



# BOOK OF ABSTRACT

**CSVS 42<sup>nd</sup> ANNUAL MEETING ON VASCULAR SURGERY**  
**VIRTUAL EDITION**

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**Program Chair: Dr. Theodore Rapanos**  
**Assistant Program Chair: Dr. Fadi Elias**

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## PAPER SESSION 1: AORTIC

### Reassessing the operative threshold for abdominal aortic aneurysm repair in the context of COVID-19

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#### Objective

The novel respiratory syndrome COVID-19 has forced healthcare systems to delay elective abdominal aortic aneurysm (AAA) repair. This study provides a structured analysis of the decision to delay AAA repair and quantify the potential for harm.

#### Methods

A decision tree was constructed modeling immediate AAA repair relative to an initial non-operative (delayed repair) approach. Risk of COVID-19 contraction and mortality, aneurysm rupture, and operative mortality were considered. We performed a deterministic sensitivity analysis for a range of patient ages (50->80), probability of COVID-19 infection (0.01%-30%), aneurysm size (5.5->7cm), and time horizons (3-9 months). We then performed a probabilistic sensitivity analysis (PSA) for three representative ages (60, 70, 80). Analyses were conducted for endovascular aortic aneurysm repair (EVAR) and open surgical repair (OSR).

#### Results

Patients with aneurysms >7cm demonstrated a higher probability of survival with immediate EVAR or OSR, compared to delayed repair, for patients under 80 years old (Figure 1). When considering EVAR for aneurysms 5.5-6.9cm, immediate repair had a higher probability of survival, except in settings with high probability of COVID-19 (10-30%) infection and advanced age (70-85+ years). PSA demonstrated that patients with large aneurysms (>7cm) faced a 5.4-7.7% absolute increase in the probability of mortality with a 3-month delay of repair (Figure 2). Young patients (60-70 years) with 6-6.9cm aneurysms demonstrated an elevated risk of mortality (1.5-1.9%) with a 3-month delay. For 60-year-old patients with 5-5.9cm aneurysms, immediate repair improved survival but this was small in magnitude (0.2-0.8%). For OSR, in the context of endemic COVID-19, delay of repair improves probability of survival when patients are old and COVID-19 prevalence is high.

#### Conclusion

The decision to delay repair of AAA should consider patient age, local COVID-19 prevalence and aneurysm size. EVAR should be considered when possible due to a reduced risk of harm and lower resource utilization.

EVAR								OSR							
Community Prevalence 0.01%				Community Prevalence 1%				Community Prevalence 0.01%				Community Prevalence 1%			
Age	Aneurysm Size (cm)			Age	Aneurysm Size (cm)			Age	Aneurysm Size (cm)			Age	Aneurysm Size (cm)		
	5.5-5.9	6-6.9	7		5.5-5.9	6-6.9	7		5.5-5.9	6-6.9	7		5.5-5.9	6-6.9	7
50-59				50-59				50-59				50-59			
60-64				60-64				60-64				60-64			
65-69				65-69				65-69	X	X		65-69	X	X	
70-74				70-74				70-74	X	X		70-74	X	X	
75-79				75-79				75-79		O		75-79			
80-84				80-84				80-84				80-84			
85+				85+				85+			X	85+			X
Community Prevalence 10%				Community Prevalence 30%				Community Prevalence 10%				Community Prevalence 30%			
Age	Aneurysm Size (cm)			Age	Aneurysm Size (cm)			Age	Aneurysm Size (cm)			Age	Aneurysm Size (cm)		
	5.5-5.9	6-6.9	7		5.5-5.9	6-6.9	7		5.5-5.9	6-6.9	7		5.5-5.9	6-6.9	7
50-59				50-59				50-59				50-59			
60-64				60-64				60-64				60-64	X	X	
65-69				65-69				65-69	X	X		65-69	X	X	
70-74				70-74	X	X		70-74	X	X		70-74	O	O	
75-79				75-79	X	X		75-79				75-79			
80-84	X			80-84	X	X		80-84			X	80-84			X
85+	X	X		85+	O	X		85+			X	85+			X

