs

### What This Article Tells Us That Is New

- Publication success was achieved for 42% of Medical Student Anesthesia Research Fellowship (MSARF) projects, and 30% of all MSARF awardees were co-authors on a publication
- More than half the awardees matched in an anesthesia residency program, whereas the enrollment rate was significantly less in individuals who were not accepted into the MSARF
- Long-term success of the program, with the specific intention of increasing physician-scientists in anesthesiology, remains to be determined

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A recent cross-sectional survey of 515 medical students in the United Kingdom revealed that, although the majority of students were interested in participating in research, 62% did not feel encouraged to take part in research, and lack of opportunity was cited as the primary reason for not performing research during medical school.<sup>4</sup> Even when research interest exists, early-career physicians weigh both the time and the potential financial burden of research training in their decision-making, along with the loss of clinical exposure, family responsibilities, and uncertainty about future funding.<sup>5-7</sup>

Early exposure to research in medical school has been shown to increase interest in both research and academic careers.<sup>8</sup> Several medical schools offer 6- and 8-week research opportunities for students between their first and second years of medical school; however, the percentage of these students who publish their work is variable, and the influence of these programs on career choices and long-term outcomes is unclear. The Foundation for Anesthesia Education and Research (FAER) created the Medical Student Anesthesia Research Fellowship (MSARF) program in 2005 to increase the pool of physician-investigators in anesthesiology. In this program, medical students are paired with academic anesthesiologists performing anesthesia-related research. To date, no formal assessment of the program has been performed. The objectives of this study were (1) to determine the research productivity (publication success) for students who participated in the FAER MSARF program, (2) to determine the percentage of students who ultimately entered an anesthesiology residency program after medical school, and (3) to determine if the percentage entering anesthesiology differed among students accepted to the program *versus* those who applied and were not accepted to the program.

## Materials and Methods

Because only publically available data were used in this study, approval of the institutional review board was not required.

### The FAER MSARF Program

The FAER MSARF is an 8-week-long program in which medical students who have completed their first, second, or third year of medical school are matched with research mentors in an academic department of anesthesiology. This may occur at the student's home medical school or at another institution. During these 8 weeks, the students are assigned a project, and they participate in clinical activities within the department. Students may work on more than one project during their MSARF program but typically are assigned one primary project. The student is paid a stipend for his/her work, and the host department is given additional funds for the student to attend the American Society of Anesthesiologists Annual Meeting that is held annually in October. All students are required to submit an abstract at the conclusion of the 8-week program; the abstract is presented at a special symposium at the American Society of Anesthesiologists Annual Meeting for MSARF participants.

Approximately 465 students participated in the program between 2005 and 2014.

### Search Strategy

A list of previous MSARF participants, along with the name of their home medical school, the name of their research mentor, the mentor's medical school affiliation, the name of the proposed project, and the participant's sex, was obtained from the FAER. Because previous studies have identified a median interval of 20 months between abstract completion and publication,<sup>9</sup> only participants in the 2005 to 2012 cohorts were included in this assessment (n = 346). The interval between the completion of the last cohort and the search date was 30 months.

A multitiered approach was used to identify the publications associated with the MSARF project. Searches were performed in February 2015 using PubMed's Advanced Search Builder function.<sup>10</sup> The first search included the student's name (*e.g.*, Barnes P.) and affiliation. Both the student's home medical school and the host site for the MSARF research project were searched. A second search included the student's name and the name of his/her research mentor (*e.g.*, Barnes P. and Sessler D.). The third search included the student's name and key words from the MSARF project and the mentor's name. A verification of matches was done to ensure that the research was performed either at the home or host medical school location. A final search was performed to identify the MSARF projects that were published by the mentor without the student listed as an author. This search included the mentor's name and broad key words associated with the project. Only peer-reviewed research articles or review articles were included as publications. Case reports, and any article published by the student before the MSARF program, were not counted toward the article tally. Two investigators searched for articles independently (S.M. and L.D.), and the lists were subsequently reviewed for discrepancies. Questions regarding authorship or dates of publication were reviewed by P.T.

The following information was abstracted from each article: month and year of publication, type of research (clinical or basic science), and the name of the journal in which the work was published. The number of citations for each article was determined using Web of Science.<sup>11</sup> For articles in which the MSARF student was an author, author order was noted (whether the student was the first author or not).

