Investigating factors that delay carotid endarterectomy (CEA) in patients with symptomatic carotid artery stenosis

Meyer, Daniel1, Karreman, Erwin3, Kopriva, David2,3 1 College of Medicine, University of Saskatchewan, Regina, Saskatchewan, Canada. 2 Department of Surgery, Section of Vascular Surgery, University of Saskatchewan, Regina Qu'Appelle Health Region, Regina, Saskatchewan, Canada

Objectives: 1. Identify the proportion of patients in Southern Saskatchewan meeting the Canadian Best Practice Recommendations For Stroke Care (2008) that “patients with transient ischemic attack or non-disabling stroke and ipsilateral 70-99% internal carotid artery stenosis... should be offered carotid endarterectomy within 2 weeks of the incident transient ischemic attack or stroke unless contraindicated.”

2. Identify those factors associated with failure to meet the guideline.

Methods: We reviewed patients who underwent CEA in our centre between January 1, 2009, and December 31, 2014, who had presented with neurologic symptoms ipsilateral to an internal carotid artery (ICA) stenosis of 70-99% (NASCET) or meeting carotid doppler velocity criteria for severe stenosis.

Results: 244 patients with symptomatic severe ICA stenosis were included. Only 31.6% of patients met the guideline for CEA within 14 days of symptom onset. Fifteen percent of patients waited longer than 14 days to present to a health care provider. Following entry into the healthcare system, the following factors were associated with meeting the guideline. Patients presenting to an emergency department were more likely to receive surgery within 14 days, compared with patients who first presented to a primary care provider’s office (p<0.001). After presentation, patients who were referred to a vascular surgeon with fewer intervening consultations were more likely to meet the 14 day guideline than those who were referred to multiple specialists (p=0.015). Patients presenting with a minor stroke were more likely to receive surgery within 14 days, compared with patients who presented with hemispheric sensory symptoms or amaurosis fugax (p=0.005).

Conclusions: Improvements in meeting the goal of CEA within 14 days of symptom onset, in patients with severe ipsilateral ICA stenosis, should be directed at patient and provider education to enhance recognition of symptoms. A system for rapid referral of symptomatic patients directly to a vascular surgeon should be established.

The fall of carotid endarterectomy and rise of carotid artery stenting in Ontario from 2002 to 2014

Mohamad A. Hussain1,2, Muhammad Mamdani3, Gustavo Saposnik3,4, Subodh Verma1,3,5, Jack V. Tu6, Mohammed Al-Omran1,2,3 1 Department of Surgery, University of Toronto, Toronto, Ontario, Canada; 2 Division of Vascular Surgery, St. Michael’s Hospital, Toronto, Ontario, Canada; 3 Li Ka Shing Knowledge Institute, St. Michael’s Hospital, Toronto, Ontario, Canada; 4 Division of Neurology, St. Michael’s Hospital, Toronto, Ontario, Canada; 5 Division of Cardiac Surgery, St. Michael’s Hospital, Toronto, Ontario, Canada; 6 Division of Cardiology, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada

Objectives: We sought to determine the utilization rates of carotid endarterectomy and stenting in the clinical setting, and examine the impact of major clinical trials on these rates.
Methods: We conducted a population-based time-series analysis of all individuals who underwent carotid endarterectomy and stenting in Ontario between April 1, 2002 and March 31, 2014 using validated databases. We used exponential smoothing modelling to examine trends in rates per 100,000 adults 40 years of age or older. We also compared procedure rates before and after publication of major trials by conducting interrupted time-series analyses using autoregressive integrated moving average models.

Results: A total of 16,772 patients were studied (N=14,394 endarterectomy [86%]; N=2,378 stenting [14%]). The overall rate of carotid revascularization decreased from 6.0 procedures per 100,000 in April 2002 to 4.3 procedures per 100,000 in the first quarter of 2014 (29% decrease; \(P<0.001\); Figure). The rate of endarterectomy decreased by 36% from 5.6 to 3.6 procedures per 100,000 (\(P<0.001\)), whereas the rate of stenting increased by 72% from 0.39 to 0.67 procedures per 100,000 (\(P<0.001\)). Neurosurgeons preformed less endarterectomy and more stenting, whereas the rates did not significantly change among vascular surgeons. We observed a marked increase (\(P<0.001\)) in the rate of stenting following publication of the SAPPHIRE trial in 2004, whereas the rate of stenting remained unchanged following publication of subsequent trials in 2006 and 2010. In contrast, the rate of endarterectomy was unchanged after SAPPHIRE, but decreased following subsequent trials published in 2006 (\(P=0.04\)) and 2010 (\(P=0.005\)).

Conclusions: Although the overall rates of carotid revascularization and carotid endarterectomy have fallen since 2002, the rate of carotid stenting has risen since the publication of stenting-favorable SAPPHIRE trial. Subsequent conflicting clinical trials were associated with a decreasing rate of endarterectomy but did not appear to impact the rate of stenting.

Figure. Rates of carotid artery revascularization in Ontario, Canada from 2002 to 2014 in relation to publication of major clinical trials

What are the Current Indications for Carotid Doppler Ultrasound?
Jean-Jacob Brassard1, Stéphane Elkouri2 MD, Pierre Robillard MD3 1University of Montreal, Faculty of Medicine, 2CHUM, Department of Vascular Surgery, 3CHUM, Department of Radiology

Introduction: The United States Preventive Task Force guidelines currently state that the usage of carotid Doppler should be limited to symptomatic cases of carotid stenosis. Choosing Wisely Canada guidelines state that neuro-imaging, including carotid Dopplers, should not be obtained in cases of syncope with normal neurological examination. The goal of this study is to describe current indications for carotid Doppler and to evaluate their relevance according to previously described guidelines.

Methods: We obtained the approbation from our ethics research committee. Carotid Dopplers performed between January 1st and June 24th 2015 in our institution were obtained from a prospectively accrued database. We excluded all cases of intraoperative Dopplers. For each were identified patient demographics, clinical information on the request form, main indication(s) and the
requesting physician. A survey based on the identified indications was sent to 50 vascular experts to assess their opinion.

**Results:** 1253 Dopplers were included for a total of 1429 indications. 61,0% (N=871) of indications were for asymptomatic stenoses: 20,8% (n=297) pre-operative, 9,4% (n= 135) carotid murmur, 8,7% (n=125) presence of cardiovascular risk factors or active peripheral arterial disease, 7,0% (n=100) research, 4,3% (n=61) asymptomatic stenosis follow-up, 2,4% (n=35) post-operative, 2,3% (n=33) detection of an asymptomatic stenosis and 5,2% (n=75) other reasons. 14,3% (N=205) of indications included symptoms unspecific to carotid stenoses: 6,1% (n=87) trouble of equilibrium, 2,2% (n=32) syncope, 1,5% (n=22) headache and 4,5% (n=64) other symptoms. 24,7% (N=353) of indications were for symptomatic stenoses: 11,8% (n=168) transient cerebral ischemia, 6,2% (n=89) cerebrovascular event and 6,7% (n=96) symptoms suggestive of neurological processes.

**Conclusion:** According to our results there is a large discordance between current indications for carotid Doppler and most recent guidelines.

**Long-term outcomes of conservative management for large inoperable abdominal aortic aneurysms**
Shamim Lotfi, Stephanie Hajjar, Prasad Jetty, Tim Brandys, Andrew Hill, Dalibor Kubelik, Sudhir Nagpal, George Hajjar, Division of Vascular Surgery, The Ottawa Hospital, Ottawa ON

**Objective:** To determine the long-term outcomes of patients with large abdominal aortic aneurysms (AAA) that met size-criteria for repair but who were not medically fit for surgery or refused repair.

**Methods:** A prospectively maintained database of 71 patients who had inoperable large aortic aneurysmal disease (2000-2016) was analyzed retrospectively. Fifty patients had AAAs. Twenty-one patients with thoracoabdominal aortic aneurysms and aortic dissections were excluded from the study. Primary outcome was aneurysm-related mortality. Survival status was determined through death certificates, death summaries, obituaries and telephone interviews with the family doctor and/or next of kin.

**Results:** There were a total of 50 patients (median age 82) with AAAs who met size criteria for repair (34 males; 16 females). Median follow-up was 34 months. The median size of the AAA when first considered for repair was 5.7cm. The most common reason for non-operative management was medical comorbidities (n=34). Seven patients underwent EVAR during follow-up as institutional experience with endovascular repair improved. All-cause mortality was 82% (n=41) with a median survival of 38 months. There were 10 (20%) aneurysm-related mortalities secondary to rupture with a median time to rupture of 23 months. The average last known AAA size prior to rupture was 6.9 cm.

**Conclusion:** The majority of patients with large AAAs undergoing non-operative management will die of non-aneurysm related causes with a median survival of over 3 years. A small proportion of patients did go on to rupture but did so after 2 years, which is in keeping with outcomes in large randomized trials. This suggests that a non-operative approach may be acceptable in patients with large AAAs who are medically complex or who have other reasons that preclude surgery.
Any IFU deviation predicts device failure in patients undergoing EVAR in mid-term follow-up
Charbonneau P, Herman CR, Mekhaiel S, Hongku K, Hossain S, Lee K, Dubois L, Steinmetz OK
Divisions of Vascular Surgery, Dalhousie University, University of Western Ontario and McGill University.

Background: A variety of devices exist for endovascular repair of abdominal aeurysms (EVAR). Device specific instructions for use (IFU) detail anatomical constraints to application and deployment of devices and are developed from rigorous bench testing. Non-adherence to IFU occurs frequently in order to avoid open surgery. The purpose of this study is to determine if IFU violations are associated with increased risk of device failure during follow-up.

Methods: This multicenter retrospective observational study included patients undergoing elective endovascular repair for abdominal aneurysmal disease with up to six different devices. Demographic, anatomical data and follow-up data were collected on all patients from 2005 to 2014. IFU violations were device-specific and included neck diameter, length, and angulation and iliac diameter and length. Device failure included a composite outcome of re-intervention, migration, endoleak (type II excluded), rupture, limb occlusion, sac growth, or aneurysm-related mortality over the follow-up period. Kaplan Meier survival and cox proportional hazard modeling were performed. Any IFU violations as well as neck-specific IFU violations were analyzed.

Results: In 468 patients undergoing EVAR, 49% had at least one IFU violation. Patients with IFU violations appeared to be older (age >80, 41.8% vs. 31.1%), were more likely to have peripheral vascular disease (13.8% vs. 5.9%), and were less likely to be male (78.9% vs. 92%). The most frequent IFU violations included diameter deviations of the neck (16.3%) and of the iliac (22.1%) whereas length violation of the neck and the iliac occurred with less frequency, 5.8% and 3.2 % respectively. Overall device failure rate was 12.9%. Mean follow-up time was 1.9 and 2.1 years for patients with and without an IFU violation, respectively. Kaplan Meier survival revealed a significant association between the presence of an IFU violation and device failure (log rank p=0.02) (see Figure 1). When adjusted for clinical variable through Cox hazard modeling the association remained significant (1.7, 1.0-2.9; HR, 95% CL). When neck-specific violations were considered independently, Kaplan Meier survival and Cox modeling revealed a significant association between neck-specific IFU violation and device failure (log rank p=0.0005, 1.9, 1.2-3.4; HR, 95% CL) (see Figure 1).

Conclusion: Almost half of the patients undergoing EVAR had a device specific IFU violation indicating that implanters are pushing the boundaries of device capabilities. Our study identified that any IFU violation was significantly associated with device failure over time. Caution should be applied to patients being considered for EVAR where IFU deviations exist.
Off-Label Endograft use is Associated with Increased Overall Mortality and is Predicted by Anatomic Severity Grading Score for Abdominal Aortic Aneurysm
Brandon C. Cain, MD, Sebastian Larion, MD, Sadaf S. Ahanchi, MD, Jean M. Panneton, MD. Eastern Virginia Medical School, Norfolk, VA

**Objectives:** We sought to determine if anatomic severity grading (ASG) score correlates with off-label endovascular aortic aneurysm repair (EVAR) with currently available endografts. Additionally, the outcomes for off-label use were analyzed comparative to on-label graft implantation.

**Methods:** We completed a retrospective review of EVARs for elective infrarenal abdominal aortic aneurysm (AAA) repair with five commercially available endografts from 2009-2013. ASG score was calculated using 3-D reconstruction software and device implantation in relation to indication for use (IFU) for each endograft was determined. We then analyzed the ASG score as a predictor of IFU implantation. We also compared the primary outcomes of adjunctive procedures, reinterventions, post-operative type I or III endoleaks, and overall and aneurysm-related mortality between grafts implanted on-label and those off-label.

**Results:** We identified 145 patients during the study period that met the criteria of elective EVAR for infrarenal AAA. The mean age of the cohort was 73.3 years with a majority of males. Overall, 89 grafts were deployed on-label and 56 off-label. Major demographics were similar between groups with
The mean ASG score of 22.6. The average ASG score of the on-label group was significantly lower (21.7) than the off-label group (23.9), (p=0.01). Multivariate analysis determined neck length (p=0.004, OR=1.91) and aneurysm angle (p=0.006, OR=2.06) to be the components of the ASG score that were independently predictive of off-label use. At a mean follow up of 32 months, overall mortality was significantly lower in the on-label group by Kaplan Meier analysis (p=<0.001). Outcomes did not differ for intraoperative adjunct procedures, reinterventions, post-operative type I or III endoleaks or aneurysm related mortality.

**Conclusions:** Total ASG score correlates with IFU in EVAR for infrarenal AAA with neck length and aneurysm angle components predicting off-label use. Overall mortality is increased in off-label EVAR but longer follow-up may be necessary to identify further adverse outcomes.

**Effectiveness of point-of-care ultrasound performed by medical students compared to physical examination by vascular surgeons in the detection of abdominal aortic aneurysms**

T. Mai1, M. Woo MD1,2, K. Boles3, P. Jetty MD1,3 1Faculty of Medicine, University of Ottawa 2Department of Emergency Medicine, The Ottawa Hospital 3Division of Vascular Surgery, Department of Surgery, The Ottawa Hospital

**Objective:** To determine the effectiveness of point-of-care ultrasonography (POCUS) performed by a medical student versus physical examination by vascular surgeons compared to a gold standard reference scan for the detection of abdominal aortic aneurysms (AAA).

**Methods:** We conducted a prospective, observer-blinded study recruiting patients from an outpatient vascular surgery clinic. Participants were screened for AAA by standardized physical examination by a vascular surgeon, followed by POCUS exam by a blinded medical student. The student underwent prior training by a vascular sonographer and emergency physician on 60 patients (16 were supervised). A GE Logiq ultrasound machine was used to measure proximal, mid, and distal aortic diameters. Patients underwent a reference scan (CT or vascular sonographer-performed ultrasound) within 3 months of the visit.