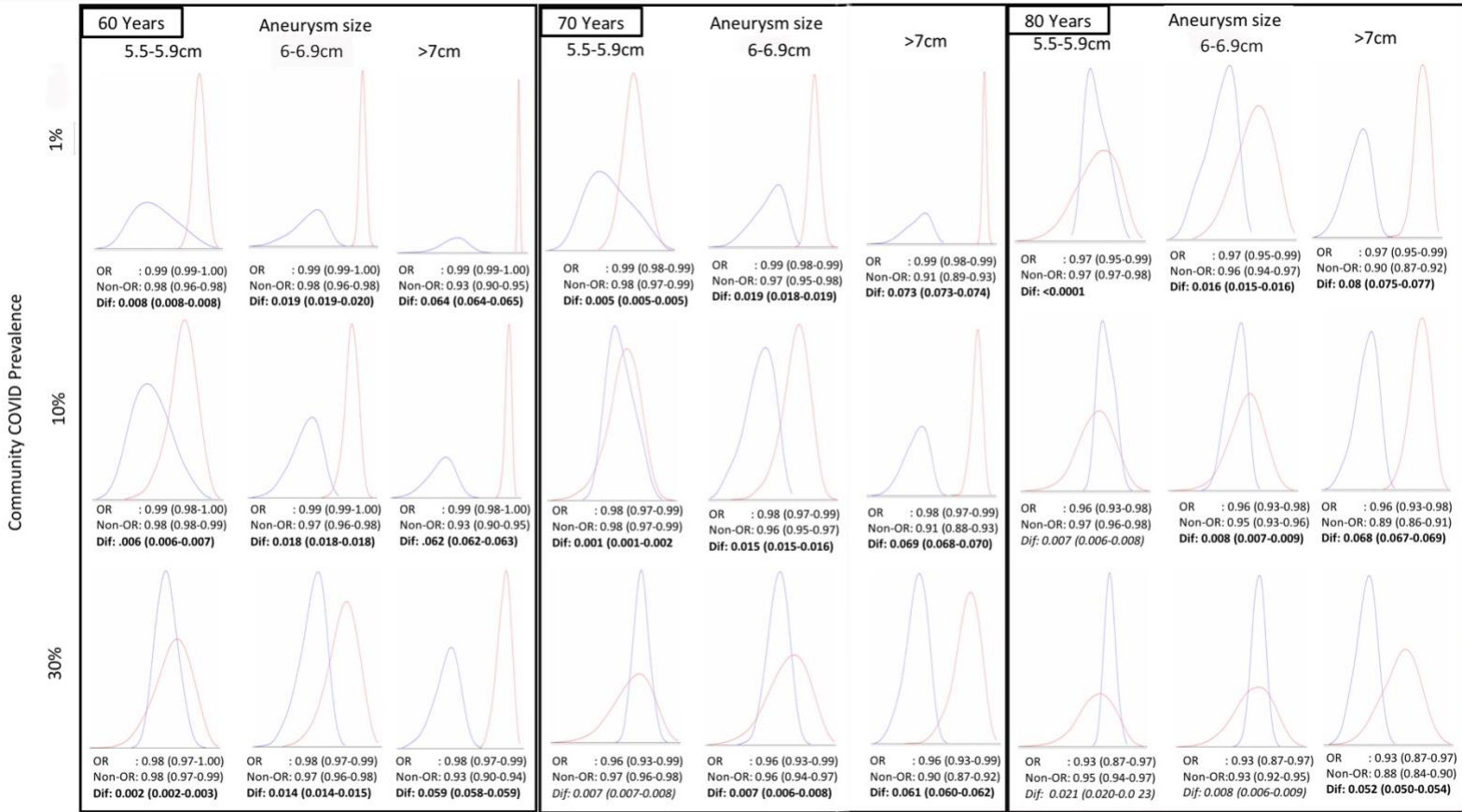
**Figure 1.** Comparison between an immediate and initial non-operative (delayed) strategy involving endovascular abdominal aortic aneurysm repair (EVAR) and open abdominal aortic aneurysm repair (OSR). The colour gives the dominant strategy considering a delay of repair of 3 months. Dominant strategy is additionally shown for alternate time horizons (time of delay) of 6 and 9 months.

Red: Operative strategy dominant

Blue: Non-operative strategy dominant

X- Changes to operative strategy at 6 months of deferral

O- Changes to operative strategy at 9 months of deferral



**Figure 2.** Probabilistic sensitivity analysis for endovascular aortic aneurysm repair assuming different community COVID prevalence, patient age and aneurysm size. The density distribution for probability of survival demonstrates the uncertainty around this outcome, and is shown in each case for the operative (OR - red) and non-operative (delayed repair) strategy (Non-OR- blue). The far-right of the x axis is 100% survival probability. The mean of each distribution is given below each plot, with 95% credibility interval in parentheses. The mean absolute differences in probability of survival for the two strategies (Dif) are given, with 95% credibility intervals in parentheses. This difference is bolded when the operative strategy is dominant, and italicized when the non-operative approach is dominant.

