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SHORT COMMUNICATIONS

Impact of a 5-Year Research-Oriented Medical School Curriculum on Medical Student Research Interest, Scholarly Output, and Career Intentions

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Abstract
The impact of research experiences on medical student career intentions is unclear. Short-term outcomes from the Cleveland Clinic Lerner College of Medicine's five-year research curriculum show that most medical students can generate scholarly work during medical school and sustain a high level of interest in research as a career option.

Introduction
One of the main goals driving the establishment of the Cleveland Clinic Lerner College of Medicine of Case Western Reserve University (CCLCM) in 2002 was to incorporate comprehensive research training into medical education in order to encourage medical students to become physician investigators.[1] The five-year CCLCM program integrates research activities and learning experiences that expose students equally to basic, laboratory-based and to clinical, human subjects research. The first two summers form the core of research education as each student participates in one basic and one clinical research experience. During these summers, students complete short-term research projects that are accompanied by coursework and journal clubs to provide exposure to and analysis of core concepts in each field. In Years 1 and 2, weekly seminar series complement the research curriculum, and these continue on a biweekly basis during Year 3 and monthly during Years 4 and 5. Subject to approval by the Research Education Committee (REC), students choose a research mentor and topic area for their required thesis project that is started during year 3 or 4. Students are encouraged, but not required, to complete core clinical rotations prior to beginning their year-long thesis research. An overview of the program and details of the design and implementation of the research curriculum have been described previously.[2]

Given the curriculum's balanced approach to research, we examined the proportion of students who chose to perform basic/translational or clinical research projects for their thesis work, and determined the extent to which these choices correlated with students' scholarly output, career intentions, and research interests.

Participants included 112 of 120 CCLCM graduates from four class cohorts (2009-2012) who consented to release their program evaluation data for research purposes. Students completed an in-house graduation questionnaire (GQ) designed by Curricular Affairs faculty to elicit student feedback about program outcomes and students' career interests not collected elsewhere. Data on thesis category classification were derived from a form developed by the REC and completed by thesis chairs when assessing student performance during the formal thesis defense. Classification coding was confirmed by a member of the REC who read each thesis abstract. Clinical research was defined as patient-based or public health research, while

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laboratory-based projects were deemed basic or translational depending on the REC member's judgment of the project's direct relevance to human disease. A classification of "other" was included for projects focusing on bioinformatics, education, or behavior research.

We discovered that 38% of theses from CCLCM graduates were in clinical research while 25% were in basic science, 33% in translational science, and 4% classified as other (Table 1). This distribution shows that over 50% of CCLCM's graduates chose to complete basic/translational thesis projects, which is much higher proportionally than the 21-37% of medical students choosing laboratory-based research projects reported by other medical school programs requiring student research.[3,5]

We used self-reports from graduating students to identify the scholarly products associated specifically with the research thesis project (Table 1). The majority of students reported generating some type of scholarly product, with only 8% of students reporting no publications, abstracts, or posters. Once again, we note that the percentage of students with scholarly products is larger than reported by other programs with research requirements.[3-5] Furthermore, we did not detect a correlation between the category of research (e.g. basic, clinical) and the number of publications, abstracts, or posters (Table 1).

Graduates' Self-reports of Scholarly Products	**Number of Students (%) listing at least one scholarly product type or none**				*All Theses (n = 112)*
	Basic Science (n = 28)	*Translational Science (n = 37)*	*Clinical Science (n = 43)*	*Other (n = 4)*	
Publication where you are first author	16(57)	21(57)	25(58)	3(75)	65(58)
Publication where you are co-author	10(36)	16(43)	19(44)		45(40)
Abstract published in proceedings	18(64)	26(70)	23(53)	4(100)	41(63)
Oral presentation at conference	14(50)	12(32)	21(49)	1(25)	71(43)
Poster at conference	20(71)	30(81)	32(74)	3(75)	85(76)
No scholarly work	3(11)	2(5)	4(9)		9(8)

