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Development and implementation of a sustainable research curriculum for general surgery residents: A foundation for developing a research culture

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ABSTRACT

Background: Different methods to incorporate research training during residency are suggested, however, long-term impact is not studied well. This study reports development of a research curriculum with milestones, a long-term outcome and sustainability, and its impact on the overall departmental research culture.

Methods: The research curriculum that included a research seminar for resident preparation, annual milestones, and structured research mentoring was implemented in our hybrid program in 2012. The research output for five-year period before and after the implementation was evaluated as peer-reviewed publications, presentations, and grant submissions. Further, secondary effects on faculty and medical student research was evaluated.

Results: Following implementation, we observed a significant increase in the number of resident presentations ($p < 0.05$) and higher trends for publications and grant submissions. Medical student research increased significantly in terms of both presentations and publications ($p < 0.05$). Consequently, we observed a significant improvement in the overall department research productivity.

Conclusions: Our resident research curriculum was associated with improved long-term research productivity. It allowed residents to work closely with faculty and medical students leading to more collaboration resulting in an enhanced scholarly environment.

Introduction

In this internet-savvy generation, patients are now more aware of recent scientific developments and thus demand advanced care.[1] Further, through technological developments and increases in evidence-based practice for care delivery, research has become the foundation of future medical practice. The Accreditation Council for Graduate Medical Education (ACGME), therefore, included research training and requirements in surgery residency and mandated resident participation in scholarly activity.[2,3] Since scholarly activity during a busy general surgery residency is a challenge for many residents, the ACGME requires surgery residency programs to "establish and maintain an environment of inquiry and scholarship with an active research component."[2] There are many known barriers, however, that still exist in completing scholarly work during residency. These include a lack of training time, infrastructure, funding sources, access to dedicated time off for research, and, for some residents who do not plan an academic career, a lack of enthusiasm.[4–6]

To improve research interest and participation of residents, however, a variety of guidelines and research curricula have been used in a variety of specialties, including general surgery.[4–8] These curricula include simple guidelines, structured programs or reward programs. For general surgery residency, the impact of a structured research curriculum with specific annual milestones, have not been evaluated for long-term outcomes and sustainability. Moreover, impact of such a resident curriculum on overall productivity and development of a research culture in the department has not been assessed. Our work, therefore, focuses on development of a research curriculum and milestones and assessing its implementation and sustainability over a five-year period in our hybrid; i.e., a community hospital-based, university-affiliated program.

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This study also evaluated the secondary effects of this curriculum on overall departmental research culture, including the changes in medical student and faculty research productivity.

Materials and methods

Research curriculum and implementation

During the academic year 2011–2012, resident participation in research activity was made mandatory for all our postgraduate year (PGY) 1–3 residents. This requirement was followed by a research curriculum and milestones that were developed and transitioned into the program during the 2012–2013 academic year. This curriculum included the following specific components:

1. *Research Seminar for Resident Preparedness*: A half-day research seminar was designed and conducted to prepare all residents for research. This included didactic lectures and hands-on sessions on a broad range of topics such as framing a research question, mentor selection, literature review, research methods, and research compliance (i.e., Institutional Review Board process, and data security and safety). Each lecture or session was conducted by a subject matter expert. For example, we invited a biostatistician to discuss different research methods and statistics while the literature review session was led by an experienced librarian. In the first year of implementation, this seminar was designed and mandated for all our PGY 1-3 residents. Subsequently, the seminar became mandatory for all incoming surgery interns in preparation to initiate a research project starting PGY 1.
2. *Research Meetings*: Monthly departmental research meetings were used as a platform for residents to share their research ideas and preliminary study design to get feedback from faculty members and other experts. The meetings were designed for residents to get clarification on their projects and provide concrete next steps.
3. *Research Mentoring*: A full-time PhD Research Director was hired to provide one-to-one research mentoring to residents and to track their progress through research milestones. The research director oversaw compliance aspects of research so other surgery faculty could focus on the scholarly projects and mentoring. The research curriculum included mentoring, frequent meetings with their research advisor, and help with statistical analysis.
4. *Annual Milestones*: Annual milestones were created (Table 1) to keep residents on track, give them guidelines for initiating and completing their research projects, and allow them to mentor junior residents during their PGY 5.