## The Effect of Socioeconomic Status on Patients Undergoing Elective AAA Repair in a Publicly Funded Healthcare System

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### Objective

The association between socioeconomic status (SES) and outcomes after abdominal aortic aneurysm (AAA) repair is poorly described in the context of a publicly funded health system. The purpose of this study was to determine the effect of SES on short and long term mortality and morbidity in AAA repair patients in the province of Nova Scotia, Canada.

### Methods

A retrospective analysis of all elective AAA repairs in Nova Scotia between 2005 and 2015 was performed using the Discharge Abstract Database and provincial physician billing codes. Postoperative 30-day outcomes as well as long term survival were compared across socioeconomic quintiles, defined by the Material Deprivation Index (MDI). Postoperative outcomes included including mortality, stroke, myocardial infarct, length of stay and discharge to home. The relationship between baseline characteristics, MDI, and 30-day mortality were analyzed by univariable logistic regression. Multivariable logistic regression and survival analysis were used to calculate adjusted 30-day mortality and long-term survival, respectively.

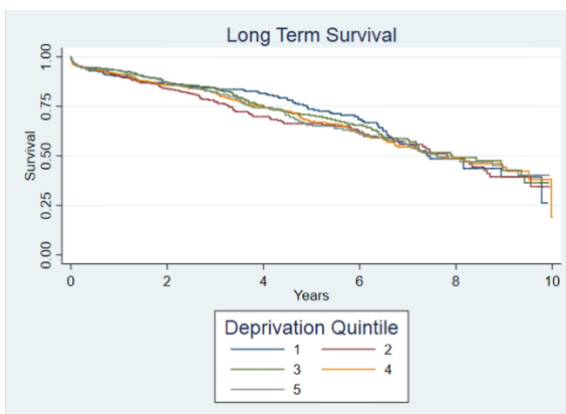
### Results

A total of 1829 patients underwent AAA repair from 2005-2015. 30-day outcomes including death ( $p=0.910$ ), stroke ( $p=0.749$ ), myocardial infarct ( $p=0.061$ ), length of stay ( $p=0.3488$ ), and discharge to home ( $p=0.847$ ) were similar across MDI quintiles. After adjusting for variables that were significant on univariable analysis (age, sex, history of stroke, and open vs endovascular approach) multivariable analysis revealed age  $>70$  (OR 2.41, CI 1.51-3.84;  $p<0.001$ ), history of stroke (OR 2.21, CI 1.27-3.94;  $p=0.006$ ), and endovascular approach (OR 0.18, CI 0.09-0.38;  $p<0.001$ ), but not MDI ( $p=NS$ ) to be associated with increased 30-day mortality. There was no effect of MDI quintile on long-term survival on univariable or multivariable analysis (Figure 1).

### Conclusions

SES does not appear to affect short nor long-term mortality after AAA repair in a publicly funded healthcare system.

Figure 1: Long Term Survival after Elective AAA repair by Income Quintile



## **Era of infrarenal endovascular aortic aneurysm repair predicts preoperative anatomic severity and short-term patient outcomes**

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### **Objective**

The release of draft NICE (National Institutes for Health and Care Excellence, UK) guidelines which proposed that infrarenal aortic aneurysm disease be treated with open surgical repair (OSR) in those fit, medical management in those unfit, with endovascular aneurysm repair (irEVAR) confined to ruptures lead to a reexamination of the evidence for EVAR. The rationale for this approach relied on data from the early era of EVAR; we hypothesize that significant differences in patient selection, management, and postoperative outcome might depend on irEVAR treatment era.

### **Methods**

A retrospective cohort of irEVAR patients from “early” (2008-2010) and “late” (2015-2017) periods at a single treating institution, was assembled. Preoperative demographics and intraoperative events were abstracted from chart review, and preoperative anatomy assessed using the SVS Anatomic Severity Grading system. Comparisons between early and late era preoperative anatomy were assessed in the context of early postoperative outcomes and device implantation characteristics.