**Results:** 51 patients were enrolled between October 2015 and March 2016. Mean age of recruited patients was 72 years old, and 57% were male. Mean BMI was 27.9 ± 4.3 and mean waist-hip ratio was 0.96 ± 0.10. 15 AAA were detected by the reference scan, with an average diameter of 2.96 cm. Physical examination by a vascular surgeon detected 10 of 15 AAA with 2 false positives (sensitivity and specificity of 66.7% (95% CI 38.4-88.2) and 94.4% (95% CI 81.3-99.3), respectively). POCUS detected 14 of 15 AAA (sensitivity and specificity of 93.3% (95% CI 68.1-99.8) and 100% (95% CI 88.4-100), respectively). 7 of the 51 POCUS scans were indeterminate (>1 cm of the aorta was not visualized). Average time to conduct the physical examination was 35 seconds vs. 4.17 minutes for POCUS. Mean absolute difference between POCUS and the reference scan was low (2.6 mm). There was a strong linear correlation (R²=0.94) between maximal aortic diameter measured by POCUS vs reference scan.

**Conclusion:** A medical student with training can use POCUS to identify an AAA with a high degree of accuracy. POCUS was found to be more effective in detecting AAA when compared to physical examination by vascular surgeons. The introduction of POCUS training at the medical student level, and its wide-scale implementation as an extension to physical examination, may lead to improved detection of AAA.

**Sheath Size and Age are Predictors of Vascular Complications post-Trans Aortic Valve Implant (TAVI)**

Raju S1, Eisenberg N2, Montbriand J1, Cusimano RJ1, Feindel C2, Ouzounian M2, Horlick E3, Osten M3, Tsang W3, Roche-Nagle G4 Division of Vascular Surgery1, Division of Cardiovascular Surgery2, Department of Surgery, Division of Cardiology3, Department of Medicine, Toronto General Hospital, University Health Network, University of Toronto, Toronto, ON
Objectives: Vascular complications (VC) remain a significant morbidity in TAVI patients and are associated with worse outcomes. This research analyzed the incidence and predictors of VC in transfemoral (TF) TAVI cases.

Methods: A retrospective chart review of 388 TAVI patients from 2007-2015 revealed 237 TF, 146 transapical and 5 direct-aortic cases. All VC were classified according to the Valve Academic Research Consortium-2 guidelines.

Results: There were 42 surgical cut-down and 195 percutaneous TF cases (Table 1). While VC occurred in 66 (27.8%), only 8 (3.38%) were classified as major complications. Post-operative VC occurred in 40 cases (16.9%), with 4 (1.6%) being major. Of these, 26 (10.9%) were intra-operative, with 4 major (1.6%) and 22 minor (9.3%). Procedures to correct VC occurred in 10 (4.2%) cases, with the majority (80%) being surgical and the rest, endovascular. Fisher’s exact test found age as the only univariate predictor of minor perioperative complications (p = .038), with those with complications being older (84.3 yrs, SD = 7) than those without (80.7, SD = 8.7). Nine surgical procedures, mainly embolectomies, were performed to correct post-op complications. Logistic regression showed left sided access sheath size was a significant predictor of major (B = .244, p = .004) and minor (B = .162, p = .005) complications after controlling for predictive medical covariates. Dissections and hematomas were major etiologies of peri-operative and postoperative complications, respectively. 30-day all-cause mortality was 2.5 % (n=6). Perioperative vascular complications were significantly correlated with procedural mortality (p =.005, R = .185), in-hospital mortality (p<.000, R = .232) and 30-day mortality (p = .002, R = .2).

Conclusions: VC contribute to operative morbidity in TAVI patients. We observed low major VC rates over an 8-year period with a multidisciplinary team approach. Age and sheath sizes were predictors of perioperative complications and post-operative VC respectively.

Table 1: Pre-operative characteristics of Transfemoral Cases

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Result (N=237)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean years</td>
<td>81.03 (s.d. = 8.6)</td>
</tr>
<tr>
<td>Male</td>
<td>147 (62.0%)</td>
</tr>
<tr>
<td>BMI, mean</td>
<td>27.85 (s.d. = 6.3)</td>
</tr>
<tr>
<td>Aortic Valve Area (AVA), mean</td>
<td>0.76</td>
</tr>
<tr>
<td>NYHA: Class III / Class IV</td>
<td>208 (87.8%)/ 11 (4.64%)</td>
</tr>
<tr>
<td>Logistic EuroScore : Mean (Median)</td>
<td>12.92 (9.92)(s.d. = 9.3)</td>
</tr>
<tr>
<td>Percutaneous access</td>
<td>195 (82.2%)</td>
</tr>
<tr>
<td>Prosthesis Type</td>
<td></td>
</tr>
<tr>
<td>• Medtronic CoreValve (26mm, 29mm, 31mm)</td>
<td>144 (60.8%)</td>
</tr>
<tr>
<td>• Edwards Sapien (23mm, 26mm)</td>
<td>93 (39.2%)</td>
</tr>
<tr>
<td>Biggest Sheath Size</td>
<td></td>
</tr>
<tr>
<td>• Surgical</td>
<td>26F</td>
</tr>
<tr>
<td>• Percutaneous</td>
<td>22F</td>
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</tbody>
</table>
Transapical delivery of a custom branched aortic arch endograft in an animal model
Shaun MacDonald MD1,2, Jonathan Misskey MD2, Matthew Robinson MD3, Ravi Sidhu MD MEd1,2, Brad Munt MD2,4, Jason Clement MD5 1Division of Vascular Surgery, Saint Paul’s Hospital, Vancouver, British Columbia, Canada, 2Division of Vascular Surgery, University of British Columbia, Vancouver, British Columbia, Canada, 3Division of Vascular Surgery, Royal Jubilee Hospital, Victoria, British Columbia, Canada, 4Department of Cardiology, Saint Paul’s Hospital, Vancouver, British Columbia, Canada, 5Department of Radiology, Saint Paul’s Hospital, Vancouver, British Columbia, Canada

Objective: Long working distances, unfavorable anatomy, and aortoiliac occlusive disease can make transfemoral TEVAR in the aortic arch difficult or impossible. This study aims to assess the physiologic feasibility of the transapical deployment of a custom branched aortic arch endograft in a swine model.

Methods: 6 female adult cross Yorkshire-Landrace pigs (51±3kg) were selected for endograft implantation. Following median sternotomy, transapical access through the left ventricle was obtained into the aortic arch and a 20 Fr introducer carrying a 20x78mm endograft with a single 6x18mm brachiocephalic branch was inserted and deployed. Antegrade branch cannulation was achieved through the left ventricular introducer sheath, and an 8x38mm balloon expandable covered stent (BECs) was deployed. Left ventricular function and aortic valve integrity were assessed in all animals via left ventricular angiography, at necropsy, and 3 were selected for dynamic intracardiac echocardiography (ICE) during the entire procedure.

Results: Transapical deployment of the branched endograft was successful in all animals (6/6). 1 pig developed ventricular fibrillation prior to side-branch cannulation and was euthanized. Antegrade brachiocephalic trunk cannulation was successful in the remaining 5 animals. Mean blood pressure decreased from 41.8±9.4 to 38.7±9.6 mm Hg (P<0.001) with sheath crossing of the aortic valve, and returned to baseline following sheath removal (40.4±16 mm Hg). Mean heart rate rose throughout the procedure from 67±13 to 95 ±36 (p <0.001) and remained elevated at experimental completion. ICE demonstrated no abnormalities in pre or post-implantation cardiac function in the surviving 5 animals, and mild to moderate aortic regurgitation (AR) with sheath crossing that returned to baseline post sheath removal. Ventricular closure was hemostatic in 5/5 pigs, and postoperative necropsy demonstrated no gross damage to the aortic valve, myocardium or aorta in any of the 6 animals.

Conclusions: Transapical branched endograft delivery with antegrade branch cannulation is feasible, well tolerated and does not significantly influence hemodynamic or cardiac parameters in an animal model.

Management of the left subclavian artery during thoracic endovascular aortic repair
Kyle A. Arsenault, a Jason Faulds, a Darren Klass, b Joel Price, c Michael T. Janusz aUniversity of British Columbia, Department of Surgery, Division of Vascular Surgery, bUniversity of British Columbia, Department of Radiology, cUniversity of British Columbia, Department of Surgery, Division of Cardiovascular Surgery

Objectives: Management of the left subclavian artery (LSA) during Zone 2 or more proximal thoracic endograft deployment remains controversial. The method of revascularization and proximal LSA control varies widely in the literature and there are limited comparative studies. We sought to review our experience and outcomes with LSA revascularization during thoracic endovascular aortic repair (TEVAR).

Methods: We performed a retrospective chart review of all TEVARs at our institution from March 2005 to February 2016. We included all patients that had a Zone 2 or more proximal landing zone. Patient characteristics, anatomical considerations, operative techniques, and outcomes were collected from paper charts, electronic medical records and an imaging database. We compared
methods of LSA revascularization for the outcomes of mortality, stroke, spinal cord ischemia, endoleak, and need for re-intervention. A composite endpoint of stroke, spinal cord ischemia, Type Ia or Type II endoleak, need for re-intervention due to the LSA, occlusion of the left vertebral artery, and thrombosis of the LSA revascularization was used to compare methods of proximal LSA control. Continuous variables were analyzed using the Student’s t-test or the Mann-Whitney U test, as appropriate. Categorical variables were analyzed using the chi-squared test. A p value of less than 0.05 was considered statistically significant.

**Results:** Eighty-five patients underwent TEVAR with Zone 2 or more proximal landing zones during the study period. Thirty-two (37.6%) procedures were for aneurysmal disease and 32 (37.6%) for aortic dissection. Eighteen patients (21.2%) had TEVAR for traumatic aortic injury while 3 had repair of other aortic pathologies. Thirty-day mortality was 5.9%. Median followup was 21.6 months [interquartile range: 6.2-55.9]. Management of the LSA included: no revascularization in 16 (18.8%), carotid-subclavian bypass in 65 (76.5%), subclavian-carotid transposition in 1 (1.2%) and in-situ fenestration in 3 (3.5%). There was no significant difference in the rate of mortality, stroke, spinal cord ischemia, endoleak or the need for revascularization between these groups. Of the patients undergoing carotid-subclavian bypass, control of the proximal LSA included: no occlusion in 8 (12.3%), surgical tie in 5 (7.7%), suture ligation in 10 (15.4%), neurosurgical aneurysm clip in 4 (6.2%), locking Weck Hemoclips in 18 (27.7%) and Ampliclips in 20 (30.8%). The composite endpoint was reached in 6 patients with no proximal LSA occlusion (75.0%), 2 patients with surgical ties (40.0%), 2 patients with suture ligation (20.0%), 3 patients with neurosurgical aneurysm clips (75.0%), 4 patients with locking Weck Hemoclips (22.2%) and 10 patients with Amplatz plugs (50.0%). Suspected cranial nerve injury was documented in 5 patients with locking Weck Hemoclips (27.8%) and 2 patients with suture ligation (20.0%).

**Conclusions:** This retrospective cohort study demonstrates no significant differences in outcomes between different methods of revascularization of the LSA. However, there were few events overall and the non-bypass groups had small sample sizes. There is a trend towards an increase in the composite outcome with LSA control with neurosurgical aneurysm clips and Ampliclips compared to suture ligation or locking Weck Hemoclips. However, there may be an increased risk of cranial nerve injury with these latter two methods. This study provides vascular surgeons some guidance in management of the LSA during TEVAR.

**Single Institution Experience with Hybrid Endovascular and Surgical Repairs Involving the Aortic Arch: A Retrospective Review.**

Samuel Gurupatham BHSc¹, Mohammad Qadura MD PhD¹, Tara Andrinopoulos¹, David Szalay MD FRCS¹ Division of Vascular Surgery, McMaster University, Hamilton, Ontario, Canada.¹

**Objective:** A hybrid approach, involving surgical debranching of the great vessels followed by endovascular stenting, has been increasingly used as an alternative to entirely open surgical repair of aortic arch pathology. This study reviews and reports our single-centre experience with hybrid aortic arch repair over the past decade.

**Methods:** A total of 43 patients who underwent hybrid arch repair from 2005 to 2015 were identified. Key endpoints involved the presenting pathology, peri-operative details and post-operative outcomes.

**Results:** The mean age was 64.9 years at the commencement of surgery (61.4% males (n=27), 38.6% females (n=16)). Presenting pathologies included: aneurysms (77%), dissections (16%), pseudoaneurysms (5%) and transections (2%). While the majority of procedures were multi-staged, single-stage interventions were completed for 16.3% (n=7) of patients. Emergent surgeries were done in 23.3% of cases; the remaining 76.7% of cases were elective. The proximal extent of endovascular repair was Zone 0 (n=4), Zone 1 (n=12) and Zone 2 (n=20). The 7 remaining patients had proximal landing zones in what would be considered Zones 3 or 4, but all these had aberrant or anomalous distal origins of a great vessel that required debranching. Technical success rates of surgical revascularisations and subsequent endovascular stenting were both 100%. The 30-day perioperative
event rates for mortality, stroke and cardiac events were 9.3% (n=4), 4.7% (n=2) and 9.3% (n=4) respectively. At 2 years, total mortality and stroke rates were 11.6% (n=5) and 7.0% (n=3) respectively. The 2-year primary patency of the revascularizations was 97.8% and the associated primary-assisted patency was 100%. Secondary interventions were necessary for 32% (n=12) of the patients, 75% of which were warranted due to endoleaks. The remaining secondary interventions were required to resolve graft collapse (n=1) and disease progression (n=2).

**Conclusion:** Hybrid approaches are viable alternatives to entirely open surgical treatments of acute and chronic aortic arch pathology and may be particularly attractive for high risk patients. Surgical revascularizations appear durable but endovascular re-intervention is not uncommon and highlights the need for careful surveillance post-repair.

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**Anatomic Predictors of Negative Aortic Remodeling In Medically Treated Uncomplicated Chronic Type B Dissection**
Kevin Lee MD, Kevin Braden MD, Audra Duncan MD, Luc Dubois MD, MSc, Guy DeRose MD, Adam H. Power MD, MPhil, Division of Vascular Surgery, Western University & London Health Sciences Centre, London, ON, Canada

**Objectives:** Chronic uncomplicated type B dissection patients treated with medical therapy are at risk of future aortic complications. The purpose of this study is to determine the anatomic predictors of negative aortic remodeling in chronic uncomplicated type B dissection patients.

