

CME

Status of Anesthesiology Resident Research Education in the United States: Structured Education Programs Increase Resident Research Productivity

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BACKGROUND: The enhancement of resident research education has been proposed to increase the number of academic anesthesiologists with the skills and knowledge to conduct meaningful research. Program directors (PDs) of the U.S. anesthesiology residency programs were surveyed to evaluate the status of research education during residency training and to test the hypothesis that structured programs result in greater resident research productivity based on resident publications.

METHODS: Survey responses were solicited from 131 anesthesiology residency PDs. Seventy-four percent of PDs responded to the survey. Questions evaluated department demographic information, the extent of faculty research activity, research resources and research funding in the department, the characteristics of resident research education and resident research productivity, departmental support for resident research, and perceived barriers to resident research education.

RESULTS: Thirty-two percent of programs had a structured resident research education program. Structured programs were more likely to be curriculum based, require resident participation in a research project, and provide specific training in presentation and writing skills. Productivity expectations were similar between structured and nonstructured programs. Forty percent of structured programs had > 20% of trainees with a publication in the last 2 years compared with 14% of departments with unstructured programs (difference, 26%; 99% confidence interval [CI], 8%–51%; $P = 0.01$). The percentage of programs that had research rotations for ≥ 2 months was not different between the structured and the nonstructured programs. A research rotation of >2 months did not increase the percentage of residents who had published an article within the last 2 months compared with a research rotation of <2 months (difference, 13%; 99% CI, 10%–37%; $P = 0.14$). There was no difference in the percentage of faculty involved in research in structured compared with unstructured research education. In programs with <20% of faculty involved in research, 15% reported >20% of residents with a publication in the last 2 years compared with 36% in programs with >20% of faculty involvement (difference, 21%; 99% CI, -4% to 46%; $P = 0.03$).

CONCLUSIONS: Our findings suggest that structured residency research programs are associated with higher resident research productivity. The program duration and the fraction of faculty in resident research education did not significantly increase research productivity. Research training is an integral component of resident education, but the mandatory enhancement of resident research education will require a significant change in the culture of academic anesthesiology leadership and faculty. (Anesth Analg 2013;116:205–10)

It has been suggested by Reeves and Greene¹ that “without research the profession of anesthesiology is in danger of becoming a trade union.” However, to conduct

meaningful research that is capable of generating funding, investigators require substantive training in research methodology. Kitz and Biebuyck² have stated that “teaching and training when not continually enriched by the leaven of research become flat and unimaginative, and eventually, fixed in outmoded concepts.” In an editorial several years ago, research in anesthesiology was referred to as “the road not yet taken,” and the leadership was urged to find creative ways to promote research training programs.³ In addition, we were informed that the status of anesthesiology in the medical community was at risk if training in research was not enhanced, and it was advocated that research

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*ACGME Program Requirements for Graduate Medical Education in Anesthesiology Available at: http://www.acgme.org/acWebsite/downloads/RRC_progReq/040_anesthesiology_f07012011.pdf

Table 1. U.S. System for Anesthesiology Resident Training

	Roles and responsibilities
Accreditation Council for Graduate Medical Education Residency Program Directors	Accreditation body for all post-MD medical training programs within the United States; establishes standards and guidelines
American Board of Anesthesiology	Design, implementation, and supervision of an educational program that educates residents in each of the Accreditation Council for Graduate Medical Education competency areas Examination and certification of physicians who complete anesthesiology training an accredited program in the United States

experience should be integrated into the resident curriculum and spread over Clinical Anesthesia year 1 through Clinical Anesthesia year 3 of training.⁴ The Accreditation Council for Graduate Medical Education (ACGME) requires accredited U.S. anesthesiology programs to facilitate scholarly activity during residency training, but the guidelines are not well defined and are open to individual interpretation of the program chair and residency program director (PD⁴; Table 1).

