

The changing face of academic general surgery in Canada: a cross-sectional cohort study

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Background: Little is known regarding the research and training expectations faced by modern general surgery graduates interested in pursuing academic surgical careers. In this study, we describe the changing face of the Canadian academic general surgeon by outlining the in-residency research productivity and postresidency clinical and academic training trends over time.

Methods: Our cross-sectional cohort included Canadian academic general surgeons, defined as those with a university-affiliated appointment as assistant, associate or full professor. Academic surgeons were identified by the Royal College of Physicians and Surgeons of Canada online directory as well as directories of university and hospital websites. Data points included institution, faculty appointment and rank, graduation year, graduate education, fellowship training and research productivity.

Results: Our cohort included 417 surgeons from 17 Canadian academic institutions. The majority of surgeons were male (72.9%), had completed at least 1 fellowship (72.9%) and had had some form of supplementary research training (51.8%). Surgeons in the cohort had practised a median of 17 (10–27) years. The mean number of total and first-author publications for the participants in this study has increased consistently each decade before the 1980s ($p < 0.001$). The proportion of academic surgeons completing graduate degrees has increased steadily every decade, reaching a peak of 61.5% for surgeons graduating in the 2010s.

Conclusion: The Canadian academic surgeon is becoming increasingly productive in research during residency and is pursuing higher levels of graduate education and more fellowships than ever before. These changes probably correspond to an evolving employment and research funding landscape that places tremendous academic pressure on surgical trainees.

Contexte : On en sait peu sur les attentes en matière de recherche et de formation auxquelles doivent aujourd'hui répondre les diplômés en chirurgie générale qui souhaitent poursuivre une carrière professorale dans le domaine. Nous décrivons ici l'évolution du parcours des professeurs de chirurgie générale canadiens à partir des tendances de productivité en recherche durant la résidence et de formation théorique et pratique après la résidence.

Méthodes : Nous avons formé une cohorte transversale de professeurs de chirurgie générale adjoints, agrégés et titulaires affiliés à un établissement universitaire canadien à partir du répertoire en ligne du Collège royal des médecins et chirurgiens du Canada ainsi que des répertoires figurant sur les sites Web des universités et des hôpitaux. Les variables examinées comprenaient l'établissement, le poste et le rang occupés, l'année d'obtention du diplôme, les études supérieures, la formation postdoctorale et la productivité en recherche.

Résultats : La cohorte était constituée de 417 chirurgiens représentant 17 établissements universitaires canadiens. La majorité d'entre eux étaient des hommes (72,9%), avaient effectué au moins 1 stage postdoctoral (72,9%) et avaient reçu une formation supplémentaire en recherche (51,8%). Le nombre d'années de pratique médian était de 17 (10 à 27) ans. Le nombre moyen de publications des membres de la cohorte à titre de coauteur et d'auteur principal a augmenté chaque décennie jusqu'aux années 1980 ($p < 0,001$). Le pourcentage des professeurs de chirurgie ayant un diplôme d'études supérieures a aussi augmenté de façon constante d'une décennie à l'autre, pour atteindre 61,5 % dans les années 2010.

Conclusion : Les professeurs de chirurgie canadiens font de plus en plus de recherche durant la résidence, sont plus nombreux à poursuivre des études à des niveaux supérieurs et effectuent plus de stages postdoctoraux que jamais. Ces changements s'expliquent probablement par l'évolution du marché de l'emploi et du financement en recherche, 2 facteurs qui exercent une pression énorme sur les chirurgiens en formation.

Recognizing that technical advances, increasing subspecialization and resource limitations have contributed to significant changes to surgical practice,¹ a national Task Force on the Future of General Surgery recently completed a project to (a) understand the current practice landscape of general surgery and (b) ensure that residency training programs optimally prepare residents for transitioning into this environment.² The report acknowledged that “subspecialized training and focused practice is the new reality” for the modern surgeon, with 43% of Canadian surgeons practising primarily within a single subspecialty of general surgery, such as colorectal or breast surgery. Furthermore, the required technical competencies, such as the ability to perform cesarean sections or diagnostic colonoscopies, vary greatly between academic and community practice. Therefore, the report concluded that in addition to providing foundational training, residency programs should identify and introduce enhanced areas of expertise tailored to meet differing practice contexts.