For students who had graduated from medical school, match lists from the students' medical schools were reviewed for specialty choice. Searches were also performed using Doximity and LinkedIn.<sup>12,13</sup> Names identified through these searches were verified by medical school year of graduation and medical school identity at the time of the MSARF fellowship. A list of students who had applied to the MSARF program but were not accepted was also obtained from the FAER. Match data were obtained for students for whom

FAER had the student's name, year of training at the time of application to the MSARF program, and medical school.

### Statistics

Descriptive statistics were used to summarize the results. The primary outcome was the publication rate, defined as the percentage of MSARF students who were authors on at least one article. A one-sample *t* test was used to compare the MSARF abstract-to-publication ratio to the percentage of abstracts presented at biomedical meetings that resulted in publication as estimated by a 2007 Cochrane review (44%).<sup>14</sup> Probability distributions for binary outcomes were obtained using the binomial distribution. Characteristics of students and studies of those who published articles and those who matched into anesthesiology residency programs *versus* those who did not were evaluated using a chi-square test. A chi-square test was also used to compare match data for students who participated *versus* students who were not accepted into the MSARF program.

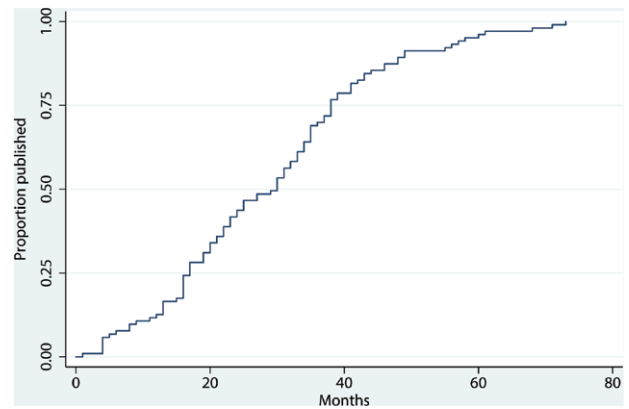
A multivariable logistic regression model was built to evaluate the association between student and project characteristics and subsequent article publication (model 1) and matching into an anesthesiology residency program (model 2). Candidate variables included student sex, medical student year (senior student or first-year student), project type (basic science or not), whether the student completed the fellowship at their home institution, and whether the student was a co-author on a publication (in model 2). Variables with a univariate association of *P* value less than 0.1 were included in the multivariable model.

Data were analyzed using Stata SE (Version 12; College Station, TX). A *P* value less than 0.05 was used to define statistical significance.

### Results

Forty-two percent of the 346 primary MSARF projects were subsequently published. There was no difference between the MSARF abstract-to-publication ratio and the publication rate of articles from abstracts presented at scientific meetings as estimated by a Cochrane review analysis (42 *vs.* 44%; *P* = 0.57).<sup>14</sup>

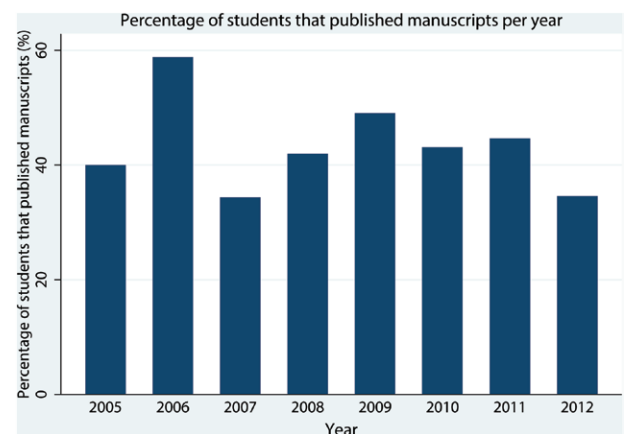
Thirty percent (*n* = 105; 95% CI, 25 to 35%) of all the MSARF students were authors on a peer-reviewed publication. Of the students who were co-authors on an article, 72% (*n* = 76) were first, second, or third author on the publication. Thirty-two students were first author, 22 were second author, and an additional 22 were third author on at least one publication. Of the students who did publish, the median number of publications was 1 (interquartile range, 1 to 2). Thirty-six students had multiple publications. Student publications appeared in 70 journals. The median number of citations was 3 (interquartile range, 1 to 10). The median time to publication was 29.5 months (interquartile range, 16 to 38 months) (fig. 1). There was no difference in the publication success by year of the



