

## Selected Abstracts from the October Issues of the Journal of Vascular Surgery and the Journal of Vascular Surgery: Venous and Lymphatic Disorders<sup>☆</sup>

Editors: Peter Gloviczki and Peter F. Lawrence

### Variation in the elective management of small abdominal aortic aneurysms and physician practice patterns

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**Objective:** Recent vascular societal guidelines have recommended an abdominal aortic aneurysm (AAA) size threshold for elective intervention; however, limited data have documented how well these AAA diameter benchmarks are being met. The objective of this study was to analyze variation in management of AAAs based on diameter and to determine the physician's rationale for intervention on small AAAs in relation to recommended treatment guidelines.

**Methods:** A retrospective review of a statewide vascular surgery registry of all elective endovascular or open surgical AAA repairs from January 2012 to January 2016 was performed. Patients were dichotomized on the basis of aortic diameter at time of intervention into either guideline size AAAs or small AAAs, which were defined as <5.5 cm in men, <5.0 cm in women, or with growth <1.0 cm/y. An internal review was conducted of all small AAAs to determine the physician's rationale for intervention. The primary outcomes were variation in adherence to recommended treatment guidelines and the physician's rationale for treatment of small AAAs. Risk-adjusted major complication and mortality rates were calculated at 30 days and 1 year using a propensity score matching analysis.

**Results:** Among the 3932 patients who underwent an elective AAA repair, 485 (12.3%) were repaired at diameters smaller than recommended by guidelines. The median AAA size in the small AAA cohort was 5.1 cm (interquartile range, 4.7-5.3 cm) vs 5.6 cm (interquartile range, 5.2-6.1 cm) in the guideline-based group. Percentage of small AAA repairs varied widely between hospitals from 1.4% to 44.4%. The physician's rationale for the majority of early interventions included the patient's anxiety (12.0%), combined aortoiliac occlusive disease (14.8%), aneurysm anatomy (28.2%), and does not adhere to guidelines (30%). The small AAA cohort had no significant difference in the 30-day or 1-year risk-adjusted mortality in comparison to guideline size AAAs.

**Conclusions:** Despite well-established aortic diameter threshold guidelines, marked variation exists both at the hospital level and in terms of the physician's rationale for

the management of elective AAA repairs. These findings demonstrate the challenge of providing uniform care for patients with AAAs despite established guidelines.

### The 10-year outcomes of a regional abdominal aortic aneurysm screening program

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**Objective:** In 2007, Medicare established ultrasound screening guidelines to identify patients at risk for abdominal aortic aneurysm (AAA). The purpose of this study was to evaluate AAA diagnosis rates and compliance with screening during 10 years (2007-2016) of the Screen for Abdominal Aortic Aneurysms Very Efficiently Act implementation within a regional health care system.

**Methods:** A retrospective chart review of all patients screened for AAA from 2007 to 2016 within a regional Veterans Affairs health care system was conducted. Screening criteria were men 65 to 75 years of age who smoked a minimum of 100 cigarettes in their lifetime. An AAA was defined as a maximum aortic diameter  $\geq 3$  cm. A comparison was made of the AAA diagnosis rate and clinical adherence rate of screening criteria between the first 5 years and total years evaluated. AAA-related mortality was identified by using terminal diagnosis notes or autopsy reports. All data were recorded by August 31, 2017.

**Results:** A total of 19,649 patients ( $70.7 \pm 4.8$  years of age, mean  $\pm$  standard deviation) were screened from January 1, 2007, to December 31, 2016. There were 9916 new patients screened from 2012 to 2016. A total of 1232 aneurysms (6.3% total patients) were identified during the 10-year period. The overall AAA diagnosis rate has declined from 7.2% in the first 5 years to 6.3% in 10 years (13.5% decrease;  $P < .01$ ). There were 66 patients found with AAA  $\geq 5.5$  cm (5.3% of AAAs), and 54 of these patients received successful elective repair. A total of 2321 patients died (11.8%) and 6 deaths were suspected AAA ruptures (0.03%) within the analysis period. A total of 3680 patients screened (18.7%) did not meet screening criteria: 593 patients were <65 years of age, 3087 patients were >75 years of age, and 59 patients were women. This rate has declined from 28.2% within the first 5 years to 18.7% overall in 10 years (33.7% decrease;  $P < .01$ ). The compliance of screened patients using screening criteria improved

<sup>☆</sup>Full articles available online at [www.jvascsurg.org](http://www.jvascsurg.org)  
1078-5884/  
[http://dx.doi.org/10.1016/S1078-5884\(19\)31508-4](http://dx.doi.org/10.1016/S1078-5884(19)31508-4)

significantly from 61.7% in 2007 to 92.4% in 2016 ( $P < .01$ ). The overall compliance rate since implementation of the screening program during the past 10 years is 81.3%.

