

Vascular networks were created with endothelial colony-forming cells derived from cord blood.

**Results:** MSCs from various tissue sources demonstrated appropriate stem cell markers via flow cytometry. P-MSCs exhibited increased apoptosis in response to H<sub>2</sub>O<sub>2</sub> compared with ASCs and BM-MSCs ( $P < .001$ ). ASCs demonstrated increased apoptosis after exposure to TNF- $\alpha$  and hypoxia compared with MSCs ( $P < .001$ ). No difference in senescence activity was detected by various MSCs. ASCs demonstrated elevated overall survival in response to H<sub>2</sub>O<sub>2</sub> ( $P < .05$ ). BM-MSCs and P-MSCs exhibited increased survival after exposure to TNF- $\alpha$  and hypoxia ( $P < .001$ ). ASCs exhibited no difference in tube formation after exposure to H<sub>2</sub>O<sub>2</sub> compared with controls. However, ASCs exhibited significant decreases in mean tube length after exposure to TNF- $\alpha$  and hypoxic conditions compared with controls ( $P < .05$ ).

**Conclusions:** ASCs remain potent under oxidative stress conditions, whereas P-MSCs and BM-MSCs thrive under inflammatory and hypoxic conditions. This report outlines how MSCs respond to various conditions unique to vascular injury and indicate that ASCs may be the optimal cell source in critical limb ischemia, because oxidative stress is the dominant factor determining cell viability in this condition.

#### Clinical Evaluation of Suspected DVT Guides the Decision to Prophylactically Anticoagulate but Does Not Impact the Decision to Perform After-Hours Duplex Venous Scanning or Increase Its Yield

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**Objectives:** The utility of after-hours duplex venous scanning (DVS) for suspected DVT in emergency department (ED) patients has been debated. Availability of safe, prophylactic, low-molecular-weight heparin, cost containment efforts, and retention of scarce sonographers have to be balanced against 24/7 demand for services. We determined the incidence of DVT in DVS ordered after hours, correlation between the Wells score and prophylactic anticoagulation, as well as urgently performed DVS, and complications of delaying DVS until regular hours.

**Methods:** Records of all ED encounters between July 1, 2009 and June 30, 2010 associated with a DVS ordered after hours were reviewed. The decisions to prophylactically anticoagulate and whether to perform DVS urgently or delayed until regular hours were at the discretion of the ED physician and a vascular surgeon. DVS findings, number of urgent and delayed studies, the Wells scores, D-dimer levels, and outcomes were recorded.

**Results:** DVT was found in 12% ( $n = 22$ ) of 181 DVS ordered after hours. DVT was found in 19% of 42 DVS done urgently and in 10% of 139 DVS delayed an average 10 hours 17 minutes ( $P = \text{NS}$ ). Wells scores were available for all patients and D-dimer levels for 43 (Table). Seventy-eight percent of patients with a Wells score  $\geq 3$  had prophylactic anticoagulation, whereas only 40% of patients with a Wells score  $< 3$  had prophylactic anticoagulation ( $P = .0001$ ). In contrast, 36% of patients with a Wells score  $\geq 3$  had urgent DVS and 20% of patients with a Wells' score  $< 3$  had urgent DVS ( $p = \text{ns}$ ). Prophylactic anticoagulation was given to 86% of patients eventually found to have DVT versus 40% of patients eventually found to have no DVT ( $P < .0001$ ). There were no PEs or bleeding complications.

**Conclusions:** The incidence of DVT in ED patients who had urgent after hours DVS was no different than in those whose DVS was delayed until regular hours. High pretest probability can be achieved with clinical evaluation prior to DVS, and this guided the decision to prophylactically anticoagulate but did not impact the decision to perform urgent DVS. Most patients eventually found to have DVT did receive prophylactic anticoagulation, and delay of DVS did not result in complications. We believe that most patients in whom there is high clinical suspicion for DVT can safely get prophylactic anticoagulation and delayed DVS. Patients in whom there is low clinical suspicion should not get urgent DVS.

Table. Wells score and D-dimer results

Variable	Wells score $\geq 3$ (%)	D-dimer (%)
Sensitivity	64	100
Specificity	88	17
Positive predictive value	42	9
Negative predictive value	95	100

#### Asymptomatic 50% to 75% Internal Carotid Artery Stenosis in 288 Patients: Risk Factors for Disease Progression and Ipsilateral Neurologic Symptoms

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**Objectives:** This study evaluated the safety of an observation protocol in asymptomatic patients with moderate internal carotid artery stenosis, and to identify characteristics associated with disease progression.

