National Trends in General Surgery Resident Exposure to Complex Oncology-Relevant Cases

Amir A. Khan, MD,* Jan Rakinic, MD, FACS, FACRS,* Roger H. Kim, MD, FACS,* John D. Mellinger, MD, FACS,* and Sabha Ganai, MD, PhD, MPH, FACS*,†

*Department of Surgery, Southern Illinois University School of Medicine, Springfield, Illinois; and †Department of Population Science and Policy, Southern Illinois University School of Medicine, Springfield, Illinois

OBJECTIVE: To evaluate trends in surgical resident exposure to complex oncologic procedures in order to determine whether additional fellowship training is necessary.

DESIGN: An observational study of national Accreditation Council for Graduate Medical Education case log statistical reports was conducted to determine the average number of cases for selected oncology-relevant procedures completed during training. Linear regression and Cusick trend tests were used to assess temporal trends with the null hypothesis assuming an estimated slope of zero. Instrumental variable estimation was used to study the effect of duty-hour restrictions on oncologic cases per year.

SETTING: United States general surgery residency training programs.

PARTICIPANTS: Graduating surgical residents completing their training between 2000 and 2016.

RESULTS: Across the study interval, mean case volume was 950.6 ± 29.7 (standard deviation) cases with 38.9 ± 3.1 complex oncologic cases per graduating resident. Decreasing trends were noted for average exposure to lymphadenectomies (−7.8 cases/decade; 95% confidence interval [CI] −8.8 to −6.8) and low rectal procedures (−0.9 cases/decade; 95% CI −1.2 to −0.6). There was no clinically important change in complex soft-tissue resections and foregut cases. A significant increase was seen in number of hepatopancreaticobiliary procedures (+3.9 cases/decade; 95% CI 3.1-4.7). Using instrumental variable estimation, there was a modest decline in cancer-relevant cases by 5.0 cases/decade (95% CI 4.5-5.6), while there was an increase in 38.5 total cases/decade (95% CI 10.4-66.7) associated with duty-hour restrictions.

CONCLUSIONS: Case numbers for several complex oncologic procedures remain low, justifying a need for further fellowship training depending on individual resident experience. (J Surg Ed 76:378−386. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: surgical education, surgical oncology, resident training, duty-hour restrictions

COMPETENCIES: Patient Care, Systems-Based Practice

INTRODUCTION

Advances in medical knowledge and surgical innovation have altered the scope of general surgery. Practice shifts including greater use of laparoscopic, endovascular, endoscopic, and interventional techniques have led to changes in the case volume and complement experienced by residents.[1] Concurrently, implementation of Accreditation Council for Graduate Medical Education duty-hour reform and a focus on clinical competency have altered the traditional residency model.[2] Exposure to open operations and "teaching-assistant" cases has decreased, with an associated decrease in operative autonomy.[3-5] Graduating surgery residents now lack confidence performing common bile duct explorations, Whipple procedures, liver resections, and esophagectomies,[6] with deficiencies noted by program directors in their preparation for independent practice.[7]

Disclosures: There are no financial conflicts of interest relevant to the conduct of this study.

Correspondence: Inquiries to Sabha Ganai, MD, PhD, MPH, FACS, SIU Simmons Cancer Institute, 315 W. Carpenter Street, Springfield, IL 62794; fax: (217) 545-7762; e-mail: sganai@siumed.edu

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A majority of chief residents are now pursuing fellowship training in order to improve confidence and proficiency in their desired specialty.[6] In 2012, complex general surgical oncology (CGSO) received approval for American Board of Surgery subspecialty certification and has been advocated as a pathway to improve competence in performance of complex oncologic cases.[8,9] In light of these changes, this study evaluates national trends in resident exposure to oncologic cases in the context of case minimums for board-certification pathways for colorectal surgery, thoracic surgery, and CGSO, as well as fellowship training-program requirements for breast oncology and hepatopancreaticobiliary (HPB) surgery.

MATERIALS AND METHODS

A retrospective analysis of Accreditation Council for Graduate Medical Education statistical reports from United States general surgery residents graduating in 2000 to 2016 was conducted in order to determine case exposure to selected oncology-relevant procedures. These reports include data submitted by accredited surgical residency programs and include cumulative graduating resident case volume and specific procedural averages for cases.[10] Because case logs do not specify indications for procedures, only certain cases were selected based on their relevance to oncologic surgery. Modified radical mastectomy (MRM), major lymphadenectomy, cervical lymph node dissection (CLND), and retroperitoneal or pelvic lymph node dissection were categorized as total lymphadenectomies. Adrenalectomy and radical excision of soft-tissue tumors were analyzed as complex soft-tissue cases. Transanal rectal excisions (TRE) and abdominoperineal resection (APR) were grouped as low rectal cases. Esophageal resections and total gastrectomy (TG) were examined as foregut cases, and major hepatic resections and pancreatectomies were analyzed as HPB cases.

