

CANADIAN SOCIETY FOR VASCULAR SURGERY
ABSTRACTS
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Friday, September 28th, 2018

PAPER SESSION I: TREATMENT OF PERIPHERAL VASCULAR DISEASE

Rivaroxaban plus aspirin versus standard dual antiplatelet therapy following Angioplasty for Lower extremity Peripheral Arterial Disease in patients with critical limb ischemia and claudication (RIVAL-PAD)- 12-month results of a randomized trial

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Objective To determine the safety and efficacy of a 90-day regimen of rivaroxaban versus clopidogrel, in addition to aspirin long-term following lower extremity angioplasty.

Methods In this single-centre, open label, phase 2, randomized trial (RIVAL-PAD), eligible patients with symptomatic lower extremity PAD, confirmed on imaging, were randomly assigned intraoperatively (1:1) to receive a 90-day regimen of rivaroxaban 2.5 mg twice daily vs clopidogrel 75 mg daily, in addition to aspirin 81 mg long-term in both treatment arms. The primary endpoint was a composite outcome of lesion-specific primary patency, and freedom from target lesion revascularization (TLR) or major amputation. Patency and ABIs were determined on duplex surveillance imaging at 1, 6 and 12 months, by blinded observers. Data on adverse events were obtained in conjunction with a Data Safety Monitoring Board. Major bleeding based on the ISTH definition was the safety endpoint. This study is registered with ClinicalTrials.gov (NCT02260622).

Results Between February 2015 and June 2016, 20 patients (44 target lesions) were randomly assigned to either rivaroxaban plus aspirin (R+A) (10 patients, 19 target lesions, 80% CLI) vs clopidogrel plus aspirin (C+A) (10 patients, 25 lesions, 50% CLI) at the time of their infrainguinal angioplasty procedure. There were no significant baseline differences with respect to ABIs [0.67 vs 0.61], lesion lengths [8.7 cm vs 9.9 cm], Bollinger scores [61.2 vs 77.7], Run-off scores [9.0 vs 8.6], CTOs [21.1% vs 28.0%], and bailout stents [60% vs 70%], in the R+A vs C+A arms. There were significant differences in post-intervention ABIs [0.86 vs 0.65 (p=0.02) at 6 months, 0.91 vs 0.72 (p=0.04) at 12 months], average target lesion PSV [152.7 cm/s vs 240.9 cm/s (p=0.04), at 6 months], and a non-significant trend in the composite primary end-point (primary patency, freedom from TLR and amputation) [84.2% vs 63.6% (p=0.14) at 6 months, and 73.7% vs 59.1% (p=0.32), at 12 months], in favour of patients randomized to the R+A arm. No major or minor bleeding events were observed.

Conclusion A post-intervention regimen of rivaroxaban 2.5 mg twice daily for 90 days, in combination with aspirin long-term appears to be safe and has potential as an alternative to standard dual antiplatelet therapy in patients undergoing lower extremity interventions for symptomatic PAD. Results of this study support the conduct of a larger-scale clinical trial.

Everolimus Drug-Eluting Stents are Associated with Improved Outcomes for the Treatment of Infringuinal Bypass Graft Stenoses

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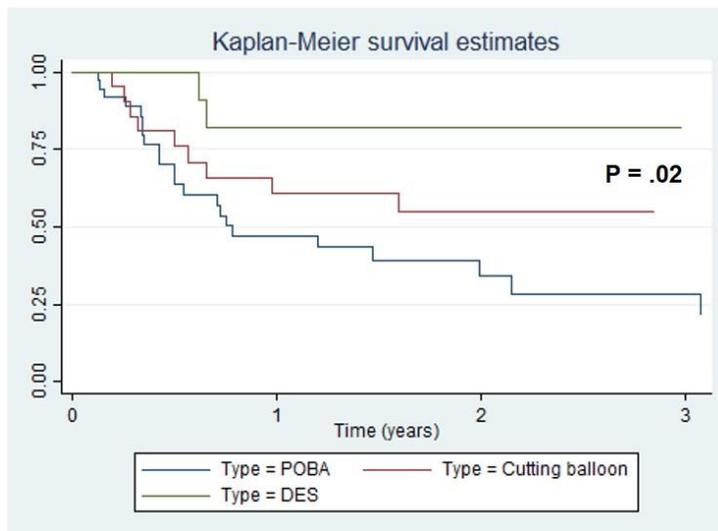
Objective: The use of Everolimus-drug eluting stents (eDES) for endovascular bypass graft revision has not yet been reported. The objective of this study was to describe and compare clinical outcomes of eDES vs. percutaneous cutting balloons (PCB) vs. angioplasty (POBA) for the treatment of infringuinal bypass graft stenoses.

Methods: An institutional analysis of patients with infringuinal bypass graft stenosis treated by endovascular intervention (8/2010-12/2017) was conducted. Primary patency of the treated lesion and limb salvage were described overall and stratified by endovascular treatment modality using Kaplan-Meier (KM) curves and log-rank tests.

Results: Over the 7-year study period, 42 patients with 76 infringuinal bypass stenoses were treated by endovascular intervention (eDES=14, PCB=23, POBA=39). Mean age was 63±2 years, 52% were male, and 55% were black. The majority of patients were diabetic (60%) with a history of smoking (74%), and nearly all (83%) had ≥2 comorbidities. Half (49%) of bypasses being treated were femoropopliteal, followed by popliteal-distal (26%) and femorotibial (25%) configurations. The location of revision was the proximal anastomosis in 37%, mid-bypass in 26%, and distal anastomosis in 37%. There were no significant differences in baseline characteristics, bypass configuration, or revision location between treatment groups ($P \geq 0.19$). Technical success for endovascular bypass intervention was 100%. Mean follow-up for all patients was 28±2 months. Based on KM analysis, primary patency was significantly better for patients treated with eDES (86%) compared to PCB (61%) or POBA (44%) ($P=0.02$; Figure). Limb salvage was achieved in 95% of patients, including 93%, 91%, and 97% for eDES, PCB, and POBA, respectively ($P=0.55$).

Conclusions: This is the first study reporting the results of Everolimus-eluting stents for the treatment of infringuinal bypass graft stenoses. Use of Everolimus -eluting stents for endovascular bypass graft revision is not only feasible, but may be more effective than other endovascular therapies.

Figure. Based on Kaplan-Meier curve analysis, primary patency of bypass graft stenoses was significantly better for patients treated with eDES compared to PCB or POBA.



Frailty Assessment in Older Adults Undergoing Interventions for Peripheral Arterial Disease

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Objectives The objective of this study was to determine the prevalence of frailty in patients with PAD and compare the incremental value of 6 non-performance-based frailty scales to predict poor outcomes following interventions for PAD.

Methods FRailty Assessment In Lower Extremity arterial Disease (FRAILED) was a prospective cohort study designed to examine frailty in patients with PAD. Consecutive patients undergoing endovascular or open interventions for PAD (Rutherford class ≥ 3) were enrolled. Frailty was assessed using the Edmonton Frailty Scale (EFS), FRAIL scale, Groningen Frailty Indicator (GFI), modified Frailty Index (mFI), Multidimensional Prognostic Index (MPI), and the modified Essential Frailty Toolset (mEFT). The primary outcome was a composite of all-cause mortality and morbidity.

Results The cohort consisted of 149 older adults with a mean age of 70.5 ± 10.8 years. Patients with claudication and critical ischemia accounted for 40% (N=60) and 60% (N=89) respectively. Depending on the scale, the prevalence of frailty ranged from 37% to 70%. The incidence of all-cause mortality was 6.3% in the cohort over a median follow-up of 1.3 years. After adjusting for age, sex, predicted operative risk, diagnosis, and procedure type, the frailty scales with the greatest incremental value for mortality and morbidity were found to be the GFI (standardized adjusted OR 3.22, 95% CI 1.32 to 8.86, BIC 88.7) and the mEFT (standardized adjusted OR 1.99, 95% CI 1.01 to 3.97, BIC 93.2). The four other frailty scales were not statistically significant in the multivariable logistic models.

Conclusions: The prevalence of frailty and the prognostic impact of frailty varied depending on the scale used. The GFI and mEFT performed well and were most predictive of mortality and morbidity in patients with PAD undergoing interventions. The GFI and mEFT may be more appropriate to use in clinical practice when assessing frailty in patients with PAD.

Geographic Variation in the Rates of Amputations Across Ontario: A Blueprint For Improvement

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Objective: Amputation-prevention efforts are often disjointed across health providers and structured within silos of health care delivery. As a first step towards reducing disparities in limb preservation among peripheral artery disease (PAD) and diabetic patients across Ontario, we sought to compare regional differences in amputation rates.

Methods: From population-based administrative health data for Ontario, all PAD or diabetes-related lower extremity minor and major amputations were identified between April 1, 2011 and March 31, 2016, among residents over the age of 40. Age and sex-adjusted quarterly amputation rates were determined for each of the 14 Local Health Integration Network (LHIN) regions (Figure) in addition to crude rates in specified subgroups: age over 70, female sex, lowest income quintile, dialysis patients, and patients living in long-term care.

Results: The adjusted rate of minor or major amputations ranged from 5.37 to 21.45 per 100,000 person-quarters. The adjusted rate of major amputations ranged from 2.47 to 12.62 per 100,000 person-quarters. LHINs with the most sparsely populated geographic area, many rural and remote communities, and low population density (LHINs 13 and 14) had the highest rates of amputations, whereas LHINs with most densely populated urban areas (LHINs 6 and 8) had the lowest rates of amputations. The same LHINs were high or low outliers whether looking at rates of any amputation, major amputations alone, diabetic patients alone, PAD patients alone, or the pre-specified subgroups.

Conclusion: PAD and diabetes-related amputation rates differ based on geographic region. Further research is required to understand the basis for these regional differences in amputation rates across Ontario in order to help design and implement effective amputation prevention strategies.

Figure. Map of Local Health Integration Network Regions of Ontario.



Status of Cardiac Markers in patients with Peripheral Arterial Disease and Critical Limb Ischemia

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Objective: Critical limb ischemia (CLI), a severe form of Peripheral Arterial Disease (PAD), is caused by substantial reduction in arterial blood flow to the extremities. Several studies demonstrate significant prevalence of coronary artery disease (CAD) in patients with CLI, leading us to hypothesize that patients with symptomatic PAD will express several diagnostic cardiac markers of CAD in the absence of acute coronary syndrome (ACS).

Methods: We recruited 1,200 PAD and non-PAD patients. We stratified patients based on their clinical history, claudication distance and ankle-brachial index into 1) non-PAD 2) severe PAD and 3) CLI. In each group, 30 patients were matched based on their age, sex and cardiovascular risk factors. We performed ELISA to measure the levels of Troponin I (Trop), Creatine Kinase–MB (CK), NT terminal of pro-B-type natriuretic peptide (NT-pro-BNP), Oncostatin M (OSM) and Fatty acid binding protein 3 (FABP3). Patients with acute limb ischemia, ACS, heart/kidney failure, or arrhythmia were excluded. We considered cardiac markers with a p-value <0.05 as significantly expressed.

Results: We detected cardiac markers in plasma of patients with PAD and CLI in the absence of ACS. FABP3 and NT-pro-BNP showed a positive correlation with the severity of PAD. FABP3 demonstrated the strongest correlation with PAD and CLI. The optimal cutoff point for FABP3 to predict CLI was estimated to be 3336 pg/mL (sensitivity 91% with specificity 100%).

Conclusion: Markers used to stratify CAD are elevated in patients with PAD and CLI in the absence of ACS. Our work also demonstrates a direct correlation between these markers and severity of PAD. FABP3, a protein involved in intracellular transport of long-chain fatty acids demonstrated the strongest correlation with PAD, indicating an important role played by lipid metabolism in the development of PAD. We are currently investigating the pathophysiology of FABP3 and its role in CLI.

Role of Drug-Coated Balloons in Femoro-Popliteal Disease in TASC Types C & D Patients

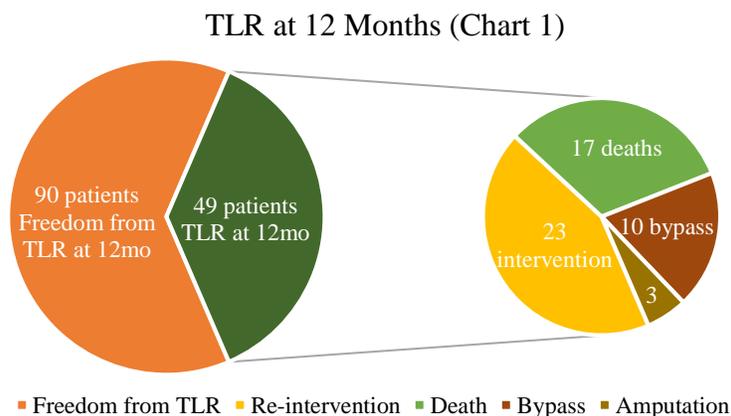
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Objective: This study seeks to assess clinical outcomes of a single-centre experience following drug-coated balloon (DCB) angioplasty in patients with TASC II Types C & D femoro-popliteal peripheral artery disease (PAD).

Methods: This retrospective study evaluates the patients who underwent DCB angioplasty for femoro-popliteal PAD at our centre between 2010 and 2016, with at least one year of follow-up. Of 424 patients with DCB-treated femoro-popliteal disease, 152 were classified as TASC II Type C or D. Demographics and comorbidities including age, sex, smoking status, hypertension, diabetes, and dialysis were recorded, alongside intervention details. Freedom from TLR within one year of intervention—defined as requiring bypass surgery or repeat percutaneous endovascular intervention—was the primary outcome. Secondary outcomes included major above-knee or below-knee amputation and death.

Results: We analyzed 152 patients, excluding 13 due to immediate re-intervention, amputation, bypass surgery, or death within thirty days of intervention. Of these 139 patients, 92 (66%) were Type C and 47 (34%) were Type D, with a mean treated lesion length of 18 ± 6 cm. 75% were current or past smokers; 83% had hypertension; 63% had diabetes; 5% were on dialysis. The dominant indication (45%) was severe claudication (Rutherford 3), the remaining 55% being Rutherford 4-6. *De novo* lesions made up 62% of cases, with in-stent stenosis or occlusions and recurrent stenosis each representing 19%. 27% of lesions were simultaneously treated with a short bare stent or drug-eluting stent, and 46% had multifocal disease treated as part of the procedure. 2% of patients had major amputation at one-year, and mortality was 12%. TLR at one-year was 24% (33 of 139).

Conclusion: Freedom from TLR in this cohort of patients with TASC II Types C & D PAD patients was found to be 88% at six months and 76% at twelve months. Our initial results show drug-coated balloons have a promising role in management of complex femoro-popliteal disease.



Friday, September 28th, 2018

PAPER SESSION II: TREATMENT OF THORACIC AORTA

Endovascular treatment of thoracoabdominal aortic aneurysms using branched and fenestrated grafts: Single-Centre experience

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Objectives: To report a Canadian single centre consecutive series of thoracoabdominal aortic aneurysms (TAAA) treated with custom branched and fenestrated endovascular aortic repair (BEVAR).

Methods: Research Ethics Board approved retrospective review of 60 consecutive TAAA's treated with BEVAR between 2006 to May 2017. Technical success was defined as successful deployment of the stent grafts with absence of type I or III endoleak, and patent target vessels at the end of the procedure.

Results: Mean age was 75.9 ± 7.3 years, with 38.3% females. TAAA aneurysm Crawford classification was: I: 1 (2%), II: 13 (21.6%), III: 14 (23.3%), IV: 32 (53.3%), with 19 (31.7%) having a staged procedure. Mean aortic diameter was 66.9 ± 12.8 mm. Technical success was 98%. Previous aortic surgery had occurred in 23 (38.3%) with 3 (5%) having chronic dissection. Operative details are presented in Table 1. In-hospital mortality was 5/60 (8.3%). Post-operative myocardial infarction, stroke, and renal failure requiring dialysis occurred in 4 (6.7%), 2 (3.3%), and 1 (1.7%) cases, respectively. Spinal cord injury (SCI) was the most common complication occurring in ten (16.7%) patients, of which 4 cases were transient (SCI). Table 2 provides the characteristics of patients who developed SCI vs no-SCI cases.

Conclusions: This consecutive single centre experience demonstrates that BEVAR may be safely performed with a high technical success rate. SCI is a common complication following BEVAR and, despite intra-operative measures to minimize SCI rate in high risk patients, the incidence has not decreased.

Table 1: Operative details of BEVAR for TAAA patients

Operative details	N = 60
Pre-operative CSF drainage (%)	37 (61.7%)
Branched only procedures (%)	34 (56.7%)
Fenestrated only procedures (%)	14 (23.3%)
Combination of Branched + fenestrated procedures (%)	12 (20%)
Branches/patient (Mean \pm SD)	2.5 ± 1.7
Fenestrations/patient (Mean \pm SD)	1.1 ± 1.5
Iliac procedures: (14)	14 (23.3%)
Access related (%)	8 (13.3%)
Fluoroscopy time (min) (Mean \pm SD)	114 ± 45
Contrast (ml) (Mean \pm SD)	249 ± 112
Technical success (%)	59 (98%)

BEVAR: Branched and Fenestrated Endovascular Aortic Repair; CSF: Cerebrospinal Fluid; TAAA: Thoracoabdominal Aortic Aneurysms.

Table 2: Patient's characteristics stratified by SCI vs no SCI following BEVAR for TAAA patients

In-hospital outcomes	SCI = 10 (16.7%)	No-SCI =50 (83.3)	p-value
Early SCI (< 24 h)	4 (40%)	NA	NA
Late SCI (> 24 h)	6 (60%)	NA	NA
Transient SCI	4 (40%) (3 Late SCI)	NA	NA
Permanent SCI	6 (60%) (3 Late SCI)	NA	NA
Crawford Classification			
Type I	0	1 (2%)	1.00
Type II	2 (20%)	11 (22%)	1.00
Staged	5 (50%)	14 (28%)	0.26
CSF drainage	10 (100%)	28 (56%)	0.07
Endoleak type II	3 (30%)	5 (10%)	0.12

BEVAR: Branched and Fenestrated Endovascular Aortic Repair; CSF: Cerebrospinal Fluid; SCI: Spinal Cord Injury; TAAA: Thoracoabdominal Aortic Aneurysms.

In situ laser fenestration for arch branch revascularization during emergent thoracic endovascular aortic repair: Effective and durable

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Objective: Retrograde in situ laser fenestration of the left subclavian artery (LSA) or common carotid artery (CCA) during emergent thoracic endovascular aortic repair (TEVAR) is an innovative method to revascularize arch branches for diverse thoracic aortic pathologies. This study provides an update on our expanded experience with extended follow up to determine the efficiency and durability of this technique.

Methods: Patients who underwent TEVAR with aortic arch branch revascularization from 2009 through 2018 were retrospectively reviewed. After TEVAR endograft was deployed over a branch orifice, in situ retrograde laser fenestration was performed through retrograde access and balloon-expandable covered stent deployed in the LSA or CCA. Postoperative imaging with computed tomography angiography was performed to assess branch patency, endoleaks, and fenestration related reinterventions.

Results: TEVAR with laser fenestration was successfully performed in 60 patients (38 men; mean age, 61 years) in an urgent/emergent setting for diverse thoracic aortic pathologies including 16 ruptures. Seventeen had acute complicated type B aortic dissection, 15 had intramural hematoma, 17 chronic dissection. TEVAR was done in 2 zone 0, 7 zone 1 and 51 zone 2. A balloon

expandable covered stent was placed across the fenestration into 56 LSA, 3 LCA and 1 RCA. Mean length of stay was 9 days. Mean follow-up was 2.44 years. In-hospital mortality was 8.3%. Stroke rate was 3.3% (2/60) and 3 had permanent paraplegia. Follow-up CTA demonstrated 100% primary patency of branch stents. There was no type III endoleak but three type Ic endoleaks required early coiling (1) and late restenting (2) for a 5.45% fenestration related major reintervention rate.

Conclusions: In situ retrograde laser fenestration is a rapid, effective and durable method to revascularize arch branches during emergent TEVAR. The high technical success, low fenestration-related morbidity and reintervention rate and excellent branch stent patency support using this versatile technique.

Knowing When Not To Intervene: A Systematic Review of Non-operative Management in Blunt Thoracic Aortic Injury

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Objective: The role of non-operative management of blunt traumatic thoracic aortic injury (BTAI) continues to evolve. Our objective was to summarize the growing body of literature on this practice.

Methods: A systematic search of PubMed and Embase was completed to identify original articles reporting retrospective or prospective primary data on BTAI patients managed without surgical intervention during their index hospitalization. Articles meeting inclusion criteria were selected based on abstract and full text screening. Study selection and data abstraction were performed in duplicate, with discrepancies resolved by a third reviewer.

Results: Out of 2,162 identified studies, 74 were included and reported on 8606 BTAI patients who were managed non-operatively between 1970 and 2016. Only one study was prospective. The median non-operative sample size was 11 patients. Characterization of injury grade differed across studies and injuries to the ascending aorta or aortic arch were often included in outcome summaries. Follow-up varied widely from 1 day to 8 years. Among the 59 studies with information on injury grade (N=1,250 patients), injury healing or improvement on follow-up imaging was reported in 226 patients (18%), who mostly had intimal tears. Injury progression or requirement of a subsequent procedure was reported in 69 patients (5.5%), along with 37 aortic-related deaths (16%).

Conclusions: An increasing number of reports support non-operative management of intimal tears, consistent with SVS guidelines. However, retrospective interpretation of the intention of treatment, heterogeneous injury characterization, and variable follow-up remain major limitations to the informed use of non-operative management across all BTAI grades.

The Influence of Surgical Technique on Device Rotation and Fenestration Alignment in Advanced Endovascular Aneurysm Repair

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Objective: To assess the interaction between operator insertion technique and iliac artery anatomy on the rotation of fenestrated endovascular devices in an aortoiliac phantom model.

Methods: Flexible aortoiliac models were constructed using a 15% (w/v) polyvinyl alcohol cryogel cast in 3D-printed molds and polymerized with four freeze-thaw cycles. Cook Z-fen devices were deployed under both fluoroscopic and direct visualization and device rotation was calculated by tracking the affixed gold positional markers. Stent graft rotation during deployment was evaluated using three insertional techniques: 1) insertion of the delivery system with no correction of device orientation, 2) gradual rotation of the delivery system during insertion to correct device orientation, and 3) insertion of the delivery system with no rotation and correction of orientation only once the delivery system is completely removed from the model.