Similarly, one would expect that a surgeon’s expectations — that is, mentorship, medical education, medical leadership, quality improvement and research productivity — would also differ between academic and community practice. In the United States, a national survey of general surgery program directors acknowledged that research productivity was important for surgeons pursuing academic faculty positions but much less so for those pursuing community work.³ Furthermore, even the definition of a clinician-scientist or surgeon-scientist reflects an ever-evolving academic landscape: clinicians are pursuing PhD training more often; increasingly, these candidates are “late bloomers” who choose to pursue research careers during medical school or residency training.⁴

Little is known regarding the expectations faced by modern general surgery graduates interested in pursuing academic surgical careers. In this study, we describe the changing face of the Canadian academic general surgeon by outlining in-residency research productivity and postresidency clinical and academic training trends over time.

METHODS

Study population

Our cross-sectional cohort included all Canadian academic general surgeons, defined as those with a university-affiliated faculty of medicine appointment as assistant, associate or full professor. Pediatric, vascular and thoracic surgeons were excluded as their disciplines typically function in distinct divisions within Canadian academic institutions. Surgeons without a university-affiliated professorship appointment of any rank, as well as those holding professor emeritus, clinical instructor/associate or locum positions, were also excluded.

Data extraction

We identified academic surgeons by hand-searching the Royal College of Physicians and Surgeons of Canada online directory as well as the directories on university and hospital websites. A predefined, prepiloted extraction form was used to gather data points related to institution, faculty appointment and rank, graduation year (as defined as Royal College designation), graduate education, fellowship training and research productivity. We then confirmed the accuracy and completeness of faculty lists and academic rank information by direct email correspondence with individual general surgical divisions at each institution. We used Scopus, an abstract and citation database of peer-reviewed journals in the life sciences, social sciences, physical sciences and medical sciences, to research productivity metrics including level of authorship, year of publication and H-index as a crude measure of citations and impact. This database allows for focused searches by variations of name and institution to more accurately identify publications linked to individual authors. In the piloting phase of data extraction, initial data collection was performed by 2 authors (N.M., M.A.) and a 10% audit was performed by at least 3 authors (A.T., N.G., A.M.) to ensure greater than 90% agreement on surgeon identification and evaluation of key metrics. Differences in extraction strategy were identified, discussed and resolved, and the audit process was repeated until target agreement was achieved. Following this, data extraction was completed by 2 authors (N.M., M.A.) and all uncertainties were resolved by group consensus. Given the fact that this study used publicly available data, the need for ethics approval was waived by the Ottawa Health Science Network Research Ethics Board.

Statistical analysis

Categorical variables were described as proportions and compared using χ^2 testing. Continuous variables were described as means and standard deviations and compared using analysis of variance testing. SAS 9.4 software was used for all statistical analyses.

RESULTS

Our cross-sectional cohort included 417 surgeons from 17 academic institutions across Canada. Most of the surgeons were male (72.9%), had completed at least 1 fellowship (72.9%) and had obtained some form of supplementary research training (50.8%) (Table 1). Most surgeons had obtained the Fellow of the Royal College of Surgeons of Canada (FRCSC) designation after the year 2000 (51.6%) with a median of 17 (10–27) years in practice. Eighty-seven (20.9%) people had attained full professorship status.

Table 2 outlines the types and locations of fellowship training pursued by our cohort. The most commonly

completed fellowships included surgical oncology (18.0%), hepatobiliary and transplant surgery (13.9%) and colorectal surgery (13.7%). Most surgeons completed Canadian fellowships; among this subset of participants, the University of Toronto (56.3%) was the most common location for training. Surgeons who had undertaken fellowships in the United States had done their fellowship training at locations more uniformly distributed across the country; among this subset of participants, the Memorial Sloan Kettering Cancer Center (11.5%), the Cleveland Clinic (9.2%) and the University of Miami (9.2%) were the most popular training destinations.