**Methods:** A retrospective review of vascular surgery database at a university affiliated medical center was performed to identify all patients with uncomplicated chronic type B dissections between 2004 and 2014. Anatomic parameters were measured at the initial computed tomography angiogram (CTA) and at the most recent CTA. Negative aortic remodeling was defined as aortic growth greater than 5 mm or aortic diameter greater than 60mm during follow up period.

**Results:** Sixty-four patients were identified with chronic type B dissections (mean age: 59.9±11.5 years), who were mostly males (72%) with a history of hypertension (80%). Initial maximum aortic diameter was similar between the negative aortic remodeling group and control group (46.3mm VS 46.1mm, p=0.95). Negative aortic remodeling occurred in 65% of patients. The negative group experienced aortic dilation by a mean of 17.7mm to a mean maximum diameter of 64±16mm during the follow up period (mean of 4.7±3 years). Anatomic predictors of negative aortic remodeling were identified as the presence of elliptical true lumen configuration (p=0.018) and lack of false lumen thrombosis at initial CTA (p=0.0029). Intimal tear size was not predictive of negative aortic remodeling in our study (p=0.08). Patients with negative remodeling had a higher mortality during the follow up period (20% vs 6%, p=0.021).

**Conclusion:** The majority of patients with chronic type B dissection experienced continual aortic enlargement following medical therapy. The presence of elliptical true lumen configuration and lack of false lumen thrombosis at initial CTA were associated with negative aortic remodeling. Negative aortic remodeling is associated with higher mortality during medical therapy.

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**Friday, September 16th, 2016**

**PAPER SESSION IV: CHALLENGES IN WOUND HEALING/VENOUS DISEASE/VENOUS ACCESS**

**Topical Oxygen Therapy Results in Complete wound healing in diabetic foot ulcers**
Janelle Yu, Suzanne Lu, Ann-Marie McLaren, Elisa Greco, Karen Cross1,2,3,4,5, 1Division of Plastic Surgery, St. Michael’s Hospital, Toronto, Canada, M5B 1W8, 2Assistant Professor, Department of Surgery, Faculty of Medicine, University of Toronto, 3Adjunctive Professor, Yeates School of Graduate Studies, Ryerson University, 4Associate Scientist, Keenan Research Centre for Biomedical Science, 5Assistant Professor, Department of Surgery, Faculty of Medicine, University of Toronto; Division of Vascular Surgery, St. Michael’s Hospital
**Introduction:** Diabetic foot ulcers (DFUs) are a significant problem in an aging population with 15% developing a wound over their lifetime. These patients are high risk to undergo amputations with a 1-year mortality rate of 31%, which is greater than the lifetime risk of mortality from cancer. The Natrox™ oxygen deliver system (ODS) is a novel device used to deliver localized topical oxygen to a wound to promote healing. The aim of this study is to compare the Natrox™ ODS in patients with non-healing DFUs to standard best practice.

**Methods:** This is a prospective randomized control for which 20 subjects were randomized into a Natrox™ ODS group (n=10) versus a non-placebo control group (n=10). Subjects were followed once weekly in each arm of the study. In the treatment group, a Natrox™ ODS was applied to the DFU. Regular dressings and standard care were used in control group. Standard of care for both groups included offloading the limb. The DFU was photographed at weekly intervals for 8 weeks to analyse ulcer surface area using standardized digital imaging software.

**Results:** The majority of the study population was male (90%) with a mean age of 56.1 ± 6.7 years. All patients were treated as outpatients and no patients were lost to follow up. DFU’s were present without healing for a mean duration of 76 weeks prior to study entry. 90% of patients receiving topical oxygen via the Natrox™ ODS healed. Only 20% of the patients in the control group healed their ulcers in the study time frame (8 weeks).

**Conclusions:** The Natrox™ ODS represents a potentially exciting new technology to decrease healing time and promote wound closure in patients with non-healing DFUs. More prospective powered randomized studies are needed to determine the benefits of topical oxygen, but our current results are extremely promising.

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**Continuous Oxygen Ambulatory Therapy Improves Wound Healing in Chronic Diabetic Foot Ulcers**

Paul Hayes, Consultant vascular surgeon, University of Cambridge, On behalf of the TODFU study investigators

**Introduction:** Oxygen is fundamental to cellular life, and its absence causes cell senescence and death. It has been recognised for many years that without it effective wound healing is not possible. Oxygen is needed to fight infection, generate new collagen, support cell division and enable epithelial migration. The presence of underlying morbidities such as arterial disease, diabetes, venous insufficiency and oedema mean that the majority of chronic wounds exhibit a level of hypoxia. Several therapies aimed at increasing wound oxygen levels have been developed. Whilst some of these have been effective, they have often failed to gain widespread utilisation because issues relating to cost or patient acceptability.

Continuous Oxygen Ambulatory Therapy (COAT) delivers a steady flow of oxygen to the wound surface, whilst retaining patient mobility. The small, portable oxygen generator and its novel oxygen diffusion system raise wound oxygen tensions 24/7.

**Method:** 32 patients with chronic diabetic foot ulcers (DFU) were treated with COAT at 6 UK vascular centres, in 2 phases. These patients had hard to heal wounds despite being cared for in tertiary diabetic foot clinics.

**Results:** In the 1st phase, 10 DFU were treated. Satisfaction with the novel device was rated as 9.9/10. Pain fell in the wounds by 29%, despite a number of patients being insensate. The wounds reduced in area by 53% in 8 weeks.

In phase 2, all the DFU had been present for at least 6 months. Only 9% of patients failed to respond to the oxygen. By 9 weeks median wound reduction was 52%.

**Conclusion:** These studies in hard to heal wounds have shown that this simple technique has significant potential for use in the therapy of DFU, and may reduce the growing morbidity associated with this difficult problem.
Randomized Control Trial of Negative Pressure Wound Therapy for High Risk Groin Wounds in Lower Extremity Revascularization

Kevin Lee, MD, Patrick Murphy MD, Matthew V. Ingves MD, Luc Dubois MD, MSc, Audra Duncan, MD, Guy DeRose, MD, Thomas Forbes, MD, Adam Power MD, MPhil
Division of Vascular Surgery, Western University, London, ON, Canada

Objective: Revascularization of the lower extremity requiring groin incision is associated with a high rate of surgical site infection (SSI). The objective of this study was to assess the effect of negative pressure wound therapy (NPWT) on rates of infection following primary closure of high risk groin wounds in vascular surgery patients undergoing lower limb revascularization.

Methods: We performed a randomized controlled trial at an academic tertiary medical center. High risk groin wounds were defined as having previous femoral artery cut down, body mass index (BMI) greater than 30 kg/m² or major or minor ischemic tissue loss. We randomized patients to NPWT or standard group once the surgical incision was primarily closed. The primary outcome of the study was overall 30 day groin SSI. Our secondary outcomes were length of stay, readmissions, reoperations, amputations and mortality.

Results: A total of 101 patients were randomized during 13 months. Criteria for inclusion was previous femoral artery cut down in 24%, greater than 30 kg/m² BMI in 36%, and ischemic tissue loss in 40%. The most common revascularization procedure performed was femoral to distal bypass (51%), followed by femoral to femoral artery bypass (20%), and other (29%). Primary outcome of 30 day SSI showed a lower trend but was nonsignificant in NPWT group (11%) compared to the standard dressing group (19%) (p=0.24). There was one in hospital SSI in both groups (p=0.96). Length of hospital stay was significantly shorter for the NPWT group compared to the standard group (6.4 days vs 8.9 days, p=0.01).

Conclusion: We found a trend towards lower groin surgical site infection in high risk vascular surgery patients treated with negative pressure wound therapy compared to standard dressing. The NPWT group had significantly shorter length of hospital stay than standard group. Our study was underpowered due to lower than expected infection rates.

Economic Implications of Publically Funded Endovenous Saphenous Vein Ablation (EVA)

Abdalla Butt¹, Year 2, M.D. Undergraduate Program, David Kopriva¹,², MDCM, FRCS(C)
¹University of Saskatchewan, College of Medicine, ²Regina Qu’Appelle Health Region

Objectives: 1) To compare health system costs for long saphenous stripping/ablation before and after the introduction of publically funded EVA.
2) To determine if availability of EVA of long saphenous system has changed utilization rates over historical controls undergoing long saphenous stripping.

Methods: In mid-2007, publically funded EVA was introduced in our province. We retrospectively reviewed administrative data and patient charts to capture cases of long saphenous vein stripping 2003-2014, and cases of EVA (long saphenous endovenous laser treatment [EVLT] and radiofrequency ablation [RFA]) 2007-2014. Accounting for the change in practice pattern that occurred slowly between 2007-2009, we divided our patients into pre-EVA era (2003-2006) and post EVA era (2010-2014). Procedure costs were determined by models used by our health region for this purpose.

Result: Utilization rates for long saphenous vein intervention remained similar in the pre-EVA (90 procedures per year) and post-EVA eras (92 procedures per year, p=0.83). Surgical stripping performed by general surgeons decreased from a mean of 52 procedures per year pre-EVA to 7.2 procedures per year post EVA (p<0.001). Long saphenous stripping performed by vascular surgeons decreased, from 38 cases per year pre-EVA to 13 cases per year post-EVA (p=0.007). Case costs of surgical stripping ($1965.12/case) were higher than EVA (EVLT, $1358.79/case, and RFA, $1410.54/case). The total annual costs of long saphenous vein intervention decreased from $176,860.35 pre-EVA to $134,524.88 (p=0.02).
**Conclusion:** Introduction of publically funded EVA has reduced rates of surgical stripping of the long saphenous vein and reduced costs to our health system by approximately $42335.47 per year.

**Venous stenting for lower extremity venous occlusive disease: The Vancouver General Hospital experience**
Kyle A. Arsenault, Jerry C. Chen, Joel Gagnon, York N. Hsiang, University of British Columbia, Department of Surgery, Division of Vascular Surgery

**Objectives:** Endovenous stenting of the iliocaval venous system (EndoVS) has become a viable and efficacious option for treatment of venous occlusive disease of the lower extremity. We reviewed our initial experience with this procedure to assess patient outcomes.

**Methods:** We undertook a retrospective chart review of all EndoVS performed by vascular surgeons at the Vancouver General Hospital between February 2013 and December 2015. Patient demographics, procedure details, complications, and follow-up data were collected from the patient's charts. Data are presented descriptively.

**Results:** EndoVS was performed in 18 patients from February 2013 to December 2015. Fifteen of the patients (83.3%) had a prior history of DVT. Three of these patients (16.7%) had recent DVT treated with catheter-directed thrombolysis. Eight patients (44.4%) had preoperative imaging evidence of May-Thurner syndrome. Preoperative CEAP classification was C3, C4, C5 or C6 in 6, 5, 2 and 5 patients, respectively. Thirteen patients (72.2%) had symptoms of venous claudication. Preoperative CEAP classification was C3, C4, C5 or C6 in 6, 5, 2 and 5 patients, respectively. Thirteen patients (72.2%) had symptoms of venous claudication. All patients received MR venography prior to intervention. All procedures were performed percutaneously in the operating room with mobile fluoroscopy, duplex ultrasound and IVUS guidance. Four patients had complete occlusion of the IVC requiring recanalization and IVC stenting. Technical success was 100%. One case was complicated intraoperatively by proximal stent migration requiring piecemeal endovenous retrieval. All patients were discharged on anticoagulation. Median clinical follow-up was 5.8 months [interquartile range: 5.0-10.0]. At this time, 13 patients (72.2%) had significant improvement in their symptoms of swelling or venous claudication while two had minimal change. Two patients had initial improvement followed by return of their symptoms, one of which underwent a second procedure and is doing well postoperatively. One patient stopped their anticoagulation early against medical advice and presented with thrombosis of their venous stent requiring thrombolysis and venoplasty. All five patients with CEAP C6 disease demonstrated healing of their chronic venous ulcers. Median imaging follow-up was 7.4 months [5.4-10.4]. Primary patency was 88.9%. Secondary patency was 94.4%

**Conclusions:** Our initial experience with EndoVS is favorable with clinical improvement in the majority of patients. Primary and secondary patency in this short-term follow-up was excellent. Long-term follow-up is required to properly assess the durability of these procedures.

**Vascular Access in the Lower Limb**
Bhola C, Kim D, Eisenberg N, Oreopoulos G, Lok C, Roche-Nagle G.
Division of Vascular Surgery, Department of Surgery, Division of Vascular Interventional Radiology, Joint Department of Medical Imaging, Division of Nephrology, Department of Medicine, Toronto General Hospital, University Health Network, University of Toronto, Toronto, ON

**Introduction:** Worldwide, the majority of kidney failure patients are treated by hemodialysis. The demand for vascular access surgery is increasing rapidly because of the continuing expansion of this population. A reliable access to the circulation for haemodialysis is essential. A proportion of hemodialysis patients exhaust all options for permanent arteriovenous (AV) access (fistula or graft) in both upper extremities. Arteriovenous thigh grafts are a potential vascular access option in hemodialysis patients who have exhausted all upper-limb sites. This paper reports our experience with vascular access in the thigh.

**Methods:** We performed a retrospective review of the University Health Network's Division of Nephrology dialysis access database to identify all thigh AV access grafts placed between November
1995, and November 2015. Electronic medical records were then reviewed to determine demographic and clinical information. The charts were examined for subsequent surgical or endovascular procedures performed on the accesses. The patency of each thigh AV access was determined from the time of surgical creation placement, and the reason for failure documented.

**Results:** A total of 41 hemodialysis patients received 47 thigh AV accesses for hemodialysis vascular access during the study period. The average age of the cohort was 46 years (range 13-79 years). The majority of the patients 53.6% (n=22) were female and the majority of AV accesses 55.3% (n=26) were placed in the left leg. Three patients were lost to follow up but of the remaining 38 patients, the average patency for the grafts (n=44) was 1130.6 days (range 0- 4745 days). Thirty six percent (n=17) of the grafts required surgical revision to eradicate infection or to maintain patency. Seventeen of 44 grafts (38.6%) served as definitive haemodialysis AV access during the patients' lifetime of dialysis. The majority failed due to infection 43.1% (n=19) or thrombosis 13.6% (n=6).

**Conclusions:** Arteriovenous thigh graft access is used infrequently, but they have a good patency. However, they require frequent revisions and have a high infection rate resulting in the ultimate loss of the access in 43.1% of cases. Despite this, an acceptable proportion of leg grafts provide durable access for the dialysis lifetime of the patient.