Case classification varied slightly in the annual statistical reports. Data for major lymphadenectomy, pelvic lymph node dissection, adrenalectomy, radical excision of soft-tissue tumors, and major hepatic resections are listed consistently throughout reports from graduating years 2000 to 2016. Average numbers for pancreatic resections are divided into 3 subcategories including total pancreatectomy, Whipple procedures, and distal pancreatectomies from graduating years 2000 to 2004 and from 2010 to 2016, but were reported as a composite measure from 2005 to 2009. Reports from 2000 to 2004 and 2010 to 2016 list esophagectomy and esophagogastrectomy as separate cases, and are grouped for analysis. Reports from 2005 to 2009 classify esophagectomies as "esophageal resection/bypass," and were included in our analysis. MRM, CLND, TRE, APR, and TG are listed as separate cases in reports from years 2000 to 2004 and in 2010 to 2016, but are not listed in 2005 to 2009. This period contains 1 major mastectomy category that also included simple mastectomies. TG cases are not specified during the same time period, and fall under "Other Major Stomach Operation." Due to lack of discrete data, case numbers for MRM, CLND, TRE, APR, and TG for graduates from 2005 to 2009 were not analyzed.

Since data were never collected from graduating residents on actual total work hours, estimates were calculated for average total work hours based on the following 4 assumptions: (1) 110 hours per week prior to the 2003 academic year, (2) 80 hours per week after the 2003 academic year, (3) 48 total workweeks per year, and (4) 5 full-time residency years.[11] Time intervals for dedicated research during residency were not accounted for and were assumed to not influence case totals. Duty-hour estimates ranged from 26,500 hours for the 1999 to 2000 cohort to 19,200 hours for the 2008 to 2016 cohorts.

Average "Surgeon Total" numbers were analyzed as cases per graduating resident using linear regression assessing for temporal trends, with the null hypothesis assuming an estimated beta coefficient (slope) of zero. Spearman's rho and Cusick trend tests were used to estimate correlation of case trends over time. The 95% confidence intervals (CIs) are provided for estimated change in case numbers per decade. Instrumental variable (IV) estimation was performed using 2-stage least-squares IVs regression in order to estimate cases using total graduating duty hours less than 20,000 as an instrument.[12] Statistical analysis was performed using STATA version 14 (College Station, TX). Nonhuman subject research determination was obtained from the Southern Illinois University Springfield Committee for Research in Human Subjects (15-266).

RESULTS

Over the study interval, there were 17,820 graduating chief residents, with 1172 residents graduating in 2016 compared to 989 in 2000. Across this interval, total case numbers remained stable at 987 in 2016 and 967 in 2000. Mean "complex-oncologic cases" as defined by the sum of total lymphadenectomies, complex soft-tissue cases, foregut resections, low rectal resections, and HPB cases, decreased from 43.5 cases per resident in 2000 to 35.1 per resident in 2016 (Table 1; rho −0.97; trend test $p = 0.001$). Figures 1 and 2 summarize trends in procedural volume and case complement over time.

TABLE 1. Linear Trends in Total Complex Oncologic Case Numbers for Graduating General Surgery Residents

Procedure	1999-2000 (n = 989)	2015-2016 (n = 1172)	ΔCase Per Decade (95% CI)	Regression p Value	Spearman's Rho	Cusick Trend Test p Value
Modified radical mastectomy	13.8	5.0	−5.6 (−6.2 to −4.9)	<0.001	−1.00	0.002
Major lymphadenectomy	5.9	3.2	−1.6 (−2.1 to −1.1)	<0.001	−0.96	<0.001
Transanal rectal excision	2.0	1.0	−0.5 (−0.7 to −0.3)	<0.001	−0.96	0.002
Pelvic node dissection	0.8	0.3	−0.3 (−0.4 to −0.3)	<0.001	−0.95	<0.001
Neck dissection	1.5	1.3	−0.2 (−0.25 to −0.06)	0.003	−0.81	0.010
Abdominoperineal resection	3.0	2.5	−0.5 (−0.7 to −0.2)	0.002	−0.81	0.007
Radical soft-tissue resection	3.6	2.7	−0.5 (−0.8 to −0.2)	0.002	−0.70	0.005
Esophagectomy	2.3	2.1	−0.1 (−0.2 to +0.001)	0.054	−0.44	0.06
Total gastrectomy	0.9	1.0	−0.01 (−0.07 to 0.05)	0.82	0	1.0
Adrenalectomy	1.4	1.9	+0.3 (0.1-0.5)	0.009	+0.56	0.02
Pancreatectomy	4.9	8.4	+2.4 (1.8-3.1)	<0.001	+0.85	<0.001
Major hepatectomy	3.4	5.6	+1.5 (1.3-1.6)	<0.001	+0.98	<0.001
Total complex oncologic cases	43.5	35.1	−5.2 (−5.8 to −4.5)	<0.001	−0.96	0.001

Across the study interval, mean case volume was 950.6 ± 29.7 (standard deviation) per graduating resident, with 4.0 ± 0.1% of cases, or an average of 38.9 ± 3.1 per resident qualifying as complex oncologic cases. Overall, there was a significant decline in the proportion of total logged cases that qualified as complex oncologic cases from 4.5% in 2000 to 3.6% in 2016 (rho −0.97; p = 0.001).