**Conclusions:** The overall 10-year rate of AAA diagnosis is 6.3%. There are more smaller aneurysms (3.0-4.4 cm) detected and fewer large AAAs  $\geq 5.5$  cm in the last 5 years compared with the first 5 years of the screening program. The overall AAA-related mortality rate of all screened patients is 0.03%. There were 54 patients with AAA  $\geq 5.5$  cm who underwent successful elective repair resulting from the AAA screening program. The overall compliance of screened patients using screening criteria improved significantly from 61.7% in 2007 to 81.3% since implementation of the screening program during the past 10 years.

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#### Spot stenting versus full coverage stenting after endovascular therapy for femoropopliteal artery lesions

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**Objective:** Although spot stenting (SS) for femoropopliteal (FP) lesions has been preferred compared with full coverage stenting (FCS), which stenting strategy results in better outcomes has remained unclear in the real-world clinical setting. Therefore, we compared the clinical outcomes of SS and FCS for FP lesions using a propensity-matched analysis.

**Methods:** The present multicenter, retrospective study examined data from a clinical database of 1554 consecutive patients who had undergone FP endovascular therapy for symptomatic peripheral artery disease from January 2010 to December 2016. Of these patients, 1151 had undergone FP stenting. The outcome measures were primary patency and primary assisted patency obtained using propensity score matching. Interaction analysis was also performed to explore the effects of the baseline characteristics on the association between SS and primary patency.

**Results:** After propensity score matching, SS for FP lesions demonstrated a significantly lower primary patency rate compared with FCS at 3 years (29% vs 53%;  $P = .011$ ). Additionally, primary assisted patency at 3 years was significantly lower in the group with SS than in the FCS group (53% vs 72%;  $P = .014$ ). Interaction analysis showed that chronic total occlusion lesions, lesion location A (proximal superficial femoral artery portion), and lesion length  $\geq 138$  mm were associated with the noninferiority of SS compared with FCS for primary patency.

**Conclusions:** The propensity-matched analysis demonstrated that primary patency and primary assisted patency at 3 years were significantly lower with SS compared with FCS for FP lesions in real-world clinical settings. The interaction analysis suggested that SS might be suited to more complex FP lesions (ie, chronic total occlusion lesions, proximal superficial femoral artery lesion, lesion length  $\geq 138$  mm).

#### Contribution of 30-day readmissions to the increasing costs of care for the diabetic foot

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**Objective:** The inpatient cost of care for diabetic foot ulcers (DFUs) has been estimated to be \$1.4 billion annually in the United States. We have previously demonstrated that the risk of 30-day unplanned readmission for patients with DFU is nearly 22%. Our aim was to quantify the cost of readmissions for patients admitted with DFU.

**Methods:** All patients presenting to our multidisciplinary diabetic limb preservation service from June 2012 to June 2016 were enrolled in a prospective database. Inpatient costs and net margins were calculated overall and for index admissions vs 30-day unplanned readmissions.

**Results:** A total of 249 admissions for 150 patients were included. Of these, 206 admissions were index admissions and 43 were 30-day readmissions. The most common reason for readmission was the foot wound (49%), followed by a bypass wound (14%), renal complications (9%), and other systemic complications. Surgical interventions during readmission were common (47%) and included both podiatric (37%) and vascular (23%). The wound healing outcomes were favorable, with 78% of all wounds achieving healing by 1 year. Limb salvage was 91% overall. The median hospital cost per admission was \$20,111 (interquartile range, \$12,589-\$33,254) and did not differ between the index and readmissions (\$22,165 vs \$19,408;  $P = .46$ ). However, the hospital net margins were lower after readmission (\$3908 vs \$1975;  $P = .02$ ). The overall cost of care for patients requiring readmission was significantly greater than that for patients not readmitted (\$79,315 vs \$28,977;  $P < .001$ ). During the study period, DFU care at our institution cost \$7.9 million, of which \$1.2 million (16%) was attributable to readmission costs.

**Conclusions:** Readmissions for patients with DFU are common and associated with a substantial cost burden. The cost of readmission for patients with DFU was as high as the cost of the index admission but with lower hospital net margins. When extrapolated to national data, the 15% readmission cost burden we have reported would be equivalent to \$210 million hospital costs annually. Focused efforts at preventing readmissions in this high-risk patient population are essential to reducing the overall costs of care associated with DFUs.

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#### Association of opioid use and peripheral artery disease

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**Background:** Prescription opioids account for 40% of all U.S. opioid overdose deaths, and national efforts have

intensified to reduce opioid prescriptions. Little is known about the relationship between peripheral artery disease (PAD) and high-risk opioid use. The objectives of this study were to evaluate this relationship and to assess the impact of PAD treatment on opiate use.