**Friday, September 16th, 2016**
**POSTER SESSION**

**Abdominal aortic aneurysm growth is associated with changes in thrombus deposition**
Sebastian L. Launcelott MD 1, Richard J. Lozowy MSc 2, David C.S. Kuhn PhD 2, and April J. Boyd, MD, PhD 1. Vascular Surgery Health Sciences Centre 1 and Department of Mechanical Engineering, University of Manitoba 2

**Introduction** Abdominal aortic aneurysm (AAA) rupture has an associated mortality of 90%. AAA are repaired when they meet size criteria, become symptomatic, or rupture. Using aortic diameter as the primary criterion in the decision to intervene, fails to take into consideration that AAA rupture at sizes below operative thresholds, or reach extreme size without rupture. We have previously shown that AAA rupture at sites of low wall shear stress (WSS) where flow recirculation and intraluminal thrombus (ILT) tends to be more abundant. The present study examined the fate of ILT deposition in AAA growth. We hypothesized that AAA expansion would be associated with increasing ILT deposition in sites of flow recirculation.

**Methods** A total of 6 patients with serial images of AAA growth over 3 time points were studied. Aortic measurements and sites of ILT deposition were recorded. Three-dimensional AAA geometry was generated from CTA images. Predicted aortic blood flow velocity, localized pressure variation, and WSS profiles were correlated with AAA growth and ILT deposition. This study was carried out with biomedical ethics approval.

**Results** AAA growth was associated with increasing ILT deposition in most cases. The site of maximal ILT deposition strongly correlated with regions of flow recirculation and low WSS, but did not correlate with the region of maximal aortic expansion. Interestingly, in some cases the recirculation zone changed location with AAA growth and this was associated similar change in location of ILT deposition.

**Conclusion** This study has shown that ILT increases with increasing AAA size in most aneurysms, and that deposition of ILT occurs at sites with low WSS and flow recirculation. An understanding of the alterations in WSS in pulsatile flow and its effect on vascular endothelium will lead to a better understanding of AAA development and growth; and may ultimately lead to better prediction of AAA rupture potential.
Predicting Iliac Artery Deformation in Response to Guidewire Insertion Using Computational Simulations
Ryan M. Sanford1, Sean A. Crawford2,3, Matthew G. Doyle1,2, Cristina H. Amon1,3, Thomas L. Forbes2,
1Department of Mechanical and Industrial Engineering, University of Toronto, 2Division of Vascular Surgery, Department of Surgery, University of Toronto, 3Institute of Biomaterials and Biomedical Engineering, University of Toronto

Objective: The objective of this study was to use finite element analysis to predict the deformation of an iliac artery in response to the insertion of a stiff guidewire, as the first step towards simulating stent graft delivery and deployment.

Methods: The computational study was performed using the explicit finite element solver LS-DYNA (LSTC, Livermore, CA, USA). The 3-D centerline of an iliac artery was generated using the open source software The Vascular Modelling Tool Kit. An idealized iliac artery geometry was created by lofting a circle (15 mm diameter) along the centerline curve using SolidWorks (Dassault Systèmes, Waltham, MA, USA). A uniform mesh consisting of 231,702 triangular shell elements was generated using LS-PrePost (LSTC), and a constant vessel wall thickness of 1.5 mm was specified. At each end of the vessel, a boundary condition of nonlinear springs was implemented in order to simulate upstream and downstream arterial tissue. A straight guidewire with material properties of a Lunderquist (Cook Medical, Bloomington, IN, USA) was displaced to follow the path of the iliac artery centreline. This imposed displacement condition was then removed, which initiated contact between the wire and the vessel wall and caused the wire to attempt to deform back to straight. The vessel wall, with a Young’s Modulus representative of an iliac artery, then deformed in response to the deformation of the wire.

Results: The simulations showed that the insertion of the stiff guidewire causes the iliac artery to fold over, or accordion, on itself (Fig. 1). This is consistent with what has been reported in the literature and observed clinically.

Conclusions: Using LS-DYNA, we were able to accurately simulate the deformation of an iliac artery in response to the insertion of a stiff guidewire. These results will be used in later simulations of stent graft deployment.

Figure 1-Deformed Iliac Artery Due to Guidewire Insertion
The impact of limited vascular ultrasound studies on clinical decision making in patients with peripheral arterial disease
Douglas Wooster MD FRCSC RVT RPVI, Mary Angelson BScN RVT, Elizabeth Wooster B Comm M Ed, PhD Candidate, Toronto West Vascular Lab.

Introduction: Combined vascular duplex ultrasound and physiologic testing provides detailed information regarding the nature, location and severity of peripheral arterial disease. Clinical decision making (CDM) with respect to medical, catheter-directed and operative management can be dictated by these findings. Resource and facility management issues have resulted in proposed protocols for limited studies. The aim of this study is to address the impact of such studies on decision making.

Methods: 50 limbs were selected to reflect differing severity (stenosis, occlusion), location (iliac, CFA, SFA, popliteal, tibial arteries) and clinical decisions. The findings were analyzed comparing full studies, comprised of ABIs, waveforms, velocities and plaque at rest and after exercise, to the interpretation and clinical decisions if only subsets of data were available.

Results: Interventions were recommended on 22 limbs (44%); full studies were considered adequate for CDM in 100%. ABI alone was not helpful in CDM apart from a rough estimate of the presence of disease; exercise altered the interpretation in 40%. Selected waveforms at 3 levels (femoral, popliteal, ankle) guided CDM in 76%; exercise augmented this in 32%. Plaque assessment, with velocity measurements, identified location and severity accurately and improved CDM in 24%.

Conclusion: Limited ultrasound studies for peripheral arterial disease can establish the presence of disease but is inadequate to guide clinical decision making. Caution should be exercised in the use and interpretation of such protocols.

Applying Criterion Based Indications for Vascular Ultrasound Studies: Planning Quality Improvement
Douglas Wooster MD RVT RPVI, Mary Angelson BScN RVT.

Introduction: Although most facilities rely on the referring physicians’ request for testing, inappropriate indications for ultrasound studies have been cited as a quality metric and source of poor resource utilization. In 2015, the IAC mandated that ultrasound facilities undertake educational and other strategies to address this as a quality improvement initiative. We proposed to study the indications noted to develop such strategies.

Methods: Dedicated vascular ultrasound facilities were asked to participate. An electronic search of guidelines, standards and criteria for testing was done. The indication for testing in consecutive patients was collated with adherence to standards and criteria for testing, type of referring physician, patient demographics and findings. Care gaps were identified to serve as a ‘needs assessment’ for educational and other strategies to address quality improvement.

Results: 3 facilities agreed to participate (1 academic, 2 community). 4654 studies were analyzed. The vascular domains included were carotid (610), aorta (217), renal (52), upper extremity arteries (56), lower extremity arteries (1465), lower extremity venous for DVT (1377), lower extremity venous for CVI (877). Overall, appropriate criteria were cited for 76 – 96% of studies; the academic facility had higher adherence. There was no difference between Family Physician and Specialist referrals. Diagnostic positive yields were found in 48 – 68 % in different test categories; aortic screening yield was 8.1%. Specific ‘teaching points’ included ‘headaches’ and ‘neck pain’ for carotid studies, aortic screening outside of ‘targets’, ‘numb toes’ and ‘swelling’ for arterial duplex; no clear issues were identified for venous studies.

Conclusions: This study does identify inappropriate indications for vascular ultrasound with no systematic findings. There are specific teaching points that can be used to direct educational strategies for referring physicians.
Patient Understanding and Implications for Consent for Vascular Treatment and Consent
Elizabeth Wooster MEd, Ph D Candidate, OISE/University of Toronto, Douglas L Wooster, MD, FRCSC, FACS, RVT, RPVI

Objective: Consent is a mainstay in surgical procedures and patient understanding of implications may impact the consent process in shared decision making. However, there is little known about the intersection of patient understanding, patient preference, knowledge of vascular treatment and consent for treatment. We sought to examine this intersection for vascular patients within a busy vascular clinic.

Methods: We conducted a literature review about patient understanding, patient preference and vascular treatment and prepared a consent audit tool. We conducted an audit of patient charts to determine the impact of the consent intersection for 100 patients with varicose veins, 50 patients with peripheral arterial disease, 25 patients with carotid artery disease and 25 patients with aortic aneurysm.

Results: The review of the literature determined that patient consent regarding vascular procedures is unclear. The patient does not understand the risks and options being presented (48%), the patient preference differs from that of the surgeons (25%) and the post-operative recovery process was not fully understood (82%) by the patient. Our audit revealed that the primary care physician’s reason for referral and the patient’s understanding of the reason for the visit did not match (80%); the specialists’ advice differed as well (66%). The domains of patient understanding, expectations and preferences for treatment varied and was not concordant with specialists’ advice (8 – 42%). The consent intersection was wider in more complex procedures (aortic aneurysm and carotid (75%) than in peripheral arterial or venous interventions (42%). Although patient understanding of vascular interventions was reasonable (77% for catheter directed and 60% for operative procedures), awareness of consent issues was low (18- 24%).

Conclusions: An appreciation of patient understanding, expectations and preference is an important aspect of the consent discussion. There is a wide variation in these domains amongst patients and surgeons cannot assume a common basis for consent. Further research into foundations for these finding, educational approaches and the process for consent is required.

Understanding and predicting endovascular device rotation
Sean A Crawford MSc MD, Ryan M Sanford BScE, Matthew G Doyle PhD, Cristina H Amon ScD, Thomas L Forbes MD, Institute of Biomaterials and Biomedical Engineering, University of Toronto, Department of Mechanical and Industrial Engineering, University of Toronto, Division of Vascular Surgery, University Health Network, University of Toronto, Toronto, ON, Canada

Objective: Stent grafts used in the repair of abdominal aortic aneurysms can rotate unexpectedly during deployment, potentially leading to serious complications. The purpose of the current study is to understand the geometric factors of the iliac arteries that contribute to stent graft rotation.

Methods: A prospective study evaluating all patients undergoing advanced endovascular aneurysm repair at Toronto General Hospital was initiated in November, 2015. In addition to a qualitative assessment of the stent graft deployment, fluoroscopic images were quantified to determine the degree of device rotation. The local iliac artery geometric variables (radius, curvature, and torsion) were then calculated from the preoperative CTA imaging. Results were analyzed with respect to two groups (control and rotation) based on the qualitative assessment.

Results: Twelve patients have been enrolled with a mean age of 75 [66-86] and a mean aneurysm diameter of 64 mm [58-74mm]. One patient was excluded following an aborted procedure. The incidence of stent graft rotation was 58.3% (N=7) with a mean rotation of 20.4° [7.5-51.0°]. There were no significant differences in iliac diameter between the two groups. The total net torsion in the iliac arteries was significantly higher in the rotation group, 4.2±0.63 mm⁻¹ vs 1.5±0.42 mm⁻¹ (P<0.01).
There was also a trend towards increased mean curvature in the rotation group vs the control group (0.031±0.004mm⁻¹ vs 0.022±0.002 mm⁻¹).

**Conclusions:** This preliminary data from a prospectively followed cohort suggests that total net torsion of the iliac arteries may be the primary causative factor for unexpected stent graft rotation during deployment. Further studies will need to evaluate the local relationships between diameter, calcification, and torsion of the iliac arteries.

**Percutaneous TEVAR under local anaesthesia without cerebral spinal fluid drainage**

Crawford SA, Vucemilo I, Werneck C, Johnson W, Pope M.

1Division of Vascular Surgery, University of Toronto, 2Division of Vascular Surgery, Trillium Health Center

**Objective:** The objective of this study was to assess the safety of performing thoracic endovascular aneurysm repair (TEVAR) under local anaesthetic without cerebral spinal fluid drainage (CSF) drainage at Trillium Health Center.

**Methods:** A retrospective review of all TEVAR cases performed at Trillium Health Centre (2011-2015). These cases were analyzed with respect to the type of anesthesia and the use of CSF drainage.

**Results:** This retrospective case-series identified 29 patients of which 2 were excluded for use of spinal anaesthesia. 12 patients were performed under general anaesthetic and 15 patients were performed under local anaesthetic. Patients performed under local anaesthetic had significantly more co-morbidities with 80% (n=12) having ≥3 co-morbidities relative to 42% (n=5) in the general anaesthetic group. There were no significant differences in aneurysm size or extent of aortic coverage between the two groups. Spinal drains were placed preoperatively in 33% (n=5) of patients performed under local anaesthetic and in 92% (n=11) of patients performed under general anaesthetic. One patient in the local anaesthetic group with coverage of the LSA developed a delayed global paralysis on POD#12 necessitating a carotid-subclavian bypass. Other 30 day TEVAR related complications included 1 NSTEMI, 1 pneumonia in the general anaesthetic group and 1 TIA, 1 NSTEMI, 1 wound infection in the local anaesthetic group. There was a trend towards shorter length of stay in the local anaesthetic group at 5.5 days vs 8.5 days with a general anaesthetic.

**Conclusions:** In this study, there was no increased risk of paralysis in patients performed under local without CSF drainage; however, further study is required to definitively assess the risk of paralysis in this patient population. The use of local anaesthesia in this setting enables continuous intraoperative assessment of neurologic function and allows for appropriate and timely intervention if required.

**Duplex criteria for Renal Artery In-stent Restenosis**

Brandon C. Cain, MD, Joseph C. Wuamett, MD, Michael Soult, MD, Sebastian Larion, MD, Sadie Ahanchi, MD, Jean M. Panneton, MD. Eastern Virginia Medical School, Norfolk, VA.

**Objectives:** Duplex ultrasound (DUS) is the primary method to detect renal artery in-stent restenosis (ISR) but uniformly validated criteria do not exist. Literature suggests the velocity threshold for hemodynamically significant ISR (60-99%) is higher than for native renal artery stenosis.

**Methods:** We retrospectively reviewed patients undergoing renal artery stenting from 2008-2013 by a single vascular group. A cohort of patients with repeat angiography and a paired pre-procedural renal duplex ultrasound was selected. Angiograms were analyzed to categorize 0-59% stenosis versus 60-99% stenosis. Mean peak systolic velocity (PSV), mean end diastolic velocity (EDV), and mean renal artery aorta ratio (RAR) for renal arteries were collected from paired DUS exams performed within 6 months of angiogram. The full spectrum of data was analyzed with receiver operator characteristics curve analysis (ROC) to determine the cutoff PSV, EDV, and RAR for ISR. Values for ISR were chosen to maximize the sensitivity and specificity.