Decreasing trends were observed for total lymphadenectomies (−7.8 cases/decade; 95% CI −8.8 to −6.8; rho −0.99; p = 0.002), declining from 22 to 9.8 cases per resident. Total complex soft-tissue resections, including both adrenalectomies and radical excisions of soft-tissue tumors, decreased only slightly from 5 cases to 4.6 cases per graduating resident (−0.2 cases/decade; 95% CI −0.5 to 0; rho −0.47; p = 0.07). Low rectal cases decreased from 5 to 3.6 cases per graduating resident (−0.9 cases/decade; 95% CI −1.2 to −0.6; rho −0.88; p = 0.002). There was no statistically significant change in exposure to foregut cases (3.2 to 3.1 cases per resident; −0.1 cases/decade; 95% CI −0.2 to 0; rho −0.44; p = 0.11). An increase was noted for HPB cases from 8.3 to 14.0 cases per graduating resident between 1999 and 2000, and 2015 and 2016 (+3.9 cases/decade; 95% CI 3.1-4.7; rho +0.95, p < 0.0001).

Figure 3A summarizes total cases and complex oncologic case totals controlled for estimated duty hours per respective graduating class, which increased from 36.6 to 51.4 total cases per 1000 hours worked, and 1.6 to 1.8 oncology-relevant complex cases per 1000 hours worked across the study interval. Figure 3B summarizes totals for oncology-relevant complex cases and demonstrates a decreasing trend in total lymphadenectomies (p = 0.002) and an increasing trend in HPB cases (p < 0.0001). IV estimation demonstrated a modest decrease in 5.0 oncology-relevant complex cases per decade per resident (95% CI 4.5-5.6; p < 0.001) associated with duty-hour restrictions below 20,000 hours per graduating resident. This was while there was an increase in 38.5 total cases per decade per resident (95% CI 10.4-66.7; p = 0.007) associated with duty-hour restrictions.

DISCUSSION

Surgical education has undergone a broad transformation due to changes to the traditional residency paradigm and shifting clinical practices. Implementation of the 80-hour workweek may have had detrimental effects on resident education by decreasing exposure to advanced procedures, limiting continuity of care, and decreasing autonomy.[13,14] In light of these changes, our study analyzed national trends for oncologic-relevant cases performed by general surgery residents in order to

