American Journal of Transplantation 2012; 12: 772–778
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doi: 10.1111/j.1600-6143.2011.03878.x

Brief Communication

Time-Trends in Publication Productivity of Young Transplant Surgeons in the United States

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To further clarify whether the transplant surgical research workforce is adequately poised to further scientific achievement, we have investigated the publication productivity of young transplant surgeons. Our hypothesis is that recent young transplant surgeons write fewer academic manuscripts than their senior colleagues did when they were young surgeons. We compared the number of first and senior author publications in the first 5 years after completion of fellowship among recent transplant surgeons (completed fellowship 2000–2004) and former young surgeons (completed fellowship 1990–1994). Recent young surgeons wrote fewer overall manuscripts (0.94 vs. 1.67, $p < 0.05$), as well as basic science manuscripts (0.21 vs. 0.54, $p < 0.05$) and clinical manuscripts (0.73 vs. 1.14, $p < 0.05$). Adjusting for the number of trainees, we note that recent young surgeons published 59% fewer basic science publications (IRR 0.41, 95% CI 0.29–0.57, $p < 0.001$) and 33% fewer clinical publications (IRR 0.67, 95% CI 0.56–0.82, $p < 0.001$). Among fellows in the 2000–2004 cohort, there was a 32% lower chance of publishing at least one paper compared with fellows in the 1990–1994 cohort (IRR 0.68, 95% CI 0.51–0.89, $p = 0.006$). These findings raise concerns about the future place of transplant surgeons within the science that shapes our own field.

Key words: Career development, policy, research, surgeon workforce, transplant surgery

Abbreviations: ASTS, American Society of Transplant Surgeons; NIH, National Institute of Health; IRR, incident rate ratios.

Received 01 May 2011, revised 13 October 2011 and accepted for publication 16 October 2011

Introduction

Transplant surgeons have driven many of the advances in the history of organ transplantation (1–10). However, many scientific questions remain across a range of disciplines from artificial organs and immunology to organ allocation and continued surgeon insight and participation in each of these areas is vital. Unfortunately, there are reasons to worry that time constraints from clinical and administrative duties may preclude young transplant surgeons from being active participants in science (11–13). Thus, it is important to assess whether the transplant surgical research workforce is adequately poised to further scientific achievement.

Despite significant attention, the scientific productivity of transplant surgeons in the United States remains unclear (12–14). Measuring the research productivity of the workforce can be complex and imprecise. Three potential measures of scientific productivity include abstract submissions, grant funding and publications. Focusing on abstract submissions, it remains unclear whether increasing submissions is related to academic productivity or simply the popularity of meetings. Conversely, we have recently reported that young transplant surgeons rarely achieve National Institute of Health funding for their research (11). To help resolve this ambiguity, we have now focused on the publication productivity of young transplant surgeons.

Publications are a universally agreed upon metric of scientific productivity. Within this context, we have queried the National Library of Medicine Database (PubMed) for manuscripts written by recent young transplant surgeons during the first 5 years after completion of their transplant surgical fellowship (fellowship years 2000–2004). We compared both the numbers and types of publications to a cohort of former junior surgeons (fellowship years 1990–1994). Our hypothesis is that recent young transplant surgeons write significantly fewer academic manuscripts than their senior colleagues did when they were young surgeons.

Methods

General trends in transplant research

Our first goal was to assess general trends in transplant research publications over the study period. First, we used an automated query of US

Table 1: Journals queried for transplant surgeons as first or last author

Annals of Surgery
Transplantation
American Journal of Transplantation
Hepatology
Hepatology Liver Transplantation
Journal of the American Society of Nephrology
Journal of the American Medical Association
New England Journal of Medicine
Science
Nature
Cell
Proceedings of the National Academy of Science
Surgery
Archives of Surgery
Journal of the American College of Surgeons
Clinical Transplantation
Transplant International

PubMed (search terms: kidney transplantation, liver transplantation and pancreas transplantation) to determine the annual number of publications in these fields by all authors (not limited to surgeons). The query was limited to the 17 major journals most relevant to transplantation (Table 1), as defined by the American Society of Transplant Surgeons (ASTS) for its automated search component of its selection process for the annual ASTS Vanguard Award candidates, which includes a PubMed search.