**Results:** We evaluated 128 renal artery stents with acceptable angiograms (112 DSA, 16 CTA) and corresponding DUS. Angiography demonstrated 60 with <60% stenosis and 68 with ≥60%. Mean PSV,
EDV, and RAR for <60% ISR versus >60% ISR were as follows: 182 cm/s vs. 418 cm/s (p<0.001), 36 cm/s vs. 105 cm/s (p<0.001), and 2.79 vs. 5.9 (p<0.001), respectively. Areas under the operator curve for PSV, EDV, and RAR were 0.95, 0.89, and 0.89, respectively (Figure 1). The cutoff PSV, EDV, and RAR values for >60% renal ISR were 254.5 cm/s (sensitivity: 95.59%, specificity: 83.33%), 55.05 cm/s (sensitivity: 79.69%; specificity: 87.73%), and 3.05 (sensitivity: 93.65%; specificity: 70.21%), respectively.

Conclusions: Renal artery duplex is a reliable surveillance tool for detecting significant renal artery ISR. A PSV >254.5 cm/s appears to be the most useful criteria for distinguishing ISR and adds to a growing body of literature suggesting duplex criteria be adjusted when monitoring for ISR.

Can Outcomes Be Improved With Implementation of a ‘Code AAA’? A Comparison of Ruptured Aortic Aneurysm and Trauma Code Patients
Cyrus Chehroudi¹, Jason Patapas², Jacinthe Lampron², Prasad Jetty³, The Division of Vascular and Endovascular Surgery¹ and The Division of General Surgery², The Ottawa Hospital – Civic Campus, 1053 Carling Avenue, Ottawa, Ontario, Canada, K1Y 4E9

Objective: To compare hemodynamic stability, times to assessment and intervention, and mortality outcomes between trauma code and ruptured aortic aneurysm (RAA) patients.

Methods: We conducted a retrospective chart review comparing all trauma code and RAA patients (for whom no code protocol exists) presenting to The Ottawa Hospital Civic Emergency Department (ED) from July 2013 to November 2015. Data, including demographics, vital signs, time-to-physician assessment and -intervention were collected from electronic medical records and the trauma registry database. RAA patients who bypassed the ED, had ruptured pseudoaneurysms, or did not have true acute ruptures (i.e. traumatic ruptures, chronic ruptures, non-ruptured symptomatic aneurysms) were excluded.

Results: We identified 492 trauma and 35 RAA patients over the two-year study period. The RAA patients were older (74 vs 44 years, p<0.001), with an equal proportion of males (75%). RAA and trauma patients were equally unstable with minimum mean arterial pressures of 83 and 79 mmHg, respectively (p=0.27). Thirty-day mortality was similarly high at 14% for RAA and 11% for trauma patients (p=0.58). However, the mean time-to-physician assessment was significantly less for trauma patients (4.8 vs. 38.8 min, respectively, p<0.001). Conversely, the mean time-to-OR from physician...
assessments were 193 minutes for trauma and 120 minutes for RAA patients (p<0.05) with only 23% of
traumas compared to 97% of RAAs proceeding to OR immediately following ED assessment.

**Conclusion:** Compared to trauma code patients, RAA patients are equally unstable, have similar
mortality rates, are more likely to require emergency surgery, and experience a longer time to
physician assessment. Despite this, these patients are not managed according to a code protocol.
Implementing a “code AAA” may expedite surgical care, improve patient outcomes, and optimize
mobilization of OR and radiology personnel, especially in the resource-intensive endovascular era.

**Exploring the training experiences of a direct entry vascular surgery resident cohort using focus
groups**
Faysal Naji BHSc, Mina Guirgis BSc MD, Jen Hoogenes BSc MSc PhD, Fadi Elias BHSc MD, Theodore
Rapanos MD FRCS, David Szalay MD FRCS, John Harlock MD FRCS, McMaster University, Hamilton,
Ontario, Hamilton Health Sciences, Hamilton, Ontario

**Objectives:** Training in vascular surgery is currently undergoing a transition in paradigm from a 5+2
fellowship pathway to a 0+5 direct-entry pathway following medical school. Given the unique
positions of the first PGY-1-4 vascular surgery trainees in Canada, they are ideal candidates for
soliciting insight and first impressions of this new training paradigm. Very few studies have explored
or evaluated resident satisfaction and experiences during surgical training, and, to our knowledge,
none have specifically looked at the Canadian vascular surgery training programs. The aim of this
study is to explore the experiences of PGY-1-4 vascular residents currently in the 0+5 pathway, gaining
insights regarding the current status of vascular surgery programs as well as inform future program
design and development.

**Methods:** We explored the experiences of current PGY-1-4 residents via focus groups comprised of 3-
5 residents each. Participants invited include all residents in Canadian vascular surgery programs.
Focus group discussions were recorded, transcribed, anonymized, and reviewed for recurrent
themes and patterns. Themes were analyzed using a grounded theory approach, culminating into a
‘theme codebook’. Various qualitative methods were employed to ensure methodological rigour,
including triangulation and member checks.

**Results:** A total of 6 focus groups were completed, including a combination of junior and senior
residents. Recurring themes generated from the focus group transcripts include: resident operative
exposure, increasing levels of responsibility, time constraints in the operating room, staff-resident
relationship, level of academic structure, open communication routes, and integration of residency
with fellowship programs.

**Conclusion:** A wealth of insights was obtained regarding resident perspectives, program performance,
and overall reception of the new direct entry training pathway for vascular surgery. The emerging
themes serve to highlight the major strengths and weaknesses of current training programs,
informing a framework for future program development both for vascular surgery and surgical
specialties at large.

**Patient profile and peripheral vascular interventions in consecutive patients treated a single
academic center**
Liao E, Eisenberg N, Tan KT*, Roche-Nagle G, Division of Vascular Surgery, Peter Munk Cardiac Center,
*Division of Vascular Interventional Radiology, Joint Department of Medical Imaging, Toronto General
Hospital, University of Toronto, Toronto, ON

**Background:** Endovascular procedures have become the predominant method for revascularization of
patients with symptomatic peripheral artery disease (PAD), largely due to their less invasive nature
and low complication rates. Balloon angioplasty is also a reasonable alternative for patients with life
limiting claudication or limb threatening lower extremity ischemia who are not candidates for an
autologous venous graft.
Objectives: The aim of this study was to describe the health profile of patients undergoing peripheral arterial interventions. In addition, we evaluated the treatment type and technical success rates in consecutive lesions treated by endovascular means at a single academic center.

Methods: A single-center institutional database was interrogated to identify all patients undergoing endovascular interventions with and without stenting for symptomatic iliac, femoropopliteal disease (Rutherford category ≥1) between April 2014 and March 2016. Detailed information on demographics, cardiovascular risk factors, medications, and procedural data was recorded.

Results: During the study period, 544 arteries were treated, 169 were common iliac, 130 external iliac, and 245 superficial femoral arteries. The average age was 69.2 years, and 62% were male. The rate of diabetes in this population was 45.8%, 84% had hypertension, and 80% had a smoking history (current 37.1%). The majority were on an antiplatelet (83.5%) and statin (90%). The technical success rate of the common iliac was 96.4%, the external iliac 98.5%, and SFA 92.2%. The TASC profile of the lesions treated are demonstrated in Table 1. The majority of common iliac lesions were treated with PTA+stent (82%). This was in contrast to the SFA, where only 1/3 received a stent (29.4%), 51% of external iliac lesions received a stent.

Conclusion: We report a very acceptable technical success rate for peripheral interventions. The study illustrates the significant disease burden of this patient population with smoking history being a very important modifiable risk factor. While we demonstrate good medical risk factor modification, there is room for improvement and smoking cessation should be a priority.

Table 1: TASC classification of lesions treated.

<table>
<thead>
<tr>
<th>TASC</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Not recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common iliac</td>
<td>46.7%</td>
<td>24.9%</td>
<td>7.2%</td>
<td>17.2%</td>
<td>4.1%</td>
</tr>
<tr>
<td>External iliac</td>
<td>41.5%</td>
<td>22.3%</td>
<td>14.6%</td>
<td>16.9%</td>
<td>4.6%</td>
</tr>
<tr>
<td>SFA</td>
<td>20%</td>
<td>33.5%</td>
<td>16.3%</td>
<td>25.7%</td>
<td>4.5%</td>
</tr>
</tbody>
</table>

Multiple Mini Personal Interviews for selecting Vascular Surgery Residents
Mohammed Firdouse [1], Thomas Lindsay [2], Thomas Forbes [2], George D. Oreopoulos [2] [1] Faculty of Medicine, University of Toronto, Toronto, ON, Canada; [2] University Health Network, Toronto, ON, Canada

Objective: To assess the use of the multiple mini personal interview (MMPI) for the selection of PGY-1 vascular surgery residents at the University of Toronto.

Methods: Candidates and assessors for the University of Toronto’s Vascular Surgery Residency training program were surveyed on the MMPI interview format used for three consecutive CaRMS selections between 2013 and 2016 using a standardized questionnaire.

Results: A total of 50 completed questionnaires from applicants and 27 completed questionnaires from assessors were included in the analysis (100% response rate). Applicants noted that the perceived strengths of the MMPI format included the standardized and objective assessment (n=15), organization (n=18), and comprehensiveness of the process (n=9). Concerns raised by applicants included a limited time per station (n=21), assessors not having access to their curriculum vitae (n=9) and questions not being personal enough, resulting in a lack of opportunities for candidates to showcase their personalities. Assessors agreed that the MMPI process was organized (n=8), objective (n=9) and comprehensive (n=7). However, they had raised concerns about the process being 'blind' and not having access to applicants’ curriculum vitae before hand (n=6). In line with the applicants, the interviewers also mentioned a lack of time per station (n=7). Overall, almost all applicants and interviewers shared that they had a pleasant and organized experience.
Conclusion: This is the first report discussing the implementation of MMPI in a vascular surgery residency program in Canada. Our data shows good acceptability amongst both applicants and assessors and some areas for improvement.

Utility of the Assessment Urgency Algorithm in Predicting Length of Stay in a Vascular Surgery Patient Cohort
Soheil Jamshidi - PGY3 Université de Montréal, Rafik Ghali, Department of Vascular Surgery, Hôpital Maisonneuve-Rosemont

Objectives: The Assessment Urgency Algorithm (AUA), a tool developed for predicting patient risk in geriatric populations, has shown promise as a predictor of admission duration in an orthopaedic surgery cohort. We seek to evaluate the relationship between AUA score and admission duration in the vascular surgery patient population.

Methods: A prospectively enrolled retrospective chart review study was performed on consecutive patients over the age of 65 admitted to the vascular surgery service at a community teaching hospital. AUA questionnaires were administered and scores assigned upon admission. Chart review was performed following discharge to determine duration of admission and multiple clinical parameters. T-tests, ANOVA, and linear regression models were used to evaluate the relationship between AUA groupings and admission duration.

Results: Of 30 consecutive admissions to our service, informed consent was obtained in 26 cases (86.7%). 19 patients (73%) were male and the average age was 78 years (SD: 8.5). Mean and median admission duration was 20.4 and 14 days, respectively (SD 20.6). Low-risk (AUA 1-2), Medium-Risk (AUA 3-4), and High-Risk (AUA 5-6) showed average admission duration of 11.3, 24, and 40 days, respectively (p<0.01, adj R²: 0.28). A linear model comparing AUA score to admission duration showed an increase of nearly 6 days per interval increase in AUA score (p<0.01, adj R²: 0.32).

Conclusion: Despite a modest sample of consecutive patients, AUA scores at admission significantly predict admission duration in a geriatric vascular surgery cohort.

Evaluating the Effectiveness of Internal Iliac Artery Branched Endovascular Stent Grafts: Institutional Experience
Srivatsav V, Naji F, Elias F, Adrinopoulos T, Qadura M, Harlock J, Rapanos T, McMaster University, Hamilton, Canada

Purpose: To describe our institutional experience using iliac branch grafts (IBG) in aortoiliac aneurysm repair.

Methods: From October 2009 to November 2014, 31 consecutive patients (all men), mean age 73.1 years (range 51-89), underwent IBG implantation. Abdominal aortic aneurysm (AAA) with common iliac artery (CIA) involvement (n=15) and bilateral CIA (n=16) were indications. Computed tomography (CT) was used to evaluate patency and postoperative endoleaks within 1 month of implantation and after 1 year.

Results: A total of 32 IBGs were deployed in 31 patients successfully. 100% of grafts implanted were patent at 1-month and annual follow-up. The mean hospitalization duration was 4 days (range 1-40) with 1 mortality at 30 days, due to acute renal failure. 10 type II and 1 type 1b endoleak occurred, with 1 re-intervention performed for the type 1b endoleak and the balance being treated conservatively. 5 patients had complications. 19 patients complained of claudication, with 7 cases being resolved. 61% of patients were claudication free after IBG deployment.

Conclusion: IBG placement has excellent short-term outcomes and potential to limit buttock claudication.
Sex Differences in Endovascular Abdominal Aortic Aneurysms: A Meta-Analysis
Fadi Elias¹, Christopher Tarola², Ahmed F. Hegazy³, Julius I. Ejiofor⁴, John Harlock¹
¹ Department of Vascular Surgery, McMaster University, ² Department of Cardiac Surgery, Western University, ³ Department of Anesthesia, London Heath Sciences Centre, ⁴ Department of Surgery, Brigham and Women’s Hospital

Objectives: The endovascular approach has emerged over the last two decades as an effective alternative to open surgical abdominal aortic aneurysm repair. The aim of this study is to investigate the difference in mortality and perioperative complication rates in women undergoing endovascular aortic repair (EVAR) compared to men.

Methods: A comprehensive literature search was conducted involving MEDLINE, Cochrane and EMBASE to retrieve relevant entries. Data was analyzed by using a random effects model to account for heterogeneity. Pooled data was used to calculate odds ratios and 95% confidence interval for mortality and complications for women compared to men. Meta-regression was performed to adjust for age.

Results: A total of 5232 studies were retrieved from our preliminary search, and 276 were reviewed in full. After consideration of exclusion criteria, 31 studies were included in the investigation. There was no evidence of publication bias in our study (Egger’s: p=0.46). We identified significantly increased odds of 30-day mortality in females compared to males (OR 1.46 [1.19,1.79]), and meta-regression demonstrated no independent effect of age on this relationship (p=0.201). In subgroup analysis of studies based on the type of data harvested, there was a significant difference between odds ratios (Raw Data Studies: 1.76 [1.6,1.9]; Regression Studies: 1.26 [1.1,1.4]; p < 0.001). Additionally, odds of endoleak and conversion to open/abortion of EVAR were significantly lower in men compared to women, 0.86 [0.75,0.98] and 0.47 [0.35,0.63], respectively.

Conclusions: In this investigation we examined the relationship between gender and 30-day mortality after elective EVAR. We identified a significant increased odds of mortality in women, however, age did not account for the observed differences. Further investigation is required to determine the independent factors that predict this difference in mortality.