### **Results**

Choice of surgical strategy differed between the early and late cohort, with a more balanced usage of irEVAR, OSR, and complex EVAR in the late cohort, despite no significant differences in preoperative comorbidities. Preoperative anatomic severity was significantly worse in the early cohort ( $p < 0.001$ ), with adverse features contributed from proximal and distal seal zones ( $p < 0.001$ ). Device manufacturer, configuration, stent number/sizes, and oversizing differed between cohorts ( $p < 0.05$ ). Technical success was 16.2% higher in the late cohort, with significantly fewer type 1A/B endoleaks ( $p < 0.001$ ). In-hospital complications, driven by higher acute kidney injury and surgical site complications in the early cohort, resulted in a 16.5% difference between cohorts ( $p < 0.05$ ), however there were no differences in in-hospital mortality.

### **Conclusions**

We found an impact of irEVAR repair era on clinical outcome; late cohort irAAA patients are more likely to be considered for a variety of surgical management strategies, and those who underwent irEVAR had less severe preoperative anatomy, and improved early outcomes.



## **Implementation of 'CODE AAA' expedites management of patients with ruptured abdominal aortic aneurysm**

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### **Objective**

To determine the impact of a hospital-wide code protocol on processing times for patients with ruptured abdominal aortic aneurysm (RAAA).

### **Methods**

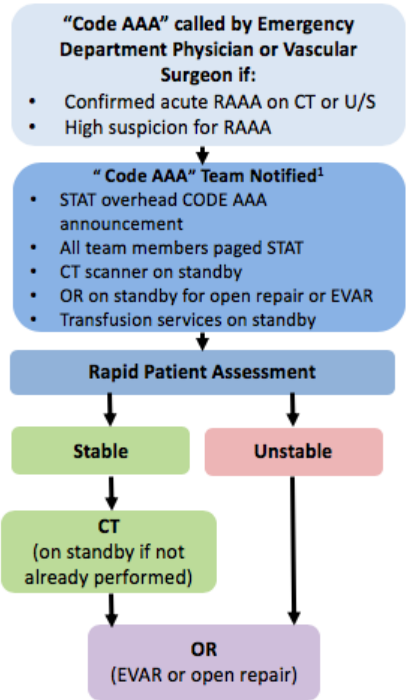
This cohort study included patients presenting with suspected or confirmed RAAA, before and after the implementation of a hospital-wide code protocol (CODE AAA, figure 1). Demographic, clinical, and time variable data (medians [IQRs]) were collected, including times to physician assessment, imaging and transfer to OR.

### **Results**

A total of 51 patients with RAAA were identified in 2 separate time periods before and after implementation of CODE AAA (2013-2015 (n=35), 2019-2020 (n=16)). Patients in both groups were similar with respect to age, gender, proportion of inter-hospital transfers (74% vs. 75%), and hemodynamic stability (minimum MAP 83 vs. 69 mmHg). A significant reduction in all median time intervals was observed after (vs. before) implementation of CODE AAA, including time to initial physician assessment (1.5 [4.75] vs. 10.5 [52.8] mins), time to vascular assessment (1.5 [6.25] vs. 21 [158] mins), time to imaging (13 [27] vs. 35 [97] mins) and time to OR (27 [50] vs. 56 [146.3] mins). The protocol was especially effective in expediting care for the subset of patients presenting to our ER without a previously known diagnosis of RAAA (table 1). Thirty-day mortality was paradoxically higher for patients presenting after implementation of CODE AAA (18% vs. 36%).

### **Conclusion**

The implementation of a hospital-wide RAAA code protocol expedited the time to physician assessment, imaging and intervention, but was not associated with improved mortality. This likely reflects an improved ability to provide expedited care to the most vulnerable population of RAAA patients that would most benefit from this protocol. Given the importance of rapid diagnosis and prompt mobilization of a multidisciplinary team for definitive management, a code protocol should be considered for centers providing care for RAAA patients.



**Figure 1. Code AAA activation and procedure at the Ottawa Hospital Civic Campus.**

<sup>1</sup> Vascular resident/staff, Anesthesia resident/staff, OR care facilitator, Radiology resident, Interventional Radiology staff, Vascular X-ray technician

Abbreviations: AAA, abdominal aortic aneurysm; RAAA, ruptured abdominal aortic aneurysm; CT, computed tomography; U/S, ultrasound; OR, operating room; EVAR, endovascular aneurysm repair

**Table 1: Median times to initial physician assessment, vascular assessment, imaging, and OR for patients with RAAA prior to and following the implementation of 'CODE AAA'.**