The status of research education in anesthesiology residency programs in the United States has never been documented, and the number of programs with a structured curriculum for resident research training is unknown. In addition, as there are no specific guidelines for research education for anesthesiology residents, we sought to characterize the differences in programs reporting a structured curriculum with those that did not. We hypothesized that a larger percentage of residents in programs with structured residency research education would produce a peer-reviewed publication compared with programs that lacked a structured program. We also hypothesized that the duration of the research rotation would correlate with resident productivity and that greater research productivity would be associated with a higher percentage of faculty involved in research.

METHODS

The study was approved by the IRB of Northwestern University, and the requirement for written informed consent was waived by the IRB. All 131 anesthesiology residency PDs identified using the ACGME database of accredited US residency training programs were contacted to participate in the study between October 2010 and March 2011. The survey instrument was developed by merging topics derived from earlier surveys and was created using Survey Monkey software (Survey Monkey Inc., Portland, OR).^{5,6} Pilot testing of the questions was not performed because of the limited sample available (U.S. PDs) and because the questions used in collecting the demographic data and the PDs' evaluation of the program characteristics had been used in previous surveys.

The survey consisted of 46 questions organized into sections by topics as shown in the online data supplement (see Supplemental Digital Content 1, <http://links.lww.com/AA/A471>). The topics addressed by the survey were department demographic information, the extent of faculty research activity, research resources and research funding in the department, the characteristics of resident research education, and resident research productivity. The PD's estimation of departmental support for resident research, the barriers to resident research education, and the role of research rotations were also assessed. The elements of structured programs were addressed in questions 6 to 8 of the survey.

The questions were formatted as multiple choice, yes–no, or 5-point Likert scales (strongly agree to strongly disagree).

To maintain confidentiality, survey responses were anonymous and were not linked to the e-mail address of the respondents. Participation was also solicited by follow-up e-mail and direct mailing reminders to encourage maximal participation. To prevent duplicate submissions, on the repeat mailings, the PDs were asked to complete the survey only if they had not already done so.

The primary outcome was resident research productivity assessed as the percentage of residents that had published an article in a peer-reviewed journal in the previous 2 years. Programs were grouped into those with a reported and those without a reported structured resident research education program.

The primary outcome was compared between structured and nonstructured program groups using the Fisher exact test. The effect of duration of the research rotation on the primary outcome was evaluated for programs with a duration < 2 months compared with those with a duration ≥ 2 months. The effect of proportion of faculty involved in research on the primary outcome was evaluated for programs with < 20% or > 20% of faculty involved in research. As a secondary analysis, we evaluated differences in programs that classified themselves as structured compared with those that reported their program as not structured with respect to characteristics and expectations of residency research, adequacy of available resources, and barriers to resident research education. Data are presented as counts and percentages of responses. All reported *P* values are 2-sided. *P* < 0.01 was required to reject the null hypothesis and to account for multiple comparisons. Confidence intervals (CIs) for differences in proportions are reported at 99%. Data were analyzed using R version 2.14.1, release date December 22, 2011 (The R Foundation for Statistical Computing, Vienna, Austria; <http://www.r-project.org>).

RESULTS

Of 131 PDs, 96 responded to the survey, for a response rate of 73%. Thirty-two percent of PDs reported a structured research education program that included a rotation devoted to research. Most programs (66%) provided some resident research education, although these programs were not structured, and 2% of the programs provided no research education during residency.

Primary Analysis

Forty percent of departments with structured programs had > 20% of trainees with a publication in the last 2 years, while 14% of departments with unstructured programs

had >20% of trainees with a publication in the last 2 years (difference, 26%; 99% CI, 8%–51%; $P = 0.01$). The percentage of programs that had research rotations for ≥ 2 months was not different between the structured and the nonstructured programs. A research rotation of >2 months did not increase the percentage of residents who had published an article within the last 2 months compared with a research rotation of < 2 months (difference, 13%; 99% CI, –10% to 37%; $P = 0.14$).