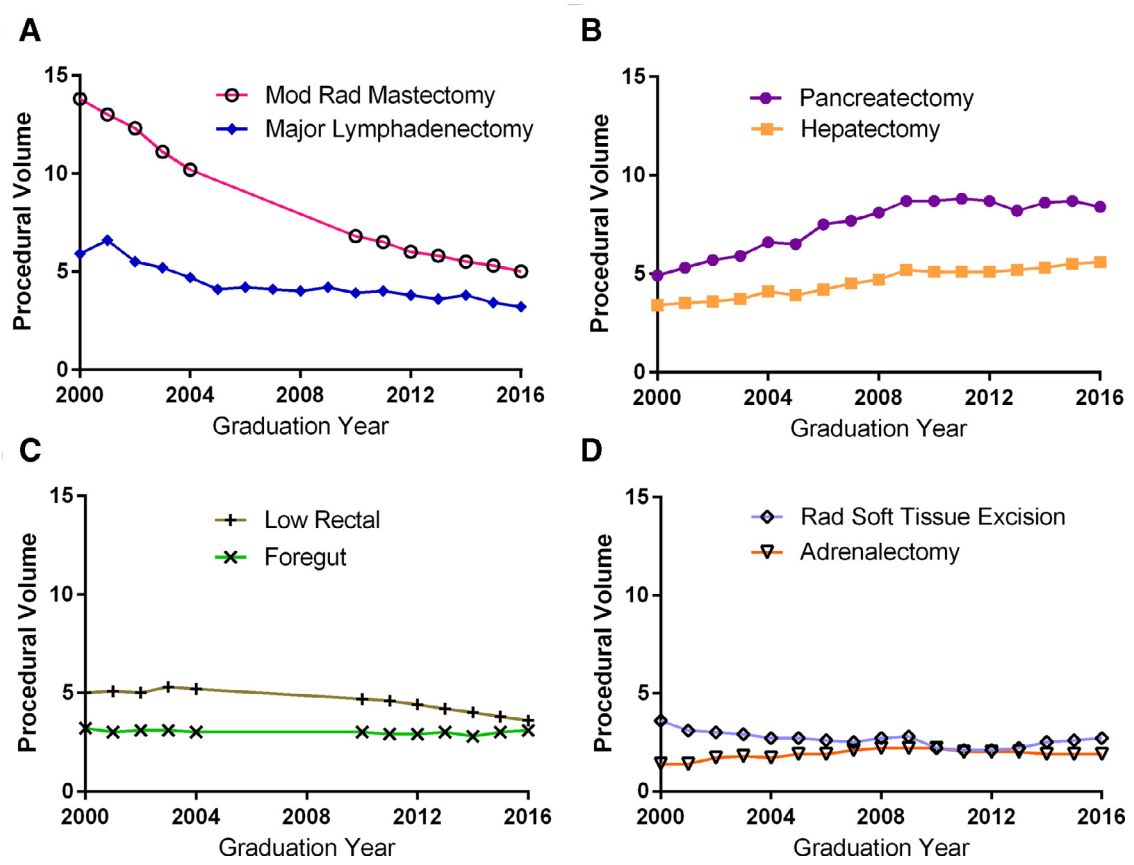

FIGURE 1. Trends in "Surgeon Total" procedural volumes by graduating academic year for (A) modified radical mastectomies and major lymphadenectomies, (B) pancreatectomies and major hepatectomies, (C) low rectal resections (APR and TRE) and foregut cases (esophagectomies and total gastrectomies), and (D) radical soft-tissue resections and adrenalectomies.

determine whether additional oncologic fellowship training is justified. We hypothesized that resident exposure to these procedures has decreased over time reflecting not only shifting practices but also structural changes in the traditional residency model. Temporal trends in select cases were analyzed in the context of duty-hour reforms and case minimums for oncologic surgery fellowship pathways.

We confirmed the presence of decreasing temporal trends and low operative exposure for several complex oncology-relevant cases, suggesting that further fellowship training may be necessary to achieve technical proficiency. Notably, statistically significant decreasing trends were noted for resident exposure to major lymphadenectomies, MRMs, and low rectal cases. The average case numbers remained largely unchanged and quite low for complex foregut cases over the study period. Despite a slight increase of resident exposure to adrenalectomies from 1.4 to 1.9 cases over the study, the mean remains low. An increase was noted in HPB cases, with residents performing approximately 8 pancreatic and 5 hepatic resections during residency in 2016.

The decline in overall exposure to certain cases is likely a result of practice changes including greater use of sentinel lymph node biopsies, increased nodal observation in melanoma, and increased utilization of primary chemotherapy in stage IV rectal cancer.[15-18] In addition, increased centralization to tertiary centers as well as improvements in medical management for peptic ulcer disease has likely contributed to low overall resident exposure to resectional foregut procedures.[19,20] These findings not only demonstrate the evolving practices within general surgery, but also reveals limited exposure to complex oncologic procedures during residency training. Several studies reflect these deficiencies as a significant proportion of graduating residents do not feel comfortable performing adrenalectomies, TREs, APRs, esophagectomies, and HPB procedures.[6,21-23] Table 2 compares minimum case requirements for completion of training across various oncologic subspecialty surgical fellowships with general surgery residency, highlighting differences in not only case complement and number, but varying emphasis on learning multidisciplinary care through case presentations.[24-27]