Table 3 provides a breakdown of research productivity during residency by decade of graduation. The mean number of total publications and first-author publications during residency has increased consistently each decade since before the 1980s ($p < 0.001$). In contrast, there has been no significant change in the mean number of senior-author publications during residency ($p = 0.46$).

Table 4 describes the disciplines of graduate education pursued by our cohort. The majority of surgeons (51.8%) had completed some form of graduate degree, most commonly in a basic science (14.6%), followed by clinical epidemiology (11.5%) and medical education (7.2%). The proportion of academic surgeons completing graduate degrees has also increased steadily every decade since before the 1980s, reaching a peak of 61.5% for surgeons graduating in the 2010s.

Table 1. Characteristics of participants (n = 417)

Characteristic	Participants, no. (%)*
Sex	
Male	304 (72.9)
Female	113 (27.1)
Number of fellowships completed	
0	113 (27.1)
1	253 (60.7)
≥ 2	51 (12.2)
Graduate studies completed	
None	205 (49.2)
Master's degree	154 (36.9)
Doctoral degree	42 (10.1)
Other (certificate, research fellowships)	72 (17.3)
Year of FRCS C graduation	
Earlier than the 1970s	3 (0.7)
1970s	12 (2.9)
1980s	69 (16.5)
1990s	95 (22.8)
2000s	137 (32.9)
2010s	78 (18.7)
Number of years in practice (after FRCS C graduation), median (IQR)	17 (10–27)
Professorship level	
Assistant professor	196 (47.0)
Associate professor	134 (32.1)
Full professor	87 (20.9)
FRCS C = Fellow of the Royal College of Surgeons of Canada; IQR = interquartile range. *Unless specified otherwise.	

DISCUSSION

The face of the Canadian academic surgeon is changing. In this study, we demonstrate that academic surgeons are becoming increasingly productive in research during residency, are pursuing higher levels of graduate education and are pursuing more fellowships than ever before. Our findings are similar to those of prior American studies outlining the increasing correlation between dedicated

Table 2. Characteristics of fellowships undertaken by participants (n = 417)

Characteristic	Participants, no. (%)*
Type of fellowship	
Breast surgery	10 (2.4)
Colorectal surgery	57 (13.7)
Critical care	40 (9.6)
Endocrine surgery	7 (1.7)
Hepatobiliary and transplant surgery	58 (13.9)
Minimally invasive and bariatric surgery	53 (12.7)
Surgical oncology	75 (18.0)
Trauma surgery and surgical critical care	40 (9.6)
Other	23 (5.5)
No graduate fellowship	113 (27.1)
Location of fellowship training	
Canada	
McGill University (Montreal, Que.)	12 (2.9)
McMaster University (Hamilton, Ont.)	6 (1.4)
University of Alberta (Edmonton, Alta.)	6 (1.4)
University of Calgary (Calgary, Alta.)	11 (2.6)
University of Ottawa (Ottawa, Ont.)	20 (4.8)
University of Toronto (Toronto, Ont.)	99 (23.7)
Western University (London, Ont.)	11 (2.6)
Other Canadian	11 (2.6)
United States	
Cleveland Clinic (Cleveland, Ohio)	12 (2.9)
Harvard University (Cambridge, Mass.)	9 (2.2)
Mayo Clinic (Rochester, Minn.)	3 (0.7)
MD Anderson Cancer Center (Houston, Tex.)	5 (1.2)
Memorial Sloan Kettering Cancer Centre (New York, N.Y.)	15 (3.6)
Roswell Park (Buffalo, N.Y.)	10 (2.4)
University of Miami (Miami, Fla.)	12 (2.9)
University of Minnesota (Minneapolis, Minn.)	5 (1.2)
Other US	60 (14.4)
Other international	12 (2.9)
Fellowships completed by decade of FRCS C graduation	
Earlier than the 1980s (n = 15 graduates)	7 (46.7)‡
1980s (n = 69 graduates)	41 (59.4)‡
1990s (n = 95 graduates)	71 (74.7)‡
2000s (n = 137 graduates)	104 (75.9)‡
2010s (n = 78 graduates)	65 (83.3)‡
Significance†	$p < 0.001$
FRCS C = Fellow of the Royal College of Surgeons of Canada. *Some participants completed more than 1 fellowship. †Significance based on χ^2 testing. ‡Percentages calculated on the basis of the number of participants who received their FRCS C designation in that decade.	