Results: In models with atherosclerotic arterial properties device rotation increased with increasing iliac artery torsion, $1.2 \pm 0.01^\circ$, $18.0 \pm 6.7^\circ$ and $38.8 \pm 9.2^\circ$ for iliac torsional values of 0 mm^{-1} , 5 mm^{-1} and 7.5 mm^{-1} respectively ($P < .05$). During insertion, stent grafts twist in the direction of the arterial torsion; therefore, the operator commonly applies counter-rotation to the device to maintain appropriate alignment. This counter-rotation increased stent graft rotation by $26 \pm 4.9^\circ$ in the high-torsion model which is equivalent to almost a full hour change in the clock position of the fenestrations ($P < .01$). Conversely, insertion of the device followed by complete removal, ex-vivo adjustment of orientation, and subsequent reinsertion did not significantly increase device rotation ($2.5 \pm 2.7^\circ$). Interestingly, rotation of the device by 90° during insertion in the opposite direction lowered device rotation by 39% ($P < 0.05$).

Conclusions: Correction of stent graft orientation with the device in-situ increases stent graft rotation during deployment and subsequently increases fenestration misalignment. These data suggest that it may be beneficial to fully remove the device prior to correcting device orientation.

Friday, September 28th, 2018

PAPER SESSION III: TREATMENT OF CAROTID DISEASE

Quality Improvement in Timing and Delivery of Carotid Endarterectomies at The Ottawa Hospital: Is the Pendulum Swinging Too Far?

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Objective: Quality improvement initiatives at The Ottawa Hospital (TOH) have aimed to reduce time between symptom onset and CEA delivery; however, recent evidence suggests that perioperative stroke risk may be higher in the hyper-acute setting. The study objective was to identify factors—such as timing—that lead to adverse outcomes post-CEA.

Methods: The cohort included all patients who underwent CEA by TOH vascular surgeons between 2003-2017. Clinical data were obtained from electronic medical records and office charts, and ultrasound surveillance data from TOH's Vascubase. Patient demographics, timing and perioperative data, and post-op complications were recorded. Statistical analyses were performed using Fisher's exact test and stratified by various variables.

Results: 1027 CEAs in 978 patients were performed during the study period, including 76.8% (n=789) for symptomatic carotid stenosis. The majority (94.9%) demonstrated preoperative ipsilateral stenosis 70-99%. Overall 30-day stroke, stroke/death, and stroke/death/MI rates were 2.1%, 2.4%, and 2.6%. Hyperperfusion syndrome and nerve injury rates were 4.1% and 5.6% (Table 1). Among symptomatic patients, CEA was performed in <2 days in 10.0% (n=79), 2-14 days in 32.9%, and >14 days in 57.1%. There was a non-significant trend towards higher stroke

rate in patients undergoing CEA within 2 days of symptoms (3.8% <2 days, 1.9% for 2-14 days, 2.2% >14 days, p=0.32). CEA<2 days was associated with the highest rate of intracranial hemorrhage (2.5%, p=0.05) and MI (2.5%, p=0.05) (Table 2). Eversion CEA was associated with the highest rate of $\geq 80\%$ ipsilateral carotid restenosis (17.9%) compared to other surgical techniques, p=0.02. Anesthetic, stenosis severity, and shunt use were not associated with adverse outcomes.

Conclusion: Despite improvement in CEA delivery for stroke prevention following symptom onset, there is an association between hyperacute CEA (<2 days) and worse outcomes. Further investigation should determine whether this represents a higher risk population who will benefit from expedient surgery, or whether a “cool-down” period is warranted.

Table 1. Overall short term (30-day) outcomes. Nerve injury and hyperperfusion syndrome were the two most common adverse outcomes. Unit of analysis varied between carotid and patient depending on the outcome observed.

Outcome	Yes	No	Total
Nerve Injury	58	969	1027
Intracranial bleed	4	1023	1027
Hyperperfusion syndrome	42	984	1026
MI	4	1023	1027
Stroke	20	1007	1027
Death	5	973	978
Combined stroke + death	23	955	978
Combined stroke + death + MI	25	953	978

Table 2. Short term (30-day) outcomes stratified by amount of time between symptom onset and CEA delivery. Intracranial hemorrhage and myocardial infarction were significantly increased among patients who underwent CEA within two days of symptom onset, Fisher’s exact test, P=0.05. Stroke rate was non-significantly increased in patients who received CEA within 2 days of symptoms, Fisher’s exact test, P=0.32.

	N/A (Asymptomatic)	<2 days	2-14 days	>14 days	Total
ICH (%)	0 (0)	2 (2.5)	1 (0.4)	1 (0.2)	4
MI (%)	0 (0)	2 (2.5)	1 (0.4)	1 (0.2)	4
Stroke (%)	2 (0.8)	3 (3.8)	5 (1.9)	10 (2.2)	20
Total (carotids)	236	79	260	452	1027

Transforming practice: Using a systems-based, multidisciplinary approach to achieve a 600% reduction in early symptomatic carotid revascularization referral and treatment

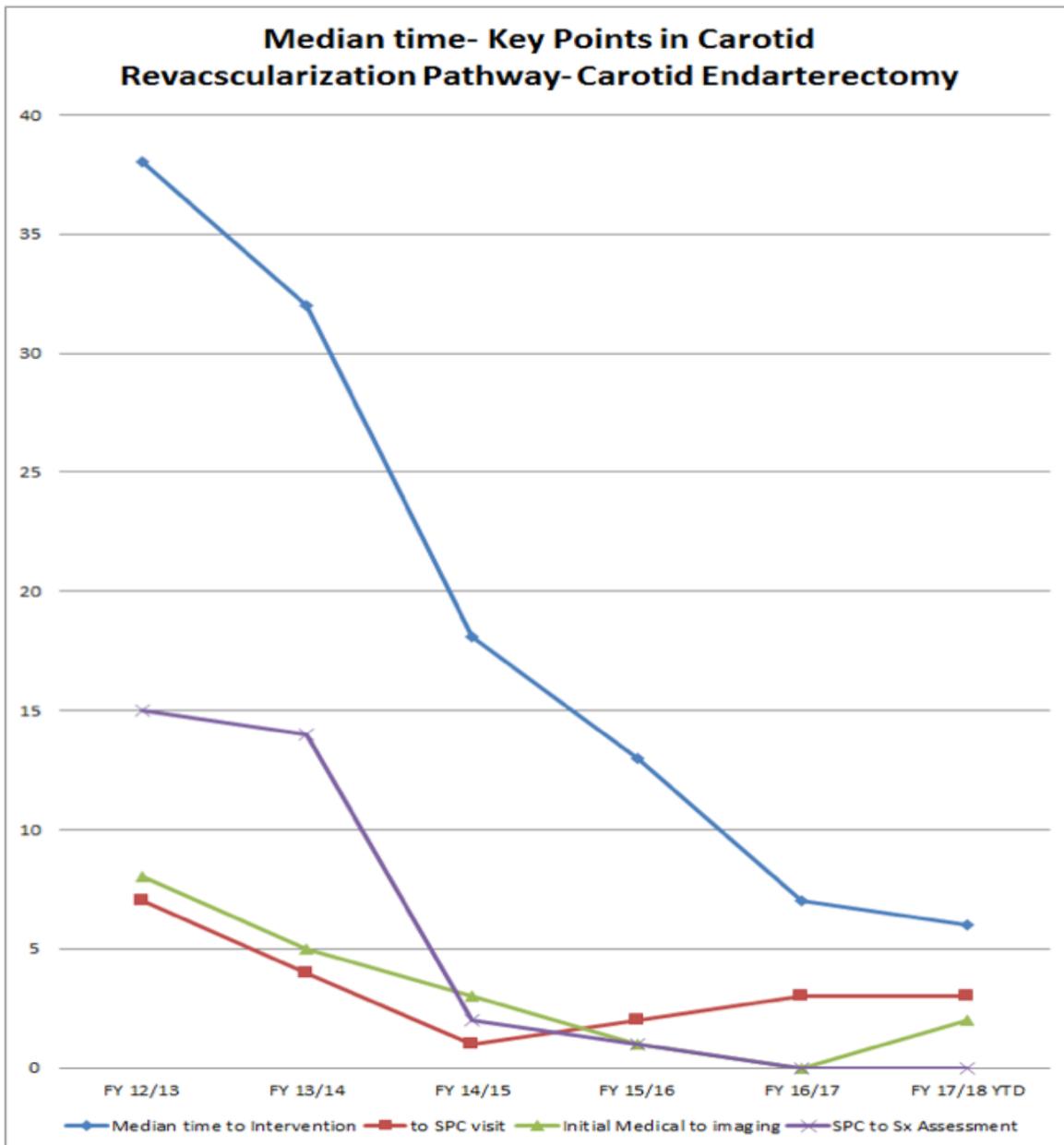
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Objectives: Achieving early carotid revascularization is a key goal for secondary stroke prevention in patients with symptomatic carotid artery stenosis (CAS). While evidence shows early revascularization provides an absolute risk reduction of 30% for severe and 15% for moderate CAS treated within 14 days (Lancet 2004;363:915), this is rarely achieved in practice. We sought to identify barriers to carotid revascularization and implement an early referral process in our institution in order to achieve this seldom-realized evidence-based standard.

Methods: LEAN methodology was used to identify barriers to early referral for symptomatic carotid disease in our institution. A multidisciplinary Carotid Revascularization Advisory Committee was formed involving Neurology, Vascular surgery, Neurosurgery, Interventional Neuroradiology, and Hospital Administration. Quality assurance feedback letters were targeted to multiple stakeholders for routine review, accountability, and process improvement suggestions.

Results: LEAN methodology determined a need for improved community access to our Stroke Prevention Clinic (SPC) and more streamlined referral to surgeons and interventionalists. By implementing a community awareness strategy and engaging on-call surgical and interventional resources, we achieved a 600% reduction in median time to carotid intervention from 38 days to 6 days (75% of patients within 10 days, 90% within 20 days) throughout a 6-year period (2012-18). Corresponding with this achievement, several key systems-based improvements occurred: median time to carotid imaging was decreased from 8 days to 2 days, median time to SPC visit from 7 days to 3 days, and median time from SPC to surgical assessment from 15 days to 0 days (Figure).

Conclusions: Our data demonstrate a LEAN assessment and institutional approach can transform the practice of secondary stroke prevention in a tertiary centre. Specifically, our 6-year results underscore the importance of establishing a Stroke Prevention Clinic with early referral pathways through a multi-disciplinary approach to carotid revascularization.



Ultrasound Surveillance Following Carotid Endarterectomy: Prudent or Pointless?

Shira Strauss MD¹, Anika Mohan², Elham Sabri³, Tim Brandys MD¹, George Hajjar MD¹, Andrew Hill MD¹, Dalibor Kubelik MD¹, Sudhir Nagpal MD¹, Prasad Jetty MD¹ ¹Division of Vascular and Endovascular Surgery, The Ottawa Hospital and the University of Ottawa, ²Trent University, Peterborough, Ontario, ³Ottawa Methods Centre, Ottawa Hospital Research Institute

Objective: To assess the utility of duplex ultrasound (DUS) surveillance with respect to rates, outcomes, and management of post-CEA restenosis.

Methods: This is a cohort study of patients who underwent CEA at The Ottawa Hospital (TOH) from 2003-2017. DUS was completed at TOH’s accredited Vascular Diagnostic Centre as per protocol (q6, 12, 18, and 24 months then yearly). Follow-up DUS and clinical data were obtained from Vascubase and electronic medical records (vOacis). Primary outcomes included time to $\geq 80\%$ restenosis and post-CEA stroke rate, as well as cost-effective analysis. Statistical

analyses involved survival analysis, χ^2 and Fisher's exact test.

Results: 1027 CEAs were performed in 978 patients over the study period. Majority were symptomatic (76.8%) with stenosis 70-99% (94.9%), and received patch arterioplasty (83.4%), without a shunt (86.3%), under regional anesthetic (90.2%). There were 28 post-op TIAs/strokes. 20 occurred within 30 days post-op, prior to the initial DUS surveillance. Four more occurred within one year and the final four after one year. No post-30 day stroke was attributed to ipsilateral carotid disease. 702 surgeries (68.4%) had DUS follow up for a total 2123.5 patient-years. DUS detected $\geq 80\%$ ipsilateral restenosis in 30 patients (3.1%) (Figure 1). Among these, none experienced post-op TIA/stroke beyond 30 days (Figure 2). As per TOH post-CEA protocol, the estimated cost of DUS surveillance in this cohort was \$311,786.40, or \$10,392 per restenosis. Not a single ipsilateral reintervention occurred during this period.

Conclusion: Severe restenosis post-CEA is rare and not associated with worse outcomes. Despite historical recommendation, TOH's management of severe restenosis has been conservative based on its benign natural history. Routine post-CEA DUS surveillance is costly and unlikely to improve outcomes or affect management, even if $\geq 80\%$ ipsilateral restenosis is detected. Further research should determine the utility of routine *contralateral* DUS in this population, who may be at higher risk for severe contralateral carotid disease.

Figure 1. Kaplan Meier curve depicting ipsilateral $\geq 80\%$ restenosis-free survival. 30 patients developed $\geq 80\%$ restenosis over 14 years post-CEA.

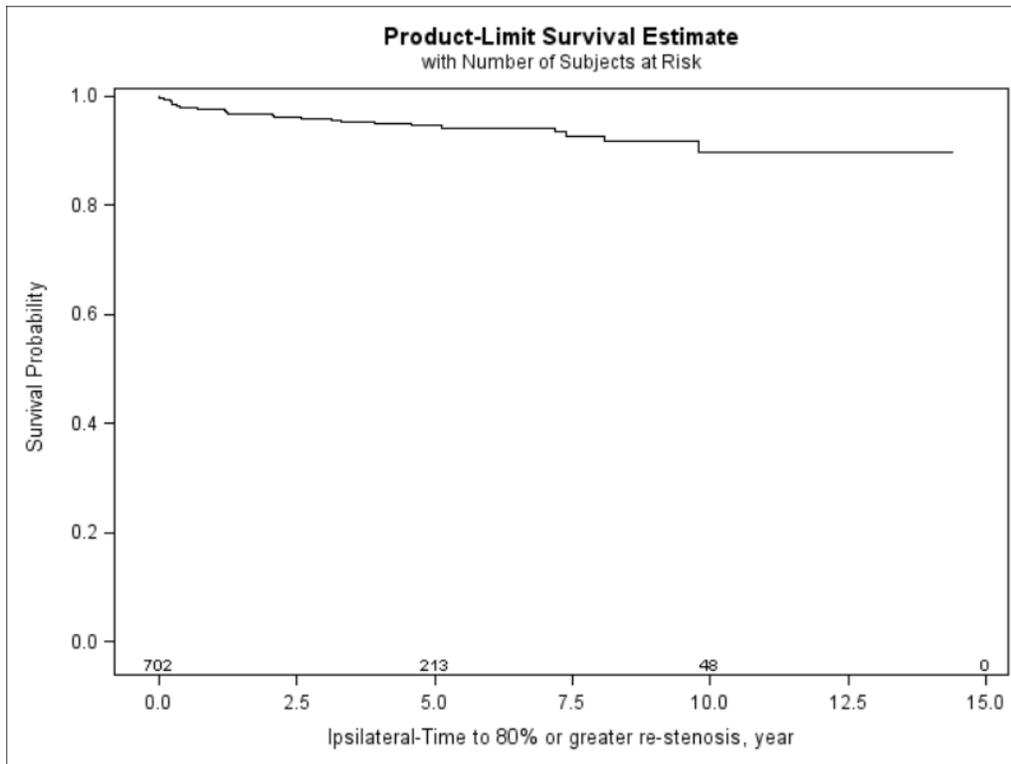
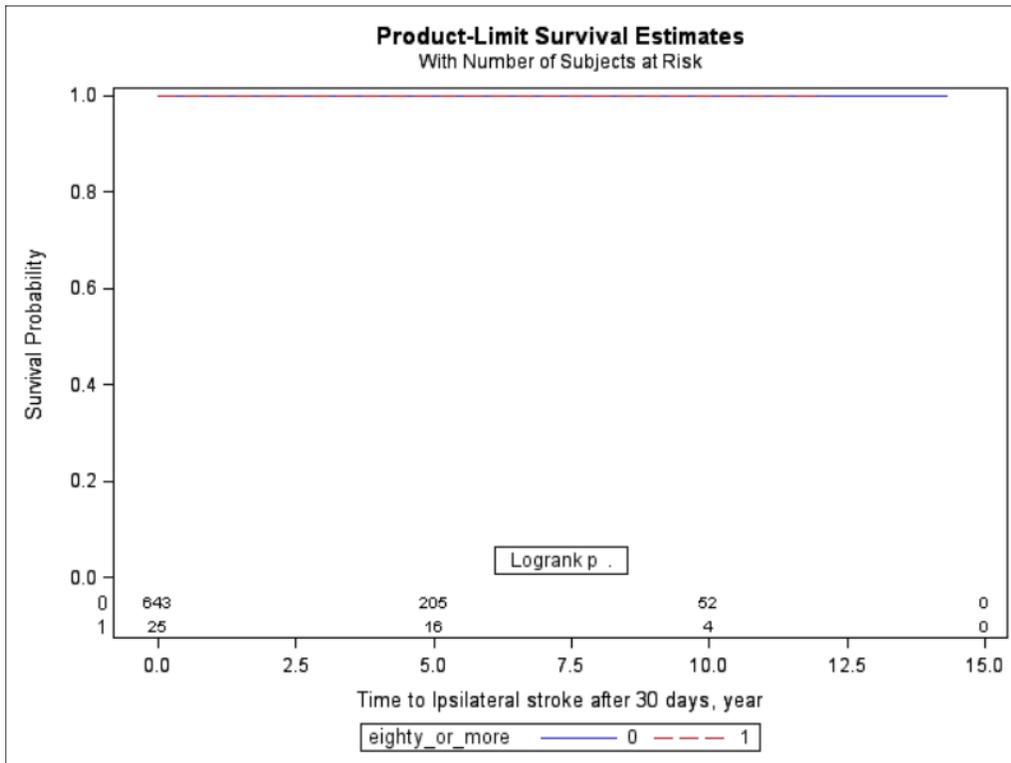


Figure 2. Kaplan meier curve comparing ipsilateral stroke in patients who developed ipsilateral restenosis <80% vs ≥80%. No stroke was attributed to the ipsilateral carotid beyond 30 days postop in either group.



Impact of Statins on Clinical Outcomes After Carotid Endarterectomy and Stenting: A Population-Based Cohort Study

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Objective: We sought to establish the rates of statin use in patients with carotid artery disease, and examine the association between statin therapy and clinical outcomes among an older population after carotid revascularization.

Methods: In this population-level, retrospective cohort study we identified all individuals ≥66 years old who underwent carotid endarterectomy or stenting in Ontario, Canada (2002-2014). We used the Ontario Drug Benefit database to establish pre-procedural and post-procedural statin use and dose on the basis of actual medication prescriptions filled. The primary outcome was a composite of 1-year stroke, myocardial infarction, or death; 5-year outcomes were also assessed. Adjusted hazard ratios (HRs) were computed using inverse-probability-of-treatment-weighting based on propensity scores.

Results: A total of 7893/10,723 (73.6%) of patients who underwent carotid revascularization were on pre-procedural statin therapy; moderate or high dose therapy was

utilized by 7384 (68.9%) of patients. The mean (SD) age of patients in the statin group was 74.7 (5.6) years and 75.6 (6.2) years in the non-statin group (n=2830); about a third were female and ~45% had symptomatic carotid disease in both groups. The composite rate of 1-year stroke, myocardial infarction, or death was lower among statin users (adjusted HR, 0.76; 95% confidence interval [CI], 0.70-0.83), as was the composite rate at 5 years (adjusted HR, 0.75; 95% CI, 0.71-0.80) (Figure 1). Individual rates of stroke, myocardial infarction, and death were also lower with statin use, and the beneficial associations with statin use were observed regardless of type of carotid revascularization procedure, carotid artery symptom status, or statin dose (Figure 2).

Conclusion: Statin therapy was associated with a ~25% lower risk of cardiovascular events in patients with significant carotid disease. Along with other supportive evidence, statins should be considered in patients undergoing carotid revascularization, and efforts are required to increase statin use in this undertreated population.

Figure 1. Adjusted Kaplan-Meier Curves of 5-Year Outcomes by Statin Therapy

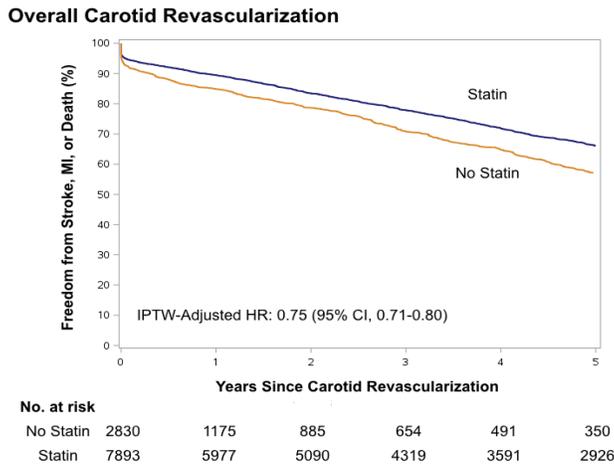
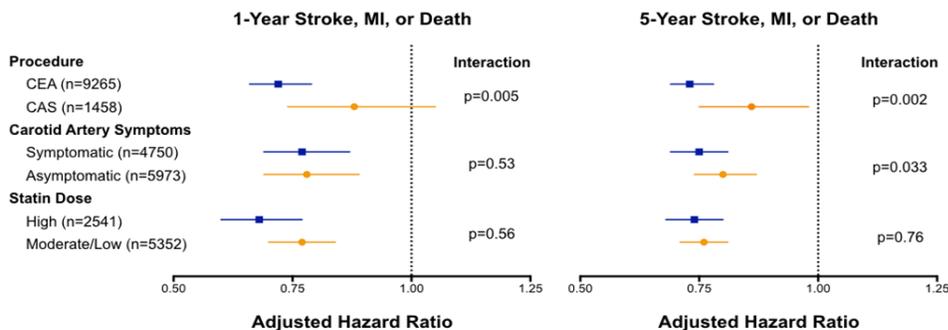


Figure 2. One and Five-Year Outcomes by Subgroup and Statin Therapy



Carotid endarterectomy after systemic thrombolysis in stroke patients : a retrospective comparative analysis

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Objective: Vascular specialists are increasingly being requested to perform carotid endarterectomy (CEA) after intravenous thrombolysis (IVT) for stroke patients, raising concerns about hemorrhagic complications. Few case series and registry reports have assessed the question, focusing on comparison with symptomatic patients. The goal was to evaluate the hemorrhagic and overall outcomes of patients undergoing CEA after IVT and comparing them with a similar population.