Publication productivity of transplant surgeons

Study population: The study cohort included all surgeons who completed an ASTS accredited transplant surgical fellowship (data provided by the ASTS) during one of two eras: 1990–1994 (former young surgeons) and 2000–2004 (recent young surgeons). For each surgeon, the observation period lasted 6 calendar years from the year of completion of the transplant fellowship (the final year of fellowship and first 5 years on faculty). For example, for individuals who completed their fellowship in July 2004, their publication record was investigated between January 2004 and December 2009. We chose to study fellows only through 2004 to avoid follow-up bias, assuring that all subjects had the entire 6-year follow-up time. Those finishing two fellowships had their last (most recent) fellowship counted only.

Publication query

Using an automated query macro, the full search names (last name, first initial and middle initial when applicable) of each fellowship graduate were queried for publications within PubMed. The query was limited to the 17 major journals as detailed above. A manuscript was attributed to an individual if they were either the first or last author. The results of this query were reviewed by hand to verify the identity of PubMed authors. Papers that had an ASTS fellow as both the first and last author were counted twice, to give each fellow "credit" for the publication. All papers were categorized as basic (laboratory) science and clinical (patient-oriented) research. Papers that were translational (had significant laboratory and patient-oriented features) were reviewed by two investigators for categorization (usually categorized as basic scientific research unless the laboratory component was truly minimal).

Statistical analysis

The two study groups (recent and former young transplant surgeons) were compared with respect to the number of fellowship graduates and the number of publications. To compare the number of publications among the two study groups, a Poisson (log-linear) regression was used at the level of the study cohort. Results are reported as incident rate ratios (IRRs). The IRR can be interpreted as the multiplicative factor of number of publications by recent junior surgeons (2000–2004 cohort) compared to former junior surgeons (1990–1994 cohort). Corrected IRRs were calculated by normalizing the number of publications that year, based on the number of fellows graduating that year, to the mean number of fellows across all years. To address the issue of author clustering (a small number of highly productive surgeons), the analysis was repeated (Poisson regression) by comparing the number of surgeons in each era who had written at least one paper.

Sensitivity analysis

To assure that the ASTS methods for journal selection was not too narrow in scientific scope, we completed a second query as a sensitivity analysis. This second query included the original 17 journals detailed above in addition to the following journals*: Clin J Am Soc Nephrol*, *Am J Kidney Dis*, *Diabetes, Cell Transplant*, *J Clin Endocrinol Metab*, *Endocrinology*, *J Immunol*, *J Clin Invest*, *J Exp Med*, *J Biol Chem*, *J Vasc Surg*, *Arch Pathol Lab Med*, *Am J Clin Pathol*, *Am J Surg Pathol*, *Lab Med*, *J Clin Oncol* and *Ann Surg Oncol*. The analytic methods for the sensitivity analysis were the same as detailed above.

Results

General trends in transplant research publications

Between 1990 and 2009, we noted a steady trend toward more papers published in the fields of kidney and liver transplantation, in general (by all authors, not just surgeons; Figure 1). In contrast, there seemed to be a modest decrease in the annual number of publications in the field of pancreas transplantation.

Publication productivity of young transplant surgeons

Two hundred five fellows finished ASTS-approved transplant surgery fellowships between 1990 and 1994, compared with 267 fellows between 2000 and 2004. On average, there were 41.0 fellows per year between 1990 and 1994 and 53.4 fellows per year in 2000 and 2004 ($p = 0.014$). Overall, 596 papers were verified as having a transplant surgeon who completed an ASTS approved fellowship as first or last author.