***Table 1**: CCLCM graduates' self-reports of scholarly products by type of thesis topic. Note that percentages do not sum to 100% as most graduates self-reported multiple products.*

An important goal of our research-focused program is to foster students' interest in research to encourage them to pursue careers as physician investigators. As a short-term measure of this outcome, we used GQ data to examine relationships among students' career plans, research intentions, and category of their thesis research (Table 2 in Appendix). Of note, a majority of the students (80%) expressed moderate or high interest in pursuing clinical research, with a preference for human subject research over analysis of large databases. Interest in clinical research was high regardless of the category of thesis research. By contrast, only 14% of students who completed clinical research theses were moderately or very interested in pursuing basic science research. This low level of interest stood out in stark contrast with the much larger proportion of students with basic or translational theses, who remained interested in performing basic science research. Fewer than half of CCLCM graduates wanted only limited future involvement with research, while less than 15% planned to pursue careers in research or administration that excluded patient care.

Many medical schools in the United States and Canada have introduced required or optional research activities in response to the widespread concern regarding the dearth of physician investigators. However, few studies have linked students' research products to their career intentions or research interests.[6] Although our outcomes are extremely short-term, preliminary evidence suggests that our research curriculum

encourages students to develop and maintain diverse research interests as evidenced by the variability in their research thesis categories. Additionally, most students generate, based on their self-reports, more scholarly products after a full year of research than reported elsewhere.[4] Most enticing is the fact that the majority of our students, at graduation, continue to express a high degree of interest in continuing to conduct research. This is perhaps not surprising considering the fact that CCLCM is a highly selective medical school program that requires its matriculants to have previous research experience and articulate an interest in research. However, it is encouraging to note that CCLCM's research curriculum is, at the very least, not suppressing students' interest in biomedical research careers.

A major limitation of this study is the assumption – or more accurately the hope – that students' current career plans will have an impact on their actual career trajectories in the longer term. Longitudinal follow-up is needed and in place to track graduates' future career development.

Another limitation is the fact that student productivity is based on self-reports. More time is needed to validate fully the scholarly work produced by students, with particular emphasis on peer-reviewed publications. Finally, it is clear that students' choice of thesis topic may be influenced by factors other than their research interests, such as availability of mentors, availability of funding, or desire to improve their applications for competitive clinical specialties.

The CCLCM program is designed to accept students who are interested in research and to place them in an environment where research is considered invaluable. The curriculum is designed to foster and expand research interest by exposing students to the many varieties of research that can impact on clinical care. The importance of research is systematically reinforced throughout the five years of the program. The result is that students retain their interest in research and plan to make it part of their professional practice.

Keywords

Research Interest, Scholarly Output, Career Intentions

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Appendix

Graduates' Career Intentions by Thesis Category	% of Students Moderately or Very Interested				
	Basic Science (n = 28)	*Translational Science (n = 37)*	*Clinical Science (n = 43)*	*Other (n = 4)*	*All Theses (n = 112)*
Conducting…					
• Research with human subjects (clinical trials, health outcome studies, etc.)	71	81	84	100	80
• Research using large databases (Medicare databases, US census data, etc.)	36	51	70	75	55
• Basic science research (animal studies, drug development, tissue sample research, etc.)	54	43	14	0	33
Working…					
• Full-time as a clinical science researcher AND as a physician seeing patients	82	89	88	100	88
• Full-time as a basic science researcher AND as a physician seeing patients	64	54	19	0	41
• Full-time with a focus on clinical care of patients and limited involvement with research	32	38	47	50	40
• Full-time in health care administration without a clinical practice (administrator, association or academic executive, business executive)	7	5	21	50	13
• As a research scientist in non-academic setting (industry, federal agency, state agency)	14	11	7	50	12
• Full-time as a researcher BUT NOT as a physician seeing patients	11	8	5	25	8

Table 2*: Relationship between career intentions of CCLCM graduates (n=112) and type of research thesis topic. Graduates used a 5-point scale, ranging from 1 (Not at all interested) to 5 (Very interested) to rate their career intentions and research interests.*