Assessment of open operative vascular surgical experience among general surgery residents

Brianna M. Krafcik, MS,[a] Teviah E. Sachs, MD, MPH,[b] Alik Farber, MD,[a] Mohammad H. Eslami, MD,[a] Jeffrey A. Kalish, MD,[a] Nishant K. Shah, BS,[a] Matthew R. Peacock, BS,[a] and **Jeffrey J. Siracuse, MD,[a]**
Boston, Mass

Background: **General surgeons have traditionally performed open vascular operations. However, endovascular interventions, vascular residencies, and work-hour limitations may have had an impact on open vascular surgery training among general surgery residents. We evaluated the temporal trend of open vascular operations performed by general surgery residents to assess any changes that have occurred.**
Methods: **The Accreditation Council for Graduate Medical Education's database was used to evaluate graduating general surgery residents' cases from 1999 to 2013. Mean and median case volumes were analyzed for carotid endarterectomy, open aortoiliac aneurysm repair, and lower extremity bypass. Significance of temporal trends were identified using the R^2 test.**
Results: **The average number of carotid endarterectomies performed by general surgery residents decreased from 23.1 ± 14 (11.6 ± 9 chief, 11.4 + 10 junior) cases per resident in 1999 to 10.7 ± 9 (3.4 ± 5 chief, 7.3 ± 6 junior) in 2012 ($R^2 = 0.98$). Similarly, elective open aortoiliac aneurysm repairs decreased from 7.4 ± 5 (4 ± 4 chief, 3.4 ± 4 junior) in 1999 to 1.3 ± 2 (0.4 ± 1 chief, 0.8 ± 1 junior) in 2012 ($R^2 = 0.98$). The number of lower extremity bypasses decreased from 21 ± 12 (9.5 ± 7 chief, 11.8 ± 9 junior) in 1999 to 7.6 ± 2.6 (2.4 ± 1.3 chief, 5.2 + 1.8 junior) in 2012 ($R^2 = 0.94$). Infrapopliteal bypasses decreased from 8.1 ± 3.8 (3.5 ± 2.2 chief, 4.5 ± 2.9 junior) in 2001 to 3 ± 2.2 (1 ± 1.6 chief, 2 ± 1.6 junior) in 2012 ($R^2 = 0.94$).**
Conclusions: **General surgery resident exposure to open vascular surgery has significantly decreased. Current and future graduates may not have adequate exposure to open vascular operations to be safely credentialed to perform these procedures in future practice without advanced vascular surgical training. (J Vasc Surg 2016;63:1110-5.)**

General surgery residents are increasingly seeking additional training after residency.[1] It has been reported that 27.5% of American general surgery residency graduates do not feel confident operating independently at graduation, and approximately 70% of general surgery residents pursue postresidency fellowship training.[1,2] Furthermore, in a survey of postgraduate year 5 (PGY-5) residents, 23% responded "no" or "unsure" when asked whether a 5-year general surgery residency prepared them to practice the full breadth of general surgery.[3] This response may be due in part to the implementation of the 80-hour work week, duty hours limitations, more subspecialty fellowships, and less case exposure during training.

General surgeons have traditionally performed open vascular surgery operations, including carotid endarterectomy (CEA), open aortoiliac aneurysm repair (OAR), and lower extremity bypass (LEB), particularly in rural areas.[4] The rise of endovascular surgery, vascular-specific residencies, and work-hour limitations may have negatively affected general surgery residents' exposure to open vascular surgery cases. Overall, exposure to subspecialty cases among general surgery residents has been shown to be gradually decreasing, specifically in vascular, thoracic, and trauma surgery.[5] This decrease in exposure could potentially limit the ability of future general surgeons to safely perform open vascular operations.[6-8] It is important to assess this fundamental change in trainee exposure to open vascular operations, both for patient safety and to adequately address future physician demands.

We evaluated the temporal trends of open vascular operations performed by general surgery residents using the American College of Graduate Medical Education (ACGME) resident case logs. Our primary goal was to quantify general surgery resident training experience with vascular surgery procedures. Further, our objective was to assess the temporal trend to see if there is a significant decrease in these procedures and if there was a clear change in any specific time period.

From the Division of Vascular and Endovascular Surgery[a] and Division of General Surgery,[b] Department of Surgery, Boston University School of Medicine, Boston Medical Center.
Author conflict of interest: none.
Correspondence: Jeffrey J. Siracuse, MD, Division of Vascular and Endovascular Surgery, Boston Medical Center, 88 East Newton St, Boston, MA 02118 (e-mail: jeffrey.siracuse@bmc.org).
The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.
0741-5214

http://dx.doi.org/10.1016/j.jvs.2015.09.062

METHODS

Publicly available ACGME statistical reporting on resident case logs was analyzed from 1999 to 2012 to identify general surgery resident participation in open vascular surgery cases. The ACGME records and provides statistical analysis of the self-reported case volumes entered by surgical residents and are categorized by specific procedure. These data are recorded as the average, standard deviation, and maximum number of each procedure type for all graduating surgical residents for a given year. The database is further subdivided by "surgeon chief," "surgeon junior," and "surgeon total." The "surgeon chief" category denotes cases performed by a PGY-5 or chief resident, while "surgeon junior" refers to cases completed during the 4 years prior to the chief year, coinciding with PGY 1 through 4. The "surgeon total" category represents the total number of cases performed by a graduating chief resident over the course of 5 years of training. This project was approved by the investigational review board at Boston University, and patient consent was waived.