Former young surgeons wrote on average 1.67 first or senior author manuscripts over their first 5 years after their transplant surgery fellowship (0.54 basic science papers and 1.14 clinical science papers; Figure 2). In comparison, recent young transplant surgeons wrote an average of 0.94 manuscripts over their first 5 years after completion of a transplant surgery fellowship, with only 0.21 basic science papers and 0.73 clinical science papers ($p < 0.05$ for comparisons of total, basic science and clinical papers between former and recent young transplant surgeons).

Similarly, correcting for the increase in the number of fellows across eras, fellows graduating between 2000 and 2004 wrote 41% fewer manuscripts (IRR 0.59, 95% CI 0.50–0.70, $p < 0.001$) compared with those graduating between 1990 and 1994. This difference was most

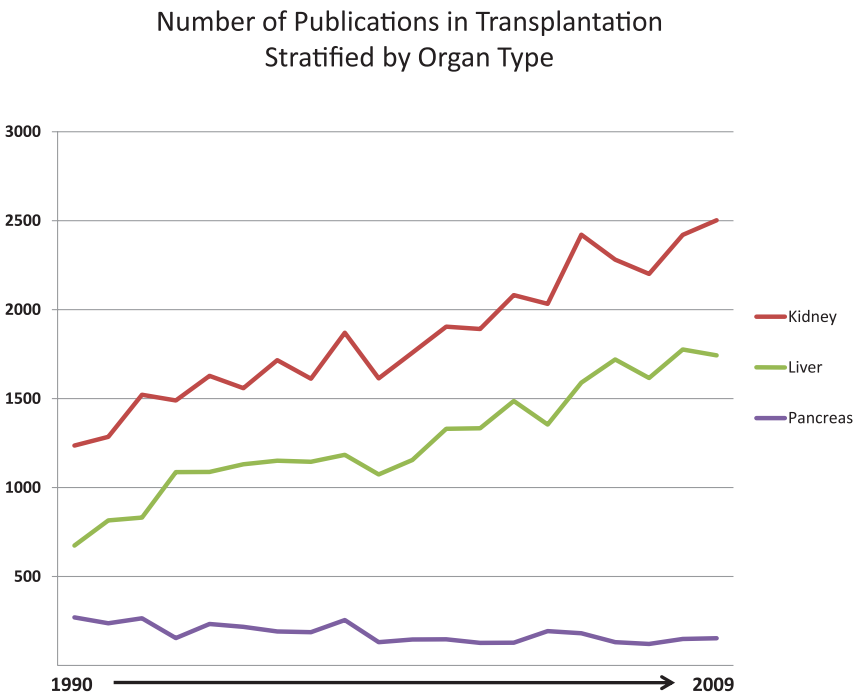

Figure 1: The number of publications in kidney, liver and pancreas transplantation by all other types of investigators (not just surgeons) within major scientific journals from 1990 to 2009. These data demonstrate increasing numbers of total publications in the field abdominal transplantation.

striking for basic science publications; recent young surgeons published 59% fewer basic science publications (IRR 0.41, 95% CI 0.29–0.57, $p < 0.001$) and 33% fewer clinical publications (IRR 0.67, 95% CI 0.56–0.82, $p < 0.001$).

It is possible that these differences are largely driven by a small number of transplant surgeons who wrote a large number of manuscripts (Figure 3). Certainly, such clustering of authorship is evident as we note that a single author from the 1990 and 1994 study cohort wrote 31 papers, representing 9.0% of all of the manuscripts during this study period. Similarly, a single author from the 2000 to 2004 study cohort wrote 17 papers, representing 6.7% of all manuscripts during this study. Between 1990 and 1994, 104 fellows wrote no publications, representing 50.7% of all surgeons during this era. Similarly, 6 authors produced 25% of all publications and 17 authors accounted for 50% of all publications. Between 2000 and 2004, 178 authors wrote no publications, representing 66.6% of all surgeons during this era. Similarly, 7 authors produced 25% of all publications and 20 authors produced 50% of all publications. To adjust for this clustering of authorship in our comparisons between eras, we compared the number of surgeons who had written at least one manuscript between the two eras. Among follows in the 2000–2004 cohort, there was a 32% lower chance that a fellow published at least one paper in his/her first 5 years after graduation from fellowship compared with a fellow in the 1990–1994 cohort (IRR 0.68, 95% CI 0.51–0.89, $p = 0.006$).