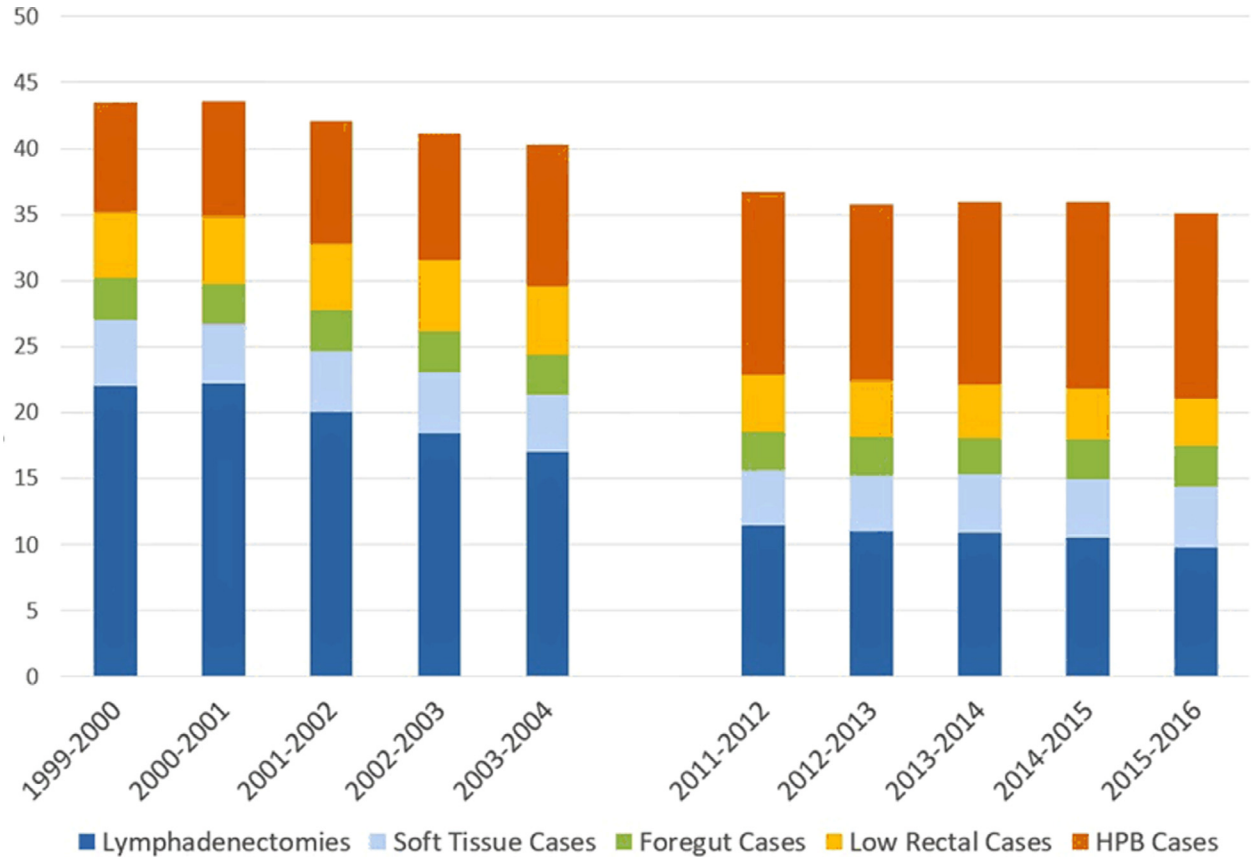

FIGURE 2. Average graduating resident case volume by procedural categories.

When controlling for estimated work hours of graduating residents, Figure 3A demonstrates that average case numbers have increased but may have reached a plateau at 50 cases per 1000 duty-hours (960 cases performed per 19,200 hours worked during a 5-year residency). There was an increase from 36.6 to 51.4 in total cases per 1000-hours worked, and 1.6 to 1.8 oncology-relevant complex cases per 1000-hours worked across the study interval. Our examination of total case volume controlled for estimated work hours reveals that case numbers dropped acutely but later rebounded as programs adapted to duty-hour reforms, a finding confirmed by Drake et al.[28] However, in contrast, this recovery is not nearly as promising upon review of the oncology-relevant procedures, which remained virtually the same across the study interval. While total case number may have recovered secondary to more effective time utilization by residents, our findings suggest that residency programs have been less successful in adapting to the effects of duty-hour restrictions in regards to operative exposure to complex oncologic cases, possibly due to changes in surgical indication.

Our analysis of resident case volume in the context of changing practices, duty-hour reforms, and oncologic surgery fellowship case minimum requirements reflect a shifting role of the general surgeon. Resident exposure to more common oncologic procedures like colon resections and partial or simple mastectomies was not specifically addressed by this study but will likely remain sufficient, and we foresee that general surgeons will be expected to remain critical in the management of majority of such cancer patients. However, the average graduating general surgeon may not be sufficiently equipped to perform some of the complex oncologic procedures examined in this study based on numbers alone. Since duty-hour reform, surgical training has demanded competency over a broader domain of procedures while concurrently offering less training time and autonomy.[29] Moreover, open approaches have decreased to 4% of all cholecystectomies, plummeting from an average of 70 per chief to 3.6, necessitating other approaches to teaching techniques such as choledochoscopy and common bile duct explorations.[30-32] With decreasing exposure to open cases, the technical learning curve particularly for complex oncologic procedures may extend into junior faculty years as operative volume and experience correlates with procedural confidence.[33]

Fellowship programs have proliferated to accommodate these demands. In addition to developing technical proficiency using case volume as a surrogate metric,