Methods: We retrospectively analyzed the data of 170 consecutive patients who have undergone CEA after stroke in our center from January 2011 to December 2016, 26 (15,1%) of them having undergone previous intravenous thrombolysis. A comparative analysis between the non-IVT and the IVT groups was performed. Overall time between diagnosis of stroke and referral to a vascular specialist was also analyzed.

Results: Age, sex and cardiovascular comorbidities were similar in both groups. Median time between IVT and CEA was 8 days (Q1-Q3 5-15 days), with 9 (41%) patients undergoing CEA less than 7 days after IVT. There were 2 (1,4%) intracranial hemorrhages in the non-IVT group vs 1 (3,8%) in the IVT group ($p = 0,950$). The overall combined stroke and death rate was 5,3%, with 4,9% in the non-IVT group vs 7,7% in the IVT group ($p = 0,913$). Post-operative cervical hematoma requiring reoperation occurred similarly in both groups (2,1% vs 3,8%, $p = 1$). Median Modified Rankin Score at 30-90 days follow-up was 1 (Q1-Q3 0-2), and was similar in both groups ($p = 0,156$). Median time between diagnosis of stroke and referral to a vascular specialist was higher for patients in peripheral centers (4 days, Q1-Q3 2-7 days) compared to university vascular centers (1 day, Q1-Q3 0-3 days, $p < 0,001$).

Conclusion: In this retrospective analysis, CEA after IVT showed similar hemorrhagic and overall outcomes when compared to the overall stroke-CEA population.

Author Disclosures: W. Fortin: Nothing to disclose, S. Elkouri: Nothing to disclose, N. Beaudoin: M. Chaput: J.F. Blair: Nothing to disclose.

Saturday, September 29th, 2018

PAPER SESSION IV: ANEURYSMAL DISEASE I

Early Experience with the INCRAFT Device

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Objective: Several low profile grafts have been created for use in endovascular aneurysm repair (EVAR) in patients with small or difficult access vessels. Our objective was to evaluate outcomes of patients undergoing EVAR with the Incraft device in a real world North American setting.

Methods: A retrospective chart review was carried out on consecutive patients undergoing Incraft implantation between February 2015 and January 2017 at two McGill University teaching hospitals. Clinical characteristics and information was obtained directly from electronic medical records. Two authors performed anatomical measurements from pre- and post-operative CT

angiograms and intraoperative angiograms independently. In cases of disagreement a consensus was reached.

Results: We included 61 patients with a median follow-up of 363 days. Minimum left and right access vessel sizes were 7.5 ± 1.7 and 7.4 ± 1.5 mm, respectively. More than 90% of grafts were implanted for aneurysm size. However, indications also included symptomatic or inflammatory aneurysm, common iliac artery aneurysm, and anastomotic pseudoaneurysm. Vessel access was percutaneous in 95% of cases. We had a mean length of stay of 0.88 ± 1.8 days with 57.3% of patients discharged same day. There were 9 procedural type II endoleaks, 10 new leaks that were discovered during follow-up and 6 that resolved. There were no 30-day mortalities. Three cancer related deaths occurred during follow-up. Early complications included 1 access site repair for bleeding, 1 access site repair for dissection, 2 aorto-uni conversions with femoral-femoral bypass due to inadvertent ipsilateral gate cannulation. Long-term complications included 1 graft limb thrombosis, 1 intervention for type II endoleak with sac expansion, which subsequently became infected and was explanted.

Conclusion: Use of the Incraft device in a real-world North American setting is relatively safe, effective, and is associated with a low rate of peri-operative complications. Data with additional follow-up are needed to assess the long-term effectiveness of the Incraft device.

A Prospective Cohort Study of a Same Day Discharge Percutaneous Endovascular Aneurysm Repair Pathway

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Objectives: A retrospective study conducted at our institution suggested that a same-day discharge pathway after percutaneous endovascular aortic repair (PEVAR) was safe. This prospective cohort study therefore evaluated the postoperative course and short-term follow-up of patients who qualified for a same-day discharge pathway designed to discharge select patients undergoing PEVAR within twenty-four hours of undergoing surgery.

Methods: We conducted a prospective cohort study of thirty-seven consecutive adults admitted to a tertiary care teaching hospital in Calgary, Alberta, Canada between January 1, 2015 and February 1, 2018 who underwent elective PEVAR of an abdominal aortic and/or iliac aneurysm. Patients were selected according to inclusion criteria listed in a short stay protocol, which was created through a systematic review of the existing literature. Patients were evaluated in the perioperative period in-hospital, at a clinic visit at 48-hours, and again in clinic at 30-days in order to collect data on complications.

Results: Of the fifty patients consented, 13 (26%) were screen failures. Thirty-four (92%) of the 37 enrolled patients were successfully discharged within 24-hours of receiving treatment. The median length of admission was 17.0 (interquartile range=7.3-21.0) hours. A multivariable linear regression model suggested that type of anesthesia, patient age, aneurysm size, preoperative glomerular filtration rate, intraoperative endoleak, and history of cardiac disease, diabetes, or chronic obstructive pulmonary disease were not associated with longer postoperative lengths of stay ($p>0.05$ for all). There were no complications at the 48-hour follow up visit. At the 30-day follow up visit, four patients had persistent type II endoleaks, one had a thrombosed iliac limb, one had an external iliac artery dissection, and one had iliac limb stenosis.

Conclusions: This study provides evidence to support initial pilot study findings suggesting that outpatient aortic surgery can be safely performed in carefully selected patients.

Percutaneous Approach To Endovascular Aortic Aneurysm Repair: A Cost-Minimization Study

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Introduction: Percutaneous access for endovascular aortic aneurysm repair (P-EVAR) is less invasive compared to surgical access (S-EVAR) and is associated with faster recovery and fewer wound complications. However, vascular closure devices (VCDs) are costly and better understanding of the precise economic impact of P-EVAR has important implications for resource allocation.

Objective: To determine the differences in cost between P-EVAR and S-EVAR.

Methods: We used a decision tree to analyze costs from a payer perspective over the course of the index hospitalization. Probabilities, relative risks, and mean difference summary measures were obtained from a systematic review and meta-analysis. We modelled differences in surgical site infection, lymphocele, and length of hospitalization. Cost parameters were derived from the US 2014 National Inpatient Sample using ICD-9-CM codes. Attributable costs were estimated using generalized linear models adjusted by age, sex, and comorbidities.

Results: A total of 6876 abdominal and thoracic EVARs were identified. P-EVAR resulted in a cost saving of \$751 per procedure. The costs for P-EVAR were \$1,287 (95%CI: 884-1835) and S-EVAR were \$2,038 (95%CI: 757-4,280). P-EVAR were converted to open in 4.3% of cases. P-EVAR patients had a difference of -1.4 days (95%CI: -0.12 to -2.68) in length of hospitalization at a cost of \$1,190/day (SE: 298). The cost saving of P-EVAR was primarily driven by the cost difference in length of hospitalization. In the base case, 4 VCDs were used per P-EVAR at \$200/device. In the two-way sensitivity analysis, P-EVAR was cost saving even when 1.5 times more VCDs were used per procedure and the cost of each VCD was 1.5 times greater (Figure). In our probabilistic sensitivity analysis, P-EVAR was the cost saving strategy in 82.6% of 10,000 Monte Carlo simulations when simultaneously varying parameters across their uncertainty ranges.

Conclusions: P-EVAR had lower costs compared to S-EVAR and is economically feasible.

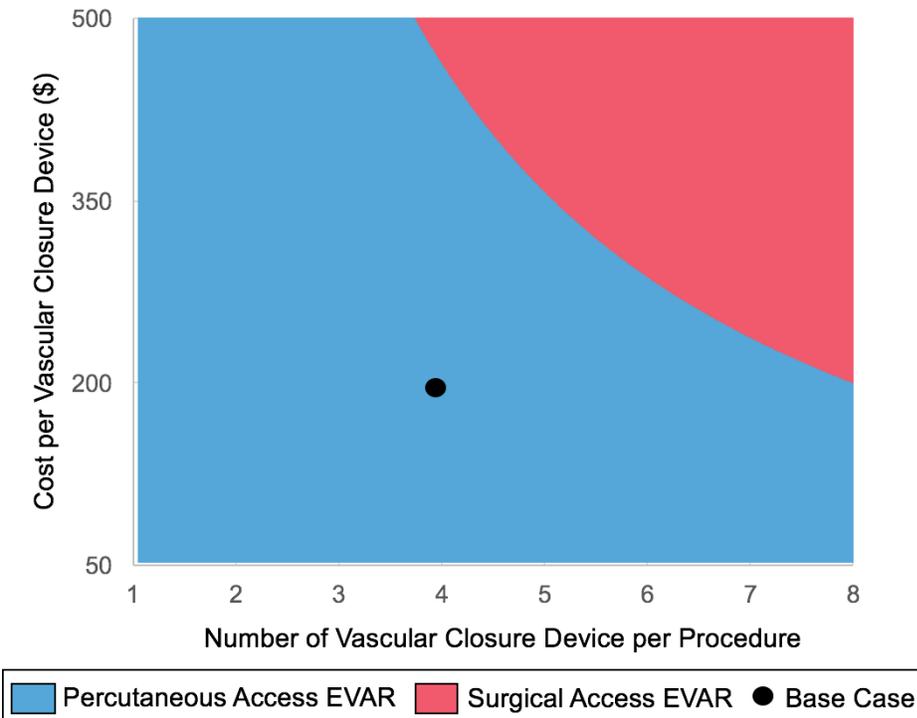


Figure: Two-way sensitivity analysis of the cost per vascular closure device and number of vascular closure devices per procedure. The figure displays the most cost saving strategy across a range of model parameters. For example, in the base case (average patient), the cost per vascular closure device was \$200 and four devices were used per procedure which lies in the blue area; therefore percutaneous EVAR is the most cost saving strategy.

Long term survival after EVAR and open repair in patients with anatomy outside EVAR IFU criteria

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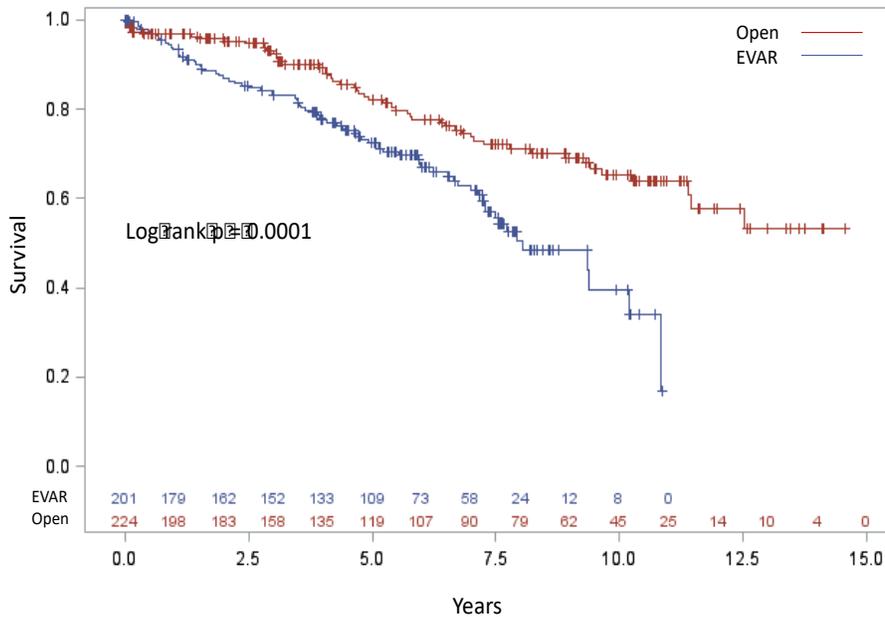
Objective: Patients who do not meet IFU criteria are often still treated by EVAR even though some studies have shown higher graft-related adverse events. The goal of this study was to compare the long-term survival of EVAR and open repair (OR) in patients with anatomy outside standard IFU criteria.

Methods: This multicentre retrospective cohort study included patients with at least one anatomic IFU violation for EVAR undergoing either elective EVAR or elective OR for AAA. Demographics, anatomic data, and follow-up data were collected on patients from 3 academic centers from 2003-2016. Device specific IFU was used for EVAR patients whereas a generic IFU for EVAR was applied to the OR patients. The main outcome of interest was overall survival. Kaplan-Meier survival and Cox proportional hazards were performed.

Results: The study population included 202 EVAR patients and 224 OR patients with at least one anatomic IFU violation for EVAR. OR patients were more likely to be younger (70.8 vs 78.1 years old) and more hypertensive (80% vs 69%) compared to EVAR patients. Median follow-up was 5.4 [IQR 2.8-9.3] and 5.2 [IQR 3.5-7.2] years for OR and EVAR patients, respectively. All-cause mortality was 30.0%. Kaplan-Meier survival analysis revealed a significant association between patients undergoing OR and increased long term survival (log-rank $P < .0001$) (figure 1). When adjusted for possible confounders and weighted for propensity for treatment through Cox hazard modelling, the association remained significant, (HR 0.6 [95%CI=0.4-0.9]). Subgroup survival analysis for proximal neck IFU violation showed no difference in mortality between OR and EVAR (HR 1.3 [95%CI=0.6-2.7]).

Conclusion: When adjusted for important clinical variables and propensity to undergo EVAR vs OR, our study identified that patients with IFU violations have improved overall long term survival with open treatment. When evaluating AAA patients with anatomic IFU violations, caution should be applied when considering EVAR.

Figure 1 - Survival analysis of AAA patients with IFU violations treated by EVAR and OR



Saturday, September 29th, 2018

PAPER SESSION V: ANEURYSMAL DISEASE II

The Futility of Surveillance for Old and Small Aneurysms

Mark Rockley¹, Dominic Leblanc², Prasad Jetty¹, University of Ottawa¹, University of Western Ontario²

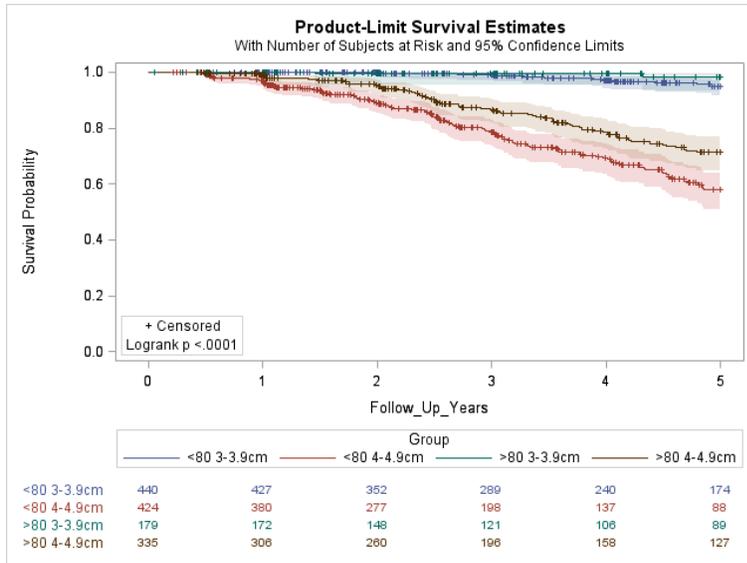
Objectives: Inspired by the Canadian Choosing Wisely campaign, we investigated the yield and cost of ultrasound surveillance for small abdominal aortic aneurysms (AAA) in octogenarians, when compared with a younger population, for detecting AAA growth that reaches a gender-specific threshold size for repair.

Methods: A retrospective cohort review was performed on all patients undergoing AAA surveillance in Ottawa between 2007 – 2017. Patients were dichotomized by enrollment age (<80 vs ≥80) with cross-over to prevent lead-time bias, and stratified by enrollment AAA size. These cohorts were cross-referenced with the Ottawa AAA Repair Database, leveraging the common LHIN to assure data capture. Survival analysis with Cox Proportional Hazards models adjusted for significant covariates, and cost-effectiveness analysis performed referencing OHIP codes.

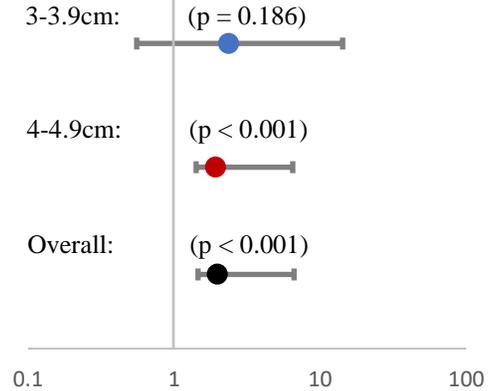
Results: A total of 1378 patients underwent serial ultrasound surveillance, of which 355 (25.8%) reached the AAA size threshold for repair, and 313 (22.1%) underwent AAA repair. Octogenarians were half as likely as their younger counterparts to experience significant AAA growth (HR = 0.51 [95% CI = 0.37 – 0.83], Figure 1A). Similarly, octogenarians were half as likely to experience an aortic event, a composite outcome including threshold-sized AAA, elective aortic repair, or aortic rupture, (HR = 0.54 [95% CI = 0.43 – 0.68], Figure 1B). When a threshold-sized AAA was identified, octogenarians were half as likely to undergo elective AAA repair (RR = 0.52 [95% CI = 0.45 – 0.59], Figure 2A). Both ruptured AAA repair (0.94%) and procedure-related 30-day mortality (0.58%) were rare, and age differences were insignificant (Figure 2B). AAA surveillance for octogenarians was substantially less cost effective, incurring \$12,080 in surveillance fees to identify one octogenarian with AAA size 3 – 3.9cm who later underwent elective AAA repair (Figure 2C, 2D).

Conclusions: Octogenarians with small aneurysms are half as likely to experience significant aortic growth. Furthermore, in the unlikely event of AAA growth, octogenarians are half as likely to undergo repair, without a significantly increased risk of requiring repair for AAA rupture. The differences in natural history between the young and elderly patients suggest a difference in aneurysm pathophysiology. In context of patient specific factors, surveillance of AAA less than 4cm in octogenarians is costly and unlikely to be beneficial.

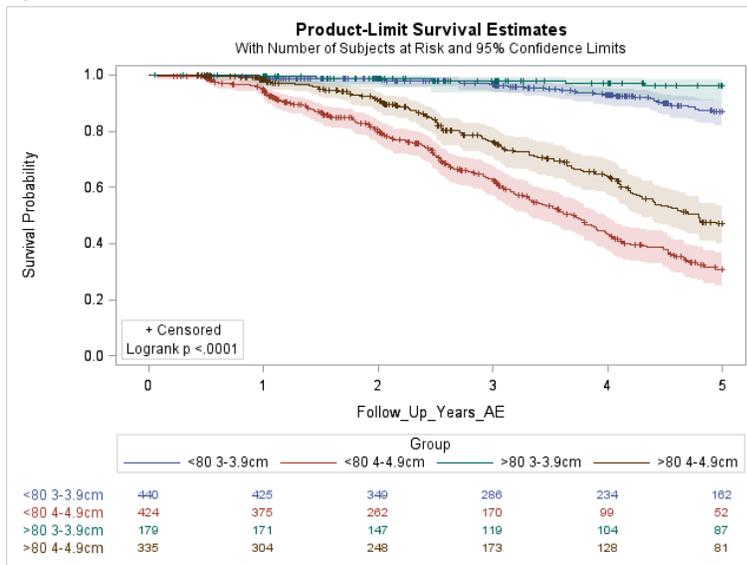
A)



Adjusted Hazard Ratio (versus Octogenarians)



B)



Adjusted Hazard Ratio (versus Octogenarians)

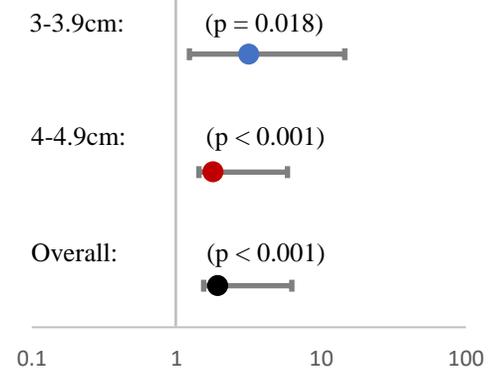


Figure 1: Kaplan-Meier Curves and Hazard Ratios demonstrating freedom from reaching **A) Gender-Specific Threshold Sized Aneurysm** and **B) Aortic Event** (threshold-size aneurysm, elective AAA repair, or ruptured AAA repair). The overall Hazard Ratio of the young cohort (< 80 years old), when compared with the octogenarian cohort, of reaching a Threshold-Sized Aneurysm or Aortic Event is 1.98 [95% CI = 1.46 – 2.68] and 1.93 [95% CI = 1.54 – 2.41] respectively. The Hazard Ratios stratified for each enrollment AAA size are also presented. (Threshold-Sized AAA: HR = 2.75 [95% CI = 0.61 – 12.27] if enrollment AAA was 3 - 3.9cm, and HR = 1.94 [95% CI = 1.42 – 2.65] if enrollment AAA was 4 - 4.9cm). (Aortic Event: HR = 3.11 [95% CI = 1.21 – 7.94] if enrollment AAA was 3 - 3.9cm, and HR = 1.86 [95% CI = 1.48 – 2.34] if enrollment AAA was 4 - 4.9cm). Cox Proportional Hazards Modelling adjusted for gender, because female gender was significantly associated with an increased hazard of reaching threshold-sized aneurysm (HR = 2.91 [95% CI = 2.17 – 3.89]) and aortic event (HR = 1.99 [95% CI = 1.59 – 2.49]).