Sensitivity analysis

The inclusion of the 17 additional journals increased the number of papers verified as having a transplant surgeon who completed an ASTS approved fellowship as first or last author from 596 to 659. Correcting for the increase in the number of fellows across eras, fellows graduating between 2000 and 2004 wrote 41% fewer manuscripts (IRR 0.59, 95% CI 0.50–0.69, $p < 0.001$), specifically 60% fewer basic science publications (IRR 0.41, 95% CI 0.30–0.55, $p < 0.001$) and 32% fewer clinical publications (IRR 0.67, 95% CI 0.57–0.83, $p < 0.001$). Among fellows in the 2000–2004 cohort, there was a 32% lower chance that a fellow published at least one paper in his/her first 5 years after graduation from fellowship compared with a fellow in the 1990–1994 cohort (IRR 0.68, 95% CI 0.52–0.89, $p = 0.005$).

Discussion

Young transplant surgeons write surprisingly few academic manuscripts, on average less than one over the course of their first 5 years after fellowship. Further, young transplant surgeons write significantly fewer manuscripts than did their senior colleagues as young surgeons. This decrease in academic productivity is particularly pronounced with regard to basic scientific research manuscripts. These findings raise concerns about the future place of transplant surgeons within the science that shapes our own field.

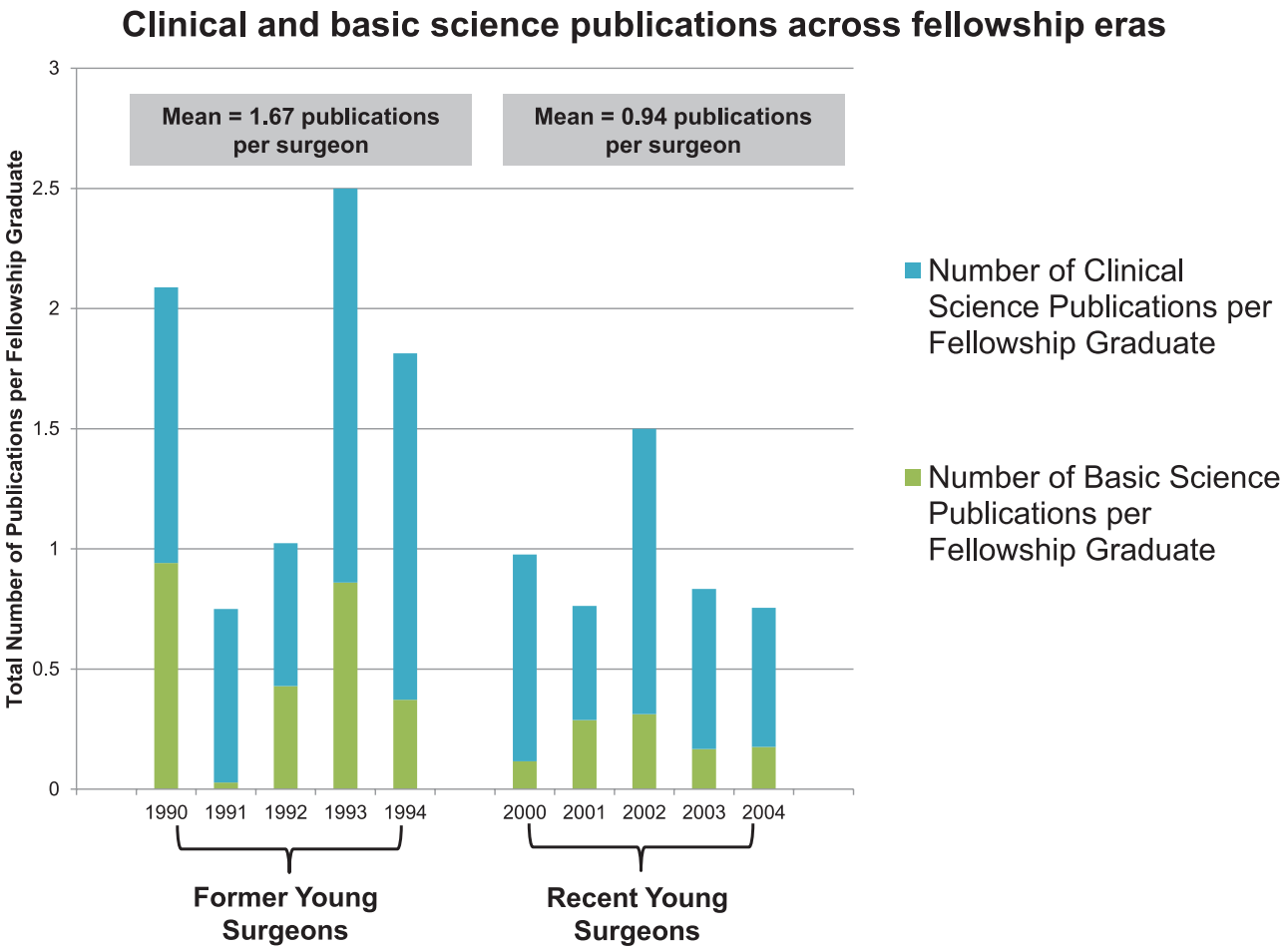

Figure 2: A comparison of clinical and basic science publications among former young transplant surgeons (completed fellowship 1990–1994) and recent young transplant surgeons (completed fellowship 2000–2004). The data demonstrate that recent transplant fellows have written significantly fewer basic science and clinical manuscripts in major journals.