	All patients		Initial patient presentation to ED		Inter-hospital transfer	
	Before code implementation (n=35)	After code implementation (n=16)	Before code implementation (n=9)	After code implementation (n=4)	Before code implementation (n=26)	After code implementation (n=12)
Median time to initial physician assessment from patient arrival [IQR]	10.5 min [52.8]	1.5 min [4.75]	116 min [90.5]	14.5 min [14]	7 min [10.5]	0 min [2.25]
Median time to vascular assessment from patient arrival [IQR]	21 min [158]	1.5 min [6.25]	336 min [233.3]	40 min [25]	11 min [31.5]	0.5 min [2.25]
Median time to imaging from initial physician assessment [IQR]	35 min [97]	13 min [27]	145 min [117]	30.5 min [11]	26 min [24]	3 min [11]
Median time to OR from initial physician assessment [IQR]	51 min [90.5]	27 min [38.5]	208 min [193.3]	73 min [23]	38 min [49.8]	21.5 min [12.25]
Median time to OR from patient arrival [IQR]	56 min [146.3]	27 min [50]	301 min [275]	93 min [25.5]	48.5 min [53.8]	21.5 min [11.5]

Abbreviations: OR, operating room; RAAA, ruptured abdominal aortic aneurysm; AAA, abdominal aortic aneurysm; ED, Emergency Department; IQR, interquartile range

## **In situ reconstruction with custom-made bovine pericardial grafts for aortic graft infections and infected aortic aneurysms**

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### **Objective**

Graft infections are a rare but serious complications of vascular surgeries and the most appropriate material for reconstruction remains a matter for debate. The aim of this study was to evaluate the results of in situ aortic reconstruction with custom-made bovine pericardial graft.

### **Methods**

A retrospective analysis was carried out for all patients who underwent in situ aortic reconstruction with custom-made bovine pericardial tube grafts between January 2009 and February 2020 at our academic tertiary centre. Complete excision of the infected graft or aortic segment, extensive debridement and in situ reconstruction with bovine pericardial grafts were applied in all patients. Peri-operative and mid-term outcomes including mortality and freedom of re-infection were analysed.

### **Results**

Bovine pericardial graft was used in 31 patients (71% male) with a median age of 69 years (range, 46-88 years) to reconstruct the descending thoracic aorta (3), thoraco-abdominal aorta (1), abdominal aorta (27). Sixteen patients (51%) were treated for infection of the native aorta and fifteen (49%) for prosthetic graft infection. The 30-day mortality was 9.7%, there were three reinfection after bovine reconstruction observed in our cohort and they were because of recurrent aorto-duodenal fistulae. Limb graft occlusions were detected in two cases during follow-up.

### **Conclusions**

Outcomes associated with custom-made bovine pericardial grafts compare favourably with those of more traditional treatment modalities. It can be used as an alternative technique when replacing aorto-iliac segment in patients with aortic graft infections and infected aortic aneurysms, if other options are not recommended or are not possible. It is associated with good patency, low reinfection rate, and acceptably low early mortality rate. Its ease of use and the rapidity of prosthesis construction make it the material of choice in our institution.

## PAPER SESSION 2: PERIPHERAL VASCULAR DISEASE

### **A single center study on paclitaxel-coated balloons in the treatment of femoropopliteal disease – Efficacy and Mortality**

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#### **Objective**

Randomized controlled trials have shown that both paclitaxel drug-coated balloons (DCB) and bare metal stents (BMS) significantly reduce restenosis in femoropopliteal lesions compared to plain balloons (PBA), while the effectiveness between DCB and BMS is not well-researched. Considering evidence suggesting an increased risk of mortality with paclitaxel treatment, we assessed the safety and efficacy of DCB compared against alternative treatments (BMS, PBA) in our patient population.

#### **Methods**

We performed a retrospective chart review of femoropopliteal interventions at a single center from 2009-2017. The intervention, patient and lesion characteristics, and target lesion revascularization (TLR) or mortality events were recorded. Data were analyzed with Kaplan-Meier curves and Cox regression models.

#### **Results**

We compared 388 patients treated with paclitaxel (DCB, DES) and 314 control patients (PBA, BMS), who showed no difference in survival curves over a 6-year period. Survival was 79.19% vs 79.91% at 2-years and 58.42% vs 63.67% at 5-years for paclitaxel and control respectively. Cox regression showed no association of paclitaxel with mortality. However, age, renal insufficiency, and critical limb ischemia predicted death.