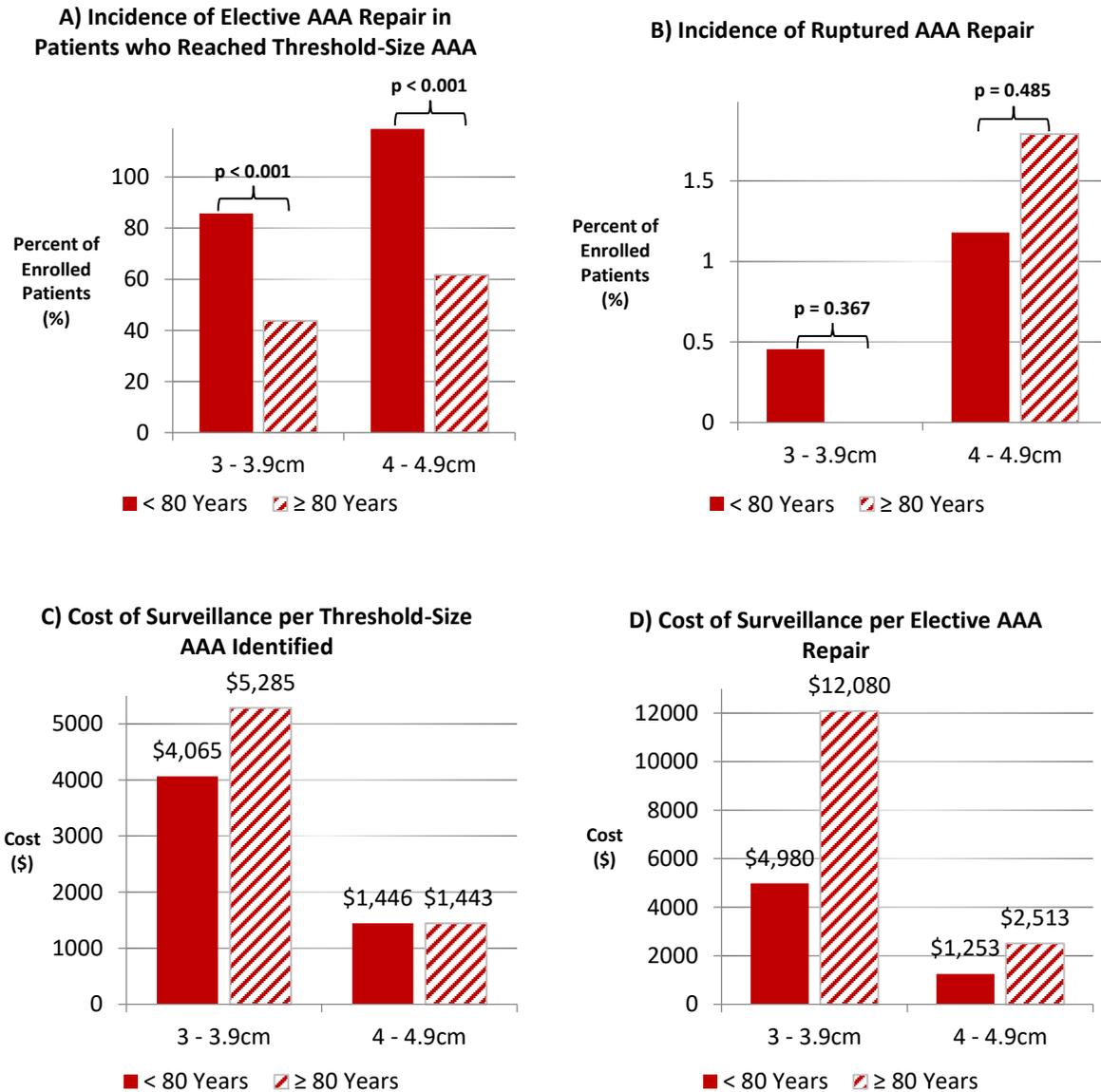


Figure 2: Incidence of AAA Repair and Resulting Cost Effectiveness Analysis. Groups are stratified by enrollment age and size of AAA at time of enrollment. A) When a threshold-sized AAA was reached, octogenarians were less likely to undergo elective AAA repair than their younger counterparts (Overall RR = 0.52 [95% CI = 0.45 – 0.59]). B) Repair of ruptured AAA for patients in the surveillance program was rare, and differences were not statistically significant. C) Cost effectiveness analysis incorporates a base cost of \$89.20 for each surveillance ultrasound (Ontario Health Insurance Plan: Code H 2 = \$57.00 Technical Cost, Code P J202 = \$32.20 Professional Cost). While the cost of surveillance to identify threshold-sized AAA was comparable between age cohorts, D) there was substantially more discrepancy in the cost of surveillance to prompt elective AAA repair.

Current risk estimation models underestimate significance of perioperative factors in predicting mortality following elective abdominal aortic surgeries

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Objective: To determine the ability of current risk estimation models in predicting operative mortality in patients undergoing elective aortic surgery. We hypothesize that

perioperative events are more likely to predict 30-day mortality compared to these risk estimation models that only incorporate pre-operative comorbidity variables.

Methods: All patients who underwent elective abdominal aortic procedures (open and EVAR) between 2002 and 2016 were included in this single centre cohort study. Emergent/urgent procedures were excluded. Data was collected on patient demographics, comorbidities, intra-operative course, post-operative course and 30-day mortality. Matched-pairs using survivor-sampling with a 2:1 ratio was utilized (2 survivors matched to one mortality by gender, age, and procedure type). Risk estimation model scores (V-POSSUM, BAR, GAS, and RCRI) were calculated and analyzed alongside perioperative factors, and CLASSIC grade (severity classification for intraoperative adverse events). Multiple logistic regression with adjustments for covariates was used to assess the relationship between predictors and outcome.

Results: A total of 2596 elective procedures were performed during the study period (open=57.6%, EVAR=38.9%, advanced EVAR=1.7%, other=1.8%). Overall 30-day mortality was 2.0% (n=53). There was a disproportionate number of female mortalities compared to the overall cohort (45.3% vs 21.5%, $p<0.0001$). Intra-operative factors significantly predicted 30-day mortality, including operative time ($p=0.036$), proximal aortic clamp level ($p=0.001$), estimated blood loss ($p=0.016$), CLASSIC grade ($p=0.0001$), and post-operative re-intervention rate ($p<0.00001$). The BAR risk model had reasonable ability (c-statistic=0.76) at predicting 30-day mortality risk. The other models (V-POSSUM, c-statistic=0.69; RCRI, c-statistic=0.60; GAS, c-statistic=0.58) performed relatively poorly. A custom risk assessment model including preoperative factors (functional status and smoking history) demonstrated a c-statistic of 0.85; however, with the inclusion of intra-operative factors (number of blood transfusions and proximal clamp time), the accuracy of the model greatly increased (c-statistic=0.98).

Conclusion: With the exception of BAR, current risk prediction models do not predict 30-day mortality as well as reported in literature. Although they are not available in preoperative decision making, intraoperative and post-operative adverse events are significant in predicting 30-day mortality. Creating a risk prediction model that incorporates perioperative events may improve identification of at-risk patients during the post-operative course.

Long-Term Outcomes Comparing Endovascular and Open Abdominal Aortic Aneurysm Repair in Octogenarians

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Objective: Patients over 80 years have significantly lower early mortality with EVAR when compared to open repair for abdominal aortic aneurysms (AAA), but long-term results remain poorly studied. We analyzed the results of both emergent and elective AAA repair in patients 80 years or older who had at least 5 years of follow-up.

Methods: Retrospective review of a prospectively collected vascular surgery database was performed to identify all patients who underwent elective repair of an abdominal aortic aneurysm between 2007 and 2012 and were 80 years of age or older at the time of surgery. Open and EVAR groups were compared using univariate statistics.

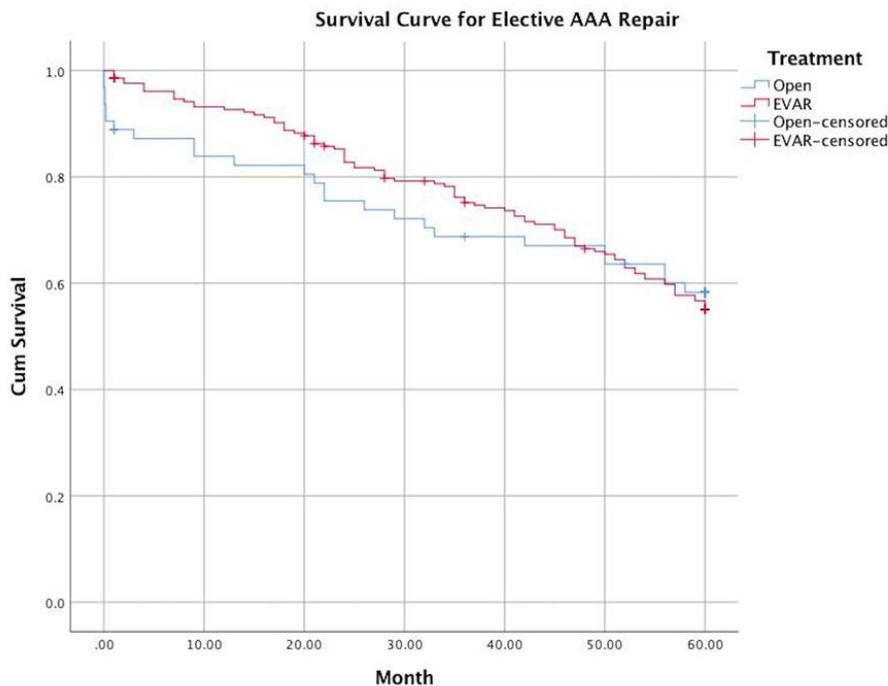
Results: The study cohort comprised of 314 patients 80 years of age or older (mean 83.5 +/- 2.9 years) who underwent repair (96 open, 218 EVAR). The groups had similar comorbidities, except that EVAR patients were more likely to be male, and open repair patients were more likely to have larger aneurysms. When compared to open repair, elective early postoperative mortality was significantly lower for EVAR patients (1% vs 14% $P<.001$).

Overall mean life expectancy was 5.9 years (5.8 years EVAR, 5.8 years open; $P=.98$). 1-year survival was significantly higher for EVAR (92.9%) compared to open repair (84.1%) ($P=.02$),

while 5-year (57.8% EVAR, 60.3% open; $P=.98$) survival did not differ between the two (Figure 1). In both groups, long-term mortality was most commonly due to cardiovascular events and malignant disease. Reintervention rates (14% EVAR, 2% open; $p=.05$) were higher in the endovascular treatment group (Figure 2).

Conclusions: EVAR results in an improved 1-year mortality in octogenarians compared to open repair, although 5-year survival is similar between the two groups. With average life expectancies over 5 years and a 14% reintervention rate, diligent follow-up is required following EVAR in elderly patients.

Figure 1. 5 year survival curve for elective open versus endovascular abdominal aortic aneurysm repair.



Impact of declining Institutional Memory on adverse events following Open Aneurysm Repair

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Since its introduction, endovascular aortic aneurysm repair has become a mainstay in the treatment of abdominal aortic aneurysms, resulting in the decline of open aneurysm repairs (OAR).

Objective: To determine if reduced OAR performance has led to a decline in institutional perioperative efficiency and an increase in post-surgical complications.

Methods: A retrospective cohort study compared perioperative data and complications of consecutive 49 juxtarenal (<1cm neck) OAR surgeries performed between 2014-2017 and 53 consecutive controls (2005-2007) at The Ottawa Hospital. There was no change in surgical personnel during this 10 year comparison.

Results: TOH experienced a 61% decline in the number of OARs performed between 2005 and 2016. Age of participants was significantly increased in the 2014-2017 group ($p=0.0141$), while the number of women was significantly decreased ($p=0.05$). Total OR time and anesthesia time were longer in the 2014-2017 group, while surgical times remained consistent. Suprarenal clamp time and blood loss during the procedure were decreased in the 2014-2017 group. ICU and overall hospital stay were not significantly different between groups, however there were large standard deviations observed for the 2014-2017 group. As well, 18.4 % of patients in the 2014-2017 group experienced post-surgical complications of Clavien Dindo Grade IIIa or higher, compared to 11.3% of patients in the historical control group. Mortality was increased in the 2014-2017 group, although this was not significant.

Conclusion: The reduced rate of OAR performance at TOH reflects the global trend towards endovascular repair. Anesthesia and OR time increased over the time period examined, reflecting a possible loss of expertise over the study period. Complications also increased over this time period for anatomically similar patients. Taken together, these findings may reflect a decreased institutional familiarity with open aneurysm repairs and post-surgical care.

Surgically Positioned Paravertebral Catheters and Post-Operative Analgesia after Open Abdominal Aortic Aneurysm Repair

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Objective: To compare post-operative morphine equivalent intake after open Abdominal Aortic Aneurysm (AAA) repair amongst analgesic modalities: Standard Analgesia (SA) with systemic opioid administration, Epidural Analgesia (EA), and surgically positioned Paravertebral catheter Analgesia (PA).

Methods: A retrospective cohort study was performed in all open AAA from 2005-2016 at the QEII Health Science Center, Halifax Nova Scotia. Total Morphine Equivalent (MEQ) on Post-Operative Day (POD) 1, 2 and 3, time in intensive care and adverse events were compared between patients with SA, EA and PA. A multivariable zero inflated poisson regression was used to determine the association between analgesic modality and MEQ. Multivariable logistic regression models were used to determine associations between analgesic modality with rates of discharge from intensive care within one day and adverse events. Adjusting co-variables included age, co-morbidities, smoking and American Society of Anesthesiology status, presence of symptoms, anatomical candidacy for endovascular repair, and surgical approach (transperitoneal vs retroperitoneal).

Results: The final study cohort included 355 patients: 177 retroperitoneal and 178 transperitoneal repairs. 117 patients underwent PA, 65 EA and 173 SA. Compared to SA, PA and EA were associated with decreased MEQ on POD1, 2 and 3 (Table 1). Compared to SA, PA and EA were associated with decreased odds of receiving opioids on POD1, 2 and 3 (Table 2). If patients did receive opioids, compared to SA, PA and EA were associated with decreased consumption on POD1 (Table 2). Compared to SA, PA was associated with earlier discharge from intensive care (OR, 2.75; 95%CI, 1.17-6.45). Compared to EA, PA was not associated with increased odds of adverse events (OR, 0.44; 95%CI, 0.08-2.44).

Conclusions: PA and EA are associated with decreased MEQ compared to SA. PA is associated with earlier discharge from intensive care compared to SA and similar rates of adverse events compared to EA.

Table 1: Morphine Equivalent Intake by Analgesic Modality

		Standard Analgesia (n=173)		Paravertebral Analgesia (n=117)		Epidural Analgesia (n=65)	
		Median	IQR	Median	IQR	Median	IQR
MEQ	on	984	342- 1525	89	33-246	49	0-90
POD1							
MEQ	on	105	57-210	45	15-99	30	0-64
POD2							
MEQ	on	45	15-120	30	0-60	10	0-45
POD3							

MEQ= Morphine Equivalent Intake in milligrams of oral morphine. POD=Post-Operative Day.

Table 2: Multivariable Zero Inflated Poisson Regression of MEQ by Analgesic Modality

	Paravertebral Analgesia (n=117)				Epidural Analgesia (n=65)			
	OR	95% CI	IRR	95% CI	OR	95% CI	IRR	95% CI
MEQ on POD1	0.05	0.01-0.40	0.40	0.26-0.63	0.01	0.00-0.09	0.17	0.11-0.26
MEQ on POD2	0.26	0.09-0.76	0.65	0.31-1.35	0.05	0.02-0.14	0.38	0.20-0.72
MEQ on POD3	0.44	0.25-0.77	0.58	0.24-1.41	0.29	0.15-0.56	0.88	0.43-1.79

OR= Odds Ratio. IRR= Incident Rate Ratio. MEQ= Morphine Equivalent Intake in milligrams of oral morphine. POD=Post-Operative Day.

Saturday, September 29th, 2018

PAPER SESSION VI: TREATMENT OF VENOUS DISEASE

Ultrasound-guided Cyanoacrylate Injection for the Treatment of Incompetent Perforator Veins

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Lower limb perforator incompetence can exacerbate chronic venous disease and is a leading cause of varicose vein recurrence following treatment. With advancements in endovenous technology, minimally invasive treatments including sclerotherapy and thermal ablation have largely replaced open surgical techniques. Cyanoacrylate glue embolization is a relatively new treatment with good long-term results. However, its use in obliterating perforating veins has not yet been examined. Here we report our series of ultrasound-guided direct cyanoacrylate injection into perforator veins for the management of chronic varicose veins.

Objective: To assess the clinical outcomes and complications following direct injection of cyanoacrylate-based adhesives into venous perforators.

Methods: A retrospective analysis of patients undergoing varicose vein treatment with VenaSeal (Medtronic of Canada Ltd., Vancouver, BC) at Vancouver General Hospital between 2015-2018 was conducted. Patients were included if perforator veins were treated with direct injection of cyanoacrylate glue. Patient demographics, class of venous disease and location of perforator veins were collected (Table 1). Outcomes at short and mid-term follow up appointments were also analyzed (Table 2).

Results: A total of 18 patients with 19 legs and 22 perforator vein injections were done. The amount of cyanoacrylate injected per perforator was 0.2 ml. The average age of patients was 63 ± 3 years with 61% being female and a BMI of 25 ± 2 kg/m². CEAP classification and the location of perforators treated are shown in Table 1. Immediate treatment success was noted in all 22 instances. Treatment success was 100% at short-term follow up. There were 3 cases of superficial phlebitis noted that had resolved by mid-term follow up. There were no deep vein thromboses or other procedural related complications noted at mid-term follow up.

Conclusion: Ultrasound-guided direct perforator injection of cyanoacrylate glue is a safe and effective treatment for patients undergoing concurrent superficial vein ablation.

Table 1: Demographics of patients treated with direct perforator injection of cyanoacrylate based adhesives

	Total Cohort (n = 18)
Demographics (mean \pm SEM)	
Age (years)	63 \pm 3
Female (%)	11 (61)
Height (cm)	171 \pm 3
Weight (kg)	73 \pm 5
BMI (kg/m ²)	25 \pm 2
CEAP (%)	
C2	6 (33)
C3	8 (44)
C4	3 (17)
C5	0
C6	1 (6)
Leg (%)	
Left	10 (53)
Right	9 (47)
Location of Perforator (%)	
Hunterian	1 (5)
Dodd	2 (9)
Boyd	6 (27)
Cockett	13 (59)

Table 2: Short- and mid-term outcomes of cyanoacrylate injection into perforator veins

	Short-Term Follow Up* (n = 15)	Mid-Term Follow Up (n = 16)
Post procedure day	10 ± 2	52 ± 9
Success (%)	15 (100)	16 (100)
Superficial phlebitis	3 (20)	0 (0)
Other complications	0 (0)	0 (0)
Sclerotherapy	0 (0)	12 (75)

*Short-term follow up is defined as the first visit within 4 weeks of index procedure. Medium-term follow up is defined as the second visit after 4 weeks of index procedure.

Non-tumescent versus tumescent based endovenous therapies for patients with saphenofemoral reflux and varicose veins – A meta-analysis

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Background: Varicose veins and chronic venous insufficiency are an increasingly common diagnosis in the adult aged population. Valvular incompetency at the saphenofemoral junction is the usual cause of the venous insufficiency leading to a variety of symptoms. Most traditional endovenous procedures (laser and radiofrequency) require injection of tumescent fluid along the saphenous vein, which can be a significant cause of patient discomfort. Newer, non-tumescent based therapies have been introduced with similar success rates and less patient discomfort, leading to high patient appeal.

Objectives: To compare the non-tumescent based endovenous therapies with the standard tumescent based endovenous therapies in regards to clinical-effectiveness and procedural related outcomes in patients with saphenofemoral incompetency and varicose veins.

Methods: The following databases: Cochrane Central Register of Controlled Trials - CENTRAL (1950 to January 2017), MEDLINE (1946 to January 2017) and EMBASE (1950 to January 2017) were searched for studies that were randomized or quasi-randomized trials comparing non-tumescent based endovenous procedures to those requiring tumescence. There were no restrictions based on language or publication status. In the case of ongoing studies, the World Health Organization's International Clinical Trials Registry Platform and the online ClinicalTrials.gov registry were also searched. We also reviewed reference lists of articles relevant to our study to ensure a more complete review. Two authors independently screened and selected studies to include. These two authors also independently assessed the risk of bias using the Cochrane RoB 2.0 tool. Data was extracted and pooled using a random-effects model.

Results: Four outcomes were reviewed. There was a significant difference found between the comparator groups for mean intraprocedural pain score, favouring non-tumescent based therapies. There was no difference for Venous Clinical Severity Score for clinical assessment and the Aberdeen Varicose Vein Quality of Life Score for the disease specific quality of life between the groups. The outcome of failure of truncal ablation at 30 days had no significant difference between the groups, though a subgroup analysis demonstrates a trend towards improved results with the novel non-tumescent based treatments as compared to the old non-tumescent treatments.

Conclusions: Currently available evidence from reasonable quality clinical trials comparing tumescent with non-tumescent based endovenous therapies show no overall difference

between the groups on a number of outcomes. Mean intraprocedural pain score appears to favour non-tumescent based interventions. Newer randomized trials comparing the treatment modalities are needed to further clarify the benefits of non-tumescent based therapies, particularly with regards to long-term outcomes.

IVC Filter Removal after Extended Implantation Periods

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Objective: Retrievable IVC filters are intended for short-term placement and serious complications have been reported in patients with chronic IVC filters. As a result national health agencies have encouraged each hospital to assess all retrievable IVC filters for filter removal. The aim of our study was to identify patients with unretrieved chronic IVC filters, document complications and removal techniques.

Methods: Using the dataset from a previous performed retrospective review of all IVC filter procedures performed between January 2001 and December 2013, we identified a cohort with unretrieved IVC filters. These patients were invited by registered mail for clinic review with CT imaging to determine complications and offer removal if indicated. Data collected included demographics, venous thromboembolism risk factors, medical comorbidities, complications and retrieval characteristics.

Results: During the study period, 1123 IVC filter procedures were performed; 69% (n = 810) were insertions and 31% (n = 313) were retrievals. Of the 663 retrievable filters, successful removal rate was 41.6% (n = 276); 22 patients had a failed retrieval attempt. Having excluded filters removed subsequent to the data collection period 289 patients were identified to still have a filter *in situ*. 193 patients were confirmed internally and/or by Ministry of Health as deceased. 89 patients were notified with no current contact information available on the remaining seven. 34 attended for review, 19 females, 15 males with an average age of 63.5 years. Complications documented at CT were 2 occluded IVCs(5.8%), 4 fractured filters (11.7%) and filter penetration in all cases (38% Grade 2, 53% Grade 3). 15 decided to proceed with filter removal, 10 refused the opportunity and 5 were unfit or had ongoing indication for the filter. 2 are awaiting removal and 2 had IVC occlusion. Retrieval was successful in 93% of cases(14/15). The mean time to removal from implant was 3846.9 days (SD 980.3). Advanced techniques were employed in 9 cases and there were no mortalities or morbidities.

Conclusion: Retrievable inferior vena cava filters are not benign, and mounting evidence suggests their complication rate may be higher than previously recognized and the incidence of which increases over time. Chronic unretrieved filters can be removed safely using standard and advanced techniques with low morbidity and mortality.

Are Demographics Affecting Vascular Surgery Volumes? A Province Wide Perspective

Jim Dooner, Island Health, Victoria BC

Objective: The purpose of this study was to evaluate the relationship between population increase, changing age demographics and the throughput of vascular procedures province wide from 1993-2016.