Smart(phone) learning experience amongst vascular residents utilizing a response system application
Wissam Al-Jundi, Giuseppe Papia, Andrew Dueck, Department of Vascular Surgery, Sunnybrook Health Science Centre, 2075 Bayview Ave, Toronto, ON M4N 3M5

Objectives: Smartphones have become the most important personal technological device. M-learning is learning through mobile device educational technology. We aim to assess the acceptability of a smartphone learning experience amongst the vascular residents and determine if results could inform formal teaching efforts.

Methods: A survey of the vascular residents at a single centre was conducted following a trial of smartphone learning experience. A vascular fellow utilized a smartphone response system application (Polltogo®, Inspirapps Inc) (figure 1) to send a daily multiple-choice question (figure 2) to the vascular residents for 20 consecutive working days. The application allows for only one attempt from each user and the answers are registered anonymously. However, each participant receives instant feedback on their response by viewing the correct answer after answering each question along with a distribution of answers amongst other users (figure 3).

Results: 9 residents participated in the trial and all of them filled a post trial survey. All the residents possessed smartphones. The majority (78%) were not aware of the concept of m-learning. The mobile engagement score (number of answers received divided by total possible answers) was 145/180 (80.6%). All the residents were “satisfied” or “very satisfied” with the experience, and the same number stated that they were “likely” or “very likely” to use this technology in the future. The majority (89%) agreed that such an application could assist them in their board exam preparation. On
3 occasions, 75% or more of the participating residents answered the multiple choice question incorrectly which resulted in addressing the relevant topics in the unit’s weekly teaching conference. **Conclusion:** Utilizing smartphones for education is acceptable amongst the vascular residents and the trial of a response system application with instant written feedback represents a novel method for using smartphones for collaborative learning. Such an application can also inform program directors and surgical trainers of their trainees’ learning needs.

Figure 1: options available when creating a question

Figure 2: an example of a multiple-choice question created through the response system application with a demonstration of the facility to attach a picture

Figure 3: An example of the display the users get after answering a question. The application allows for demonstration of the correct answer and a distribution of the answers registered.
Percutaneous endovascular aneurysm repair: a single-center economic analysis.
Cwinn MA, Morzycki A, Casey P, Lee M, Department of General Surgery, Dalhousie University, Halifax, Canada, Dalhousie Medical School, Dalhousie University, Halifax, Canada, Department of Vascular Surgery, Dalhousie University, Halifax, Canada

Objective: We sought to perform an economic analysis comparing traditional endovascular aneurysm repair (EVAR) with percutaneous endovascular aneurysm repair (pEVAR) and to evaluate the outcomes of both procedures at our institution.

Methods: This study is a retrospective chart review that included all elective endovascular aneurysm repairs performed between January 1st and December 31st 2014 at the Halifax Infirmary, a tertiary-level care center. Patients undergoing concomitant bypass grafting or internal iliac aneurysm repair were excluded. Our primary endpoint was the total upfront cost of EVAR vs. pEVAR. Secondary outcomes included access complications, length of stay, operative time, and time in the surgical step-down unit.

Results: A total of thirty-eight cases were performed in each treatment group. Mean cost of EVAR was $9977 (+/- $2522) and pEVAR was $10704 (+/-1932) (p>0.05). There was no difference in the number of access complications, length of stay, operative time, or time in the surgical step-down unit.

Conclusions: At our institution, the cost of EVAR and pEVAR are similar. pEVAR is associated with a non-significant cost increase that can be attributed to the cost of the closure devices. A percutaneous approach does not result in shorter operative times, length of stay in the step-down unit, or total length of stay.

Preliminary Results of a Prospective Trial of Endovascular Aortic Aneurysm Repair as Day Surgery
Stephen C Hanley, Oren K Steinmetz, Eva S Mathieu, Daniel I Obrand, Kent S MacKenzie, Marc-Michel Corriveau, Cherrie Z Abraham, Heather L Gill, Division of Vascular Surgery, McGill University, Division of Vascular Surgery, Oregon Health & Science University

Objectives: Endovascular aortic aneurysm repair (EVAR) allows reduced peri-operative morbidity, mortality and length of stay while maintaining long-term results equivalent to open repair. Currently, most patients are admitted to hospital post EVAR, however, there are no standard observation periods, and timing of discharge is based on clinical judgment. The aim of this study was to validate criteria for targeting patients for outpatient EVAR, and to assess the safety of outpatient EVAR.

Methods: We developed criteria to target patients for potential outpatient EVAR (infra-renal aneurysm, low peri-operative risk, to be accompanied for first 24 hours). We then prospectively selected patients for planned outpatient EVAR, and compared them to a historical control group (patients who had undergone EVAR over the previous 3 years and met outpatient criteria). We collected demographic and operative data, length of stay, complications, emergency room visits, re-admissions, re-interventions and deaths. The primary outcome was the 30-day complication rate, and this study was designed to assess non-inferiority.

Results: Prospectively, we have assessed 159 patients and planned 60 (38%) for outpatient EVAR (57% of historical controls met outpatient criteria). Compared to controls, planned outpatients are younger (75±1 vs 79±1 years, p<0.01) but have otherwise similar demographics. In planned outpatients, hospital stay is significantly shorter (0.7±0.4 vs 2.8±0.9 days, p<0.05), and 47 (78%) were discharged the same day. 30-day follow-up was available for 88% of both groups; there were no differences in complication (15 vs 15%), emergency room visit (21 vs 12%), re-admission (4 vs 7%), re-intervention (6 vs 8%) or mortality rates (2 vs 1%).
**Conclusions:** In well-selected patients, preliminary results suggest that outpatient EVAR is feasible without increasing complication rates or health care resource utilization. However, these data represent early results of an ongoing study designed to establish non-inferiority of outpatient EVAR.

**Development and Initial Evaluation of a Same Day Discharge Percutaneous Endovascular Aneurysm Repair Pathway**
Derek J. Roberts, MD, PhD; Mary E. MacDonald, MD, PhD; Marie-France Guimond, MD; Gregory Samis, MD; Jeffrey Clark, MD; Neal Maher, MD; Christi Findlay, BA; and Mark T. Nutley, MD, MSc, Division of Vascular Surgery, Department of Surgery and Department of Anesthesia, Peter Lougheed Centre and the University of Calgary, Calgary, Alberta, Canada

**Objectives:** To describe complications after percutaneous endovascular aneurysm repair (PEVAR) and evaluate a pathway developed for identifying patients appropriate for same day discharge after PEVAR.

**Methods:** We conducted a pilot retrospective cohort study of 55 adults admitted to a tertiary care teaching hospital between January 1, 2010 and January 1, 2012 who underwent attempted elective PEVAR of an abdominal aortic and/or iliac aneurysm. Outcomes included complications and whether patients would satisfy criteria for inclusion in a newly developed same day discharge pathway.

**Results:** During the study period, 48 (87%) of 55 patients’ aneurysms were successfully repaired percutaneously. Reasons for unsuccessful PEVAR included unsuitable access artery anatomy on intraoperative ultrasound (n=4) and closure device failure (n=3). Mean patient age was 73.7±9.2 years, 89% were men, and the median American Society of Anesthesiologists' classification was 3. Intraoperative complications included blood loss requiring transfusion (11%), renal artery thromboembolism (4%), a kinked iliac limb (2%), and bradycardia or laryngospasm (2%). Using the developed pathway, 22 (40%) patients would have satisfied criteria for same day discharge. Contraindications to same day discharge after PEVAR most commonly included coronary artery disease (46%), chronic obstructive pulmonary disease (29%), chronic kidney disease (4%), and cognitive difficulties requiring intensive postoperative care. Postoperative complications associated with a prolonged length of hospital stay included increased oxygen requirements (4%), an elevated white blood cell count (2%), and a persistently elevated temperature (2%), each of which would have likely been identified during postoperative patient assessment in the same day discharge pathway.

**Conclusions:** This study identified features associated with hospital admission longer than 24 hours after PEVAR and suggests that 40% of candidates for this procedure could potentially have been offered a same day discharge. These findings should be confirmed by prospective studies before being used to inform practice.

**Quality Improvement in Elective EVAR Length of Stay using Risk adjusted VQI Comparisons: A local study**
Naomi Eisenberg, Dr. Thomas F. Lindsay, Dr. George D. Oreopoulos, Graham Roche-Nagle, Division of Vascular Surgery, University Health Network, University of Toronto

**Background:** The hospital costs associated with elective infrarenal EVAR are dominated by device and length of stay. In 2013, we identified thorough the analysis of our data from the Vascular Quality Initiative that our length of stay for conventional EVAR was longer than expected (eLOS). We conducted an analysis (N = 144) and discovered the factors that contributed to eLOS and instituted a number of changes to reduce LOS. Two years later, we revisited our infrarenal EVAR population (N = 140) to examine (a) if the changes instituted demonstrated long term carry-over for LOS (b) if there was a cost savings to the hospital.

**Methods:** Demographic and risk data was extracted from our VQI database for two years prior to our LOS intervention and for two years after intervention to measure the effect of the intervention. The intervention was preparing the patients and families for post op day 1 discharge and training all staff
involved for this outcome. LOS data was calculated based on hospital records and the VQI database. Case costing was obtained from the hospital case costing system.

**Results:** We found that we were able to significantly decrease our LOS as well as identify the predictors that contributed to eLOS. Multivariate analysis revealed that, in the earlier group, POD1 neural, CV and renal issues were all significant predictors of eLOS. In the newer group, the same issues, as well as urological issues were significant predictors for LOS. Logistic regression identified that only cardiovascular issues were the significant predictor of LOS. Our LOS was reduced on average by 1 day after the intervention. Total hospital days saved was 53. In the initial cohort only 45% had an LOS of 2 days or less compared to 73.4% in the second cohort. The case costing analysis that revealed lower total average costs from $27,191 to $26,275.

**Conclusions:** Analysis and review of risk adjusted VQI data determined our LOS for elective EVAR was excessive. A simple intervention enabled a significant reduction in the EVAR LOS which resulted in cost savings without increasing the number of re admissions. This highlights the usefulness of risk adjusted quality programs where data can be analyzed in real time allowing sites to adjust local practices to improve quality and potentially costs of care episodes.

**A New ‘Angle’ on Aortic Neck Angulation Measurement**
Mark Rockley¹, Adnan Hadziomerovic¹, Carl van Walraven¹, Oonagh Scallan², Prasad Jetty¹, University of Ottawa¹, University of Western Ontario²

**Background:** Infrarenal aortic neck angulation has been identified as one of the most powerful predictors of Endovascular Aneurysm Repair (EVAR) failure. While the gold standard to measure this vital angle is 3D reconstruction and centerline measurement, most surgeons rely on estimations of angulation based on coronal and sagittal views on CT imaging. Unfortunately, neither of these 2D views accurately represent the true angle (Figure 1). The importance of calculating a true angle based on perpendicular views has been emphasized in specialties such as orthopedics, but not yet in vascular surgery. In response to this need, we have developed a novel trigonometry-based formula (the “Paired Angle Formula”) which uses coronal and sagittal measured angles to calculate the true angle (Figure 2).

**Objective:** To compare the Paired Angle Formula for estimating true aortic neck angulation with gold standard 3D centerline measurements.

**Methods:** Fifty randomly selected patients treated by EVAR at The Ottawa Hospital between 2010 – 2015 were studied. 3D centerline aortic neck angle measurements were made by radiology staff using Aquarius iNtuition. The Paired Angle Formula was applied by a vascular surgeon, resident, and student using 2D coronal and sagittal angles from CT imaging to estimate the true angle.

**Results:** Of the 50 patients selected, 47 had preoperative and postoperative CT imaging. The average age at time of procedure was 78 years; 74% of patients were male, and average preoperative aneurysm diameter was 5.73cm. A total of 94 scans were analyzed, with all except one performed with contrast. Linear regression found that 3D centerline aortic neck angle measurements were significantly and strongly associated with Paired Angle Formula estimates from all three users (R² values range 0.92-0.96; p<0.0001). Average user estimate deviations from true angles ranged from -5% to +19%. The Paired Angle Formula also accurately predicted severe angulation (>60 degrees) in pre-EVAR scans (p<0.001). Inter-observer agreement was very high (Pearson Correlation Coefficient = 0.87 and 0.88, for the resident and student respectively, with surgeon set as standard). Similar to pre-EVAR measurements, there was a high correlation between 3D reconstruction measurements and the Paired Angle Formula in post-EVAR measurements (Figure 3).

**Conclusion:** The novel Paired Angle Formula accurately estimates the true aortic neck angle. If validated in other populations with other users, this method could obviate the need for 3D imaging in patients undergoing elective EVAR. Furthermore, the importance of accurate angle measurement is not limited to vascular surgery, and has direct relevance to several other specialties including orthopedics.
Figure 1: The measured aortic neck angle appreciated in the coronal and sagittal views, compared with the true oblique angle on 3D reconstruction. The true angle is not accurately represented by the angles appreciated on either coronal or sagittal views individually.

\[
\text{True Angle} = \arccos \left( \frac{1}{2} \cos(S) \left( 1 + \sec(S)^2 - \frac{2 \sin\left(\frac{C}{2}\right)}{\cos\left(\arctan\left(\frac{\tan(s)}{2 \sin\left(\frac{C}{2}\right)}\right)\right)} \right)^2 \right)
\]

Figure 2: Paired Angle Formula to calculate the true angle of the aortic neck, by inputting the angles measured on coronal (C) and sagittal (S) views.

Figure 3: Comparison of 3-D centerline measurements, labeled as Gold Standard, and the Paired Angle Formula preoperatively (a) and postoperatively (b). Pearson correlation coefficient was very high in the preoperative group (\(p=0.86, P<0.0001\)) and postoperative group (\(p=0.84, P<0.0001\)).
Ten Years of Endovascular Aortic Aneurysm Repair: A Population-based Evaluation of Post-operative Imaging and Mortality
Charles de Mestral*, Ruth Croxford†, Naomi Eisenberg*, Graham Roche-Nagle*
*University Health Network, Toronto, Ontario, † Institute for Evaluative Clinical Sciences, Toronto, Ontario.

Objective: Compliance with regular imaging follow-up after EVAR is inconsistent and evidence supporting a defined imaging surveillance schedule is limited. We sought to characterize the frequency of post-operative imaging and explore its association with mortality.

Methods: Using administrative health databases for the province of Ontario, Canada, we identified a cohort of patients who underwent EVAR between 2004 and 2014. Minimum appropriate imaging follow-up (MAIFU) was defined as a CT scan or ultrasound of the abdomen within 90 days of EVAR as well as every 15 months thereafter. Multivariable time-to-event analysis was performed to characterize the association between post-operative imaging frequency and all-cause mortality. Two definitions of the main exposure variable (post-operative imaging frequency) were considered: (1) whether the patient met MAIFU criteria - a time-varying binary variable, (2) the proportion of the follow-up period meeting MAIFU criteria - a time-varying continuous variable.