From these patients, 660 lesions were included in our study: 117 PBA, 219 BMS, and 324 DCB. Kaplan-Meier curves for BMS and DCB did not differ but both had increased freedom from TLR compared to PBA over a 3-year period (PBA:46.22%, BMS:56.45%, DCB:52.99%). Cox regression yielded a significant hazard ratio of 0.74 [0.54-0.99] for DCB, but not for BMS (0.81 [0.58-1.13]). Covariates that predicted TLR were critical limb ischemia and popliteal involvement.

#### **Conclusion**

We found no association between paclitaxel and mortality in our patient population. Moreover, both DCB and BMS have greater freedom from TLR, but only DCB outperforms PBA when co-variables are accounted for. Therefore, our data suggests that DCB are safe and perform at least equally to BMS without leaving anything behind in the vessel.

## Peripheral Artery Disease Patients with Chronic Limb Threatening Ischemia show Altered Blood Microbiota Composition as Compared with Intermittent Claudication

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### Objective

Chronic limb threatening ischemia (CLTI) is a severe manifestation of peripheral artery disease (PAD) with high morbidity for aging populations. While metabolites produced by the intestinal microbiota have been shown to predict long-term risk of adverse events in PAD patients, the contribution of the blood microbiota to CLTI development has not been investigated. We profiled the blood microbiota of PAD patients with CLTI as compared with intermittent claudication to identify differences in microbial composition.

### Methods

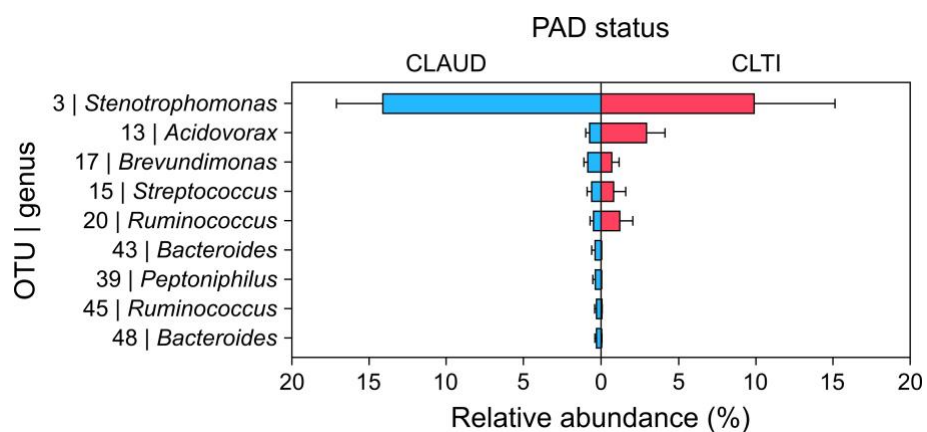
Blood samples were collected from patients aged 49-84 with intermittent claudication (CLAUD; n=15) or CLTI (n=4) as defined by clinical symptoms and ankle-brachial or toe-brachial index. Ethics board approval was obtained. The blood microbiota of CLAUD and CLTI groups was profiled using 16S rDNA sequencing and QIIME 2 analysis. Sequences were rarefied to 7,962 reads/sample for Shannon diversity and principal coordinates analyses (weighted UniFrac with PERMANOVA). A multivariate linear regression model was generated using the gneiss software package to identify differentially abundant bacterial genera between CLAUD and CLTI patients.

### Results

No differences in broad microbial diversity were identified with Shannon diversity or principal coordinates analyses. PAD status accounted for 5.7% of the variation in a linear regression model predicting microbiota composition. A cluster of nine operational taxonomic units, including the pathogenic bacterium *Acidovorax*, was differentially abundant between CLAUD and CLTI patients (p=0.015; Fig. 1).

### Conclusion

The progression of PAD from intermittent claudication to CLTI is associated with altered blood microbiota composition. Although several differentially abundant bacteria including *Stenotrophomonas* and *Acidovorax* have been previously identified as laboratory contaminants, *Acidovorax* spp. have also been detected *in situ* in symptomatic atherosclerotic plaques. These findings warrant further investigation of differentially abundant bacteria as prospective biomarkers for CLTI development in PAD patients. Future studies may explore the blood microbiota as a causative agent and potential therapeutic target for PAD.



**Figure 1. Blood microbiota composition in peripheral artery disease patients with chronic limb threatening ischemia as compared with intermittent claudication.** Differentially abundant bacteria are indicated by operational taxonomic unit (OTU) and associated genus. Relative abundances of bacteria are presented as means + standard errors of the mean for patients with intermittent claudication (CLAUD; n=15) or chronic limb threatening ischemia (CLTI; n=4).