Data collection and analysis

In this study, total research output of residents, medical students, and faculty was measured during the five-year period prior to (2007–2011) and the five-year period after (2013–2017) implementation of the research requirement and curriculum in 2012. Each year 8 categorical PGY-1 residents were accepted to our program during the study period. Data were obtained from departmental and online research databases. Research output was classified as publications (peer-reviewed journal articles and book chapters), presentations (poster and podium at local/regional/national/international meetings), and grant submissions. Each project that contained multiple general surgery residents was counted only once towards the total number of publications, presentations, and grants. Although the focus of this study was on resident research output, secondary effects of the research curriculum were also assessed, specifically research output of faculty and medical students in the Department of Surgery. The research output of medical students and faculty was classified in the presentation categories and publications similarly to that of residents. If the project contained a resident, student, and a faculty member, then it was counted once in each category towards the total number of publications and presentations. The criteria developed by the International Committee of Medical Journal Editors (ICMJE)[9] were used to determine the authorship of contributors. The data were analyzed using the independent samples *t*-test. The study was approved as exempt by the Wright State University's Institutional Review Board (IRB).

Table 1
Annual curricular milestones.

Post-Graduation Year	Core Requirements
Year 1	Meeting with research director Complete CITI training Identification of research mentor and project Present idea at the departmental research meeting
Year 2	Institutional Review Board (IRB) application submission and approval Data collection and analysis Abstract submission
Year 3	Abstract submission/conference presentations Additional data collection, if needed Manuscript writing
Year 4	Manuscript submission Manuscript revision as needed Final publications
Year 5	Mentor junior residents or students on their research related activities

Results

Annual milestones, presented in Table 1, were designed so residents could complete their research project by PGY 4. The productivity of the general surgery residents before (2007–2011) and after (2013–2017) implementation of the research requirement and curriculum is presented in Table 2. Before the implementation there were a total of 15 resident presentations compared to 123 in the five years after the implementation, representing a significant increase ($p < 0.01$) and change of 720%. Resident publications, on the other hand, increased from 22 to 35 (increase of 59%), which was not statistically significant ($p > 0.05$). After implementation, there were four resident projects that led to resident research grant submission compared to no submissions before implementation; two were funded. Table 3 illustrates the faculty and medical student output during the five-year period before compared to the five-year period after implementation of the requirement, curriculum, and milestones. There was a significant increase in medical student presentations and publications, as well as faculty presentations after implementation of the research program ($p < 0.05$).

Discussion

Research experiences during residency enable residents to learn scientific problem-solving skills and evidence-based practices. Multiple studies have investigated strategies for improving resident research in various clinical specialties, including general surgery.[4,5,7,8,10–12] The current literature, however, lacks key information including clearly defined objectives, sustainability, and feasibility of a research curriculum,[10] which was the primary objective of this work. Moreover, this study reports the secondary

Table 2
Resident research output.

Category		Total	Mean	Median	SD	p-value
No of categorical Residents	Before	185	37.0	37.0	N/A	N/A
	After	203	40.6	40.0		
No of residents in a dedicated 1-2y research	Before	10	2.0	2.0	N/A	N/A
	After	14	2.8	3.0		
No. of residents participated in mandatory research	Before	0	0.0	0.0	N/A	N/A
	After	183	36.6	40.0		
Presentations at National meetings	Before	14	2.8	3.0	1.30	0.056
	After	64	12.8	9.0	8.41	
Presentations at Local meetings	Before	1	3.0	0.0	0.45	0.008
	After	59	9.0	9.0	5.36	
Total Presentations	Before	15	3.0	3.0	1.58	0.002
	After	123	24.6	25.0	10.24	
Publications	Before	22	4.4	4.0	1.82	0.263
	After	35	7.0	7.0	4.47	
Grant Submission	Before	0	0.0	0.0	N/A	N/A
	After	4	0.8	1.0	N/A	

Table 3
Departmental research output.