The classification of each operation changed slightly over the time period considered, however, they were still easily identifiable across the years. For the purposes of this study, we evaluated three categories: CEA, OARs (ruptured and elective), and infrainguinal LEBs (all and infrapopliteal). Data specifically referring to infrapopliteal bypass and femoral-popliteal bypass were only available after 2001. Operative volume for each case was reported as mean, standard deviation, maximum number of cases for a specific resident, and total number of cases performed. The data also contained more broad classifications such as cerebrovascular, aneurysms, and peripheral obstructive (lower extremity) categories for median, 10th percentile, and 90th percentile for residents. The year listed for the data is the start of the academic year. Linear trends in the data were analyzed with SAS 9.3 (SAS Corp, Cary, NC) using a goodness-of-fit model based on the means, reported as R^2 (range, 0-1).[7] The R^2 tests goodness of fit and trend. We chose to perform an R^2 on our data to examine the overall trend rather than addressing a specific point in time. We considered analyzing based on the 80-hour work week, the development of endovascular interventions, and the integrated residencies individually. We felt that analyzing any of these three categories would be difficult because their implementation was most likely quite variable depending on institution or location. Integrated vascular surgery residencies have only recently graduated residents, with very low numbers. Many programs have yet to graduate a resident, and it would be unclear at this point what the full effect of the integrated residencies is. We also cannot determine which programs have an integrated program and which do not and how far along they are. The 80-hour work week started earlier in New York state than in other places and was not universally enforced in many locations once started. Also, many residents take 7 years to finish a program, and it would not be clear which individuals may have been affected earlier in their residency. Endovascular skill sets were introduced slowly over time, and some programs were more aggressive than others when it came to incorporating these into their practice. Therefore, for each of the three points, it would be difficult to pinpoint an ideal time to analyze each one.[7]

RESULTS

Overall. The ACGME recorded case volumes of 12,283 graduating general surgery residents from 1999 to 2012. A total of 487,761 open vascular surgery cases was completed by graduating chief residents during this time period. The majority of cases were CEAs (236,379, 48.5%). There were 68,488 (14%) open OARs, with more elective repairs (56,304, 11.5% of total cases) than ruptured (12,184, 2.5% of total cases). There were 182,893 LEBs recorded (37.5%)—further divided into infrapopliteal bypass (61,098, 12.5% of total cases).

Carotid/cerebrovascular. A decrease in case volume was identified across all categories for both chief and junior residents. The total number of CEA cases decreased from 22,826 in 1999 to 11,749 in 2012, with a similar decrease in the average number of cases per trainee (23.1 ± 14 to 10.7 ± 9, R^2 = .98). The mean number of CEA cases completed during the chief resident year showed an even more dramatic decrease, from 11.6 ± 9 cases to 3.4 ± 5 (R^2 = .98): a 71% decrease in 14 years (Fig 1). For cases recorded as surgeon junior, the volume decreased 29% from 11,313 to 8015, or an average of 11.4 ± 10 cases per resident to 7.3 ± 6 (R^2 = .95; Fig 1). Median cerebrovascular numbers were not specifically recorded, however, the median (10th, 90th percentile) number of cases recorded as cerebrovascular decreased from 22 (11, 42) to 11 (4, 23; Table).

Aneurysm repair. Nonruptured infrarenal OAR case volume decreased 80% from a total of 7315 to 1,427, translating to a decrease in the average number of these cases per graduating resident from 7.4 ± 5 cases to 1.3 ± 2 per year (R^2 = .98). The average number of cases performed during the chief year decreased tenfold, from 4 ± 4 to 0.4 ± 1 (R^2 = .97). These elective repair cases decreased during the junior resident years as well, from a mean of 3.4 ± 4 to 0.8 ± 1 (R^2 = .98; Fig 2, *a*). Open repair of ruptured infrarenal OARs showed a similar decrease in total (from 1421 to 439) and average (1.4 ± 2 to 0.4 ± 1) case volume (R^2 = .97). Chief residents' volume dropped from 812 to 110 and to an average of 0.8 ± 1 to 0.1 ± 0 (R^2 = .95; Fig 2, *b*). Median aneurysm repair overall did not delineate rupture status, but the overall volume similarly decreased (surgeon total: 11 [5, 21] to 6 [2, 14]; Table).

Open lower extremity. LEB cases decreased 60% from 1999 to 2012 from a total of 21,013 cases to 8345, with the mean resident numbers decreasing from 21 ± 12 to 7.6 ± 2.6 (R^2 = .94), (chief: 9.5 ± 7 to 2.4 ± 1.3, R^2 =. 92; junior: 11.8 ± 9 to 5.2 ± 1.8, R^2 = .96; Fig 3, *a*). Median overall cases for the broader classification of lower extremity peripheral obstructive cases fell from 26 (14, 43) in 1999 to 18 (9, 36) in 2012. Specific data on infrapopliteal bypass case volume were