**Fig. 1.** Time to publication. This graph shows the proportion of Medical Student Anesthesia Research Fellowship projects that resulted in a publication over time. Time from completion of the program to publication of the first article is shown in months. Overall, 147 of Medical Student Anesthesia Research Fellowship projects resulted in at least one published article.

MSARF program (*P* = 0.64; fig. 2). There were no differences in the characteristics of students who published an article compared with those who did not (table 1). Logistic regression analysis found that no single factor was associated with article publication (model 1).

Residency match data were available for 255 students. Fifty-eight percent of these students matched into anesthesiology residency programs (95% CI, 52 to 64%). Sex, whether the MSARF student was at his/her home institution, and basic *versus* clinical science research projects were not associated with subsequent matching into anesthesiology residency programs. However, in multivariable analysis, students who completed their MSARF fellowship as a senior medical student and those who subsequently published an article were more likely to match into anesthesiology residency programs (model 2) (table 2).



**Fig. 2.** Percentage of Medical Student Anesthesia Research Fellowship participants who published articles per year (2005 to 2012). There was no difference in the publication success by year of the Medical Student Anesthesia Research Fellowship program (*P* = 0.64).

**Table 1.** Characteristics Associated with Article Publication

	Article Published (n = 105)	Article Not Published (n = 241)	Univariate OR (95% CI)	P Value
Male (%)	55	58	0.87 (0.55–1.39)	0.57
First-year medical student (%)	75	83	0.60 (0.35–1.06)	0.08
At-home institution for MSARF fellowship (%)	43	33	1.51 (0.92–2.41)	0.08
Basic science project (%)	30	30	1.02 (0.61–1.70)	0.95

MSARF = Medical Student Anesthesia Research Fellowship; OR = odds ratio.

**Table 2.** Factors Associated with Matching into an Anesthesiology Residency Program

	Percent	Univariate Odds Ratio (95% CI)	P Value	Multivariate Adjusted Odds Ratio (95% CI)*	P Value
Male	55	0.80 (0.48–1.33)	0.39		
Senior medical student at the time of MSARF fellowship	31	3.98 (1.94–8.12)	< 0.001	3.7 (1.80–7.61)	< 0.001
At-home institution for MSARF fellowship	33	0.90 (0.53–1.52)	0.70		
Basic science project	29	0.76 (0.42–1.35)	0.34		
Student co-author on a published article	39	2.30 (1.30–4.05)	0.004	2.09 (1.17–3.75)	0.01

One hundred forty-nine students matched into an anesthesiology residency program.

\*Variables with a univariate association of  $P < 0.1$  were included in the multivariable model. Adjusted odds ratios were determined using a logistic regression model with matching into anesthesiology residency programs as the outcome of interest.

MSARF = Medical Student Anesthesia Research Fellowship.

Students who were accepted into the MSARF program were more likely to match into anesthesiology residency programs than students who applied but were not accepted into the program (58 vs. 29%;  $P < 0.001$ ). For students for whom match data were available, stratification by year of training revealed that 52% of the first-year students who participated in the program matched into anesthesiology residency programs compared with 25% of the students who were not accepted into the MSARF program ( $P < 0.001$ ). Eighty-one percent of senior medical students who participated in the MSARF program matched into anesthesiology residency programs compared with 42% of senior students who applied but were not accepted into the MSARF program ( $P < 0.001$ ).

## Discussion

The important findings of this study were that 42% of the MSARF projects were published. The overall publication rate for MSARF projects was similar to the percentage of scientific abstracts that are ultimately published.<sup>14</sup> Fifty-eight percent of the students for whom specialty information was available matched into anesthesiology residency programs. This percentage was higher than that of students who applied to the MSARF program but were not accepted. Students who completed their MSARF fellowship as a senior medical student and those who subsequently published an article were more likely to match into anesthesiology residency programs.