This is not the first work detailing the precarious status of surgical research. Previous work has focused on increasing clinical demands and the financial realities of academic medicine as critical factors affecting academic productivity of young surgeons and trainees (11,12,15–17). Questions remain about the complex financial relationships between academic and research operations and whether clinicians and institutions are willing to financially support both researchers and teachers (18). Certainly as subspecialty surgeons are faced with decreasing reimbursements, such fiscal pressures will continue to mount. Considering the unique practice of transplant surgery, it is tough to benchmark transplant surgeons to other clinical subspecialties. Previous work suggests that both cardiac and vascular surgeons have a more successful track record of federal funding compared to transplant surgeons, but specific comparisons on the basis of manuscript productivity have not been done (11,12,17,19). A broad population of young surgeons described as "mentees of members of the Society of University Surgeons and the American Surgical Association" published in average of 2.5 manuscripts in the year 2000 and 4.6 manuscripts in the year 2006, suggesting that these individuals write substantially more papers than the young transplant surgeons we studied herein (16). Nonetheless, it remains unclear how the experiences of other surgical subspecialties can inform transplant surgery.

There are several potential interpretations of these findings. One potential explanation is that young transplant surgeons are less talented and/or motivated. This is possible considering that transplantation has changed from the frontier of medicine to standard of care; different types of individuals may now be choosing transplant surgery as a career. The actual level of commitment of young transplant surgeons to research remains unclear, though previous work has reported that 78% of young transplant surgeons currently desire to have more involvement in research (11). Importantly, desire does not necessarily represent commitment and potentially inadequate commitment is a critical issue among transplant surgeons (12).