Results: 4,988 patients treated by EVAR were identified. Median follow-up was 3.4 years (IQR 2.0-5.3 years) and 90-day mortality was 1.7%. Among those who survived over 90 days, 87% (N=4,251 of 4,902) underwent at least one CT scan or ultrasound of the abdomen within 90 days and, 58% (N=2,859 of 4,902) met the definition for MAIFU. On multivariable analysis, meeting MAIFU criteria was associated with a lower risk of death when compared to missing first imaging follow-up within 90 days (HR= 0.81, 95%CI 0.69-0.96, p=0.012) as well as when compared to follow-up including first imaging within 90 days but not meeting MAIFU criteria (HR=0.78, 95%CI 0.68-0.90, p < 0.001). A larger proportion of the follow-up period meeting MAIFU criteria was associated with a lower risk of death. The strength of this latter association increased with greater time since EVAR.

Conclusions: Regular imaging after EVAR is associated with lower all-cause mortality and the reduced mortality risk appears most pronounced in the long term. Efforts to improve imperfect compliance with imaging follow-up after EVAR are warranted.

Endovascular repair of ruptured abdominal aortic aneurysms: Are outcomes device-dependent?
1Vinay Kansal, 2Sudhir Nagpal, 3Prasad Jetty, 1University of Ottawa, Faculty of Medicine 2University of Ottawa, Division of Vascular Surgery

Background: Rates of ruptured abdominal aortic aneurysms treated by endovascular aneurysm repair (rEVAR) is consistently increasing and being applied as the intervention of choice in some centres. Successful EVAR exclusion in principal eliminates imminent death. Multiple endografts are available on the market; however, device-specific short and long-term outcomes have never been studied.

Objective: To determine whether short- and long-term survival, and reintervention rate after rEVAR are device dependent.

Methods: 1038 EVARs performed at The Ottawa Hospital from October 2000 to May 2015 were reviewed from a prospectively maintained database. Data was collected by reviewing patient charts and imaging. rEVARs performed for rAAA were included. Patients were excluded if they underwent thoracic EVAR, repair for chronic rupture or repair for trauma. Variables collected were patient demographics, stability index at presentation, adherence to device instructions for use (IFU), intra-operative mortality, 30-day mortality, all-cause mortality, endoleaks, and reinterventions at 5 years. One-way ANOVA was used to compare outcomes between groups. Mortality outcomes were further assessed using Kaplan-Meier survival analysis, and multivariate cox regression modeling.

Results: A total of 96 rEVARs were performed using 3 unique devices: Cook Zenith (n=46), Medtronic Endurant (n=33), and Medtronic Talent (n=17). All Medtronic Talent grafts were of aortouniiliac configuration. Average patient age was 76.9 ± 9.4, and 75% of patients were male. 30.2% of patients
presented in unstable or extremis condition - this did not differ between devices (p=0.37). There were no significant differences in IFU adherence (overall 47.1% of cases). The overall 30-day mortality was 18.8%, and did not differ between devices (Cook Zenith 15.2%, Medtronic Endurant 15.2%, Medtronic Talent 15.3%, p=0.16). Long-term mortality did not significantly differ between devices either in Kaplan Meier survival analysis (p=0.19) or cox-proportional hazard modeling (p=0.33). Graft-related reintervention rates at 30-days and at 5 years also did not differ significantly (p=0.08, p=0.61). Notably, 2 patients of the Medtronic Talent group underwent late conversion to open repair (p=0.009). Furthermore, there was a statistically significant difference in Type I endoleak rates across devices (Cook Zenith 0.0%, Medtronic Endurant 18.2%, Medtronic Talent 17.6%, p=0.028).

**Conclusion:** Although we identified device-related differences in endoleak rates, there were no significant differences in reintervention rates or mortality outcomes. Favourable outcomes of the Cook Zenith and Medtronic Endurant over the Medtronic Talent device reflect advances in endograft technology and improvements in operator experience over time. Outcomes of this investigation support the selection of endograft by operator comfort when performing EVAR for acute rAAA.

**Saturday, September 17th, 2016**

**PAPER SESSION VI: PERIPHERAL VASCULAR DISEASE, EDUCATION AND ORGANIZATION**

**The Effect of Gender on Outcomes after Lower Extremity Revascularization**

Jiarong Wang, MBBS a,b, Yazhou He, MSca, Chi Shu, MSc a,b, Jichun Zhao, MD, PhD b, Luc Dubois, MSc, MD c,d, a West China School of Medicine, West China Hospital, Sichuan University, 37 Guo Xue Alley, Chengdu 610041, Sichuan Province, China, b Department of Vascular Surgery, West China Hospital, 37 Guo Xue Alley, Chengdu 610041, Sichuan Province, China, c Division of Vascular Surgery, London Health Sciences Centre and Western University & Department of Epidemiology and Biostatistics, Western University, London, Ontario, Canada.

**Objective:** The impact of gender on the outcomes after lower extremity revascularization is controversial. The aim of our systemic review and meta-analysis is to evaluate the gender-related outcomes after peripheral vascular interventions.

**Methods:** We systematically searched MEDLINE, Embase, Cochrane Database and Scopus to identify studies comparing outcomes following revascularization according to gender. Random effects model was applied if heterogeneity existed. Time-to-event data was reported using hazard ratios and dichotomous data was presented using odds ratios.

**Results:** A total of 40 studies were included. Pooling of short-term outcomes after intervention showed that women had significantly increased risks of 30-day mortality (OR=1.31, 95%CI, 1.11-1.55, P=.001) (Figure 1), amputation (OR=1.07, 95%CI=1.02-1.12, P=.002), early graft thrombosis (OR=1.57, 95%CI, 1.30-1.89, P<.0001) (Figure 2), embolization (OR=1.64, 95%CI, 1.24-2.17, P=.0005), incisional site complication (OR=1.56, 95%CI, 1.34-1.80, P<.0001), cardiac events (OR=1.21, 95%CI, 1.16-1.26, P<.0001), stroke (OR=1.34, 95%CI, 1.19-1.53, P<.0001) and pulmonary complication (OR=1.07, 95%CI, 1.03-1.12, P=.0006). No significant difference was found between women and men for short-term reinterventions (OR=1.06, 95%CI, 0.73-1.54, P=.74) and renal complications (OR=1.03, 95%CI, 0.76-1.39, P=.86). For of long-term outcomes, we did not find any significant difference between women and men in cumulative survival (HR=1.10, 95%CI, 0.97-1.24, P=.12), primary patency (HR=1.14, 95%CI, 1.00-1.30, P=.06), secondary patency (HR=1.07, 95%CI, 0.86-1.34, P=.54) and limb salvage (HR=0.93, 95%CI, 0.70-1.24, P=0.63). However, in the open surgery subgroup, women had significantly reduced survival when compared to men (HR=1.21, 95%CI, 1.01-1.44, P=.04). And similarly, with critical limb ischemia, women experienced reduced survival (HR=1.28, 95%CI, 1.08-1.51, P=.004).

**Conclusion:** Following lower limb revascularization, women have inferior short-term outcomes but similar long-term outcomes when compared with men. Gender-specific consideration might be required in patients undergone lower extremity revascularization. A higher treatment threshold may...
be warranted when considering intervening on women with symptomatic PAD owing to the increased risks of post-procedural mortality and complications.

Figure 1. Forest plot of studies comparing 30-day mortality following revascularization between women to men (odds ratios)

Figure 2. Forest plot of studies comparing early graft thrombosis following revascularization between women to men (odds ratios)

Magnetic Resonance Imaging as a predictor of forces required to cross peripheral arterial lesions with a guidewire
Trisha Roy, Garry Liu, Noor Shaikh, Andrew D. Dueck, Graham A. Wright, Sunnybrook Research Institute, University of Toronto, Toronto, Canada

Objective: Percutaneous vascular interventions (PVI) are associated with frequent immediate technical failure, and medium/long-term restenosis leading to re-intervention or failure. Current
imaging has limitations that make it difficult to make precise predictions of whether patients will fail PVI. Immediate risk of technical failure is typically judged only by length and degree of lesion calcification. In this study, we sought to delineate risk of immediate technical failure by utilizing MRI to characterize peripheral arterial lesions beyond degree of calcification. Following this we sought to measure guidewire crossing forces required for specific plaque morphologies, as a surrogate for risk of immediate technical failure.

**Methods:** 40 excised peripheral arterial plaques from 6 amputation patients were imaged at 7 Tesla using T2-weighted and Ultrashort Echo Time sequences at high resolution (75μm³ voxels). 15 samples were studied to validate MR imaging signatures with microCT and histology. 25 lesions were chronic total occlusions (CTOs). CTOs were classified as soft (those with fat, thrombus or microchannels), intermediate (those with loose fibrous tissue), hard (those with dense fibrous tissue/collagen), or calcified (those containing calcium). A 2kg load cell advanced the back-end of a 0.035” stiff guidewire at a fixed displacement rate of 0.05mm/s through the CTOs, and the force required to cross the lesion was measured.

**Results:** Densely “calcified” CTOs (n=4) immediately failed mechanical testing. Non-calcified “hard” CTOs (n=6) required a puncture force of 1.74N ± 0.58 (Figure 1). Intermediate CTOs (n=11) required a puncture force of 0.45N ± 0.33. Soft CTOs (n=4) required a puncture force of 0.07N ± 0.02. The difference between groups was statistically significant (One-way ANOVA (F(2,18) = 27.490, P <.05).

**Conclusion:** These results demonstrate the potential of high-resolution MRI to predict guidewire crossing forces in peripheral CTOs. Future work will determine lesion crossability in-vivo with clinical MRI scanners.

Figure 1: “Hard” dense collagen CTO and associated force displacement curve. The MRI signature of collagen (outlined in yellow) is hypointense on T2-weighted image and isointense on UTE (using smooth muscle as the reference intensity).
Comparison of superior femoral artery (SFA) angioplasty combined with open femoral endarterectomy to open surgical bypass for femoropopliteal occlusive disease

Samuel Gurupatham BHSc\textsuperscript{1}, John Harlock MD FRCS\textsuperscript{1}, Tara Andrinopoulos\textsuperscript{1} Division of Vascular Surgery, McMaster University, Hamilton, Ontario, Canada.\textsuperscript{1}

**Objective:** Open bypass repairs (OR) are recommended for treating severe Trans-Atlantic Society Consensus (TASC) class C-D femoropopliteal lesions, while TASC A-B lesion interventions preferentially involve endovascular techniques. A hybrid approach (HR), an open endarterectomy followed by percutaneous transluminal angioplasty, has been increasingly used as an alternative to entirely open surgical repair of femoropopliteal lesions of lower severities. This study reviews and reports our experiences with open and hybrid repairs.

**Method:** A total of 56 patients who underwent OR or HR for femoropopliteal lesions were identified. All primary surgeries were completed between 2012 and 2015 at two selected institutions. The primary endpoint was the primary patency (PP) of the diseased vessel.

**Results:** The mean age of patients was 69.2 years (75.0% male, 25.0% female). Of the 12 TASC A-B lesions, 3 were treated with OR and 9 were treated with HR. Technical success rates were 100% in all subgroups, with the exception of the TASC C-D HR group, where the technical success rate was 66.6%. Among the 44 TASC C-D lesions, 32 were treated with OR while 12 were treated with HR. The 6-month post-operative PP in the TASC A-B OR and HR groups were 100% and 85.7% respectively. The 6-month post-operative PP in the TASC C-D OR and HR groups were 64.5% and 81.8% respectively. Over a 1-year post-operative follow-up period, the PP in the TASC A-B OR and HR groups were 100% and 60.0% respectively. The corresponding PP in the TASC C-D OR and HR groups were 43.5% and 62.5% respectively.

**Conclusions:** Hybrid interventions are a viable alternative to completely open surgical repair for femoropopliteal lesions of lower severity and may be of particular interest to patients who are poor surgical candidates. To make clinical recommendations, further study with randomised intervention allocation and larger sample sizes are required.

A Randomized Controlled Trial Evaluating the Impact of Expert Feedback on the Acquisition of Technical Skills in Vascular Surgery

Laura Drudi\textsuperscript{1}, Melina Vassiliou\textsuperscript{2}, Liane S. Feldman\textsuperscript{2}, Heather L. Gill\textsuperscript{1}, Oren K. Steinmetz\textsuperscript{1}. \textsuperscript{1}Division of Vascular Surgery, Department of Surgery, McGill University. \textsuperscript{2}Steinberg-Bernstein Centre for Minimally Invasive Surgery, Department of Surgery, McGill University.

**Objective:** To determine the effect of expert feedback on technical skill acquisition in medical students and junior residents using an end-to-side vascular anastomosis model.

**Methods:** Medical students and junior surgical residents were enrolled into a vascular surgery technical skills curriculum requiring an end-to-side vascular anastomosis on a simulated synthetic LifeLike BioTissue model. Participants were randomized into intervention (with expert feedback; EF) and control groups. A 5-minute instructional video was given to all subjects. Baseline performance was assessed by counting fatal errors and using the Objective Structured Assessment of Technical Skills (OSAT) and Standardized Vascular Skills Assessment (SVSA) scores using the end-to-side vascular anastomosis model. The control group then completed a second anastomosis, while the EF group received expert feedback and then completed their second anastomosis following the intervention. The primary outcome was the difference in proportions of fatal errors between the groups compared to their baseline performances. A two-sided paired Z-score test was used to evaluate the proportional difference in pre- and post- interventional fatal errors. The non-parametric Wilcoxon rank sum test was used to compare OSAT and SVSA scores.

**Results:** There were 52 participants; 27 in the EF group (4 PGY-1 residents and 23 students) and 25 in the control group (2 PGY-1 residents and 23 students). At baseline, 46% of the feedback group and 27% of the control group had fatal errors. At baseline, mean OSAT scores were 15.5±5.3 in EF group and 18.3±5.3 in control group, and the mean SVSA scores were 14.9±5.1 in EF group and 17.2±4.2.
The mean proportional difference in fatal errors in the EF group was reduced by 26% (95%CI: 5.17% to 46.69%, p=0.014, and reduced by 8% (95%CI: -13.57% to 29.57%, p=0.47) in the control group. There was an improvement in mean differences in OSAT scores and SVSA scores in both groups, however, the EF group had a statistically significant higher mean differences in OSAT (p= 0.03) as well as SVSA scores (p=0.02) compared to the control groups.

Conclusions: This pilot study demonstrates that expert feedback reduces the number of fatal errors in an end-to-side vascular anastomosis model, and results in improved objective OSAT and SVSA scores compared to the control group.