## ***CANadian Acute Limb Ischemia rEgistry (CANALISE I): A Retrospective Cohort Examining Medication Use Following Non-Traumatic Acute Limb Ischemia***

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### **Objective**

Our study aims to characterize the use of antithrombotics and established secondary prevention agents following hospital admission for urgent and emergent limb revascularization.

### **Methods**

Patients discharged from the Hamilton General Hospital between April 2016 and September 2017 following non-traumatic limb ischemia requiring urgent or emergent intervention were identified via the Local Health Integration Network CorHealth database, and supplemented with information from chart review. The primary outcome was antithrombotic agent(s) at time of discharge. The secondary outcome was prescription of statins and renin-angiotensin-aldosterone system (RAAS) inhibitors at discharge as compared to admission.

### **Results**

158 patients were identified, with 148 alive at discharge. 38 patients had a pre-existing indication for anticoagulation. Of those without pre-existing indication for anticoagulation, 40.9% (n=47) were discharged on single antiplatelet therapy (SAPT), 28.7% (n=33) on dual antiplatelet therapy (DAPT), 7.0% (n=8) on anticoagulant (AC) alone, 20.9% (n=24) on AC plus antiplatelet therapy, and 2.6% (n=3) unknown. Angioplasty with stenting was associated with increased use of DAPT (HR: 7.14; 95%CI: 2.87 to 17.76; p<0.01), embolectomy/thrombectomy with AC alone (HR: 2.61; 95%CI: 1.00-6.81; p=0.049), and bypass grafting with SAPT (HR: 2.28; 95%CI: 1.11-4.69; p=0.024) at discharge. No other intervention (endarterectomy, angioplasty without stent or thrombolysis) was associated with a particular antithrombotic regimen. Neither statins (60.8% vs. 56.3%;  $\chi^2_{MN2df=1} \geq 1.45$ ; p=0.23) or RAAS inhibitors (48.7% vs. 50.6%;  $\chi^2_{MN2df=1} \geq 0.31$ ; p=0.58) were prescribed at a higher rate at discharge compared to admission.

### **Conclusions**

There is substantial heterogeneity in antithrombotic prescription following ALI, with SAPT the most commonly prescribed regimen. Other established preventative medications were not intensified following urgent and emergent revascularization. Future prospective cohort and randomized trials are required to delineate the optimal antithrombotic regimen following ischemic limb events. Increased utilization of established vascular protective medications is urgently indicated.



## **An investigation of psoas muscle area as a predictor of outcomes in patients undergoing lower limb revascularization**

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### **Objective**

To investigate if total psoas area (TPA) measured at L3/L4 vertebral levels can be used to predict postoperative outcomes in patients undergoing open revascularization procedures for chronic limb-threatening ischemia (CLTI).

### **Methods**

In this retrospective cohort study, patient biomarkers were measured from preoperative CT images (<6 months prior to procedure) and correlated with patient outcomes, including major limb amputation, mortality, and changes in ambulation assessed perioperatively and at 6, 12, and 60-months postoperatively.

### **Results**

141 patients, who underwent infra-inguinal bypass (n = 73), supra-inguinal bypass (n = 54), or both concomitantly (n = 14), were included in this analysis (86 male, 55 female). Patients that experienced mortality by 6, 12, and 60-months postoperatively had significantly lower TPA (two-tailed p = 0.0007, 0.0005, 0.0101, respectively) than survivors. These differences were independent of sex and procedure. Patients suffering major limb amputation did not have significant differences in TPA. Finally, patients who experienced losses in baseline amputation after 12 and 60-months postoperatively had significantly lower TPA measured at the superior border of L4 (two-tailed p = 0.029, 0.02).

### **Conclusions**

The presence of significant differences in TPA between patients who experience mortality and those surviving suggests that novel, non-invasive biomarkers, like TPA, may be clinically useful in predicting the risk of such complications following revascularization. Further analysis is necessary to determine precise TPA thresholds to more effectively predict the risk of postoperative complications in patients with CLTI prior to undergoing open revascularization procedures.

## The Contemporary Clinical Course of Patients with Intermittent Claudication

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### Objective

Patients with intermittent claudication (IC) rely on accurate information regarding their clinical course in order to make treatment decisions. However existing practice guidelines reference outdated natural history studies. We present the five-year contemporary clinical course of a real-world cohort with IC.