Table 3. Research productivity of participants during residency (before FRCS C graduation)

Characteristic	No. of publications, mean ± SD
Total publications by FRCS C graduation year	
Earlier than the 1980s (n = 15 graduates)	1.53 ± 1.71
1980s (n = 69 graduates)	1.42 ± 2.31
1990s (n = 95 graduates)	1.75 ± 3.68
2000s (n = 137 graduates)	4.58 ± 6.44
2010s (n = 78 graduates)	4.67 ± 6.48
Significance*	p < 0.001
First-author publications by FRCS C graduation year	
Earlier than the 1980s (n = 15 graduates)	0.67 ± 1.19
1980s (n = 69 graduates)	0.76 ± 1.31
1990s (n = 95 graduates)	0.89 ± 1.97
2000s (n = 137 graduates)	2.19 ± 3.22
2010s (n = 78 graduates)	2.21 ± 3.58
Significance*	p < 0.001
Senior-author publications by FRCS C graduation year	
Earlier than the 1980s (n = 15 graduates)	0.27 ± 0.57
1980s (n = 69 graduates)	0.18 ± 0.57
1990s (n = 95 graduates)	0.09 ± 0.32
2000s (n = 137 graduates)	0.21 ± 0.58
2010s (n = 78 graduates)	0.20 ± 0.61
Significance*	p = 0.46

FRCS C = Fellow of the Royal College of Surgeons of Canada; SD = standard deviation.
*Significance based on 1-way analysis of variance testing.

Table 4. Graduate and other education of participants (n = 417)

Characteristic	Participants, no. (%)
Graduate education field	
Basic science	61 (14.6)
Business administration	3 (0.1)
Clinical epidemiology	48 (11.5)
Education	30 (7.2)
Experimental surgery, surgical sciences	14 (3.3)
Health administration, quality improvement	4 (0.1)
Public health	15 (3.6)
Other	25 (6.0)
No graduate education	119 (28.5)
Graduation education by FRCS C graduation year	
Earlier than the 1980s (n = 15 graduates)	4 (26.7)
1980s (n = 69 graduates)	22 (31.9)
1990s (n = 95 graduates)	44 (46.3)
2000s (n = 137 graduates)	80 (58.4)
2010s (n = 78 graduates)	48 (61.5)
Significance*	p < 0.001

FRCS C = Fellow of the Royal College of Surgeons of Canada.
*Significance based on χ^2 testing.

research fellowships, graduate education and eventual faculty positions in academia.^{5,6}

The determinants of this “academic inflation” are probably multifactorial. To begin with, the employment landscape has undoubtedly placed increasing pressures on residents to be academically competitive for fellowships and

eventually full-time faculty positions in large tertiary care centres. A recent survey of Canadian general surgeons noted that more than 80% felt anxiety about the process of securing a job while in training and that 1 in 3 surgeons reported not working in the job they most desired.⁷ Furthermore, nearly 3 in 4 surgeons believed that too many residents are being trained for the number of jobs currently available.