Methods: Population data and age-related distribution were obtained from Government of BC Database. Billing codes were used to quantify the number of procedures across the spectrum of Vascular Surgery from 1993 until 2016 from the BC Medical Services Commission and Doctors

of BC. Annual procedure rates were tracked as well as the type of practitioner performing the procedures.

Results: During the study period (1993-2016) the total population grew by 34% while the population segments greater than 60yrs of age grew by 90% provincially. Consultations increased by 40% between 2001 and 2016 but despite the advancing age, there was no significant growth in the number of Abdominal Aortic Aneurysms repaired by all methods . There was a dramatic reduction in aorto- iliac reconstruction and a very stable pattern of lower extremity bypass procedures. Amputation volumes have not grown significantly over the study period and Carotid Endarterectomy has been stable. Vascular access procedures have increased by more than 400% and the number of Venous cases completed more than doubled over the period of study.

Conclusion: Despite significant growth in the segment of the population over the age of 60, there appears to be little growth in the throughput of vascular surgery across a broad spectrum of procedures. Despite growth in demand for vascular consultation there has been no increase in the surgeries performed with very notable exceptions. A substantial increase has occurred in Vascular Access procedures and Venous surgery. Both can be performed as ambulatory procedures. One is left to speculate regarding the lack of growth in procedural volumes but the limited access to inpatient beds would be one factor while lack of access to primary care and transportation issues may also have a significant impact.

Improving Critical Discharge Medication Adherence:A Vascular Quality Improvement (VQI) Initiative

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Acknowledgments: Vascular Surgery Care Team – Grey Nuns Hospital

Objective: Admission to hospital provides an ideal opportunity to ensure appropriate morbidity and mortality improving medications are prescribed. Anti-platelet (AP) medications (ex. ASA, clopidogrel) and HMG-CoA reductase inhibitors (statins) (ex. rosuvastatin) have class 1A evidence for patients with peripheral arterial disease (PAD). Similarly, perioperative AP and statins reduce mortality following vascular surgery. Our objective is to establish a 5-component discharge improvement program that results in all eligible patients having a statin and AP prescribed at discharge.

Methods: We used the Evidence-based Practice for Improving Quality (EPIQ) model to create a comprehensive and systematic discharge protocol to improve both statin and AP therapy adherence at a Canadian center. Our multi-disciplinary team within the Division of Vascular Surgery collaborated to identify 5 key components/steps in the discharge process. Our intervention was initiated on July 24, 2017 for patients admitted to the Grey Nuns Hospital in Edmonton, Canada under the Division of Vascular Surgery. Prospective data has been collected and maintained within our regional VQI chapter with outcome results reviewed every month. To date, we have evaluated 6 months prior and 6 months after our intervention.

Results: 485 eligible patients were added to our local VQI database (Jan 1, 2017 - Dec 31, 2017). Prior to our intervention, 73.3% of patients were appropriately discharged on both AP and statin medications. Following our intervention, the average medication adherence upon discharge increased to 84.4%. Of the remaining patients that did not have indicated medications at the time of discharge, 17% were missing an AP agent and 7.5% were missing a statin.

Conclusion: Overall, this VQI initiative improved key steps in discharging patients from our centralized vascular surgery centre. We improved medication adherence for morbidity and mortality improving AP and statin therapies. With this intervention, our medication adherence is higher than both regional and national averages.

Saturday, September 29th, 2018

PAPER SESSION VII: TEACHING AND GENERAL TOPICS

Engineering the Educational Experience (E3): Creating a Genuine Clinical Experience for Trainee Learning and Assessment

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Objectives: With the move towards competency – based education, providing genuine clinical experiences that allow trainees to learn in a safe and secure environment, and assessing these experiences, continues to daunt medical educators. Recently the opportunity to develop an outpatient, ambulatory care clinic (Medical Education Teaching Clinic: METC) to offer genuine experiences to a variety of trainees arose. To ensure that the experiences maximized quality and value to the trainees while allowing for opportunities for assessment in a variety of formats, we created an engineered educational experience (E3).

Methods: To assess the engineered educational experience, we implemented a 360-degree assessment protocol. This protocol includes feedback from trainees, patients, staff physicians and support staff and is conducted using a mixed methods assessment protocol.

Results: To date, 75 medical trainees (medical students, physician assistants, and residents) have experienced the educational opportunities offered by the E3 clinic. 80% trainees ranked their experience in the METC as beneficial or very beneficial to their overall training. 85% of trainees agreed with the statement that the METC provided opportunities that they had not previously experienced during their training. Feedback from patients has been positive and included statements such as “I was surprised by the efficiency in the METC” and “the quality of care was of equal or greater quality than care I have received elsewhere”.

Conclusion: Implementing the E3 curriculum has led to greater clinical exposure for medical trainees. To date, feedback from those involved in the clinic has been positive. Additionally, with the move to competency based medical education, it has provided learning and assessment opportunities that were not previously available. E3 has also allowed trainees to further understand the interactions of the health care team for patient care.

Vascular Interventions in Head and Neck Cancer Patients: Guidelines for Best Practice

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Objectives: Head and neck cancer can involve the surrounding vasculature and require technically challenging vascular interventions. Our aim was to examine patients with vascular interventions and head and neck cancer (HNC) to determine outcomes and best practice.

Methods: We performed a retrospective review of cancer patients treated by head and neck surgery (HNS) and vascular surgery between 2007-2014. Data from electronic medical records, perioperative outcomes and survival were collected. Patency and survival were determined by Kaplan-Meier analysis.

Results: A total of 57 patients with HNC requiring vascular interventions were identified. 44 patients had squamous cell carcinoma (77%). The majority of interventions (N=36, 63%) were performed for recurrent or persistent malignancy and 77% had prior radiation therapy. Tumor resection and vascular intervention were performed concurrently in 26 patients (46%). The most

common indication for vascular intervention was bleeding (N=21, 37%), including 14 vessel ruptures. Remaining indications included invasion/encasement (N=25), stenosis/occlusion (N=12), and aneurysm (N=1). The most common intervention was stenting (N=22, 41%), followed by resection (N=20, 35%), exposure/dissection (N=12), bypass (N=8), and embolization (N=3). Of the 22 patients who were stented, 10 (45%) were placed emergently (6 blowout and 4 tumor bleeding). 6 patients (11%) required reintervention. Thirty-day mortality was 9% (N=5) and stroke rate was 7% (N=4). Primary patency at 1 year was 66% for stents and 71% for bypass, (P = .604). There was a trend toward worse 1year survival in emergency bleeding patients at 38% compared to 77% for other indications (P = .109). The overall cohort survival at 1 and 2 years was 62% and 44%, respectively.

Conclusions: Vascular involvement in head and neck cancer is a marker for poor survival. Vascular interventions are needed and feasible but should be approached with reasonable expectations and multidisciplinary collaboration.

Impaired angiogenesis and wound healing in a tissue-engineered skin made with diabetic patients-derived fibroblasts and keratinocytes

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Objective: Our aim was to create an endothelialized tissue-engineered skin model to better understand diabetic chronic ulcer. For this purpose, we assessed the effect of diabetic fibroblasts and keratinocytes on angiogenesis and reepithelialisation, two crucial steps in wound healing, with an *in vitro* skin model.

Methods: We developed a tissue-engineered skin made with fibroblasts and keratinocytes isolated from healthy or diabetic patients. Healthy skin endothelial cells were seeded in the dermis to form capillary-like tubes. The capillary network was detected by PECAM-1 immunostaining and visualized with Imaris software. Secreted angiogenic factors were quantified by ELISA. To evaluate the reepithelialisation capacity of diabetic keratinocytes, we used a tissue-engineered wound healing model made of an upper-perforated epidermis stacked over a dermal compartment. The wound healing process was then monitored over time and visualized by histology with Masson's Trichome staining.

Results: Tissue-engineered skin made with diabetic fibroblasts and keratinocytes shared some similarities with diabetic chronic wounds. The capillary network formed in diabetic tissue-engineered skin was less developed and showed an altered secretion profile of growth factors compared to healthy controls, like a 2-fold reduced secretion of NGF (p<0.001, n=6). Diabetic keratinocytes were unable to form a thick migrating tongue and initiate reepithelialisation, in contrast with healthy controls (p<0.0001, n=3). Furthermore, diabetic epidermis was thinner and showed an altered histological aspect compared to healthy controls.

Conclusion: We have developed an *in vitro* endothelialized tissue-engineered skin mimicking important features involved in diabetic ulcer like impaired angiogenesis and reepithelialisation. This model could be a useful tool for the study of diabetic wound or for the screening of therapeutic molecules.

Preoperative Anemia has Gender Based Differences in Immediate Postoperative Mortality

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Objective: The objective of the present study was to assess hemoglobin thresholds to prevent short-term mortality, adverse cardiac events, and immediate post-operative complications.

Methods: Data was extracted from the Vascular Quality Initiatives Database (VQI) from January 2010 to December 2017. After testing for differences in key baseline demographics, logistic regression analyses were running with hemoglobin and necessary covariates predicting outcomes. Predictive probabilities were saved from these models to create ROC curves. When appropriate, cutoffs were created for the ROC curves using Youden's index.

Results: There were a total of 1682 patients, with 1274 (76%) males and 408 (24%) females. There were 249 carotid endarterectomies, 498 EVARs, 308 infrainguinal repairs, 213 open AAA repairs, 233 suprainguinal repairs, and 181 TEVARs. 38% (n=639) of the study population was anemic (Hb<135 in M, 120 in F). The average preoperative hemoglobin was 133 g/L. Preoperative hemoglobin was associated with in-hospital mortality (F p < 0.0001; M p < .0001), adverse cardiac events (M p < 0.0001; F p < .02) and post-operative complications (M p <0.001; F p =0.008). COPD played an important role in predicting in-hospital mortality (F p = 0.008; M p= .01), with a higher expected mortality in those with COPD. Predicted hemoglobin cutoffs were 130 g/L with COPD and 116 g/L without COPD in females and 127 g/L with COPD and 148g/L without COPD in males.

Conclusions: Preoperative anemia is a powerful predictor of immediate mortality, adverse cardiac events and postoperative complications. There are important gender differences in risk of adverse events and preoperative anemia should be aggressively treated in vascular surgery patients. M= males; F= females

Persistent Opioid Use Following Vascular Surgery

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Objective: Canada is currently facing an opioid crisis. In 2016,1.3million Canadians commenced opioid treatment and nearly 3,000 Canadians suffered an opioid-related death. Our aim is to assess the rate and associated risk factors of prolonged opioid use in post-operative vascular surgery patients with the goal of informing and improving patient care.

Methods: In this population-based retrospective cohort study, patient data were collected for eligible vascular surgery patients ≥65 years-of-age who underwent one of five surgical interventions at the Toronto General Hospital during November 22nd, 2016 to March 31st, 2017. Data were obtained from electronic patient records, the Vascular Quality Initiative and the Ontario Drug Benefit databases. Prolonged opioid use was defined as ongoing opioid dispensing for >90 days post-discharge.

Results: 86 out of 157 screened patients were eligible for study enrollment. Patient age ranged from 65-98 years-of-age (mean=78 ± 8.2 years). Patient cohort consisted of 61 male and 25 female subjects. Of the 86 patient cohort, 48% (N=41) of patients were discharged with an opioid prescription and 11.4% (N=10) of patients continued to receive opioids for 1-year (271-365 days). Patients with opioid use for 1-year were found to have a significantly higher incidence of diabetes, 3 or more different opioid prescribers, and 3 or more opioid dispensing pharmacies. In addition, patients with 1-year opioid use had a significantly higher mean rank for duration of use of non-opioid pain medications (neuroleptics and benzodiazepines) compared to patients with

opioid use up to 270 days post-discharge, $\chi^2=31.8$, $P<0.0005$ (Kruskal-Wallis test).

Conclusion: The incidence and risk factors for prolonged opioid use in Canadian vascular surgery patients is currently unknown. Our study demonstrates a substantial number of postoperative vascular surgery patients have prolonged opioid consumption. This data is vital to better understand and improve clinical management of postoperative-opioid use in vascular surgery patients.

Friday, September 28th, 2018

POSTER SESSION

Arteriovenous fistula remains the best hemodialysis access choice for some elderly patients

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Objective: The optimal choice of hemodialysis access in elderly patients remains controversial. The present study was undertaken to determine hemodialysis dependent life-expectancy by age of the patient at dialysis initiation, and compare this to the durability of the various hemodialysis access options.

Methods: We abstracted data from our center's hemodialysis electronic database over a ten-year period to determine patient survival on hemodialysis, stratified by decade of life at dialysis initiation. We also collected data on each dialysis access to determine primary and secondary patency of access types in the various age subgroups. Kaplan Meyer survival functions were generated to represent patient survival and hemodialysis access patency.

Results: Seven hundred ninety-four patients started hemodialysis for chronic renal replacement therapy at our center during the study period. Patients in the ninth decade of life (80-89 years) had a median survival of $1.5 + 0.5$ years on dialysis but this represented two divergent patient groups. Patients aged 80-89 years who were selected for arteriovenous fistula (AVF) creation and utilized this access survived a median of $3.0 + 0.9$ years, while those patients who had an AVF, but did not utilize it had a median life expectancy of 1.5 years. Patients who dialyzed only through a central venous catheter (CVC) had a median life expectancy of $0.8 + 0.2$ years (Table 1). There were no age-related differences in AVF patency (median secondary patency $5.3 + 0.4$ years). The secondary patency of AVF was superior to both arteriovenous grafts ($1.9 + 0.8$ years) and CVC ($1.5 + 0.4$ years).

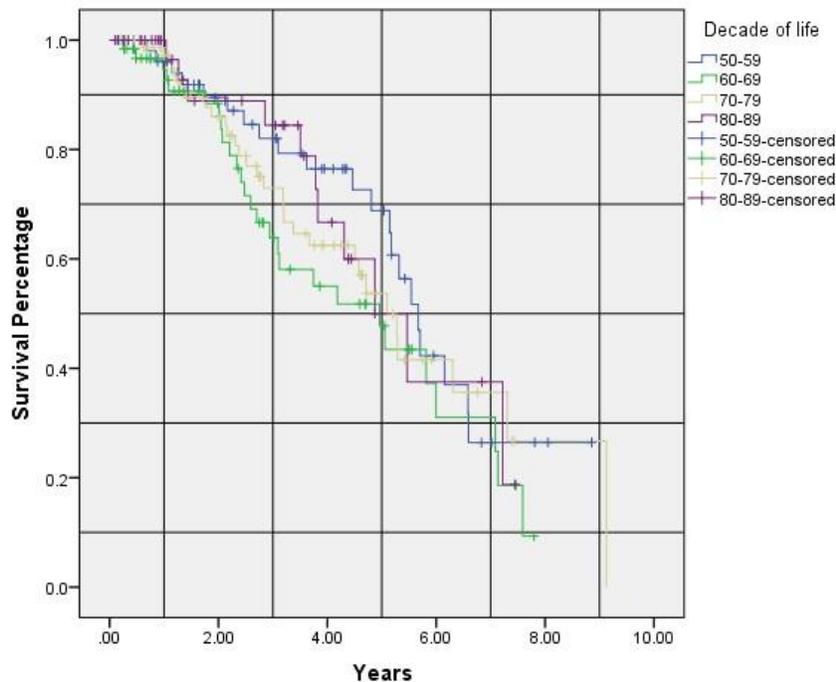
Conclusions: Patients who use an AVF have an increased median life expectancy. These patients have a life expectancy that exceeds the secondary patency of AVG and CVC. In this patient subset, AVF remains the best hemodialysis option.

Table I: Median dialysis dependent life expectancy for patients who utilized an alternate access vs AVF for dialysis vs patients who had an AVF created, but which was never utilized, due to failure of maturation, or patient preference for dialysis through a CVC. The p-value for alternate access compared to AVF is < 0.001 for all age groups combined.

Table I

Age at start of dialysis (years)	Number of patients (n)	Median life expectancy on hemodialysis with alternate access (years)	Median life expectancy for patients who utilized the AVF for dialysis (years)	Median life expectancy for patients with AVF who failed to utilize the AVF for dialysis (years)	p-value (use of AVF compared with non-use of AVF)
80-89	58	0.8	3.0	1.5	0.009
70-79	119	1.4	4.0	3.3	0.268
60-69	108	1.7	4.8	2.7	0.076
50-89	361	3.2	4.5	3.1	0.027

Figure 1: A Kaplan-Meier plot showing the secondary patency of AVFs, by decade of life at initiation of hemodialysis. Patients in the 9th decade of life have a secondary patency that is not statistically different from patients in younger age groups.



Composite self-expanding bioresorbable stents with reinforced compression performance: a computational and experimental investigation

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Objective: Bioresorbable cardiovascular stents are currently developed in order to reduce the risk of long-term thrombosis and restenosis in diseased vessels. However, absorbable polymers remain mechanically weaker and have a relatively higher degree of stent recoil than metal. Hence, we hereby intended to develop novel composite bioresorbable stents (CBRSs) made of poly (p-dioxanone) (PPDO) and polycaprolactone with mechanically reinforced compression performance for pediatric patients.

Method: The CBRSs with PPDO monofilaments and PPDO/PCL composite braiding yarns (CBYs) were fabricated on a 32-bobbin braiding machine using different ratios (7:1 for CBRS type A and 3:1 for CBRS type B), and thermally treated in air thereafter. The properties of different prototypes compressed were evaluated by a parallel compression tester. Stent stress distribution and deformation mechanisms were also analyzed by the finite element method (FEM).

Results: Partial interlacing yarns were bonded and the peeling force was as high as $2,126.67 \text{ mN} \pm 133.14$ to restrict their movement greatly, compared with the friction resistance (less than 100 mN) in the control group. The compression force was promoted dramatically in the novel composite prototype stents by 124.06% in CBRS type A and 169.58% in CBRS type B. Besides, the recovery abilities were also improved significantly (Fig. 2). Moreover, deformation mechanisms were revealed by computational simulations that bonded interlacing points among yarn played an important role.

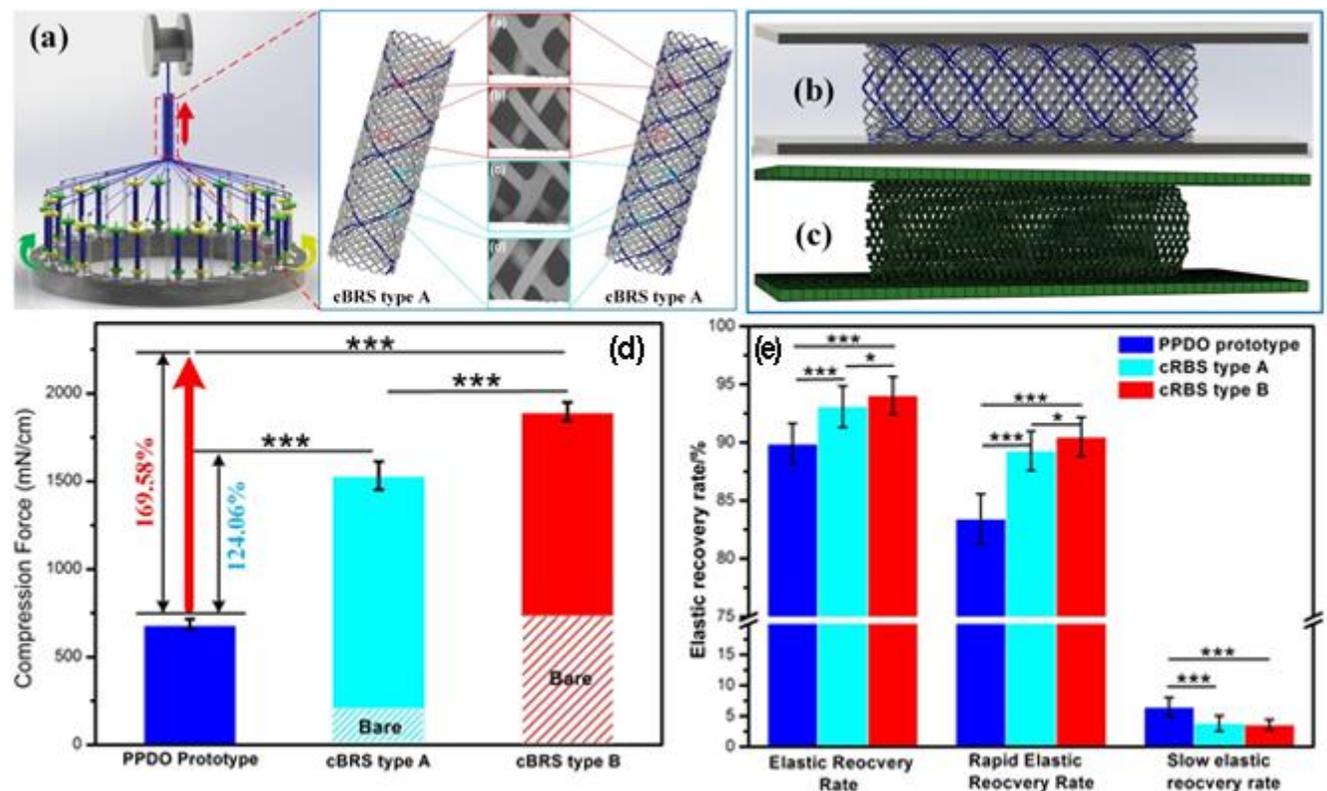


Figure (a) Schematic diagram and morphology of CBRSSs; (b) Parallel compression measurement; (c) Finite element simulation; (d) Compression force and (e) Elastic recovery rate of different prototypes

Conclusion: This study demonstrated a novel technique for designing bioresorbable polymeric prototype stents with reinforced compression performance using a braiding and annealing procedure. The advantage of this design lay in the bonded strand interlacing points that restricted stent elongation and yarn gliding, which was revealed by computational simulations. In addition, the degradation behaviour of novel composite braided stents will be evaluated in the future.

Lower Limb Amputations in Patients With Diabetes and Peripheral Artery Disease: A Time-Series Analysis of Trends 2005-2016

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Objective: Rates of cardiovascular and diabetes-related complications are generally decreasing. Whether a similar decline has occurred with lower extremity amputations remains poorly characterized. The aim of this study was to examine secular trends in the rate of lower extremity amputations among patients with diabetes and peripheral artery disease (PAD), within a single-payer regional healthcare system.

Methods: The study cohort included all individuals ≥ 40 years old that underwent diabetes or PAD-related lower limb amputation in Ontario, Canada (population, 13.6 million) between April 2005 and March 2016. Patients and amputations were identified through deterministic linkage of administrative health databases including inpatient and outpatient records. Quarterly rates (per 100,000 individuals ≥ 40 years old) of minor or major amputation as well as of major amputation alone were established. Time-series analyses were conducted using exponential smoothing models to characterize secular trends.