Sixty-four percent of programs had <20% of faculty members who were involved in research, 26% reported 21% to 40%, and 7% reported 41% to 60% of faculty-conducted research. One program reported that 61% to 80% of the faculty was involved in research and one reported 100% faculty involvement. There was no difference in the percentage of faculty involved in research in programs with structured research education and those without structured training (Table 2); however, in programs with <20% of faculty involved in research, 15% of PDs reported >20% of residents with a publication in the last 2 years compared with 36% in programs with >20% of faculty involvement (difference, 21%; 99% CI, –4% to 46%; $P = 0.03$).

Secondary Analysis

There were differences in the characteristics of structured programs compared with nonstructured programs (Table 2). A higher percentage of structured programs had research

curricula and reported resident participation in a research project, training in presentation and writing skills, and availability of research assistance. Nonetheless, there was no significant difference in resident expectations between the programs with structured versus those with nonstructured training. There was no difference between the 2 groups in the selection of trainees' choice of an academic career ($P = 0.68$).

Responses to questions regarding the research resources in departments that had structured programs and those that did not are shown in Table 3. Thirteen percent of PDs with structured programs disagreed with the adequacy of the department research network compared with 49% of PDs with nonstructured programs (difference, –36%; 99% CI, –14% to –58%). There were no differences in the reported availability of faculty skill in research, faculty nonclinical time, research resources, or chair support between the structured and the nonstructured groups.

PDs with and without structured research education programs reported their perceived barriers to resident research education, as shown in Table 4. The largest percentage difference was between PDs with and without a structured program with regard to the lack of a curriculum serving as a barrier to resident research education. The other important finding was a difference of 28% (99% CI, 14%–42%) in disagreement between the PDs' perceived lack of chair support for resident research. There was a significant association between the lack of a research education curriculum

Table 2. Characteristics, Expectations, and Outcomes of Structured and Nonstructured Resident Research Programs

	Structured (n = 31)	Nonstructured (n = 65)	Difference (99% confidence interval)	P
Program characteristics				
No. residents				0.15
1–10	7	1	6 (–6 to 18)	
11–20	21	11	10 (–11 to 31)	
>20	72	88	–16 (–39 to 7)	
Faculty involved in research				0.65
$\leq 20\%$	60	66	–6 (–33 to 21)	
>20%	40	34	6 (–21 to 33)	
Program duration				0.50
<2 mo	48	58	–10 (–38 to 18)	
≥ 2 mo	52	42	10 (–18 to 38)	
Resident research curriculum	93	58	35 (15 to 55)	0.001
Resident participation research project	94	48	46 (27 to 65)	<0.0005
Didactic research topics	81	66	15 (–8 to 38)	0.14
Presentation skill training	81	48	33 (8 to 57)	0.002
Scientific writing	68	28	40 (14 to 66)	<0.0005
Department funding for resident projects	85	67	18 (–4 to 40)	0.12
Departmental research assistant available for resident projects	79	41	38 (13 to 62)	0.001
Expectations				
Journal club presentation	58	49	9 (–19 to 37)	0.51
Department educational presentation	58	57	1 (–27 to 28)	0.92
National meeting presentation	77	58	19 (–0.6 to 44)	0.11
Manuscript preparation and submission	55	35	20 (–8 to 47)	0.08
Outcomes				
Percentage of residents with publication in last 2 years				0.005
<20	60	86	–26 (–51 to –1)	
>20	40	14	26 (8 to 51)	
Percentage of residents entering academic practice in last 2 years				0.68
<20	33	42	–9 (–36 to 18)	
21–40	37	38	–1 (–28 to 26)	
>40	30	20	10 (–15 to 35)	

Data presented as percentage of respondents.