**Methods:** Patients with asymptomatic moderate internal carotid disease (peak systolic velocity [PSV]  $> 125$  cm/s and end diastolic velocity [EDV]  $< 125$  cm/s by duplex ultrasound imaging) correlating to 50% to 75% diameter reduction were monitored for 3 years. Progression to greater than 75% diameter reduction (EDV  $> 125$  cm/s) or presentation with focal neurologic symptoms (stroke, amaurosis fugax, transient ischemic attack) was documented. Comorbidities, smoking status, and medications were recorded. Log-rank testing, Wilcoxon models, and Kaplan-Meier plots provided statistical analysis.

**Results:** During follow up, 26 of 288 patients (9%; 137 men, 151 women) developed symptoms (stroke: 9 [3.1%]; transient ischemic attack: 3 [1%]; amaurosis fugax: 3 [1%]), or asymptomatic increase in diameter to  $> 75\%$  (11 patients [3.8%]). All-cause mortality was 11% (33 patients). Seventeen patients (5.9%) underwent carotid endarterectomy and five (1.7%) had carotid stent placement. The event incidence was significantly higher for men ( $P = .02$ ), but survival was not different. The rate of disease progression or development of symptoms was 5.5% at 12 months and increased to 7.2% by 24 months. Comorbidities with the highest associated event incidences were coronary artery disease (8.1%), hyperlipidemia (7.3%), and hypertension (6.7%). Medications associated with lower event incidences were insulin (2.8%) and angiotensin-receptor blockers (1.9%).

**Conclusions:** Sequential surveillance of asymptomatic patients with moderate carotid disease is safe, with only 5% becoming symptomatic and 4% having disease progression. Male patients with coronary artery disease, hyperlipidemia, and hypertension are at increased risk and are candidates for frequent screening and/or early intervention.

#### Deep Venous Thrombosis After Saphenous Endovenous Radiofrequency Ablation: Is It Predictable?

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**Objectives:** Endovenous radiofrequency ablation (RFA) is a safe and effective treatment for varicose veins secondary to saphenous reflux. Deep venous thrombosis (DVT) is a known complication of this procedure. The purpose of this study is to describe the frequency of DVT after RFA and associated predisposing factors.

**Methods:** We performed a retrospective data analysis from December 2008 to December 2011, during which 277 consecutive office-based RFA were performed in our institution using the VNUS ClosureFast catheter. Duplex scans were completed 2 weeks postprocedure in all patients to confirm saphenous vein obliteration and evaluate the deep venous system for thrombosis. Risk factors assessed for development of DVT included greater vs lesser saphenous, side treated, number of cycles used, hypercoagulable state, history of DVT, tobacco use, medications (oral contraceptives, aspirin, warfarin, clopidogrel), and vein diameter at the junction of the superficial and deep systems.

**Results:** Seventy percent of the patients were female, 56% were right side, and 86% were performed on the greater saphenous vein. Mean age was  $54 \pm 14$  (range, 23-88 years). 3% of patients had a diagnosis of hypercoagulable state and 8% had a history of DVT. Follow-up ultrasound imaging showed thrombus protrusion into the deep system without occlusion was present in 11 patients (4%). DVT, as defined by thrombus protrusion with complete occlusion of the femoral or popliteal vein, developed in two patients (0.7%). Previous DVT was the only factor associated with DVT ( $P = .018$ ). Although not statistically significant, there was a trend toward higher risk of DVT in LSV patients. Factors associated with protrusion into the deep system were lesser saphenous vein ( $P = .035$ ), and factor V Leiden ( $P = .026$ ).

**Conclusions:** The use of RFA to treat patients with saphenous reflux involves a small but definite risk of DVT. This study demonstrates that the risk of DVT or any thrombus protrusion in to the deep system is greater in patients with previous DVT, factor V Leiden, and treatment of the lesser saphenous vein. Periprocedural anticoagulation should be considered in this subset to reduce the risk of complication after RFA.

#### Response of Neointimal Hyperplasia and the Adventitial Sc $\alpha$ 1<sup>+</sup> Stem Cell to Nitric Oxide

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**Objectives:** Recently, Sc $\alpha$ 1<sup>+</sup> stem cells have been identified to reside in the adventitia of the arterial wall. However, their role in the formation of neointimal hyperplasia is unknown, as is the effect of nitric oxide (NO) on these cells. We hypothesize that Sc $\alpha$ 1<sup>+</sup> stem cells contribute to neointimal development and that NO limits the involvement of adventitial Sc $\alpha$ 1<sup>+</sup> cells in the arterial injury response, thereby inhibiting neointimal hyperplasia.