Results: A total of 19,961 patients underwent minor or major lower extremity amputation(s), of which 12,755 (64%) underwent a major amputation. A total of 18,745 (94%) patients had PAD; 16,366 (82%) had diabetes; and 15,150 (76%) had both PAD and diabetes. The rate of any amputation initially declined between 2005Q2 and 2010Q4, but increased again by 2016Q1 (Figure 1) with PAD-related minor or major amputations following a similar trend (Figure 1). A significant increase was observed in the rate of any amputation among patients with diabetes, and those with diabetes and PAD (Figure 1). While the rates of major amputations decreased, albeit not significantly, among PAD patients, diabetes-related major amputations did not decrease (Figure 2).

Conclusions: Diabetes-related lower extremity amputations have increased over the last decade. These data support renewed efforts to prevent and decrease the burden of limb loss among patients with diabetes.

Figure 1. Lower Extremity Amputations (Minor or Major) in Ontario, Canada

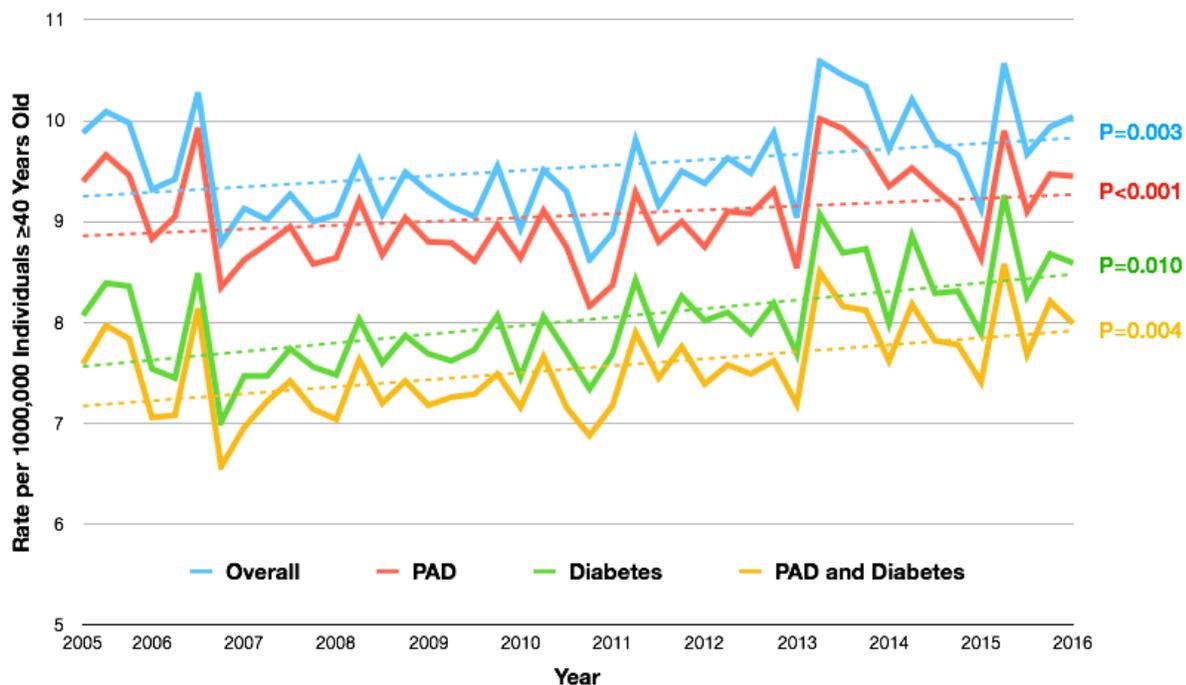
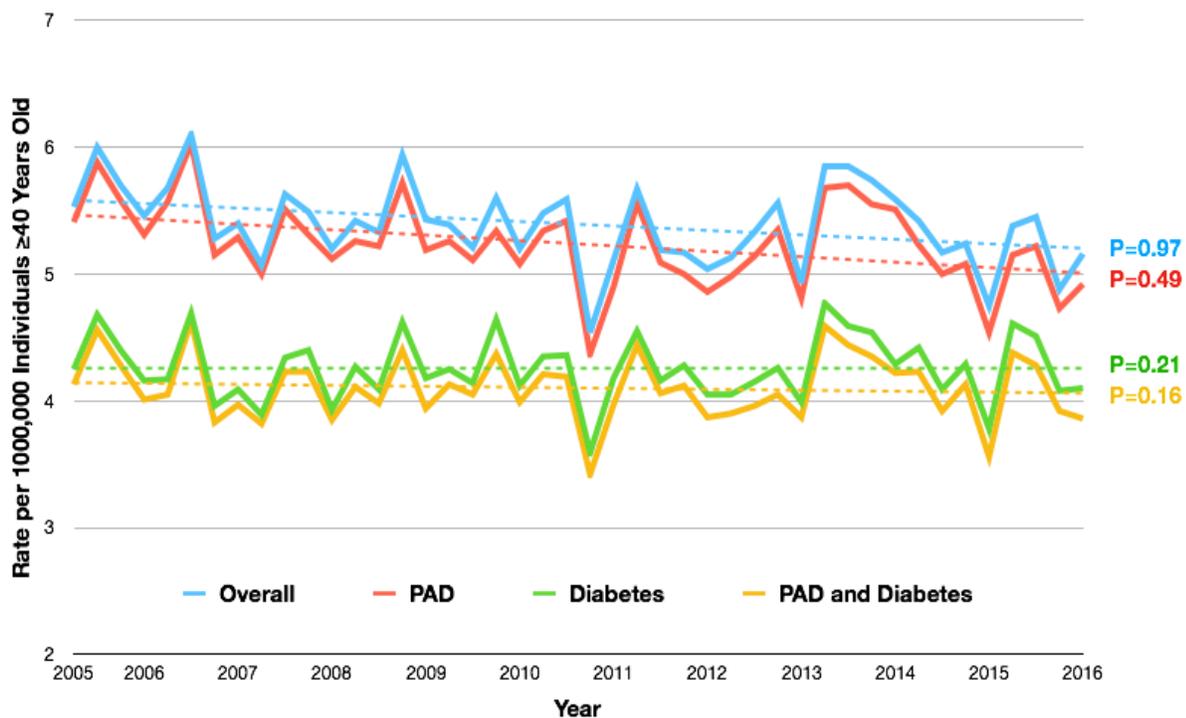


Figure 2. Major Lower Extremity Amputations in Ontario, Canada



Identification of Circulating Micro-RNA Profile in Patients with Peripheral Artery Disease and Critical Limb Ischemia

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Objective: Peripheral arterial disease (PAD) is caused by atherosclerosis of the lower extremities. Almost 5% of patients with PAD progress into the advanced stage, critical limb ischemia (CLI). Patients with CLI are at a significant risk of major limb amputation and death. Therefore, there is an immense requirement for the early diagnosis and management of CLI. Several studies suggest that miRNA, small non-coding ribonucleic acids, can be used as biomarkers of chronic diseases such as heart failure and diabetes. We hypothesize that miRNA can be used as a diagnostic biomarker for PAD and CLI.

Methods: to address our objectives, we built a bio-bank of 1,200 PAD and non-PAD patients. We stratified patients based on their clinical history, claudication distance and ankle-brachial index into 1) non-PAD 2) moderate PAD 3) severe PAD and 4) CLI. In each group, 20 patients were matched based on their age, sex and cardiovascular risk factors. For each group, we purified and sequenced the circulating plasma miRNA using miRNA columns and Next Generation RNA sequencing. While comparing non-PAD to PAD patients, we considered miRNA with a p-value of <0.05 and at least 1.5 fold change as significantly expressed miRNA.

Results: We identified 876 miRNAs in plasma. In which 46 miRNAs are differentially expressed (19 miRNAs are up regulated and 27 are down regulated) in PAD patients relative to non-PAD patients. After searching existing miRNA databases, we identified 16 novel miRNAs that are associated only with PAD. Our in-depth analysis identified hsa-miR-3909 and hsa-miR-483-5p as potential markers for CLI.

Conclusion: For the first time, we identified novel and known miRNA that can be used as biomarkers for CLI. Future studies looking at the gene targets of these miRNA are currently being investigated at our lab.

Postoperative Delirium: The Impact of Pre-Operative Cognitive Impairment, Type of Vascular Procedure and Cost Implications

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Objective: Prospectively study preoperative risk factors for post-operative delirium (POD) to identify high risk patients and assessed its impact on hospital costs.

Methods: The Montreal Cognitive Assessment (MoCA) was administer pre-operatively to elective vascular surgery (VS) patients to assess cognitive function. POD was identified using the Confusion Assessment Method (CAM), chart and psychiatrist confirmation review. Demographic information, medications, substance abuse, psychiatric disorders and previous delirium were prospectively recorded. VS patients (elective and emergency) retrospectively provided cost information related to sitter use and LOS related to: delirium alone, dementia alone, and delirium and dementia.

Results: 174 patients were enrolled (72.9% male, age 69.9 years \pm 11), 119 (68.8%) had MoCA scores <24 indicating cognitive impairment, with 7.5% having severe impairment (dementia). POD incidence was 12 %. MoCA scores were lower in those who underwent amputation (15.9 out of 30, $P < 0.000$) compared to open and endovascular aortic surgery patients (23.6 out of 30). Predictors of delirium included lower limb amputation [OR 15.63, 95% CI 3.41-71.54, $P < 0.000$], open aortic repair [OR 6.00, 95% CI 2.21-16.32, $P < 0.000$], cognitive variables: dementia [OR 5.63, 95% CI 2.21-16.32, $P < 0.001$], MoCA scores ≤ 15 [OR 5.77, 95% CI 1.48-22.49, $P = 0.021$], previous delirium [OR 3.45, 95% (CI) 1.29-8.71, $P = 0.013$]. Retrospective

review of VS 434 patients identified differences between sitter needs: delirium and dementia (M = 13.59 days), delirium alone (M = 3.9 days) or dementia alone (M < 1day [17.7 hours]). Fifteen patients accounted for 69.7% of unit sitter costs and 43.7% of costs were accounted for by patients with pre-existing cognitive impairment.

Conclusions: Preoperative MoCA screening can identify those at highest risk for POD. POD is predicted by type of vascular surgery, impaired cognition (MoCA score) and previous delirium and has significant cost implications.

Deformation Characteristics of Venous Stents: A Comparative Assessment

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Purpose: Stents are often used to maintain the vessel's restored diameter during and/or after endovascular treatment for different diseases such as iliac veins stenosis causing the post-thrombotic syndrome. To improve the success of the treatment, we need to understand the stent deformation characteristics (foreshortening, compliance, radial pressure, and collapse). These important factors contribute to each stent performance regarding hyperplasia, migration, and restenosis, which are challenges associated with the durability of venous stents. We studied the deformation characteristics of the stents commonly used in our institution to treat venous diseases (Wallstent, Cook-Vena, Cook- Z).

Method: Finite Element Analysis, a computer simulation method, and analytical unit-cell study were employed to study the uniform expansion of the selected stents. The unit-cell study focuses on the bending mechanics of the struts, which play the main role in the expansion mechanism. Chosen stent models for simulation had the same diameter (8.5 mm) and the same geometry available for clinicians.

Results and Conclusion: The maximum foreshortening for Cook-Z, Cook-Vena, and Wallstent was found to be 11.3%, 14.2%, and 83.75% of the initial length, respectively. Thus, if predicting the final length of the stent is critical (e.g., deployment close to a branch orifice), Cook Z can be the best choice because of the least foreshortening. In terms of collapse force (resistance force against pinching force), steel stents required a larger force (Cook- Z, 2.6 N/cm and Wallstent, 1.4 N/cm) than Nitinol stents (Cook-Vena, 0.9 N/cm). Consequently, they are more reliable to treat the disease like May-Thurner syndrome, which tends to apply concentrated (pinching) force (Figure 1). Wallstent applies a larger radial pressure particularly for vessels with a diameter larger than 6 mm (Figure 2). Thus, they may be chosen for a long lesion with high recoil.

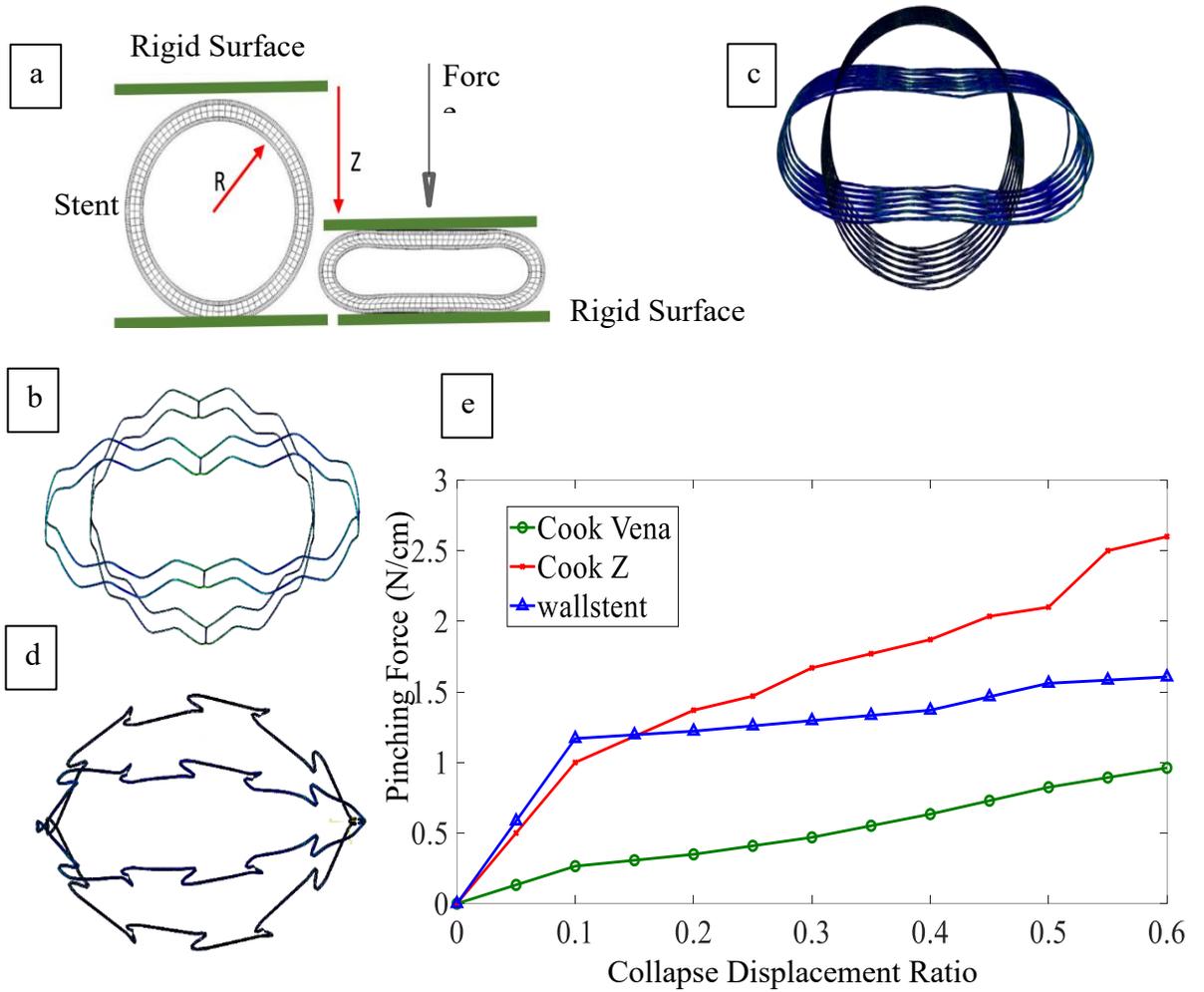


Figure. 1. (a) Schematic of collapse FE simulation; the force is applied on the upper surface to compress the stent between two rigid surfaces, the displacement and the force is measured in each increment. Collapse FE simulation results, deformed Vs. initial configuration of (b) Cook Vena ring, (c) Cook Z ring; (d) Wallstent one pitch; (e) collapse force Vs. displacement ratio (Z/R).

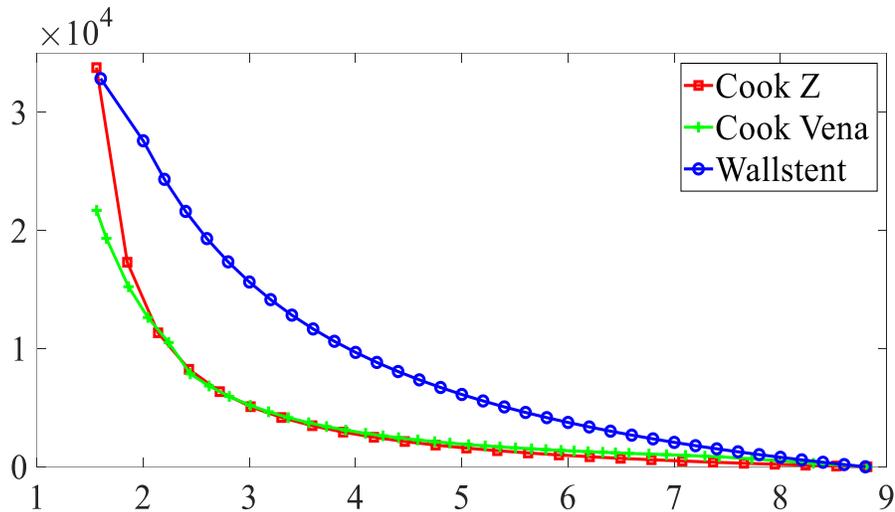


Figure 2: Radial Pressure of each stent. The horizontal axis illustrates the vein diameter and the vertical axis is the magnitude of radial pressure that is applied by the stent to the vein wall at the contact area (struts outer surface).

Prolonged versus Brief Balloon Inflation for Arterial Angioplasty

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University of Ottawa¹

Objective: Angioplasty is a fundamental treatment for atherosclerotic disease, however the optimal duration of balloon inflation has not been identified. Our study investigated whether prolonged inflation of at least 1 minute duration, when compared with brief inflation, affects residual stenosis after arterial angioplasty. This study is registered on PROSPERO (92702).

Methods: In compliance with PRISMA, two independent reviewers conducted a systematic review of EMBASE, MEDLINE, CENTRAL, trial registries and grey literature. Data abstraction and quantitative analysis was performed independently, according to pre-specified criteria. The primary outcome was residual stenosis after initial angioplasty, in addition to other pre-specific clinical and radiographic outcomes.

Results: Six relevant articles were identified, of which one investigated peripheral vascular angioplasty and five investigated coronary artery angioplasty, encompassing a total of 1496 procedures (Figure 1A). The studies were at moderate risk of bias, and displayed features of publication bias (Figure 1B - 1C). Minimal heterogeneity allowed for meta-analysis. Prolonged balloon inflation was significantly associated with lower risk of residual stenosis post-inflation (RR 1.78 [95% CI: 1.49-2.14], Figures 2A - 2B) in addition to less than half the risk of arterial dissection and need for adjunctive procedures such as stenting (RR 2.42 [95% CI: 1.73-3.38], and RR 2.14 [95% CI: 1.54-2.96] respectively). Following adjunctive procedures, less residual stenosis was still observed in the prolonged angioplasty group (RR 1.50 [95% CI: 1.08-2.07], Figure 2C). Follow-up did not reveal a significant difference in the incidence of restenosis, however there was a significant benefit of prolonged inflation in reducing severity of stenosis (MD 3.18 [95% CI: 0.43-5.92], Figures 2D - 2E). Sensitivity analysis accounting for the effect of vascular bed location or study design did not reveal significant differences.

Conclusions: Prolonged angioplasty significantly improves immediate radiographic results, however the long-term effect is less pronounced. Prolonged angioplasty is justified, particularly in situations where adjunctive stent placement is avoided. This is the first review investigating the ideal duration of balloon inflation. Because peripheral interventions are not limited by symptomatic end-organ ischemia to the same degree as coronary interventions, a

clinical trial evaluating further prolongation of angioplasty inflation duration in small caliber peripheral arteries is warranted.