Table 3. Perceived Department Research Resources Reported by Program Directors of Structured Versus Nonstructured Residency Research Programs

		Structured (n = 31)	Nonstructured (n = 65)	Difference (99% confidence interval)	P
Chair actively supports resident research	Strongly agree/agree	94	82	12 (-4 to 28)	0.01
	Neutral	0	15	-15 (-26 to -3)	
	Strongly disagree/disagree	6	3	3 (-9 to 15)	
Faculty skilled in research	Strongly agree/agree	81	71	10 (-13 to 33)	0.29
	Neutral	16	14	2 (-18 to 22)	
	Strongly disagree/disagree	3	15	-12 (-26 to 2)	
Adequate research network	Strongly agree/agree	58	35	23 (-4 to 50)	0.005
	Neutral	29	16	13 (-11 to 37)	
	Strongly disagree/disagree	13	49	-36 (-14 to -58)	
Adequate research resources	Strongly agree/agree	55	25	30 (3 to 57)	0.05
	Neutral	23	25	-2 (-26 to 22)	
	Strongly disagree/disagree	22	50	-28 (-53 to -3)	
Faculty nonclinical time allocation	Strongly agree/agree	52	29	23 (-4 to 50)	0.10
	Neutral	13	22	-9 (-29 to 11)	
	Strongly disagree/disagree	35	49	-14 (-41 to 13)	

Data reported as percentage of respondents.

Table 4. Perceived Barriers to Residency Research Education Reported by Program Directors

	Response	Structured (n = 31)	Nonstructured (n = 65)	Difference (99% confidence interval)	p
Accreditation Council for Graduate Medical Education clinical training requirements	Strongly agree/agree	77	76	1 (-23 to 24)	0.22
	Neutral	10	18	-8 (-26 to 10)	
	Strongly disagree/disagree	13	6	7 (-10 to 24)	
Accreditation Council for Graduate Medical Education requirement on scholarly activity	Strongly agree/agree	68	46	20 (-6 to 47)	0.06
	Neutral	13	27	-14 (-35 to 7)	
	Strongly disagree/disagree	19	27	-8 (-31 to 15)	
Lack of resident research curriculum	Strongly agree/agree	13	45	-32 (-57 to -7)	<0.0005
	Neutral	13	35	-22 (-44 to 0)	
	Strongly disagree/disagree	74	20	54 (30 to 78)	
Lack of chair support for resident research	Strongly agree/agree	0	6	-6 (-13 to 2)	<0.0005
	Neutral	0	22	-22 (-25 to -9)	
	Strongly disagree/disagree	100	72	28 (14 to 42)	
Lack of department funds	Strongly agree/agree	32	51	-19 (-45 to 8)	0.08
	Neutral	29	17	12 (-12 to 36)	
	Strongly disagree/disagree	39	32	7 (-20 to 34)	
Lack of technical research support	Strongly agree/agree	36	52	-16 (-43 to 11)	0.23
	Neutral	16	22	-6 (-27 to 15)	
	Strongly disagree/disagree	48	26	22 (-5 to 49)	
Lack of faculty mentors	Strongly agree/agree	39	52	-13 (-41 to 14)	0.04
	Neutral	16	22	-6 (-27 to 15)	
	Strongly disagree/disagree	45	26	19 (-8 to 46)	
Lack of faculty interest in resident research program	Strongly agree/agree	45	55	-10 (-38 to 18)	0.12
	Neutral	29	17	12 (-12 to 36)	
	Strongly disagree/disagree	26	28	-2 (-27 to 23)	
Faculty nonclinical time allocation	Strongly agree/agree	42	56	-14 (-42 to 14)	0.08
	Neutral	23	15	8 (-14 to 30)	
	Strongly disagree/disagree	35	26	9 (-17 to 35)	
Lack of resident interest	Strongly agree/agree	42	55	-13 (-41 to 15)	0.04
	Neutral	45	25	20 (-7 to 47)	
	Strongly disagree/disagree	13	20	-7 (-27 to 13)	
Lack of resident research time	Strongly agree/agree	35	45	-10 (-37 to 17)	0.03
	Neutral	23	29	-6 (-30 to 18)	
	Strongly disagree/disagree	42	26	16 (-11 to 43)	

Data reported as percentage of respondents.