Bringing Simulation-Training to the Masses: Why Group Learning can be an Effective Low-Cost Alternative to the Traditional Hot-Seat Model
Husain Khambati1, Michael Yacob1, Christine Seabrook2, Laura Gerridzen2, Yvonne Ying2, 3
University of Ottawa, 1Division of Vascular and Endovascular Surgery, 2Surgical Foundations, Department of Surgery, 3Division of Pediatric Plastic Surgery

Background: With the advent of competency-based training, most surgical programs will begin to rely heavily on simulation to better prepare residents for practice. Participation in simulation sessions has been shown to improve future performance, but it is unclear if passive observation of simulation scenarios in larger group-settings can produce an equivalent benefit.

Methods: First-year surgery residents at the University of Ottawa were enrolled in a week-long simulation course. Groups of 4 to 5 residents were exposed to various simulation-based scenarios, either through active participation or passive observation. Residents were individually assessed by blinded medical experts on 3 of the scenarios using a global rating scale consisting of medical management, communication, and overall performance. Scores were analyzed using multivariate analyses. Costs of the simulation were analyzed using two models: the participant-observer model, which estimated the cost of one resident running the simulation while the remaining group observes, and the participant-centered model, which estimated the cost of running each resident through each station.

Results: 32 residents were enrolled in the course, and 28 underwent testing on each of the three scenarios. Scores were analyzed based on resident exposure during the course; previous exposure to the scenario, through active participation or passive observation, led to improved performance on medical management and overall performance compared to those who had not been exposed (p<0.05). However, active participation did not improve performance relative to passive observation. Previous exposure to the scenarios did not improve resident performance on communication aspects of the scenarios. The cost/resident/session was 53.125 CAD for the participant-observer model, versus 140.625 CAD for the participant-centered model.

Conclusion: Analyses not only confirm the overall advantage of simulation-based training, but additionally suggest that active participation was not necessary to benefit from the experience; residents were able to learn from passive observation in the scenarios. This, coupled with the lower costs, supports the idea of simulation-based training in larger group-settings to allow for exposure to more scenarios rather than increased active participation.

Ontario Current State Assessment and Proposed Program Framework: Acute Care Vascular Services
Thomas L. Forbes1, Michael Setterfield2, Vevien Braga3, on behalf of the members of the Vascular Care Working Group of the Cardiac Care Network, 1Division of Vascular Surgery, University Health Network & University of Toronto, 2Cardiac Care Network, Toronto, ON

Objective: To determine the current status of vascular services provision in Ontario and to propose a provincial vascular framework to improve the quality and access to hospital-based care.
Methods: In September 2014 a questionnaire was distributed to all Ontario acute care hospitals. The survey was closed in December 2014. Hospitals were asked to report their 2013/14 case volumes.

Results: 99 of 121 (82%) acute care hospitals in Ontario responded to the survey, revealing variability in the provision of vascular care, infrastructure and access to care. Twenty-seven hospitals performed at least one core procedure (open aortic aneurysm (AA) repair, carotid endarterectomy (CEA) or lower extremity (LE) revascularization), the majority of which were performed by vascular surgeons or interventional radiologists. Of the 17 hospitals with a non-invasive vascular laboratory, 6 (35.3%) are accredited. Of the 25 hospitals reporting annual, elective, infrarenal AA repair volumes, 6 (24%) performed less than 10 open AA repairs, and 4 (16%) performed more than 50; 11 (44%) performed less than 10 endovascular AA repairs, and 9 (36%) performed more than 50. Of the 23 hospitals reporting annual CEA volumes, 3 (13%) performed less than 10, and 11 (47.8%) performed more than 50. Of the hospitals performing LE bypass procedures, 46% reported annual case volumes greater than 50, and 62% performing percutaneous LE interventions reported the same. Uninterrupted 24/7 emergency care provision was provided by 83% of hospitals.

Conclusion: In Ontario, variability exists in the provision of hospital based vascular care, the supporting infrastructure and patient access. In response, a Program Framework for Acute Care Vascular Services was proposed in August 2015 that includes three distinct and coordinated levels of hospital-based vascular programs with specific procedure complexities, case volume requirements, emergency coverage obligations, and human resource and infrastructure requirements.

Saturday, September 17th, 2016
PAPER SESSION VII: THE AORTA

Long-term results of the NAIS procedure for aortic graft infections and mycotic aneurysms: a single-center experience
Julien Bernatchez, MD, Valérie Gauvin, MD, Nathalie Gilbert, MD, Pascal Rhéaume, MD, CHU de Québec, QC, Canada

Objective: Since the neo-aortoiliac system (NAIS) procedure was first described, the treatment of aortic graft infections and mycotic aneurysms has markedly evolved. Many centers have published their short-term and mid-term results using this procedure but evidence is limited regarding longer follow-up. The goal of this study was to evaluate the long-term outcome of a single center’s cohort of patients treated with a NAIS reconstruction for aortic infections and to identify variables associated with a negative outcome.

Methods: 75 patients who underwent a NAIS procedure at our institution from January 2000 to December 2015 were identified using our center’s database. Demographics, clinical presentation, operative data, post-operative and long-term outcomes were collected.

Results: NAIS reconstructions were performed for 56 aortic graft infections (including 21 aorto-enteric fistulas) and 19 aortic mycotic aneurysms. The graft configuration mostly associated with infection was aortobifemoral (73%). Peroperative cultures were positive in 58 patients (77%) and 25% were polymicrobial. Thirty-day mortality was 13% and in-hospital mortality was 17%. Significant post-operative complications included 3 major amputations (4%) and 7 anastomotic ruptures from reinfection (9%). Perioperative death predictors included diagnosis at presentation (aorto-enteric fistulas vs mycotic aneurysms) (HR: 6,2), positive per-operative cultures (HR: 4,6), fungal infections (HR: 3,2) and post-operative anastomotic rupture of the NAIS (HR: 9,7). Primary graft patency at 1 and 5 years were 89% and 70%, and secondary patency rates were 95% and 92% respectively. Limb salvage at 5 years was 96%. First-year survival was 83% and five-year survival was 63%.

Conclusion: These results indicate that the NAIS procedure is a reliable option to treat aortic infections with acceptable perioperative complications. Ultimately, most patients demonstrate a favorable long-term outcome after the post-operative period. Indeed, the durability of the procedure...
is its best feature and is demonstrated by excellent graft patencies, and low amputation and reinfection rates.

**Long-term outcomes of conservative management for large inoperable abdominal aortic aneurysms**

Shamim Lotfi, Stephanie Hajjar, Prasad Jetty, Tim Brandys, Andrew Hill, Dalibor Kubelik, Sudhir Nagpal, George Hajjar, Division of Vascular Surgery, The Ottawa Hospital, Ottawa ON.

**Objective:** To determine the long-term outcomes of patients with large abdominal aortic aneurysms (AAA) that met size-criteria for repair but who were not medically fit for surgery or refused repair.

**Methods:** A prospectively maintained database of 71 patients who had inoperable large aortic aneurysmal disease (2000-2016) was analyzed retrospectively. Fifty patients had AAAs. Twenty-one patients with thoracoabdominal aortic aneurysms and aortic dissections were excluded from the study. Primary outcome was aneurysm-related mortality. Survival status was determined through death certificates, death summaries, obituaries and telephone interviews with the family doctor and/or next of kin.

**Results:** There were a total of 50 patients (median age 82) with AAAs who met size criteria for repair (34 males; 16 females). Median follow-up was 34 months. The median size of the AAA when first considered for repair was 5.7 cm. The most common reason for non-operative management was medical comorbidities (n=34). Seven patients underwent EVAR during follow-up as institutional experience with endovascular repair improved. All-cause mortality was 82% (n=41) with a median survival of 38 months. There were 10 (20%) aneurysm-related mortalities secondary to rupture with a median time to rupture of 23 months. The average last known AAA size prior to rupture was 6.9 cm.

**Conclusion:** The majority of patients with large AAAs undergoing non-operative management will die of non-aneurysm related causes with a median survival of over 3 years. A small proportion of patients did go on to rupture but did so after 2 years, which is in keeping with outcomes in large randomized trials. This suggests that a non-operative approach may be acceptable in patients with large AAAs who are medically complex or who have other reasons that preclude surgery.

**Psoas Muscle Area and All-Cause Mortality After Endovascular and Open Aortic Aneurysm Repair**

Laura Drudi1, Kim Phung2, Matthew Ades2, Jesse Zuckerman2, Louis Mullie2, Samuel Mamane2, Mark Leventhali2, Oren K. Steinmetzi1, Heather Gilli1, Cherrie Abrahami1, Daniel I Obrand1, Jonathan Afilalo1,2,3,  
1 Division of Vascular Surgery, McGill University, Montreal, QC, Canada  
2 Centre for Clinical Epidemiology, Lady Davis Institute, Jewish General Hospital, Montreal, QC, Canada  
3 Division of Cardiology, Jewish General Hospital, Montreal, QC, Canada

**Objective:** We sought to determine if psoas muscle area (PMA) was associated with post-operative mortality after endovascular or open aortic aneurysm repair.

**Methods:** Consecutive patients who underwent elective endovascular or open aortic aneurysm repair between 2010-2015 were included in the analysis. Pre-operative CT scan images were analyzed with the CoreSlicer.com semi-automated software tool to measure and add the cross-sectional area of the left and right psoas muscles at the axial level of the L4 vertebrae. Measurements were made by two independent observers blinded to clinical data. The primary endpoint was all-cause mortality.

**Results:** The cohort consisted of 149 patients with a mean age of 78.7±7.1 years. The mean PMA was 24.0±5.8 cm² in males and 14.3±3.1 cm² in females. There were 33 deaths over a mean follow-up of 682 days. After adjusting for age, sex, revised cardiac risk index, and surgical approach, Cox regression revealed a graded association between low PMA and all-cause mortality (Figure 1) with a hazard ratio of 0.86 per cm² (95% CI 0.79 to 0.93).

**Conclusions:** PMA is independently associated with all-cause mortality after elective endovascular and open aortic aneurysm repair, and may be integrated in the pre-operative risk assessment to identify and optimize high-risk frail patients.
Understanding the burden for abdominal aortic ultrasound scanning for aneurysm care in a publicly-funded health system: An analysis of census data.
Douglas L Wooster, MD, FRCSC, FACS, RVT, RPVI. Division of Vascular Surgery, University of Toronto. Elizabeth M Wooster, MEd, PhD Candidate, OISE/University of Toronto.

Background: Abdominal aortic aneurysm (AAA) screening has been shown to improve health outcomes, save lives and be cost-effective. Full implementation of an organized program will represent a burden for ultrasound scanning. This study was designed to address that issue in the environment of a publicly-funded health system.

Methods: Statistics Canada census data was used to identify the characteristics of the target population of men between 65 and 75 years of age. We analyzed the eligible number, temporal variation due to an aging population, regional variations and the impact of adoption rate for screening and yields; the AAA screening program was modeled over a 10 years and sensitivity analysis determined the resource burden.

Results: There are approximately 450,000 men in the target population in Ontario (screening ‘backlog’). The annual eligibility increase ranges from 24,000 to 46,000 over the next 10 years. At the present time, 20% of eligible patients are screened. There are regional variations with both population size and age distribution. A 5% yield of AAA would generate 24,000 total patients requiring surveillance with 1200 added patients each year. There are 120 ultrasound facilities doing approximately 400 aortic tests/year/facility. Each facility can do 120–200 additional tests/year. With full screening in the province, there would be adequate resources to assess the newly eligible patients but not the ‘backlog’.

Conclusions: Population data and the literature provide information to strengthen public policy decision-making and resource allocation for AAA screening. Change in practice with full implementation of an AAA screening program will require additional resources for access to ultrasound services.

Late open surgical conversion after endovascular abdominal aortic aneurysm repair: A review of 15 years of experience
Vinay Kansal, University of Ottawa, Faculty of Medicine, Sudhir Nagpal, University of Ottawa, Division of Vascular Surgery, Prasad Jetty, University of Ottawa, Division of Vascular Surgery

Background: Late open conversion following endovascular aneurysm repair (EVAR) represents a failure of therapy, used to treat complications refractory to secondary endovascular intervention.
With liberalization of EVAR and expansion to populations outside of instructions for use it is imperative to better understand predictors and prevent this outcome.

**Objective:** To understand the patterns of presentation, graft specific differences, outcomes of interventions, and relationship to instructions for use (IFU) adherence amongst patients who underwent late open conversion of EVAR.

**Methods:** Records of 1038 consecutive patients who underwent EVAR at The Ottawa Hospital between October 2000 and May 2015 were reviewed from a prospective database. Patients requiring conversion to open repair >1 month after implant were identified. Patients who underwent fenestrated, branched or thoracic endovascular repair were excluded. Variables analyzed included date of interventions, adherence to IFU, graft type, interval to open conversion surgery, reason for removal, operative technique, length of stay, hospital complications, and death.

**Results:** A total of 16 patients underwent EVAR that required subsequent late conversion to open repair. Initial grafts implanted included Medtronic Talent (8 patients, 50.0%), Medtronic Endurant (3 patients, 18.8%), Cook Zenith (4 patients, 25.0%), and Terumo Anaconda (1 patient, 6.2%). Average time to intervention was 3.3±2.5 years, and this interval decreased over the study period (4.6±3.0 years for EVARs before 2007 vs. 2.89±1.37 years for EVARs after 2009). Indications for conversion were graft infection in 4 patients (25%), aneurysm rupture in 2 patients (12.5%), endograft migration in 3 patients (18.8%), sac expansion secondary to Type 1A endoleak in 3 patients (18.8%), sac expansion secondary to Type II endoleak in 2 patients (12.5%), and sac expansion without detectable endoleak in 2 patients (12.5%). 9 patients (56.2%) underwent open conversion by stent graft explantation with in situ graft reconstruction, the remaining 7 patients were treated with open cerclage of the aneurysm sac around the device. 30-day mortality was 18.8%. Major in-hospital complications occurred in 10 patients (62.5%). An additional 2 patients (12.5%) required post-conversion surgical reintervention. During initial EVAR, operators were adherent to device IFU in 7 cases (43.8%), which is markedly lower than IFU adherence rates of 88.0% amongst uncomplicated EVARs in our database.

**Conclusion:** Conversion to open repair following EVAR is associated with significant morbidity and mortality. The rate of operator adherence to IFU at time of initial EVAR in this cohort of open conversions is markedly low in comparison to the overall EVAR cohort. The decreasing interval to open conversion is concerning and may be a reflection of increasing liberalization of EVAR to populations outside of IFU.