**Methods:** The mouse femoral artery wire injury model was performed in 10-week-old male C57BL/6 mice. Treatment groups included control, injury, and injury + NO (n = 5/group). Arteries were harvested at 24 hours, 3 days, 7 days, and 2 weeks after injury and assessed for Sca1<sup>+</sup> cells using immunofluorescence. Sca1<sup>+</sup> staining was graded on a scale of 0 to 4 for the intima, media, and adventitia in four high-power fields per section.

**Results:** Sca1<sup>+</sup> staining in the adventitia after injury significantly decreased at 24 hours ( $1.9 \pm 0.13$ ,  $P = .001$ ) and 3 days ( $1.9 \pm 0.12$ ,  $P = .001$ ) and returned to baseline by 2 weeks. Sca1<sup>+</sup> staining in the media after injury significantly increased by 7 days ( $2.3 \pm 0.23$ ), and persisted to 2 weeks ( $2.4 \pm 0.19$ ) after injury ( $P = .001$ ). Sca1<sup>+</sup> staining in the intima after injury also significantly increased by 7 days ( $3.0 \pm 0.14$ ) and persisted to 2 weeks ( $2.7 \pm 0.14$ ) after injury ( $P = .001$ ). In the adventitia, NO had no significant effect on Sca1<sup>+</sup> levels. However in the media, NO significantly decreased Sca1<sup>+</sup> levels at 7 days ( $1.5 \pm 0.19$ ) vs injury alone ( $P = .002$ ). In the intima, NO significantly decreased Sca1<sup>+</sup> levels at 7 days ( $2.2 \pm 0.23$ ) and 2 weeks ( $2.3 \pm 0.18$ ) vs. injury alone ( $P = .001$  and  $P = .03$ , respectively).

**Conclusions:** The level of resident Sca1<sup>+</sup> stem cells decreases in the adventitia after arterial injury and then increases in the media and neointima, suggesting that Sca1<sup>+</sup> stem cells contribute to the formation of neointimal hyperplasia. NO decreases Sca1<sup>+</sup> levels in the intima and media after injury, suggesting one mechanism by which NO may inhibit the formation of neointimal hyperplasia. Together, these data suggest an important role of Sca1<sup>+</sup> stem cells in the arterial injury process. Identification of the mechanism of Sca1<sup>+</sup> inhibition by NO could lead to a therapy to prevent neointimal hyperplasia.

#### Patients With Chronic Obstructive Pulmonary Disease Have Shorter Survival but Superior Endovascular Outcomes After Endovascular Aneurysm Repair

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**Objectives:** This study was conducted to determine the effect of pulmonary disease on outcomes after endovascular abdominal (EVAR) and thoracoabdominal (eTAAA) aneurysm repair.

**Methods:** A prospective study of high-risk patients undergoing EVAR and eTAAA repair between 1998 and 2009 was used to contrast clinical and endovascular outcomes between chronic obstructive pulmonary disease

in group 1 was lower than that in group 2 ( $P < .0001$ ; Fig 1). Furthermore, survival in group 1 was dependent upon the severity of disease, with Global Initiative for Chronic Obstructive Lung Disease classification I and II similar to group 2, and classifications III and IV demonstrating lower survival rates ( $P < .0001$ ; Fig 2). Relevant pulmonary function test variables included a lower forced expiratory volume in 1 second and forced expiratory flow 25%-75%, which were associated with decreased survival. Surrogate endovascular outcome analyses demonstrated that group 1 patients had fewer endoleaks (20% vs 25%,  $P = .05$ ) and more rapid sac shrinkage rate (1.66 mm/y difference,  $P < .001$ ).

**Conclusions:** The perioperative risk of mortality between COPD and non-COPD patients is eliminated when endovascular techniques are used. Long-term survival in COPD patients is most strongly related to the severity of their disease, and forced expiratory volume in 1 second and forced expiratory flow 25%-75%, are reasonable indicators of poor long term outcomes. Morphologic changes following EVAR and eTAAA repair are more favorable in COPD patients, with a lower endoleak rate and faster sac shrinkage.

#### Are Lower Extremity Endovascular Procedures Associated with Fewer Hospital Readmissions?

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**Objectives:** As pressure to contain health care costs increases, there has been greater scrutiny of readmissions in the vascular surgery population. The objective of this study was to evaluate postoperative readmissions after open (OPEN) and endovascular (ENDO) lower extremity (LE) procedures for PAD (peripheral artery disease).

**Methods:** Inpatients with PAD and LE procedures were selected from the Cerner Health Facts database between October 2008 and December 2010, using International Classification of Diseases-9 Edition-Clinical Modification diagnosis codes (claudication, rest pain, and ulceration/gangrene) and procedure codes for LE revascularization (ENDO and OPEN). Readmission  $\leq 30$  days of discharge was determined. Charlson comorbidity index was used to adjust for comorbidities, and  $\chi^2$  and multivariable logistic regression were used to compare patients who received ENDO and OPEN procedures.