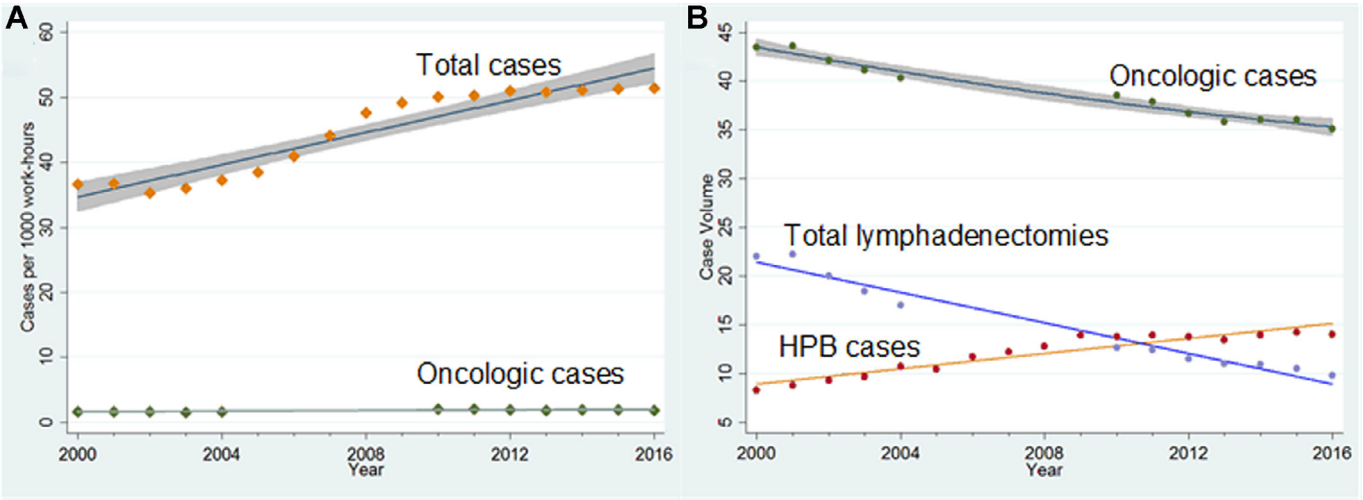

FIGURE 3. Linear regression for temporal trends of cases completed by graduating surgical residents from 2000 to 2016. (A) Total cases and complex oncology-relevant case totals are divided by estimated number of duty hours completed at graduation to provide cases per 1000 work-hours over time. (B) Complex oncology-relevant case totals, total lymphadenectomies, and HPB cases are reported as average counts over time. Gray shading indicates 95% confidence intervals.

many fellowship-training paradigms (including breast oncology and CGSO) also aim for comprehensive exposure to the multidisciplinary management of cancer by including nonoperative rotations in medical oncology, radiation oncology, and pathology. While fellowships would serve as additional time to make up for the "estimated 20% lost hours" resulting from duty-hour restrictions, they offer the opportunity for the trainee to focus and better understand the complexity of delivery and timing of cancer therapies, as well as hone confidence to become leaders of multidisciplinary teams. In addition to increasing case volume, fellowships may also shift exposure toward more complicated cases. However, fellowships have burdens including the impact of delaying entry into clinical practice on student debt.[34]

There are several limitations to this study. Case logs are subject to recall and reporting bias, which may lead to underestimation of cases performed and overall operative experience.[35,36] Moreover, resident case logs do not differentiate between oncologic and nononcologic cases. Cases were selected based on relevance to oncologic procedures with the assumption that cases with potentially nononcologic indications would promote development of transferable skills and experience for performing cancer-related procedures. This assumption has the potential to overestimate resident experience with cancer-related procedures. While there were missing case logs for select procedures like MRM and APR from 2005 to 2009, the analysis was based on linear trends and regression slopes from graduating years 2000 to 2016, so point estimates and CIs are still able to be provided. In addition, while we modeled with an estimated 80-hour workweek starting in July 2003, residents may have been delayed in this transition, and may now be working less hours with more efficient use of physician extenders. In addition, it is not clearly known how much time the average surgical resident spent working (or residing in hospitals) prior to July 2003, although this is assumed to be over 100 hours per week in many programs,[37,38] particularly if call varied between every 3 days to every 2 days with minimal days off per month. Finally, we were not able to directly compare general surgery resident case logs concurrently with colorectal surgery or CGSO resident case logs as these are not publicly available, so are unable to determine the influence of competing fellowship and residency programs on general surgery resident case numbers.