Category		Total	Mean	Median	SD	p-value
Faculty Presentations: National	Before	40	8.0	8.0	1.58	0.027
	After	119	23.8	22.0	13.01	
Faculty Presentations: Local	Before	1	0.2	0.0	0.45	0.023
	After	81	16.2	21.0	10.03	
Faculty Presentations: Total	Before	41	8.2	8.0	1.30	0.025
	After	200	40.0	34.0	20.51	
Faculty Publications	Before	64	12.8	14.0	4.15	0.197
	After	83	16.6	16.0	4.39	
Medical Student Presentations: National	Before	2	0.4	0.0	0.55	0.019
	After	42	8.4	8.0	6.11	
Medical Student Presentations: Local	Before	0	0.0	0.0	0.0	0.035
	After	50	10.0	14.0	7.11	
Medical Student Presentations: Total	Before	2	0.4	0.0	0.55	0.030
	After	92	18.4	23.0	12.16	
Medical Student Publications	Before	8	1.6	2.0	1.14	0.024
	After	18	3.6	4.0	1.14	

impact of a structured and sustainable research curriculum on faculty and medical student research.

Research during surgery residency is difficult due to time limitations. Further, the research training that incoming residents have varies significantly based on their background and interests, so they require structured training and research education.[4,12] Therefore, a structured research curriculum with annual milestones was developed that helped residents divide their scholarly project into separate tasks. Although previous studies showed short-term benefits of research programs and increased research output,[12–14] our results showed that a well-developed structured research curriculum could be effective in increasing research productivity and sustainable over a longer period of time. For example, we observed increased numbers of presentations, publications and grant submissions from residents. This demonstrates that residents were successful in achieving their milestones, especially until PGY 3 in terms of submission of abstracts and presentations. The number of resident publications, although 59% higher after curriculum implementation, were not comparable to the increase in the number of presentations as observed earlier.[8,13] The fact that manuscript publication requires extensive effort and time could have limited senior residents in achieving this milestone. We believe that providing more help to these residents in the area of manuscript writing and closely assessing their writing progress through the milestones could further improve the number of publications in our program. According to anecdotal feedback we received from our residents, a structured approach in dividing a research project into different tasks gave them clear direction, made their research project more manageable, and enhanced their overall experience. Further investigation is needed to elucidate the individual effect of the addition of a full-time research director on the resident's research productivity. Since not inhibited by any clinical duties, the research director was able to closely mentor and monitor research projects as observed by Sabir and others[13] in their program.

The research curriculum for residents appears to have had a positive impact not only for the residents, but also the scholarly activity of the department overall. Increasing the resident interest in scholarly activity is believed to have provided increased incentive for faculty surgeons to pursue research projects as well. Moreover, the increased number of projects has also created more opportunities for medical students to get involved, leading to increased research productivity of medical students. These changes have resulted in a culture shift in our program towards a more scholarly environment. Participating in research during general surgery residency helps increase the number of residents going into academic surgery[15,16] and continued research and publication of non-academic surgeons.[17] Similarly, we believe that getting medical students involved in research projects with general surgery residents may lead to increased interest in further research endeavors, and possibly in pursuing a career in the field of academic general surgery.

Our study was conducted at a single institution; consequently, the caution should be exercised in generalizing the results to other

residency programs and clinical settings. Additionally, implementing a research curriculum, especially the addition of a research director requires financial investment and resources by the affiliated institution, which may not be available to all programs.

One of the strengths of this study is that it was conducted over a five-year period after curriculum implementation, showing longer-term outcomes than the previous literature. This confirms sustainability in the design and broad participation by residents, faculty and medical students. Further, there was no significant change in the department during this period. The type and number of faculty, resident research background and availability of optional research years remained stable. The number of residents, the number of preselection publications and other resident demographics did not change significantly over the years during the study period. The majority of our residents did not have significant research experience prior to joining our program. Thus, such factors had minimal to no impact on the data and results.

Conclusion

Increasing resident participation in research not only meets ACGME requirements, but helps develop scientific inquiry useful for lifelong learning, improved clinical performance,[18] and increased the likelihood of pursuing a career in academic surgery.[15,16] Implementing these milestones and the educational curriculum in other residency programs is a viable strategy for assisting residents in completing scholarly activity. More mentoring and help with manuscript writing could further increase the number of peer-reviewed publications by residents. The proposed curriculum was associated with improved research productivity of residents and increased productivity of faculty and medical students, creating an overall positive change in the research culture of our general surgery department.

Meeting presentation

This work was presented at the Association for Program Directors (APDS) annual meeting, May 3–5, 2018 (Austin, TX).

Declaration of competing interest

Authors have nothing to disclose.

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