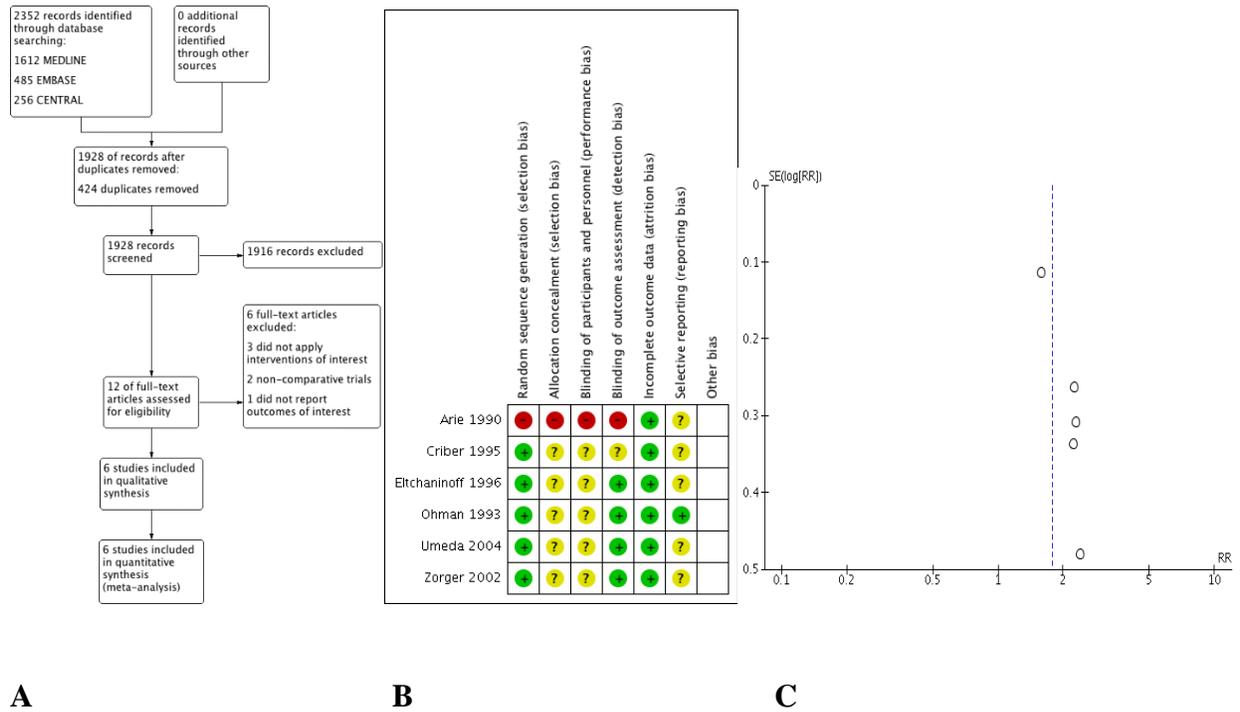
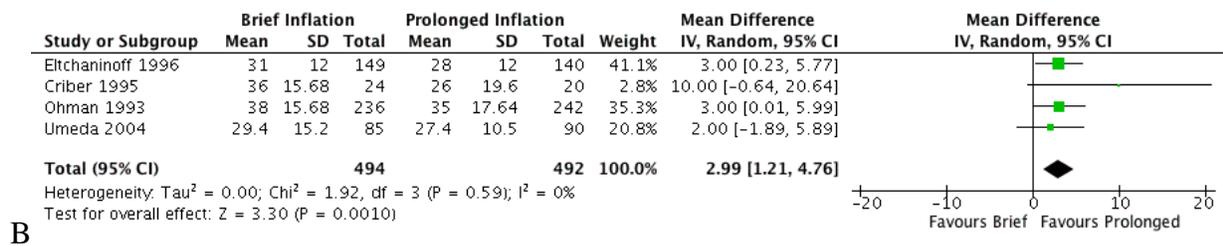
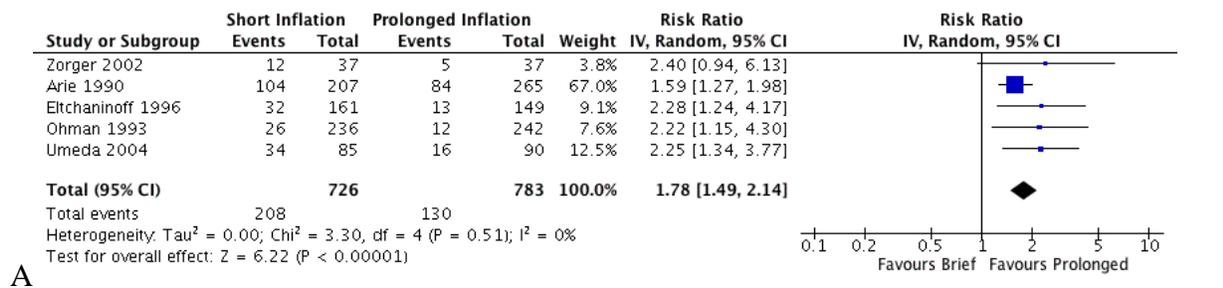


Figure 1: Study Acquisition and Bias Characteristics. A) Systematic review PRISMA study flow diagram. In total, the 6 studies included in the qualitative and quantitative analysis included 1496 procedures. B). In accordance with Cochrane Guidelines, each included study was individually assessed for risk of bias. C) Funnel plot summarizing the five studies reporting on the primary outcome. The vertical dotted line indicates the overall pooled effect measure (RR). The paucity of low weight publications reporting relatively low effect measure is consistent with potential publication bias.



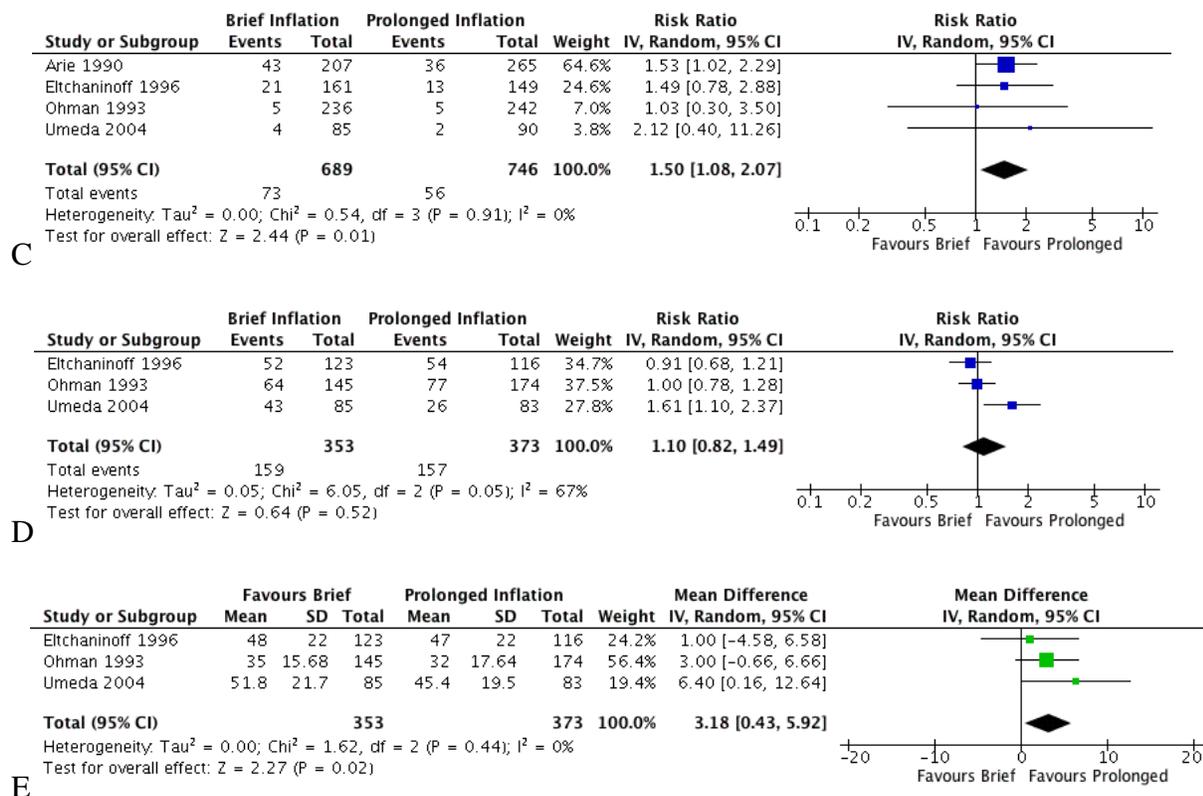


Figure 2: Selected Forest Plots of Meta-Analyses. Articles are listed in increasing order of disparity in balloon inflation duration between treatment arms:

- Primary Outcome:** Risk of residual stenosis immediately after initial angioplasty inflation.
- Severity of residual stenosis immediately after initial angioplasty inflation, measured as a continuous outcome of percent stenosis.
- Risk of residual stenosis on index procedure completion angiogram, following any adjunctive procedures.
- Risk of stenosis on follow-up angiogram, at least 3 months following index procedure.
- Severity of stenosis on follow-up angiogram performed at least 3 months following index procedure, measured as a continuous outcome of percent stenosis.

AAA Anatomic Severity grading score: Identifying anatomic attributes that best predict EVAR outcomes

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Objectives: The Society for Vascular Surgery anatomic severity grading (ASG) score is a classification system for abdominal aortic aneurysms (AAAs) stratifying candidates for endovascular aneurysm repair (EVAR). Our objective is to determine the predictive capability of total ASG score, subscores, and individual attributes for implant-related complications, endoleak, and reinterventions.

Methods: Patients who underwent EVAR between 2009 and 2012 with M2S three-dimensional (3-D) computed tomography reconstructions were retrospectively reviewed. ASG scores were calculated from morphologic measurements by two blinded observers. Twenty-five attributes comprise subscores for aortic neck, AAA, iliac arteries and total ASG score.

Results: We identified 100 patients with mean ASG score of 18.6 ± 4.5 (range, 7.5-29). Mean AAA diameter was $54\text{mm} \pm 10$. Mean follow-up was $3.93 \text{ years} \pm 2.5$. Inter-observer variability was determined using Intraclass Correlation Coefficient (ICC), reflecting degree of correlation and agreement. Inter-rater agreement was good to excellent for total ASG score calculations (ICC= .86, 95% CI .70-.92). Area under the receiver-operating curve analysis was performed to study outcomes. Total ASG score was not a significant predictor of any outcomes. A neck subscore of ≥ 3 was highly predictive for Type 1a endoleak (AUROC=.82; $p=.005$, 95% CI .71-.93) and aneurysm enlargement (AUROC=.71, $p=.003$). AAA tortuosity predicted 30-day reinterventions (AUROC=.84, $p=.02$); Iliac calcification predicted 30-day reinterventions (AUROC=0.84, $p=.021$) and 30-day implant complications (AUROC=0.8, $p=.027$). The AAA and iliac subscores did not correlate with any significant outcomes.

Conclusions: Total ASG score consists of several subscores and attributes, not all of which predict outcomes. The aortic neck subscore was predictive of Type 1a endoleak and sac enlargement; AAA tortuosity and iliac calcification predicted 30-day reinterventions or 30-day implant complications. This study suggests that total ASG score can be simplified to reflect attributes most predictive of EVAR outcomes.

In Situ Tissue Engineering Oriented PLA/PCL Composite Vascular Graft (cVG) – Design and Characterization

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Objective: Vascular grafts used for in situ tissue engineering processes may suffer not only from insufficient mechanical properties, but also from vulnerabilities related to their biocompatibility. Bicomponent composite degradable vascular grafts were developed with superior mechanical properties and long-term anticoagulant activity to meet the requirement of small diameter vascular prostheses with high performance.

Method: Composite vascular graft (cVG) prototypes were created by combining a flexible polylactic acid (PLA) knitted fabric with a soft polycaprolactone (PCL) matrix. Two types of cVG (cVG-H and cVG-L) with different density of PLA fabric were developed using a PCL coating and a freeze-drying fabrication method. The inner surface of a cVG was subjected to a covalent and electrostatic adsorption through a “two-steps” heparinization process (Figure 1). The mechanical properties and anticoagulation features were carried out in vitro to evaluate the characteristics of cVG.

Results: As showed in the Figure 1, the cVG exhibited a uniformly normal structure with a compact interface combination of the PLA multifilament and the PCL matrix, as well as a good deformability of the vascular membrane. CVG had higher strength than commercial expanded polytetrafluoroethylene (ePTFE) samples. The radial strength of cVG-H was twice as high as cVG-L, and cVG-H also features a better compliance. The excellent compression recovery of cVG also demonstrated the advantage of the composite structure. In addition, the “two-steps” modification of cVG (PCL-LBL) had shown a better anticoagulation behaviour compared to the covalent grafting heparin cVG (PCL-HEP), even in the context of this mucopolysaccharide released for a month.

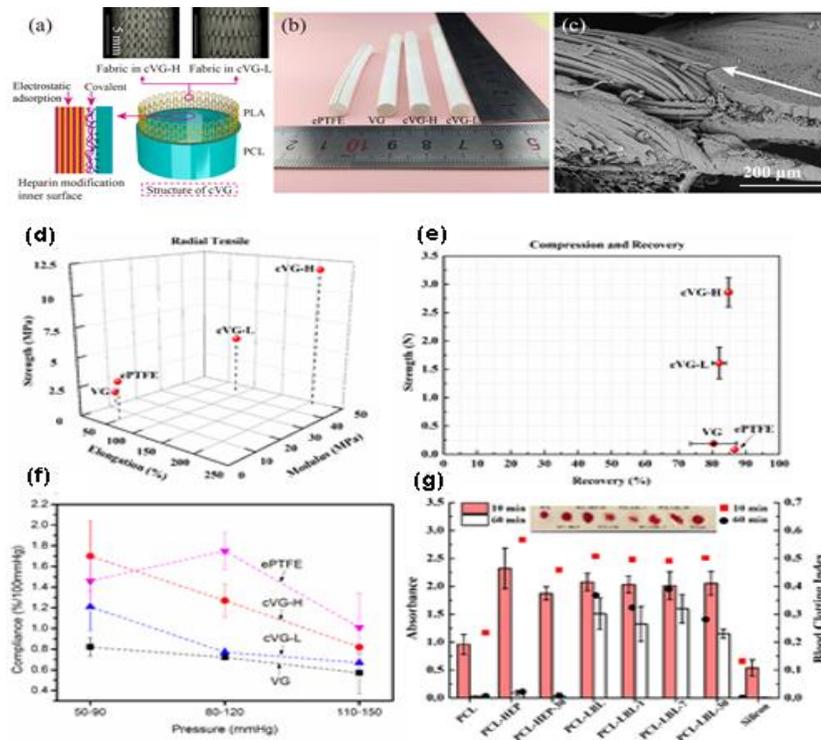


Figure 1. (a) Schematic diagram of the cVG structure; (b) Morphology of the cVG, the VG (without a PLA reinforced fabric) and the commercial ePTFE vascular graft; (c) SEM showing the combination of PLA and PCL in cVG; (d) Radial tensile properties; (e) Compression and recovery properties; (f) Compliance property; (g) Anticoagulant property.

Conclusion: An in situ tissue engineering oriented vascular graft was designed, developed and characterized. These vascular graft prostheses have good mechanical and long-term anticoagulant properties. This work provides data support to the development of in situ tissue engineering vascular grafts, and guides breeding research in the development of small diameter blood conduits.

The Contribution of 30-Day Readmissions to the Soaring Costs of Care for the Diabetic Foot

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Objective: The risk of 30-day unplanned readmission in DFU patients is nearly 20%. Our aim was to quantify the cost of readmissions in patients admitted with DFU.

Methods: All patients presenting to our multidisciplinary diabetic limb preservation service (6/2012-06/2016) were enrolled in a prospective database. Inpatient costs and net

margins (\$USD) were calculated overall and for index admissions *versus* 30-day unplanned readmissions.

Results: A total of 249 admissions in 150 patients were included. Of these, 206 admissions were index admissions and 43 were 30-day readmissions. The most common reason for readmission was the foot wound (49%), followed by bypass wound (14%), renal (9%), and other systemic complications. Surgical interventions during readmission were common (47%), and included both podiatric (37%) and vascular (23%) interventions. The mean hospital cost per admission was \$25,915±1,309, and did not differ between index admissions vs. readmissions (\$25,649±2,384 vs. \$28,792±4,902; P=0.59). However, there was a trend toward lower hospital net margins following readmissions (\$4,978±1,010 vs. \$2,700±1,289; P=0.07). The overall cost of care for patients requiring readmission was significantly higher than for patients who were not readmitted (\$115,288±19,325 vs. \$42,525±3,664; P<0.001). Over the course of the study period, DFU care at our institution cost \$7.9 million, of which \$1.2 million (15%) was attributable to readmission costs. Wound healing outcomes were favorable, with 78% of all wounds achieving healing by one year.

Conclusions: The cost of readmissions for DFU patients is just as high as the cost of the index admissions, but with lower hospital net margins. When extrapolated to national data, the 15% readmission cost burden that we report is equivalent to \$210 million in hospital costs annually. Focused efforts at preventing readmissions in this high-risk patient population are essential to reducing the overall costs of care associated with DFU.

Prospective evaluation of postoperative urinary retention in EVAR patients: an interim analysis of a novel Vascular Quality Initiative project

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Objective: Quality improvement (QI) aimed at reducing length of stay (LOS) of endovascular aneurysm repair (EVAR) patients identify numerous areas for improvement, including optimizing management of Foley catheters. The Vascular Quality Initiative (VQI) program collects standardized quality indicators for EVARs. A novel ‘hashtag’ method have allowed collection of non-standardized variables.¹ We aim to prospectively evaluate EVAR Foley usage and postoperative urinary retention (POUR) rates using the VQI.

Methods: Using hashtags¹, our local VQI registry collected these unique variables starting July 2017: intraoperative Foley usage and removal, alpha-blocker or 5-alpha reductase inhibitor usage, prior benign prostatic hyperplasia (BPH) surgery, and POUR defined as re-insertion of a urethral catheter. Inclusion criteria were males over 18 years presenting for EVAR. Usage and management of Foley catheters were at the surgical teams’ discretion. We present our interim analysis results up to Dec 31, 2017 inclusive. Fischer’s exact test and student’s t-test were used to compared differences between categorical and continuous variables respectively.

Results: 46 patients were included with mean age of 73.1 years. 2 patients (4.3%) developed POUR. Comparing patients with and without POUR, LOS was significantly different (9 vs. 2.1 days, p=0.01), but not intra-operative Foley usage (2 vs. 25, p=0.62), Foley removal POD 0 (0 vs. 9, p=0.32) or POD 1 (2 vs. 14, p =0.27), operative time (142 vs. 146 min, p=0.7), BPH medication usage (0 vs. 11, p=0.62) or surgery (0 vs. 1, p=0.88).

Conclusion: We implemented a novel VQI hashtag method to prospectively collect Foley and POUR outcomes in EVAR patients. Rates of POUR were low and variability in Foley catheter usage and management was observed. Ongoing data collection is required to make formal recommendations about Foley catheter usage in this population.

The use of growth factors for the treatment of chronic venous leg ulcers: a systematic review and meta-analysis

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Objectives: To evaluate the impact of growth factors or treatments high in growth factors on patients with lower limb chronic venous leg ulcers (VLU).

Methods: We conducted a systematic review and meta-analysis of randomized trials (RCTs). MEDLINE and EMBASE up to February 2018 were searched. Studies were eligible for inclusion if they compared a growth factor versus placebo or standard care in patients with VLUs. Two reviewers independently selected RCTs and assessed risk of bias. Primary outcome measure was complete wound healing, and secondary outcomes were percent reduction in wound area and adverse events. Pooled proportion of patients were calculated using a random effects model and heterogeneity among studies was assessed using inconsistency statistic and subgroup analyses.

Results: From 1460 studies, we included 12 RCTs (n=722). RCTs assessed platelets (platelet lysate, platelet gel, platelet rich growth factor, platelet-rich plasma, platelet-rich fibrin), keratinocyte growth factor-2 (KGF-2), endothelial growth factor, transforming growth factor- β 2, and granulocyte macrophage-colony stimulating growth factor (GM-CSF). There was no significant difference between any growth factor versus placebo in complete wound healing (437/722 (59.97%) versus 285/722 (39.47%); RR 1.34, 95% CI 0.94-1.90, P=0.10; I²=71%, 11 trials; *low quality evidence*). Subgroup analysis indicated that GM-CSF held a significant increase in the number of wounds completely healed, while placebo demonstrated significantly more wounds completely healed when compared to KGF-2. When any growth factor was compared to placebo there was a significant increase in percent wound reduction by 48.72% (95% CI 39.14-58.30, P=<0.00001; I²=0%, 4 trials; *low quality evidence*). There was no significant difference in overall adverse event rate.

Conclusion: In patients with chronic VLUs, growth factors have non-significant effect in complete wound healing. However, growth factors may increase percent reduction in wound area. This suggests that additional interventions may be needed to achieve complete wound healing.

Ankle-brachial index measurement with an automated oscillometric blood pressure cuff: Bringing the ABI back to the bedside

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Objectives: The ankle-brachial index (ABI), once considered a simple bedside assessment tool for peripheral artery disease (PAD), is now predominantly deferred to the vascular laboratory setting, possibly due to concerns regarding accuracy, time, and availability of equipment. Automated oscillometric blood pressure devices have improved in technology, are readily available, and may allow a simpler and quicker measurement of ABI. The objective was to determine the accuracy of ABI measurements obtained with an automated oscillometric blood pressure device in diagnosing PAD.

Methods: In this prospective, observer-blinded study, patients underwent ABI measurements in both limbs by gold-standard Doppler method (DOP) versus the automated oscillometric method (OSC), at The Ottawa Hospital Vascular Diagnostic Centre. Primary outcome measure was accuracy in diagnosing PAD using ABI \leq 0.9 as a cutoff.

Results: A total of 100 patients (199 legs) were recruited. The mean age was 67.2 years old, 60% were men and 32% had diabetes. The mean ABI by DOP was 0.92 (range 0.37-1.66),

with 41% having an $ABI \leq 0.9$. 40 legs (20%) were excluded from analysis because of unavailable DOP or OSC. Out of the 13 legs excluded for OSC missing only, 98% corresponded to a $DOP \leq 0.9$. Sensitivity and specificity of OSC were 80% (95% CI 69-90%) and 90% (95% CI 84-96%) respectively. PPV and NPV were 82% (95% CI 73-92%) and 88% (95% CI 82-94%) respectively. Overall accuracy was 86.2% (95% CI 79.8-91.1%). Area under the curve was 0.936 (95% CI 0.889-0.982).

Conclusion: Using an automated oscillometric blood pressure device appears to be a simple and accurate method to estimate the ABI, and can be performed at the bedside with minimal training. As with use of continuous wave Doppler, unobtainable pressures in some patients with compromised blood flow or with calcified arteries remains a limitation for these devices, however this also likely indicates presence of PAD.

Figure 1: Scatter plot of Doppler ABI and oscillometric ABI with linear regression

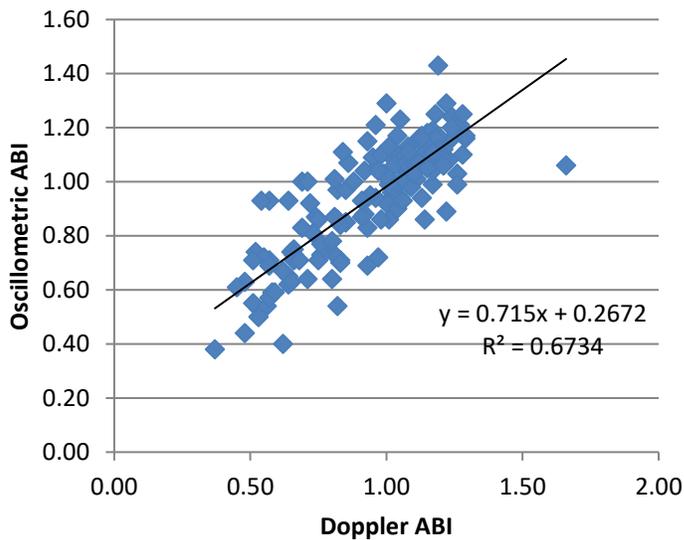
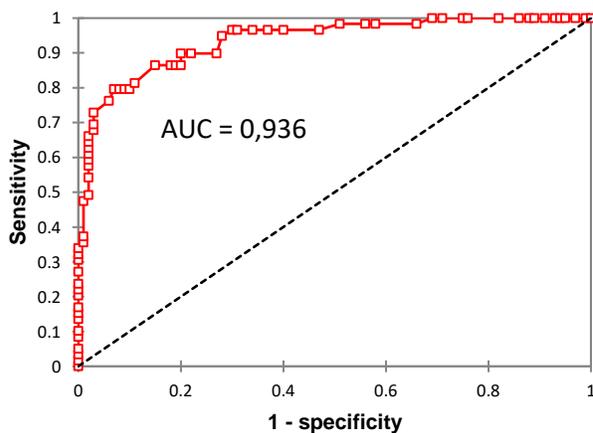


Figure 2: Receiving operator curve of DOP and OSC for the diagnosis of peripheral arterial disease



The Feasibility and Accuracy of Automated Blood Pressure Cuff Ankle-Brachial Indices Measurements in Outpatients' Screening

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Background: Peripheral artery disease (PAD) is a powerful indicator of diffuse atherosclerosis. Ankle-brachial index (ABI) measurement is recommended to screen for PAD among high risk patients, but it is underutilized in family practice settings. A major perceived barrier to PAD screening in family medicine practices is the duration of accurate ABI measurement using Doppler compared to readily available oscillometric methods, e.g. automated blood pressure cuff. Our purposes were to A) assess ABI Doppler (manual) vs oscillometric (automated) readings; and to B) determine the difference in the duration of these two measurement modalities.