Furthermore, given the surgeon’s many clinical and administrative responsibilities, there is an even greater emphasis on securing sufficient research time and funding. Unfortunately, these commodities are becoming increasingly scarce. In a survey of senior-level members of academic surgical societies, nearly 40% had stopped performing basic science research by the age of 40 because of increased clinical load and administrative duties.⁸ In the United States, inflation-adjusted funding by the National Institutes of Health (NIH) for surgical research decreased by nearly 20% from 2003 to 2013.⁹ In addition, the number of nonsurgical applications for NIH funding has increased over the past decade but the number of surgical applications has remained stagnant. In an increasingly resource-limited academic environment, surgeons face considerable challenges to remain competitive.

Although most Canadian surgeons believe in creativity and innovation, these sentiments often get lost in the overwhelming magnitude of daily clinical commitments. There is no doubt that the pursuit of these endeavours often comes with some degree of struggle and adversity. In a survey of residents across 248 general surgical residency programs in the United States, research residents believed they did not fit as well within their program, felt less likely to be well supported if they struggled, and had comparatively higher rates of attrition than their coresidents.¹⁰ These are unfortunate findings and should not be viewed as an acceptable status quo. Exploration and innovation should not be dictated solely by employment needs and institutional mandates but rather they should be embraced as a core value of Canadian surgery and pursued by those for whom research is a genuine passion.

In this study, we have demonstrated the ever-increasing expectations of and pressures on Canadian general surgical residents pursuing careers in academia. There are 3 implications of our findings. (a) For learners interested in academic surgery, these findings allow surgical trainees to understand the academic and clinical expectations they face so that they can better plan their careers and reach out to their programs for guidance. (b) For program directors, these findings should make them aware of the values and priorities that may be important for some of their residents, which will enable them to advocate for and implement at an institutional level the resources these residents need to succeed, such as salary awards, senior mentorship and protected research time. (c) Lastly, for policy-makers, these findings highlight the possible need for a more formalized pathway outlining the training guidelines and

requisite competencies for those intending to pursue academic surgery, which would guide funding allocation and accreditation procedures at the institutional level.

We hope the findings of this study will serve as a conversation starter among educators and specialty committees regarding the importance of tailoring the educational experience to best support our general surgical residents. We must strive for a well-informed and motivated resident body, early exposure to career mentorship and protected research time, as well as clear guiding principles regarding the core competencies required to succeed as an academic surgeon.¹¹ Perhaps there is an opportunity to introduce an academic stream or focus in the transition-to-practice phase of the Royal College framework,² whereby programs are required to secure an environment that allows interested trainees to simulate a true clinician-scientist role, balancing clinical and academic responsibilities while receiving the appropriate mentorship that allows them to be involved in several projects, complete graduate training and become competitive for entry into a fellowship program.

Ultimately, innovation is not an option. We must continue to innovate and adapt for the welfare of our patients and to stay relevant as surgeons. We must build an infrastructure for academic exchange, synergy and collaboration to foster an engaged and responsive network of innovative surgeons. Perhaps most importantly, we must oversee and inspire the successful development of the next generation of Canadian surgeons.

Limitations

The limitations of this study relate primarily to the observational nature of the data. By focusing on active academic surgeons in this survey, we were unable to capture individuals who may have been on academic trajectories with advanced graduate training but who ultimately sought non-academic careers out of residency. We were similarly unable to capture those who transitioned out of academic practice as junior faculty. As such, we are able to comment only on the specific subset of surgeons who held academic rank at the time of this study. We relied upon hand-searching publicly available directories, such as those on hospital and university websites, for which data quality assurance policies are unclear. Our Scopus searches were naturally limited by the inherent validity and quality assurance policies of the database. There is potential to incorrectly include or exclude publications for surgeons with common names or those who previously published under maiden names. However, an audit of the Scopus database for Japanese academic researchers noted 98% accuracy for author identification.¹²

CONCLUSION

With each passing decade, the Canadian academic surgeon is becoming increasingly productive in research

during residency, is pursuing higher levels of graduate education and is pursuing more fellowships than ever before. These changes probably correspond to an evolving employment and research funding landscape that places tremendous academic pressure on surgical trainees. Stakeholders should reflect on these changing dynamics and respond accordingly to support the next generation of Canadian general surgeons.

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