Of emphasis is the value of honing the development and maturation of clinical competence of the oncology trainee, with a focus on gaining a better understanding of tumor biology and how that dictates clinical management. Efforts to re-evaluate minimum case numbers are underway for CGSO training programs, but this will be through a combination of traditional case numbers (n = 240 minimum), as well as "multidisciplinary cases" (n = 120), where the trainee will log their involvement in multidisciplinary tumor board discussions.[9] With refinements to general surgery training programs using milestones and entrustable professional activities, we see an important focus in measuring competency in individual residents beyond time and case volume.[2,39,40] Ultimately, a balance must be found between training specialists who can competently manage the uncommon and complex, and training a much larger body of general surgeons who will

TABLE 2. Minimum Case Requirements for Oncologic Surgery Fellowships and General Surgery Residency[16-19]

Major Oncologic Cases	Breast Surgery	Colorectal Surgery	HPB	General Thoracic	Complex General Surgical Oncology	General Surgery
Partial mastectomy	50				40 breast cases with 25 multidisciplinary case presentations	40 breast cases with 5 mastectomies and 5 axillary cases
Total mastectomy	40					
Axillary sentinel node biopsy	50	NA	NA	NA		
Completion axillary node dissection	5					
Transanal rectal excision		10			50 non-HPB gastrointestinal oncology cases with 25 multidisciplinary case presentations	180 alimentary tract cases‡
Abdominoperineal resection	NA	5				
Pelvic node dissection		30 with 20 rectal cancer dissections				
Esophagectomy		NA		20†		
Total gastrectomy						
Major hepatectomy			25	NA	35 major HPB cases with 25 multidisciplinary case presentations	5 liver cases
Pancreatectomy			25*			5
Radical soft-tissue resection			NA		30 melanoma and soft-tissue sarcoma cases	25 skin and soft-tissue cases§

*HPB fellowships also require 15 major biliary tract procedures in addition to 25 major hepatic resections and 25 major pancreatic procedures.
†General thoracic residency requires 35 esophageal procedures comprising 20 esophagectomies, 10 benign esophageal cases, and 5 hiatal/paraesophageal hernia cases.
‡General surgery residency requires 180 total alimentary tract cases with no specific requirements for major oncologic cases. 5 esophagus, 15 stomach, 25 small intestine, 40 large intestine, 40 appendix, and 20 anorectal cases are required.
§General surgery residency requires 25 total skin and soft-tissue cases with no specific requirements for oncologic relevance.

remain critical for managing the majority of cancers faced by our urban and rural populations.

REFERENCES

1. Malangoni MA, Biester TW, Jones AT, et al. Operative experience of surgery residents: trends and challenges. *J Surg Educ*. 2013;70:783–788.
2. Nasca TJ, Philibert I, Brigham T, Flynn TC. The next GME accreditation system—rationale and benefits. *N Engl J Med*. 2012;366:1051–1056.
3. Carson JS, Smith L, Are M, et al. National trends in minimally invasive and open operative experience of graduating general surgery residents: implications for surgical skills curricula development? *Am J Surg*. 2011;202:720–726.
4. Eckert M, Cuadrado D, Steele S, et al. The changing face of the general surgeon: national and local trends in resident operative experience. *Am J Surg*. 2010;199:652–656.
5. Kairys JC, McGuire K, Crawford AG, Yeo CJ. Cumulative operative experience is decreasing during general surgery residency: a worrisome trend for surgical trainees? *J Am Coll Surg*. 2008;206:804–813.
6. Friedell ML, VanderMeer TJ, Cheatham ML, et al. Perceptions of graduating general surgery chief residents: are they confident in their training? *J Am Coll Surg*. 2014;218:695–703.
7. Mattar SG, Alseidi AA, Jones DB, et al. General surgery residency inadequately prepares trainees for fellowship: results of a survey of fellowship program directors. *Ann Surg*. 2013;258:440–449.
8. Michelassi F. 2010 SSO presidential address: subspecialty certificate in advanced surgical oncology. *Ann Surg Oncol*. 2010;17:3094–3103.
9. Tyler DS, Michelassi F. Finish line or beginning? Welcome the new board-certified surgical oncologists. *Ann Surg Oncol*. 2016;23:1403–1408.
10. ACGME General Surgery case log statistical reports. Available at: http://www.acgme.org/Data-Collection-Systems/Case-Logs-Statistical-Reports. Accessed January 20, 2018.
11. American Board of Surgery Training Requirements. Available at: http://www.absurgery.org/default.jsp?certgsqe_training Accessed January 20, 2018.
12. Greenland S. An introduction to instrumental variables for epidemiologists. *Int J Epidemiol*. 2000;29:722–729.
13. Feanny MA, Scott BG, Mattox KL, Hirshberg A. Impact of the 80-hour work week on resident emergency operative experience. *Am J Surg*. 2005;190:947–949.
14. Watson DR, Flesher TD, Ruiz O, Chung JS. Impact of the 80-hour workweek on surgical case exposure within a general surgery residency program. *J Surg Educ*. 2010;67:283–289.
15. Joyce DP, Lowery AJ, McGrath-Soo LB, et al. Management of the axilla: has Z0011 had an impact? *Ir J Med Sci*. 2016;185:145–149.
16. Faries MB, Thompson JF, Cochran AJ, et al. Completion dissection or observation for sentinel-node metastasis in melanoma. *N Engl J Med*. 2017;376:2211–2222.
17. Pilewskie M, Morrow M. Axillary nodal management following neoadjuvant chemotherapy: a review. *JAMA Oncol*. 2017;3:549–555.
18. Hu CY, Bailey CE, You YN, et al. Time trend analysis for primary tumor resection for stage IV colorectal cancer. *JAMA Surg*. 2015;150:245–251.
19. Barnes R. The next generation of surgical residencies: what are the challenges and the opportunities? *Arch Surg*. 1990;125:433–436.
20. Kauffman GL Jr. Duodenal ulcer disease: treatment by surgery, antibiotics, or both. *Adv Surg*. 2000;34:121–135.
21. Fronza JS, Prystowsky JP, DaRosa D, Fryer JP. Surgical residents' perception of competence and relevance of the clinical curriculum to future practice. *J Surg Educ*. 2012;69:792–797.
22. Goitein D, Mintz Y, Gross D, Reissman P. Laparoscopic adrenalectomy: ascending the learning curve. *Surg Endosc*. 2004;18:771–773.
23. Sachs TE, Ejaz A, Weiss M, et al. Assessing the experience in complex hepatopancreatobiliary surgery among graduating chief residents: is the operative experience enough? *Surgery*. 2014;156:385–393.
24. 2014 breast surgical oncology fellowship curriculum and minimum training requirements. Available at: http://www.surgonc.org/docs/default-source/pdf/2014_breast_fellowship_curriculum_training_-requirements.pdf?sfvrsn=2 Accessed January 20, 2018.
25. ACGME review committee for colon and rectal surgery, minimum case numbers. Available at: http://www.acgme.org/Portals/0/PFAssets/ProgramResources/060_CRS_Minimum_Case_Numbers.pdf Accessed January 20, 2018.