**Results:** Of 453,257 index admissions, 10,103 patients were identified with a diagnosis of PAD. Combining PAD with elective LE procedures during the index admission, 657 and 678 underwent OPEN and ENDO, respectively. Overall readmission rates for OPEN and ENDO for claudication, rest pain, and ulceration/gangrene were 9.68% vs 12.50% ( $P = .29$ ), 14.29% vs 18.60% ( $P = .38$ ), and 17.9% vs 20% ( $P = .60$ ), respectively. Readmission increased by the severity of the diagnosis for both OPEN and ENDO ( $P = .0001$ ). Men comprised 59% of the cohort, and readmission rates were not statistically different by sex ( $P = .25$ ). Race was not associated with procedure performed ( $P = .7$ ). After adjustment for age, race, sex, comorbidities, and procedure, patients with ulceration/gangrene (odds ratio [OR], 1.7; 95% confidence interval [CI], 1.17-2.41), non-Caucasian race (OR, 1.5; 95% CI, 1.08-2.19), and increased numbers of comorbidities (OR, 1.1; 95% CI, 1.01-1.22) were more likely to be readmitted. Diagnoses at readmission were similar between groups.

**Conclusions:** Less invasive endovascular procedures were not associated with decreased readmission rates compared with open surgery. Readmission rates for claudicans were unexpectedly high, with an overall rate of 11%. Predictors of readmission included black race and increased severity of disease. Further examination exploring reasons for readmission are required to decrease readmission rates in the vascular surgery population.

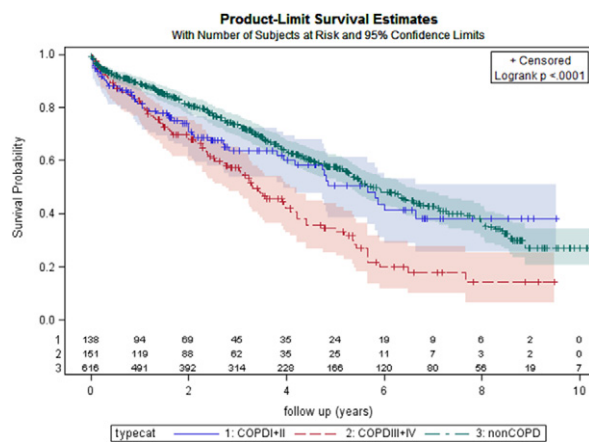


Fig.

(COPD; group 1) and non-COPD patients (group 2). COPD patients were classified in accordance with the severity of their pulmonary disease using the criteria. Survival, morphologic changes, and complications were assessed using Cox models and life-table analyses. The cause and timing of deaths between the groups was compared.

**Results:** A total of 905 patients were analyzed, of which 289 (32%) had COPD. EVAR was performed in 334 patients (37%), whereas fenestrated/branched devices were used in the remaining 571 (63%). Group 1 patients were younger ( $73.5 \pm 6.7$  vs  $75.6 \pm 8.2$  years), had a better glomerular filtration rate ( $67.8 \pm 25.8$  vs  $61.0 \pm 23.3$  mL/min/1.73 m<sup>2</sup>), had higher hematocrits ( $41.6 \pm 5.0$  vs  $40.5 \pm 4.6$ ), and had more extensive aneurysms. Mean follow-up was  $39.5 \pm 30.9$  months. Early (3% vs 3%) and late (2% vs 1%) aneurysm-related deaths were similar between the two groups. Survival

#### Midterm Results of Replacement of Synthetic Graft and Arterial Infection in the Groin With Femoropopliteal Vein

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**Objectives:** Infection of synthetic grafts or femoral arteries in the groin is a challenging problem to treat. Femoropopliteal vein (FPV) is an ideal conduit, but extensive replacement of infected aortic grafts with FPV has been associated with significant morbidity. The aim of this study was to evaluate early and long-term outcome of limited replacement with FPV of infected femoral arteries/grfts in the groin.

**Methods:** Data from 37 patients who underwent excision of infected femoral grafts and replacement with FPV over an 18-year period from 1994 to 2012 were retrospectively analyzed.

**Results:** Surgical intervention was performed in 41 limbs of 27 men and 10 women (mean age, 67.5 years) at a median of 2.5 years after the original synthetic implantation (aortofemoral n = 21, femorofemoral n = 3, femorodistal n = 5, patch angioplasty n = 2) or, on average, 22.2 days after cardiac catheterization (n = 6) and one mycotic aneurysm. Presentation included draining sinus (n = 7), abscess (n = 4), persistent fevers (n = 6), and pseudoaneurysm (n = 10; intact, 4; ruptured, 6). Twenty-five patients