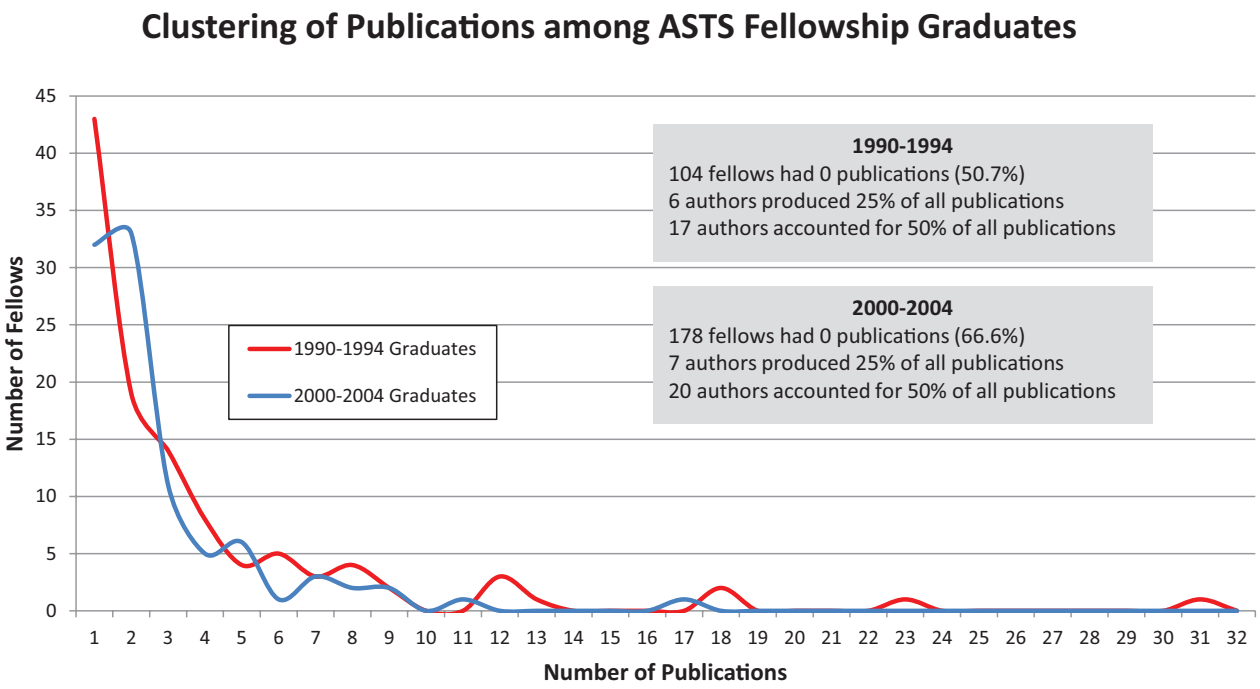

Figure 3: Clustering of publications among transplant surgeons in the United States.

Within this context, the finding that 16% of the workforce wrote one paper each is intriguing, as it could suggest either frustrated research careers or an elective transition to clinical or administrative efforts. We did assess if more manuscripts were written early in the observation period, which might support the argument for academic frustration, but we did not see any trends in the timing of publications to suggest this. Further, research commitment may require a surgeon to accept a salary commensurate with a researcher, which is likely lower than his/her full time clinical colleagues. Within this context, it is not surprising that the ASTS 2010 Compensation Report notes that 53% of "staff surgeons" reported that surgical activity was used to determine bonus payments, compared to only 19% reporting academic productivity as the criteria used to determine their financial bonus. Furthermore, young transplant surgeons spend some time of their prefellowship training in research, but this training is relatively brief in comparison to most full-time researchers. Committed surgeon–scientists may need to accept an even longer training period if they expect a successful scientific career. Finally, there may be important demographic or educational differences between the two comparison groups, such as country of origin or location of medical education that we have not measured.