The percentage of MSARF students who were a co-author on a publication was higher than the publication rate for other similar medical student programs. Burge and Hills<sup>15</sup>

evaluated medical student productivity for medical students who participated in a 6-week clinical research training program in family medicine and found that only 5% of students submitted papers for publication. In contrast, 25% of students participating in a 6- to 8-week summer research program at the Mount Sinai School of Medicine subsequently published their work.<sup>16</sup> Half of the students who participated in a competitive, 8-week structured research program in cardiac surgery at Johns Hopkins Hospital ultimately published an article.<sup>17</sup> A similar publication rate was found in an NIH-sponsored Medical Student Research Fellowship Program (50% publication rate).<sup>8</sup> A high percentage of students in the MSARF program were first, second, or third author on published articles. Using a sequence-determines-credit approach,<sup>18,19</sup> this finding suggests that MSARF students were significant contributors on the projects in which they participated.

There may be several reasons why students who completed the MSARF program did not publish an article. Although the students may have made a significant contribution to their summer project, it may have been insufficient to merit authorship. The International Committee of Medical Journal Editors recommends that four criteria be satisfied to merit inclusion as an author.<sup>20</sup> These criteria are (1) substantial contributions to the conception or design of the work or the acquisition, analysis, or interpretation of data for the work; (2) drafting the work or revising it critically for important intellectual content; (3) final approval of the version to be published; and (4) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are

appropriately investigated and resolved. It is possible that, due to the short duration of the fellowship, students may not meet all four criteria and therefore not merit being listed as authors. Additionally, the duration of the fellowship may limit students' ability to contribute to longer term projects.

The National Resident Matching Program data for 2014 revealed that 4% of all postgraduate year 1 applicants matched into anesthesiology residency programs.<sup>21</sup> The percentage of MSARF applicants and MSARF participants who enter anesthesiology (29 and 58%, respectively) is significantly higher than the national rate. This indicates that the MSARF program likely attracts students who are already interested in a career in anesthesiology; however, participation in the MSARF program significantly increases the likelihood of entering an anesthesiology-training program. A higher percentage of the senior medical students who participated in the MSARF program entered anesthesiology than first-year medical student participants. This likely reflects senior students seeking to reinforce a preexisting interest or strengthen their application for anesthesiology residency programs.

Although many specialties have summer research programs for medical students, few have evaluated their impact on specialty selection. The results of programs that have evaluated effectiveness are promising. Fifty-two percent of medical students who participated in a Johns Hopkins Hospital cardiac surgery summer research program matched into a general surgery or surgical subspecialty residency.<sup>17</sup> A longitudinal analysis of the American Pediatric Society and Society for Pediatric Research Medical Student Research Program similarly demonstrated that participation in the summer program influenced career choice.<sup>22</sup> The percentage of students who entered pediatrics was two to three times the national average, and 29% of participants remained in academic pediatrics.

It is important to consider our study's limitations. First, PubMed was the only database searched, and it is possible that medical students' articles were published in nonindexed journals. Students or mentors may have had a change of last name since the time of fellowship participation; thus, our search strategy would not discover their publication. A change of last name would also affect the accuracy of our match information, and it is possible that we did not find all students for whom match information was available. Also, we only know whether an article was published but not whether a manuscript was submitted for publication and not accepted. Finally, publication of work performed during the FAER fellowship may have occurred since the time of our search.

Ideally, in order to evaluate the effectiveness of the FAER MSARF program on both academic productivity and career choices, we would have a comparison group of students who applied to the MSARF fellowship and were either not accepted or did not accept the fellowship position. However, although we could evaluate the career choices for a subset of MSARF applicants, we were unable to evaluate the academic productivity of students who were not accepted into the

MSARF program. We could not determine whether these students performed research during medical school, their mentors' identities, or their fields of research. This information would be critical to performing such an analysis. A final limitation is that, due to the retrospective nature of the study, we lacked knowledge of important characteristics of both the students and mentors, such as previous research experience and productivity for both the student and the mentor. We also do not have information on the mentors' experience in working with medical students, percentage of time dedicated to research, or grant funding. We do not know whether the student-mentor relationship extended beyond the 8 weeks of the fellowship. It is possible that students who had a closer connection to their mentor were more likely to be included as an author or pursue a career in anesthesiology, but this is purely speculative.

