

From the Midwestern Vascular Surgical Society

Progressive shortfall in open aneurysm experience for vascular surgery trainees with the impact of fenestrated and branched endovascular technology



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ABSTRACT

Background: In 2014, we published a series of articles in the *Journal of Vascular Surgery* that detailed the decrease in volume of open aneurysm repair (OAR) completed for abdominal aortic aneurysm (AAA) by vascular surgery trainees. At that time, only data points from 2000 through 2011 were available, and reliable predictions could only be made through 2015. Lack of data on endovascular aneurysm repair (EVAR) using fenestrated (FEVAR) and branched (BrEVAR) endografts also affected our findings. Despite these limitations, our predictions for OAR completed by vascular trainees were accurate for 2012 to 2014. This report uses updated data points through 2014 in conjunction with data on FEVAR and BrEVAR obtained from industry to predict trends in OAR and how it will affect vascular surgery training through 2020.

Methods: An S-curve modified logistic function was used to model the effect of introducing new technologies (EVAR, FEVAR, BrEVAR) on the standard management of AAA with OAR starting in the year 2000, similar to the technique that we have previously described. Weighted samples and data from the United States Census Bureau were used in conjunction with volume estimates derived from the National Inpatient Sample, State Inpatient Databases, and industry sources to determine trends in OAR and EVAR. The number of cases completed at teaching hospitals was calculated using the National Inpatient Sample, and Accreditation Council for Graduate Medical Education case logs were used to forecast the number of cases completed by vascular surgery trainees through 2020. Sensitivity analysis and trend analysis were completed.

Results: Approximately 45,000 AAA repairs are completed annually in the United States, but only 15% of these are now completed using OAR compared with >50% just a decade ago. Further, with the accelerating adoption of FEVAR and BrEVAR, and expanding indications for standard EVAR, our model predicts that <3000 OARs will be completed annually by 2020. Because only a subset of these cases are completed at teaching institutions, our model predicts that a vascular surgery trainee in a fellowship program will complete only one to two OARs, whereas trainees in a 0+5 program may complete two to three OARs.

Conclusions: Our initial prediction in the 2014 report was that vascular trainees would complete approximately five OARs by 2020. After incorporating new data on BrEVAR, FEVAR, and the accelerating pace of EVAR use between 2012 and 2014, it now appears that vascular trainees will complete one to three OARs during their training. (J Vasc Surg 2017;65:257-61.)

The use of endovascular abdominal aortic aneurysm (AAA) repair (EVAR) in recent years has transformed the paradigm of surgical management of AAAs. Epidemiologic evidence

shows improved short-term mortality and reduced short-term hospital length of stay when EVAR is compared with open AAA repair (OAR) in the perioperative period.¹⁻⁴ Reduced perioperative mortality has also been seen in elective patients with moderate-risk to high-risk comorbidities in a Medicare risk-prediction model.⁵ Implementation of EVAR has further contributed to a reduction in total deaths associated with intact and ruptured AAA, including a decreased requirement for ruptured repairs.⁵

Such data have justified the progressive increase in the proportion of EVARs performed each year for AAAs. From 2000 to 2010, the proportion of EVARs used in total AAA repairs rose from 5.2% to 74%. Despite this rise, the total number of patients presenting for AAA repair (ruptured and unruptured) has remained constant at 45,000. There is concern that the number of OARs performed may be insufficient for the Accreditation Council for Graduate Medical Education (ACGME) graduation requirement of

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Author conflict of interest: none.

Presented as an oral presentation at the Thirty-ninth Annual Meeting of the Midwestern Vascular Surgical Society, Chicago, Ill, September 10-12, 2015.