26. AHPBA Certification requirement: HPB surgical fellowship, Version April 5, 2015. Available at: http://www.ahpba.org/documents/fellowship/15HBPreq.pdf Accessed January 20, 2018.

27. American Board of Thoracic Surgery Index case requirements, effective July 1, 2017. Available at: http://www.abts.org/ABTS/Initial_Certification/Operative_Requirements/Index%20Case%20Requirements-2017.aspx Accessed January 20, 2018.

28. Drake FT, Horvath KD, Goldin AB, Gow KW. The general surgery chief resident operative experience: 23 years of national ACGME case logs. *JAMA Surg*. 2013;148:841–847.

29. Teman NR, Gauger PG, Mullan PB, et al. Entrustment of general surgery residents in the operating room: factors contributing to provision of resident autonomy. *J Am Coll Surg*. 2014;219:778–787.

30. Helling TS, Khandelwal A. The challenges of resident training in complex hepatic, pancreatic, and biliary procedures. *J Gastrointest Surg*. 2008;12:153–158.

31. Schulman CI, Levi J, Sleeman D, et al. Are we training our residents to perform open gallbladder and common bile duct operations? *J Surg Res*. 2007;142:246–249.

32. Sirinek KR, Willis R, Schwesinger WH. Who will be able to perform open biliary surgery in 2025? *J Am Coll Surg*. 2016;223:110–115.

33. Maruthappu M, Duclos A, Lipsitz SR, et al. Surgical learning curves and operative efficiency: a cross-specialty observational study. *BMJ Open*. 2015;5:e006679.

34. Kassebaum DG, Szenas PL, Schuchert MK. On rising medical student debt: in for a penny, in for a pound. *Acad Med*. 1996;71:1124–1134.

35. Okike K, Berger PZ, Schoonover C, O'Toole RV. Do orthopaedic resident and fellow case logs accurately reflect surgical case volume? *J Surg Educ*. 2018;75(4):1052–1057.

36. Nygaard RM, Daly SR, Van Camp JM. General surgery resident care logs: do they accurately reflect resident experience? *J Surg Educ*. 2015;72:e178–e183.

37. Hutter MM, Kellogg KC, Ferguson CM, et al. The impact of the 80-hour resident workweek on surgical residents and attending surgeons. *Ann Surg*. 2006;243:864–875.

38. Whiting JF. Of puppies and dinosaurs: why the 80-hour work week is the best thing that ever happened in American Surgery. *Arch Surg*. 2010;145:320–321.

39. Cogbill TH, Malangoni MA, Potts JR, Valentine RJ. The general surgery milestones project. *J Am Coll Surg*. 2014;218:1056–1062.

40. Lindeman B, Petrusa E, Phitayakorn R. Entrustable professional activities (EPAs) and applications to surgical training. Available at: http://www.facs.org/education/division-of-education/publications/rise/articles/entrustable Accessed January 20, 2018.

SUPPLEMENTARY INFORMATION

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