In summary, the MSARF program has had a positive impact on students, with many students being included as a co-author on peer-reviewed articles as well as entering anesthesiology residency programs. Because the first cohorts of the MSARF program are now completing fellowship or entering practice, it is too early to ascertain whether the program has had a long-term impact in the development of academic anesthesiologists. However, the initial assessment of this program is promising, and there is some evidence to suggest that exposure to research as a medical student does result in an increase in the number of physician-scientists.<sup>8,23</sup> Therefore, the MSARF program, and similar programs, may be one strategy to help increase the number of physician-scientists in anesthesiology.

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### Competing Interests

The authors declare no competing interests.

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### References

1. Rosenberg LE: The physician-scientist: An essential—and fragile—link in the medical research chain. *J Clin Invest* 1999; 103:1621–6
2. Garrison HH, Deschamps AM: NIH research funding and early career physician scientists: Continuing challenges in the 21<sup>st</sup> century. *FASEB J* 2014; 28:1049–58

3. Schwinn DA, Balsler JR: Anesthesiology physician scientists in academic medicine: A wake-up call. *ANESTHESIOLOGY* 2006; 104:170–8
4. Griffin MF, Hindocha S: Publication practices of medical students at British medical schools: Experience, attitudes and barriers to publish. *Med Teach* 2011; 33:e1–8
5. Nathan DG: Careers in translational clinical research-historical perspectives, future challenges. *JAMA* 2002; 287:2424–7
6. Andrews NC: The other physician-scientist problem: Where have all the young girls gone? *Nat Med* 2002; 8:439–41
7. Holleman WL, Cofta-Woerpel LM, Gritz ER: Stress and morale of academic biomedical scientists. *Acad Med* 2015; 90:562–4
8. Solomon SS, Tom SC, Pichert J, Wasserman D, Powers AC: Impact of medical student research in the development of physician-scientists. *J Investig Med* 2003; 51:149–56
9. Walsh CM, Fung M, Ginsburg S: Publication of results of abstracts presented at medical education conferences. *JAMA* 2013; 310:2307–9
10. PubMed. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/advanced>. Accessed June 22, 2015
11. Web of Science. Available at: <http://wokinfo.com>. Accessed on June 22, 2015
12. Doximity. Available at: <http://www.doximity.com>. Accessed June 22, 2015
13. LinkedIn. Available at: <http://www.linkedin.com>. Accessed June 22, 2015
14. Scherer RW, Langenberg P, von Elm E: Full publication of results initially presented in abstracts. *Cochrane Database Syst Rev* 2007:MR000005
15. Burge SK, Hill JH: The medical student summer research program in family medicine. *Fam Med* 2014; 46:45–8
16. Zier K, Friedman E, Smith L: Supportive programs increase medical students' research interest and productivity. *J Investig Med* 2006; 54:201–7
17. Haggerty KA, Beaty CA, George TJ, Arnaoutakis GJ, Baumgartner WA: Increased exposure improves recruitment: Early results of a program designed to attract medical students into surgical careers. *Ann Thorac Surg* 2014; 97:2111–4; discussion 2114
18. Tschardt T, Hochberg ME, Rand TA, Resh VH, Krauss J: Author sequence and credit for contributions in multi-authored publications. *PLoS Biol* 2007; 5:e18
19. Baerlocher MO, Newton M, Gautam T, Tomlinson G, Detsky AS: The meaning of author order in medical research. *J Investig Med* 2007; 55:174–80
20. International Committee of Medical Journal Editors: Defining the Role of Authors and Contributors. Available at: <http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html>. Accessed June 22, 2015
21. National Resident Matching Program: Results and Data: 2014 Main Residency Match. National Resident Matching Program, Washington, D.C., 2014
22. Smith WH, Rogers JG, Hansen TN, Smith CV: Early career development in academic pediatrics of participants in the APS-SPR Medical Student Research Program. *Pediatr Res* 2009; 65:474–7
23. Segal S, Lloyd T, Houts PS, Stillman PL, Jungas RL, Greer RB III: The association between students' research involvement in medical school and their postgraduate medical activities. *Acad Med* 1990; 65:530–3