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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

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30 total cases for vascular surgery trainees with a minimum requirement of five OARs per year. From 1999 to 2008, OARs performed by vascular fellows dropped on average from 44.4 to 21.6 per fellow per year.⁶ This is considered chiefly problematic because a high individual physician case volume of OARs has been associated with greater mortality reduction than is associated with high institution case volume.^{7,8}

Some have suggested that OAR numbers will continue to see further decline because fenestrated (FEVAR) and branched (BrEVAR) endograft techniques are also being used to achieve greater anatomical compliance in AAA repair.^{1,2,9} FEVAR and BrEVAR implementation has shown reduced perioperative respiratory complications compared with OAR.¹⁰ Despite a high degree of procedural difficulty, FEVAR and BrEVAR have also been beneficial for juxtarenal and thoracoabdominal aortic aneurysm repair after previous EVAR or OAR, including patients considered high risk.¹¹

Through previous work, we estimated reliable predictions for OAR numbers at teaching hospitals through 2015 based on the National Inpatient Sample (NIS), State Inpatient Databases, and ACGME case log data from 2000 to 2011.^{1,2} Regression estimates through 2012 to 2014 have proven to be accurate. Future predictions, however, have been limited because of a lack of data on FEVAR and BrEVAR endograft implementation. Therefore, in this study, we examined updated data points through 2014 and included industry numbers on FEVAR and BrEVAR to provide increasingly accurate predictions for the amount of available OARs for vascular surgery trainees through 2020.

METHODS

Database and selection. A retrospective analysis was completed using the NIS, a part of the Health Care Utilization Project that is maintained by the Agency for Healthcare Research and Quality. The NIS is the largest all-payer inpatient database and includes a stratified 20% random sample of all nonfederal inpatient hospital admissions throughout the United States. Clinical records were derived using the Ninth Revision of the International Classification of Diseases diagnosis and procedure codes to ensure that the sample included patients who underwent treatment primarily for AAA. This study was exempt from Institutional Review Board approval given the deidentified nature of the data via a large database. Patient consent was not required.

"Open aneurysm" included infrarenal AAA, juxtarenal AAA, pararenal AAA, and suprarenal AAA. Variables included the year and procedure performed.

An S-curve modified logistic function was used to model the effect of introducing new technologies (EVAR, FEVAR, BrEVAR) on the standard management of AAA with OAR starting in the year 2000, similar to the technique that we have previously described.² New

technologies undergo predictable growth over time that can be modeled using S-curve logistic regressions. S-curve modified logistic regression is best suited for modeling systems in which new technology is adopted and the rate of initial adoption is slow until some critical mass (ie, sufficiently trained physicians) is reached. Adoption is then fast until a saturation point is reached (ie, patients not candidates for EVAR). Weighted samples and data from the United States Census Bureau were used in conjunction with volume estimates derived from the NIS, State Inpatient Databases, and industry sources to determine trends in OAR and EVAR. Specifically, the State Inpatient Database was used to confirm the numbers acquired from the Current Procedural Terminology (American Medical Association, Chicago, Ill) codes within the NIS. From the ACGME, the mean number of cases done for AAA repair was documented. Finally, industry (Cook Medical, Bloomington, Ind) provided the FEVAR and BrEVAR figures. The number of cases completed at teaching hospitals was calculated using the NIS, and ACGME case logs and used to forecast the number of cases completed by vascular surgery trainees through 2020 (prediction modeling). Sensitivity analysis and trend analysis were completed.

RESULTS

Approximately 45,000 AAA repairs are completed annually in the United States, but only 15% of these are now completed using OAR compared with >50% just a decade ago (Fig). Further, with the accelerating adoption of FEVAR and BrEVAR and expanding indications for standard EVAR, our model predicts that <3000 OAR will be completed annually by 2020 (Table). Because only a subset of these cases are completed at teaching institutions, our model predicts that a vascular surgery trainee in a fellowship program will complete only one to two OARs, whereas trainees in a 0+5 program may complete two to three OARs (Fig; Table).

DISCUSSION

EVAR continues to rise in proportion to OAR in AAA repair given favorable perioperative outcomes and reduced hospital length of stay, among other benefits.¹ As EVAR has gained favor, the proportion of OARs dropped from 95% of the total case load in 2000 to just 20% in 2012. Despite the acknowledged rise of EVAR and the recent advent of FEVAR and BrEVAR graft techniques, AAA repairs have remained constant at 45,000.

The decline in the number of OARs performed each year has resulted in significant apprehension within the vascular community given an associated link between institutional and individual surgeon case volume and the mortality rate of OAR.^{12,13} Furthermore, vascular trainees will have progressive difficulty meeting graduation and minimal yearly competency requirements. Residents have performed progressively fewer open vascular

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