($\rho = 0.40$; 99% CI, 0.14–0.62; $P < 0.0005$) and the PDs' reported disagreement with the chair support of resident research education. There was a significant negative association between the reported chair support for resident research as a department resource and the PDs' report of the department chair support as a barrier to resident

research education ($\rho = -0.71$; 99% CI, -0.52 to -0.85; $P < 0.0005$). There were also significant correlations between the reported chair's support as a barrier to implementation of research education and the perception of a lack of faculty mentors ($\rho = 0.47$; 99% CI, 0.22–0.70; $P < 0.0005$), lack of faculty nonclinical time ($\rho = 0.42$; 99% CI, 0.15–0.62;

$P < 0.0005$), lack of faculty interest ($\rho = 0.28$; 99% CI, 0.02–0.51; $P < 0.006$), lack of resident research time ($\rho = 0.32$; 99% CI, 0.03–0.55; $P < 0.002$), lack of department funds ($\rho = 0.37$; 99% CI, 0.11–0.60; $P < 0.0005$), and lack of technical support ($\rho = 0.35$; 99% CI, 0.08–0.56; $P < 0.001$).

Ninety percent of the PDs with structured programs reported that research constituted an integral part of residency training compared with 60% (difference, 30%; 99% CI, 10–51; $P = 0.003$) of those without structured programs. Fifty-two percent of PDs agreed that the ACGME must insist on research training, and whereas 79% of PDs believed that residency programs should offer research rotations, only 19% thought that research should be a required rotation.

DISCUSSION

The important finding of this study is that in anesthesiology, as with other subspecialties, residents in the programs with structured research education were significantly more productive than those in programs without structured research training.⁷ Most research rotations in the structured programs were >1 month, but there was no difference in productivity when the program duration was stratified at 2 months. This finding is consistent with that found in urology residents that increasing dedicated research time from 3 to 6 months did not result in an increase in the number of articles submitted.⁸ In the aforementioned study, there was an increase in article submission when dedicated research time was increased to 1 year, suggesting that the duration of most anesthesiology resident research rotations is too short to measure an effect of duration of the research rotation.⁸ Resident research productivity was not increased with a higher percentage of faculty involved in research, suggesting that the construct of the program and not the number of faculty involved is a more important factor affecting resident productivity.

Despite the recommendations of mandatory research exposure during residency and extensive research training during compulsory fellowship training, our survey found that currently only 32% of the programs have a structured research education program for residents. The survey revealed several important differences between the programs that had structured resident research education and those that did not. Structured programs were more likely to have an organized curriculum and a requirement for a research project. They included training in scientific writing and oral presentation skills and were more likely to provide support to the resident. Under ideal conditions, a structured program would include a competency-based curriculum, time and support for the development of a research project, and a method of assessment of attainment of the competencies.⁷ The program could take on various forms, either laboratory or clinical science investigation or even secondary assessments such as meta-analysis.

The findings of our survey were similar to those of other specialties that have also demonstrated that comprehensive, structured resident research training enhances research productivity and the number of residents choosing academic careers.^{9–11} Forty percent of the respondents to our survey reported that 40% to 80% of their graduates chose academic careers. Research education develops critical appraisal skills, intellectual curiosity, and a pattern of lifelong learning

that has been associated with a greater likelihood for academic success.^{12–14} Research education has also been shown to result in better clinicians. Internal medicine residents who participated in the Veterans Affairs PRIME Program for research education had better clinical competence scores than their peers who had not participated in the program, and all participants passed their board examination in the first attempt.¹⁵ In addition, the institution of research seminars has been associated with changes in hospital policies that resulted in cost savings and improved quality of patient care.¹⁶ A survey of internal medicine trainees revealed that residents also value research training very highly; 86% of graduates and 66% of senior residents were of the opinion that all physicians should have research experience.¹⁷ It has been shown that residents with prior research experience are more likely to undertake research during residency and should be identified during the interview process; however, anesthesiology PDs consistently rank research experience low in importance among selection criteria in comparison with clinical performance and test scores.^{7,18,19}