Methods: Eligible patients attending family medicine clinics at St. Michael's Hospital were invited to participate in the study. Doppler followed by automated cuff measurements of both limbs were taken and timed. Paired t-test was used to compare ABI measurements of the two modalities, and Wilcoxon Ranked test was utilized to compare the mean duration of Doppler to automated cuff modalities.

Results: 104 consecutive patients were tested; 49% were women, and the mean age was 74 years. 73% of patients were diagnosed with Hypertension, 42% were diabetics, 60% had Dyslipidemia, and 41% were smokers. Average ABI measured with automated cuff differed significantly from average Doppler readings of respected limbs; mean difference (95% confidence interval) was 0.076 (-0.11 to -0.04) for right side, and 0.078 (-0.11 to -0.04) for left limbs. However, this difference was not of clinical significance. The time taken to measure ABI was similar; 9.6 +/- 2.1 minutes for automated cuff vs 10.9 +/- 6.4 minutes for Doppler, p-value = 0.065.

Conclusion: Oscillometric ABI measurements can be performed in a similar time frame as Doppler measurements. Despite statistical difference in measurements obtained by the two modalities, these differences are unlikely to be clinically significant. Therefore, oscillometric ABI measurements could be considered as an alternative to standard manual measurement techniques in family practice settings to screen for PAD.

Age and Sex Stratified Trends in Elective and Ruptured Abdominal Aortic Aneurysm Repair from 2003 to 2016

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ON, Canadaⁱ; Division of Vascular Surgery, Peter Munk Cardiac Centre, University Health Network, Toronto, ON, Canada^j; Brigham and Women's Hospital Heart and Vascular Center, Boston, MA, USA^k; Harvard Medical School, Boston, MA, USA^l; Division of Cardiac Surgery, Department of Surgery, University of Toronto, Toronto, ON, Canada^m; Division of Cardiac Surgery, Li Ka Shing Knowledge Institute of St. Michael's Hospital, Toronto, ON, Canadaⁿ; Department of Surgery, King Saud University, Riyadh, Kingdom of Saudi Arabia^o.

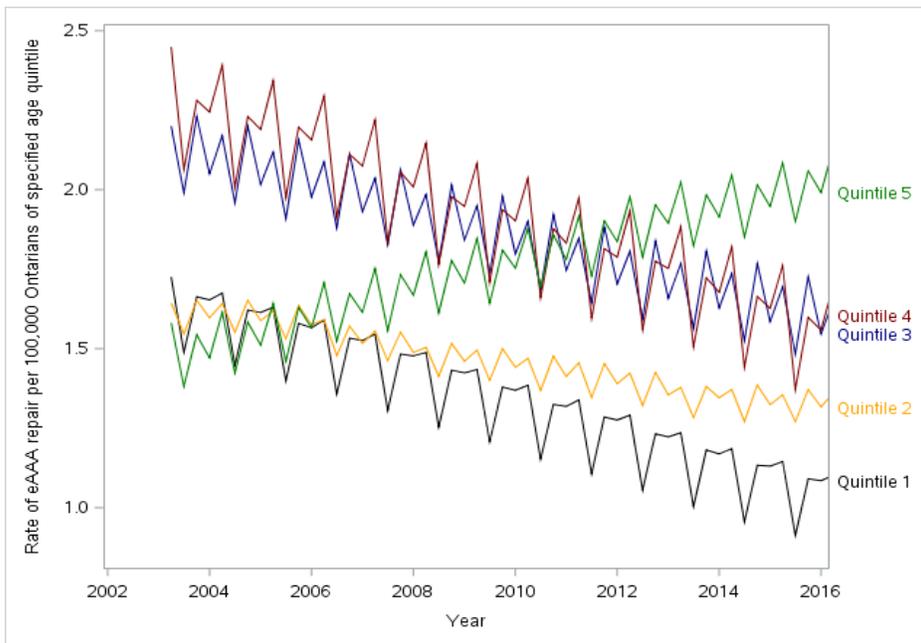
Objective: To determine the trends in open (OSR) and endovascular (EVAR) repair of elective (eAAA) and ruptured abdominal aortic aneurysm (rAAA) stratified by age and sex from 2003 to 2016.

Methods: We conducted a population-based time-series analysis of eAAA and rAAA repairs in Ontario, Canada from 2003 to 2016. Quarterly rates of age and sex stratified OSR and EVAR were calculated. We fit exponential smoothing models to examine the age and sex stratified changes in overall and approach specific rates of eAAA and rAAA repair.

Results: We identified 19,489 eAAA [12,232 OSR (63%) and 7,257 EVAR (37%)] and 2,732 rAAA [2,466 OSR (90%) and 266 EVAR (10%)] repairs from 2003 to 2016. The overall rates of eAAA and rAAA repair did not change significantly over the study period (6.39 to 5.59/100,000 and 1.62 to 0.50/100,000, respectively). Similarly, the age and sex stratified rates of eAAA and rAAA repair did not demonstrate any significant change. However, the rate of eAAA repair increased in patients >79 years old (1.3/100,000 to 2.2/100,000, 70% increase, $p=0.33$), while eAAA repair decreased in all remaining strata (Figure 1). The rates of eOSR decreased significantly across all age and sex strata ($p<0.005$ for all strata), except in females ($p=0.23$) (Figure 2). The rates of eEVAR significantly increased across all age and sex strata ($p<0.007$ for all strata), especially in patients >79 (1545% increase, $p=0.007$). The approach specific rates of rAAA repair remained stable ($p>0.25$ for all strata).

Conclusion: EVAR demonstrated significantly increased uptake in all strata, particularly in older patients, while eOSR decreased significantly in all but the female stratum. The increased eAAA repair rate among older patients reflects the availability of a lower risk repair option for comorbid patients, while stable use of eOSR in females may reflect continued graft-related limitations for female AAA repair.

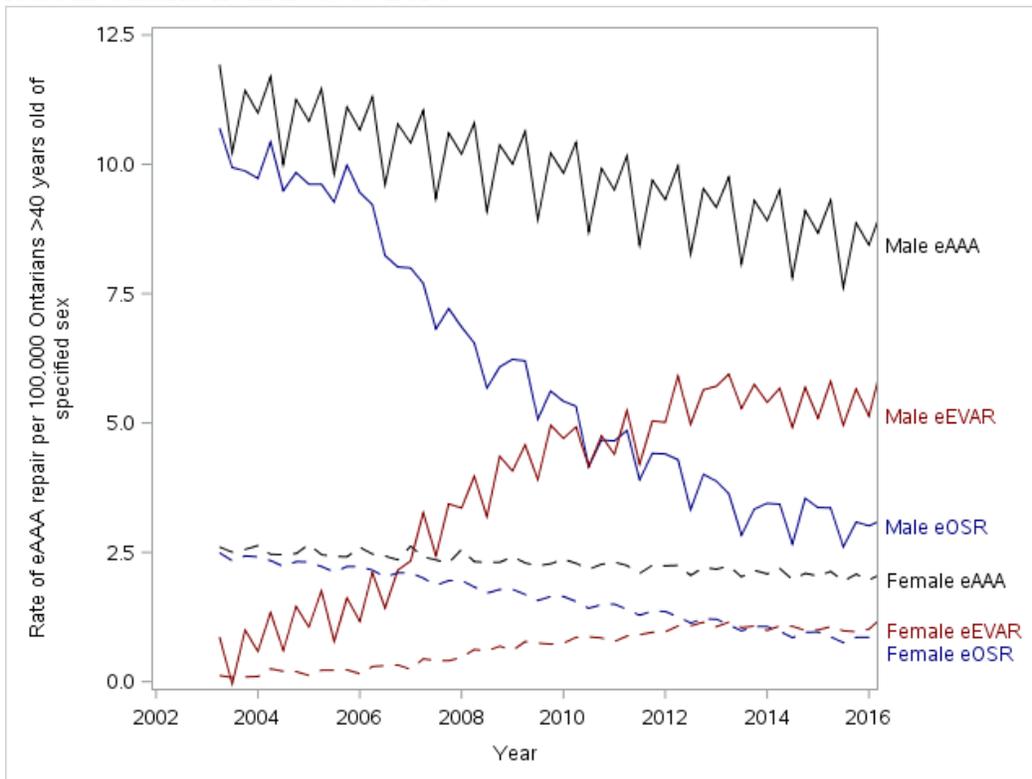
Figure 1: Winter's additive models of age quintile stratified eAAA repair rates in Ontario from 2003 to 2016



Age quintiles defined as 40-64 (quintile 1), 65-69 (quintile 2), 70-74 (quintile 3), 75-79 (quintile 4), and >79 years old (quintile 5).

eAAA=elective abdominal aortic aneurysm

Figure 2: Winter's additive models of overall and approach specific sex stratified eAAA repair rates in Ontario from 2003 to 2016



eAAA=elective abdominal aortic aneurysm; eEVAR=elective endovascular aortic repair; eOSR=elective open surgical repair

Carotid Endarterectomy in the Elderly: The McGill Experience

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Objectives: Carotid endarterectomy (CEA) is a well-established surgical intervention for stroke prevention in patients with carotid stenosis of all ages. Some studies suggest that CEA is more risky in the elderly with worse outcomes, while others have found no difference. Our objective was to evaluate and compare outcomes of CEA between elderly and younger patients at our institution.

Methods: All hospital charts were reviewed for consecutive patients undergoing CEA from the Jewish General Hospital and the Royal Victoria Hospital from October 2009-December 2015. Primary outcomes were ipsilateral stroke, death, and restenosis at 30-days and 1-year. Secondary outcomes were cranial nerve injury, myocardial infarction (MI), hematoma, wound infection, cerebral hyperperfusion, and transient ischemic attacks within 30 days. Primary and secondary outcomes were compared between patients age ≥ 80 years and < 80 years old.

Results: 359 patients were included in this study with a mean age 70.1 ± 9.5 , $n=246$ (68.5%) male, and $n=272$ (75.8%) symptomatic. Elderly patients were more often symptomatic (93.8% vs. 71.8%, $P < 0.0001$) and had an increased length of stay (2.89 ± 5.3 vs. 1.59 ± 1.76 , $P = 0.006$). There was no statistically significant difference in primary outcomes between patients < 80 years and ≥ 80 years including 30-day stroke (2% vs. 0%), death (no deaths in either group), restenosis (9.2% vs. 12.3%), 1-year stroke (2% vs. 0%), death (0.3% vs. 0%), or restenosis (16.7% vs. 13.8%). However, elderly patients had significantly increased MI risk post-operatively (4.6% vs. 0.7%, $P = 0.01$). Other complications, including cranial nerve injury (6.1% vs. 6.2%) was similar between groups.

Conclusions: We found that CEA in the elderly does not have an increased risk of stroke or death up to one year post-operatively. However, the post-operative length of stay is increased and complicated by significantly more MIs, which should weigh into the decision of whether to operate on an elderly patient.

Optimization of the in situ laser fenestration of stent-graft: in vitro studies

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Introduction: The in situ fenestration of stent grafts is a bailout technique for patients presenting an emergent life-threatening complex aortic pathology to be amenable to Endovascular Aneurysm Repair (EVAR). However, questions still remain unanswered regarding the suitability between the stent grafts and the utilization of instruments for the fenestrations. We hereby performed a series of in vitro studies regarding the influence of common commercially stent grafts made of polyester fabrics in response to instruments as laser probes used for in situ fenestration, the non-compliant as well as the cutting balloons.

Method: Cook, Medtronic, Vascutek, Bolton and Jotec devices were used to perform in vitro fenestration. The puncture was initially performed using an Excimer Laser fitted with probes of 2.3 mm and 3.2 mm diameter. The orifices were then dilated by non-compliant or cutting

balloons whose diameters ranged from 6 mm to 12 mm. The fenestrations were documented by gross observations, light microscopy and SEM.

Results: The in situ fenestration procedure is feasible in all stent grafts with adequate ancillary instruments. No obvious difference was observed when using different diameters of laser probes and different levels of energy. With the increased diameter of the balloons, the area and the tearing of fenestrations expanded among all devices. The cutting balloons caused a longer tearing compared to the non-compliant one featuring 6 mm in diameter. The selection of the stent graft (based upon its structure) and the types of balloons contributed to the tear directions in the different fabrics.

Conclusion: The Anaconda stent grafts fenestrated by a non-compliant balloon of 6 mm or 8 mm diameter were considered as the most acceptable procedures. Only the Zenith TX2 was appropriate for the cutting balloon of 6 mm in diameter. A prudent selection of both the stent grafts and the ancillary instruments used for the fenestrations could be recommended.

A Comparison of Duplex Findings Two Years Following Cyanoacrylate Embolization versus Endovenous Laser Ablation of the Greater Saphenous Vein

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Objectives: To describe and compare duplex imaging findings, of the greater saphenous vein (GSV) following cyanoacrylate embolization (CE) relative to endovenous laser ablation (EVLA).

Methods: Patients treated with CE and EVLA at our institution were matched by time of procedure and vein size. GSV diameter was measured at the saphenofemoral junction (SFJ), mid-thigh (MT) and knee. Duplex ultrasound was repeated post-treatment in the same non-invasive laboratory with an identical protocol. Clinical data was collected by retrospective chart review.

Results: Forty two patients (21 EVLA, 21 CE), underwent post-procedure US at a median of 12 months (Q1:7 Q3:23)(CE) and 14 months (Q1:7 Q3:19)(EVLA). MT measurements, following CE, demonstrated a mean reduction in vein diameter of 59% (SD 5%), 35% (SD 18%), 48% (SD 13%), 59% (SD17%) at immediate post-op, 0-11, 12-23, >24 months respectively. Absolute MT vein diameter, following CE, (Figure 1.) demonstrated a reduction over time. Following EVLA, the MT vein segment was no longer visualized in 59% of successful cases. Average reduction in MT diameter was of 52% (SD 6.5%) immediately post EVLA and 63% (SD 12%) in successful patients after > 1 month. There was no statistically significant difference in anatomic success rates (Table 1.) following CE (95%) and EVLA (90%) (p=1.0).

Conclusions: Overall, anatomic success was similar between the two procedures. However, we observed notable differences in duplex findings postoperatively. Following EVLA, the vein is smaller and often undetectable months following closure. In the CE group, our initial results suggest an immediate reduction in vein diameter. It then dilates, likely as vasospasm resolves, followed by a decline in vein diameter over the following months. This correlates to observations in animal models and other clinical settings. However, this decline is mild and slower than anticipated. Longer term follow-up will be required to determine late findings on duplex imaging years after CE of the GSV.

	EVLA (Q1:Q3)	Cyanoacrylate (Q1:Q3)
Male : Female	9:12	5:16
Age	50 (42:57)	49 (45:59)
Median time of follow-up (months)	14 (7:19)	12 (7:23)
Co-treatment of anterior thigh tributary branch (%)	4.7%	14.3%
Access at or below knee (%)	90%	90%
Anatomic success rate (%)	95%	90%
Segment Involved in Failure		
# Total recanalization	0	1
# SFJ and MT	2	0
Re-interventions	1	1
Median # sclerotherapy sessions	2 (0:3)	1 (0:4)

Table 1. Comparison of clinical and anatomic variables following endovenous laser therapy (EVLA) and cyanoacrylate embolization (CE).

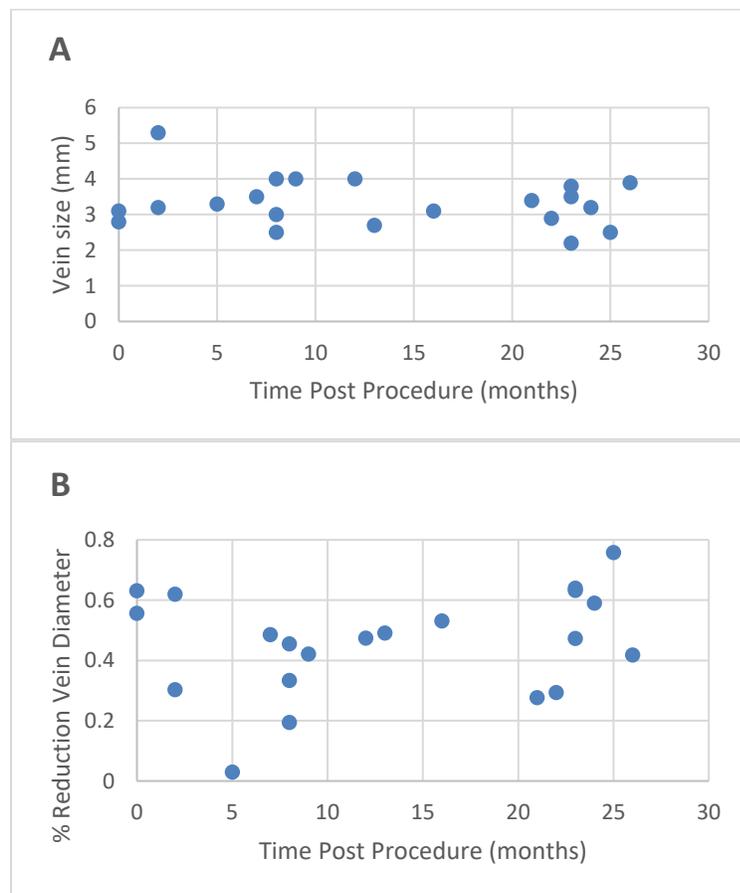


Figure 1. Mid-thigh venous diameter following cyanoacrylate embolization (CE). A – Absolute vein diameter in the mid-thigh following CE. B – Percent reduction in vein diameter following CE.

In Vitro Fatigue Evaluation of Chimney EVAR – A Case Study

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Objective: The objective was to evaluate the positional stability and physical properties of stent-grafts and covered stents that have been used in an aortic arch chimney EVAR for a specific patient who had a thoracoabdominal aneurysm.

Methods: An accelerated mechanical fatigue test of 120 million cycles (3 life-years) was applied to a Cook® stent-graft and an Atrium® covered stent that were deployed inside a customized polyurethane phantom using a chimney EVAR approach. They were then mounted on an Electroforce® accelerated fatigue tester. Fabrication of the polyurethane phantoms was based on the DICOM® images of the patient. The fatigued phantom with the endovascular devices inside was monitored by CT scans and endoscopy views to determine changes in the size and position of the devices. Post-fatigue tests including scanning electron microscopy (SEM), bursting strength and fabric count were performed to identify any changes in the physical properties of the stent-graft fabric.

Results: The distal angle between the chimney covered stent and the thoracic stent graft experienced significant changes during 10 to 20 million cycles ($129.53^\circ \pm 2.56^\circ$ and $127.13^\circ \pm 1.54^\circ$, respectively) compared to the control group at zero cycles ($134.97^\circ \pm 2.99^\circ$) ($p < 0.05$). The total length of the chimney covered stent changed significantly during the first 1 million cycles from (39.33 ± 0.05) mm to (38.03 ± 0.45) mm ($p < 0.05$). The proximal angle and area, bursting strength and graft fabric count remained stable during fatiguing. No apparent surface abrasion was observed by SEM.

Conclusions: This chimney EVAR approach for this particular patient maintained acceptable positional and dimensional stability based on this in vitro mechanical fatigue study that mimicked a three-year life period. These conclusions are helpful in providing clinically relevant follow-up information for this particularly challenging patient who required the off-label use of two EVAR devices.

Acute and Chronic Renal Dysfunction Post Open and Endovascular Abdominal Aortic Aneurysm Repair

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Objectives: Abdominal aortic aneurysms (AAA) remain an important health problem. Aspects of both endovascular (EVAR) and open repair place patients at risk for renal dysfunction in the short and long term, which increases the risk of postoperative morbidity and mortality. The current study analyzed the incidence of acute and chronic renal dysfunction as well as contributing factors in patients post AAA repair.

Methods: Retrospective chart review of patients who underwent open or endovascular repair of AAA at Toronto General Hospital from Aug 1st 2010 to June 30th 2016 yielded 587 patients from the Vascular Quality Initiative database. Follow up creatinine values were obtained via medical records.

Results: Following application of exclusion criteria which included preoperative dialysis or kidney transplant, any absent primary outcome, a total of 521 patients remained. Repair urgency included elective, symptomatic and rupture. Group comparison is included in table 1.

Preoperative creatinine values were not significantly different between the groups ($p=0.11$). There was a significantly higher than expected number of patients in the open group ($n=30, 20.1\%$) compared to the EVAR group ($n=21, 5.6\%$) who experienced acute renal dysfunction ($p < 0.0002, \chi^2 = 25.3$) which was defined as a creatinine increase of $>44.2 \mu\text{mol/L}$ or dialysis. In this group, new permanent dialysis was required in 2 (0.5%) EVAR repair patients, 2 (1.3%) open repair patients and temporary dialysis in 1 (0.7%) open patient. Follow up creatinine was obtained at a mean 1283 days postoperatively. Change in creatinine (preoperative to follow up) was significantly greater at $31.8 \mu\text{mol/L}$ in the EVAR group vs $16.7 \mu\text{mol/L}$ in the open group ($p = .0006, \text{MWU}=23430$).

Conclusions: Open repair was associated with increased incidence of acute renal dysfunction post operatively. At long term follow-up, the EVAR group had a significantly increased change in creatinine over the open group.

Table 1: EVAR and Open Group Comparison

	Method of Repair (sd)		Statistical test (if appropriate)	P value
	Open	EVAR		
N	149	372		
Average Age at Repair yrs	68.3 (8.0)	76.0 (7.4)	t-test equal variances assumed	$p < 0.0002$
Percent Male (%)	119 (79.9)	312 (83.9%)	Chi square test	$p = 0.27$
Average Preoperative Creatinine ($\mu\text{mol/L}$)	89.0 (31.8)	94.9 (38.0)	MWU	$p = 0.11$
Urgency			Chi square test	$p(\chi^2=8.0, = .018)$
Elective	117 (78.5)	327 (87.9)		• A higher than expected number of elective surgeries in the EVAR group
Symptomatic	13 (8.7)	22 (5.9)		• A higher than expected number of ruptured surgeries in the open group.
Rupture	19 (12.8)	23 (6.2)		