**Methods:** In this retrospective cohort study, the Truven Health MarketScan database (Truven Health Analytics, Ann Arbor, Mich), a deidentified national private insurance claims database, was queried to identify patients with PAD (two or more *International Classification of Diseases, Ninth Revision* diagnosis codes of PAD  $\geq 2$  months apart, with at least 2 years of continuous enrollment) from 2007 to 2015. Critical limb ischemia (CLI) was defined as the presence of rest pain, ulcers, or gangrene. The primary outcome was high opioid use, defined as two or more opioid prescriptions within a 1-year period. Multivariable analysis was used to determine risk factors for high opioid use.

**Results:** A total of 178,880 patients met the inclusion criteria, 35% of whom had CLI. Mean  $\pm$  standard deviation follow-up time was  $5.3 \pm 2.1$  years. An average of 24.7% of patients met the high opioid use criteria in any given calendar year, with a small but significant decline in high opioid use after 2010 ( $P < .01$ ). During years of high opioid use,  $5.9 \pm 5.5$  yearly prescriptions were filled. A new diagnosis of PAD increased high opioid use (21.7% before diagnosis vs 27.3% after diagnosis;  $P < .001$ ). A diagnosis of CLI was also associated with increased high opioid use (25.4% before diagnosis vs 34.5% after diagnosis;  $P < .001$ ). Multivariable analysis identified back pain (odds ratio [OR], 1.89; 95% confidence interval [CI], 1.84-1.93;  $P < .001$ ) and illicit drug use (OR, 1.87; 95% CI, 1.72-2.03;  $P < .001$ ) as the highest predictors of high opioid use. A diagnosis of CLI was also associated with higher risk (OR, 1.61; 95% CI, 1.57-1.64;  $P < .001$ ). A total of 43,443 PAD patients (24.3%) underwent 80,816 PAD-related procedures. After exclusion of perioperative opioid prescriptions (4.9% of all opioid prescriptions), the yearly percentage of high opioid users increased from 25.8% before treatment to 29.6% after treatment ( $P < .001$ ).

**Conclusions:** Patients with PAD are at increased risk for high opioid use, with nearly one-quarter meeting described criteria. CLI and treatment for PAD additionally increase high opioid use. In addition to heightened awareness and active opioid management, our findings warrant further investigation into underlying causes and deterrents of high-risk opioid use.

### Survival after major lower extremity amputation in patients with end-stage renal disease

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**Objective:** This study evaluates survival of patients with end-stage renal disease (ESRD) after major lower extremity amputation (MLEA), given the burden of peripheral arterial disease in patients with ESRD, the hindrance posed by cardiovascular disease on their survival, and the national investment in ESRD-related care.

**Methods:** A retrospective review of all hemodialysis patients (HD) and renal transplant (RT) recipients who underwent MLEA between January 2007 and December 2011 in the United States Renal Data System was performed. Univariable, Kaplan-Meier, multivariable logistic, and Cox regression analyses were used to evaluate patient survival among HD patients and RT recipients overall; and within strata of amputation level, gender, and race.

**Results:** There were 32,540 MLEAs (HD, 92%; RT, 8%). Among HD patients, the median survival was 6 months for above knee amputation (AKA) and 16 months for below knee amputation (BKA). The risk-adjusted mortality was higher for AKA compared with BKA (adjusted hazard ratio [aHR], 1.48; 95% confidence interval [CI], 1.44-1.52;  $P < .001$ ), females compared with males (aHR, 1.04; 95% CI, 1.01-1.08;  $P = .004$ ), but lower for blacks (aHR, 0.78 95% CI, 0.76-0.81;  $P < .001$ ) and Hispanics (aHR, 0.74; 95% CI, 0.70-0.79;  $P < .001$ ) compared with white HD patients. Among RT recipients, the median survival was 16 months for AKA and 47 months for BKA. Mortality was significantly higher for above knee amputees compared with below knee amputees (aHR, 1.83; 95% CI, 1.60-2.10;  $P < .001$ ). However, there was no difference in mortality between the gender and racial categories of RT recipients. There was a twofold increase in the 30-day mortality (adjusted odd ratio, 1.94; 95% CI, 1.66-2.25;  $P < .001$ ) and long-term mortality (aHR, 2.18; 95% CI, 2.05-2.32;  $P < .001$ ) for HD patients relative to RT recipients.

**Conclusions:** Survival after MLEA is limited in patients with ESRD. It is relatively better for RT recipients compared with HD patients. Mortality was higher for females compared with males, but lower for blacks and Hispanics compared with white HD patients. There were no gender- or race-specific difference in mortality among RT recipients. These estimates of life expectancy should guide the informed decision-making process for patients and their healthcare providers when the need for intervention arises after MLEA in these unique categories of patients.