Young transplant surgeons may publish less than their senior colleagues did simply because transplant surgeons are busier. Anecdotally, this seems likely true, as clinical transplant volumes have increased (median number of transplant per center per year has increased from 161 in 1990–1994 to 249 in 2000–2004 (20). In addition, younger surgeons may have more responsibilities within the home, as dual career families have become more common. Potentially as important, senior transplant surgeons may be busier than senior surgeons in the past. Certainly the institutional and professional administrative duties of a senior transplant surgeon are more complex and potentially onerous than in the past, as financial and regulatory pressures have increased. More specifically, it may be possible that the brightest young minds in transplantation are managing the challenges of the Center for Medicare and Medicaid Services (CMS) regulations, Scientific Registry for Transplant Recipients (SRTR) reports and insurance contracts in lieu of scientific investigation. Further, senior attending surgeons are generally required to participate in clinical care in a more hands-on fashion than in the past. These commitments may leave less time for research mentorship. Within this context, previous work has suggested that the number of manuscripts published by senior and surgical investigators has decreased over the past 10 to 15 years (16). It is also interesting that even the most productive surgeons in the younger cohort were less productive; potentially it has become more difficult to publish in the later era. Finally, young transplant surgeons may less commonly be listed first or last author on manuscripts, although it is difficult to know when to attribute meaningful scientific contribution in these situations.

It is possible that publication of scientific research in academic journals has less primacy as a measure of academic productivity for young transplant surgeons. However, it is

interesting that abstracts submissions to transplant surgical meetings are actually increasing, although at the same time we present data suggesting that fewer manuscripts are being written. It is significantly more work to publish a paper that it is to present an abstract. The peer review process involved in publications is rigorous, though critical for the integrity and quality of the scientific work. Potentially, young transplant surgeons are not adequately committed to completing academic projects or are not producing science that meets the expectations of peer reviewers.

Our data suggests that the involvement of transplant surgeons in basic scientific research seems to be changing to a larger degree than surgeon involvement in clinical research. Within this context, transplant surgeons with expertise in the basic sciences may become increasingly rare. As both basic investigation and surgery have both become more complex and subspecialized, maintaining expertise in both fields may no longer be possible for most young transplant surgeons. Conversely, there may be new opportunities in the flourishing field of health services research for young transplant surgeons, an academic discipline possible better suited for a transplant surgeon.

If the current work environment for many young transplant surgeons has led to diminished research productivity, one potential approach is the development of comprehensive transplant centers. These transplant programs would have a strong research focus and provide broad based scientific infrastructure and collaborations with surgeons and PhD transplant researchers. Scientific productivity would be amply rewarded and valued within the institution. Further, clinically focused transplant centers would provide work environments for surgeons who were focused on clinical excellence and not burden the surgeons with institutional pressures and requirements for research. The strengths of both of these types of institutions could be harnessed in a collaborative fashion to further clinical and translational research endeavors. Young transplant surgeons strongly committed to research could pursue jobs at comprehensive transplant centers. Important questions remain regarding this approach, which admittedly is simple and idealistic. For example, it is unclear whether "comprehensive" transplant centers would be able to compete clinically or financially with clinically focused transplant centers.

In all, it is important for the transplant surgical community to understand their current and future research workforce. Further, as young surgeons consider career choices, it is important that transplant surgery understands and details the work environment for young surgeons. This work suggests that the publication of manuscripts is relatively uncommon by young transplant surgeons and that young transplant surgeons write fewer manuscripts than their predecessors. This work, in conjunction with our previous work, suggests that significant changes are needed to preserve a robust transplant surgical research workforce (11). Whether surgeons should and are willing to make the tradeoffs potentially necessary to increase surgical research remain unclear. Further discussion is needed to decide the level of serious research participation that we desire within our field.

Acknowledgment

M.J.E. was supported by the National Institutes of Health–National Institute of Diabetes and Digestive and Kidney Diseases (K08 DK0827508).

Disclosure

The authors of this manuscript have no conflicts of interest to disclose as described by the *American Journal of Transplantation*.

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