Active chairperson support for the resident research education program was reported by more PDs with structured resident research programs. There was a significant correlation between the perception that the lack of chairs support was a barrier to the implementation of resident research education and the perceived lack of faculty nonclinical time and faculty interest as barriers to research education. This was not a surprising finding because the chair may not be directly involved in research education, but the support of the chair is essential for allocation of resources and for promoting faculty participation in resident research education. As of 2003, the ACGME no longer requires the department chair to serve as the residency PD; nonetheless, resident education remains one of the essential elements of the departmental mission and therefore a critical component of the chairperson's overall responsibility. Historically, chairs were appointed based on their record of academic accomplishments and history of funded research and are therefore the ideal candidates for supporting and promoting research and academic pursuits among residents and faculty.²⁰ More recently, it has been demonstrated that search committees tend to value managerial skills more than research accomplishments when selecting anesthesiology chairs and that chairs also view research, scholarship, and federal funding to be less important than business acumen and skills.²¹ Another possible reason for this shortage of chairs with funded research may be that funded researchers lack the operational and leadership skills required to be a chair. In a comparison of anesthesiology and surgical chairpersons, a direct correlation was noted between departmental research performance and the chair's grant funding and publication record, and anesthesiology chairs tended to be ranked lower than their surgical counterparts.²⁰

Seventy percent of respondents reported that research constituted an integral part of residency training and 52% agreed that the ACGME must insist on research education during residency training. However, regardless of the type of resident research training program, the PDs agreed that the current ACGME clinical rotation requirements made it difficult to offer research rotations. A larger proportion (79%) of PDs believed that research rotations should be

offered whereas only a small number (19%) believed that the rotations should be mandatory. Residents are able to spend at least 8 months during their training in research-related activities and still fulfill all the ACGME requirements and be eligible for the American Board of Anesthesiology examination. Furthermore, it has been shown that the implementation of ACGME work hour restrictions, in fact, allowed residents time to develop academic interests and resulted in an increase in resident research publications.²²

Limitations of this study are that the findings represent the views of the PDs and not those of the leadership or faculty at large. However, the assessments of the PDs are more than likely to be accurate because they facilitate the execution of the educational program and have a clear understanding of the impediments to the implementation of a research curriculum. Furthermore, the policies and guidelines they establish are usually a reflection of the opinions of the department membership. We did not assess resident gender or personal factors such as family obligations, leisure activities, and work stress that may have affected resident research productivity. Because the survey was anonymous, there was no way of determining whether there was a difference among responders or if our results demonstrate a selection bias of respondents based on their interest in the topic. It is possible that the data may reflect a bias in favor of programs with research education, but because of the large number of responders and the reported variation in the level of research education in the programs, we feel that the results are a valid representation and therefore can be generalized to our specialty. Resident publication may be affected by other factors such as the participation in a multicenter trial for which they are unlikely to get credit, data validation, or participation in an ongoing study with defined authorship; however, we chose it as a measure of resident research productivity because it has been used by other investigators in this way.²³⁻²⁵

In conclusion, the findings of our survey demonstrate the continued need for enhancement of research scholarship during anesthesiology residency training. Our findings suggest that the support of the chairperson and a structured curriculum are important determinants of resident research education performance as measured by research publications. ■■

DISCLOSURES

Name: Shireen Ahmad, MD.

Contribution: This author helped design and conduct the study, and helped write the manuscript.

Attestation: Shireen Ahmad attests the integrity of the original data and the analysis.

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