### Methods

This is a retrospective cohort study of adults (over age 40) with IC evaluated at two tertiary vascular surgery centers between April 1, 2013 and March 31, 2018. The cohort was defined using vascular ultrasound and clinic visit records. Outcome follow-up up to 5 years from the index ultrasound date was ascertained through linkage to population-based administrative health databases for the province on Ontario. The primary outcome was major amputation or urgent revascularization, considering elective revascularization and death as competing risks. Secondary outcomes included all-cause mortality, major amputation or death, and myocardial infarction, stroke or death. The association between the incidence of the primary outcome and patient and disease characteristics was evaluated through univariable Fine & Gray regression.

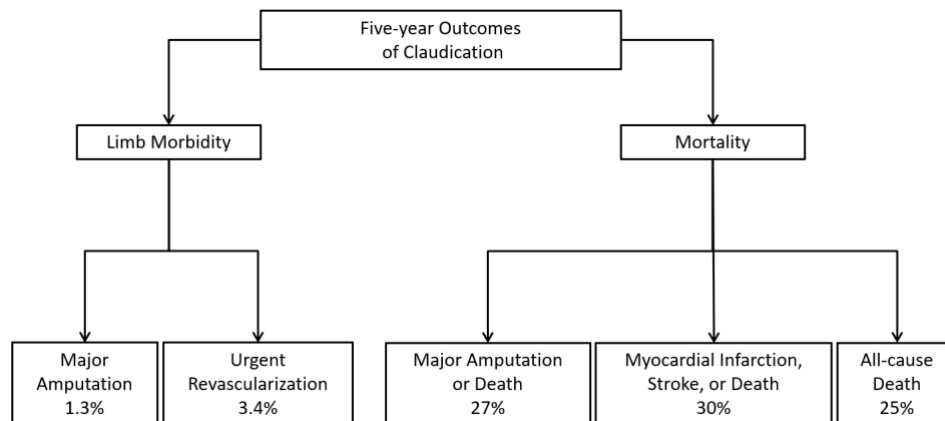
### Results

Among 1,109 patients with IC, the 5-year cumulative incidence of major amputation, urgent revascularization, elective revascularization, and death without amputation or revascularization was 1.3%, 3.4%, 9.9% and 22.0% respectively (Figure 1). An increased incidence of major amputation or urgent revascularization was associated with younger age, current smoking, diabetes and chronic kidney disease.

### Conclusion

The contemporary 5-year probability of limb-threatening ischemia or amputation among patients with IC is under 5% and the 5-year probability of death is 25%.

Figure 1. Five-year Outcomes of Claudication



## PAPER SESSION 3: TECHNOLOGY AND INNOVATION

### Novel physician-modified steerable endovascular catheter

Melissa Jones, MSc,<sup>1</sup> Mark Rockley, MD, MSc,<sup>2</sup> and Prasad Jetty, MD, FRCSC<sup>2</sup>

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### Objectives

To design and demonstrate the utility of a novel, physician-modified steerable endovascular catheter for endovascular procedures.

### Methods

A 5F, 0.038", 65cm Beacon Tip Kumpe catheter (Cook Medical) and a 36" 4-0 prolene suture were used to perform the simple steerable modification (Figure 1). The extended range of the steerable endovascular catheter was compared to four common 5F endovascular catheters (Van Schie 5, Van Schie 2, Cobra 2, and Kumpe) using MATLAB R2018b modeling. The steerable endovascular catheter modification was then performed in an endovascular case to evaluate utility of the device.

### Results

Figure 2 demonstrates the extended capability of the physician-modified steerable endovascular catheter in comparison to four common 5F endovascular catheters. Both the Kumpe and the Van Schie 2 catheter embody a single angulation at the catheter tip and have an upward conical range around the central axis. The Cobra 2 catheter projects in a plane nearly 90 degrees to the central axis, while the double curve of the Van Schie 5 allows the wire to project back towards the central axis. The shapes of both the Cobra 2 and the Van Schie 5 offer a unique advantage over the Kumpe and Van Schie 2 to "reach around" obstacles that otherwise intersect the central axis. In comparison, the physician modification provides the steerable catheter with an additional degree of freedom resulting in near-spherical range, as well as reinforcement of the catheter tip allowing for precise deployment with wire advancement. The modification is customizable to the surgeon's preferences and application. The concept has been applied locally in our division during a difficult contralateral gate cannulation case.

### Conclusions

A simple, intraoperative modification to existing endovascular catheters may improve their usability during endovascular procedures while reducing additional procedure costs and avoiding regulatory board approval required of novel steerable endovascular devices.

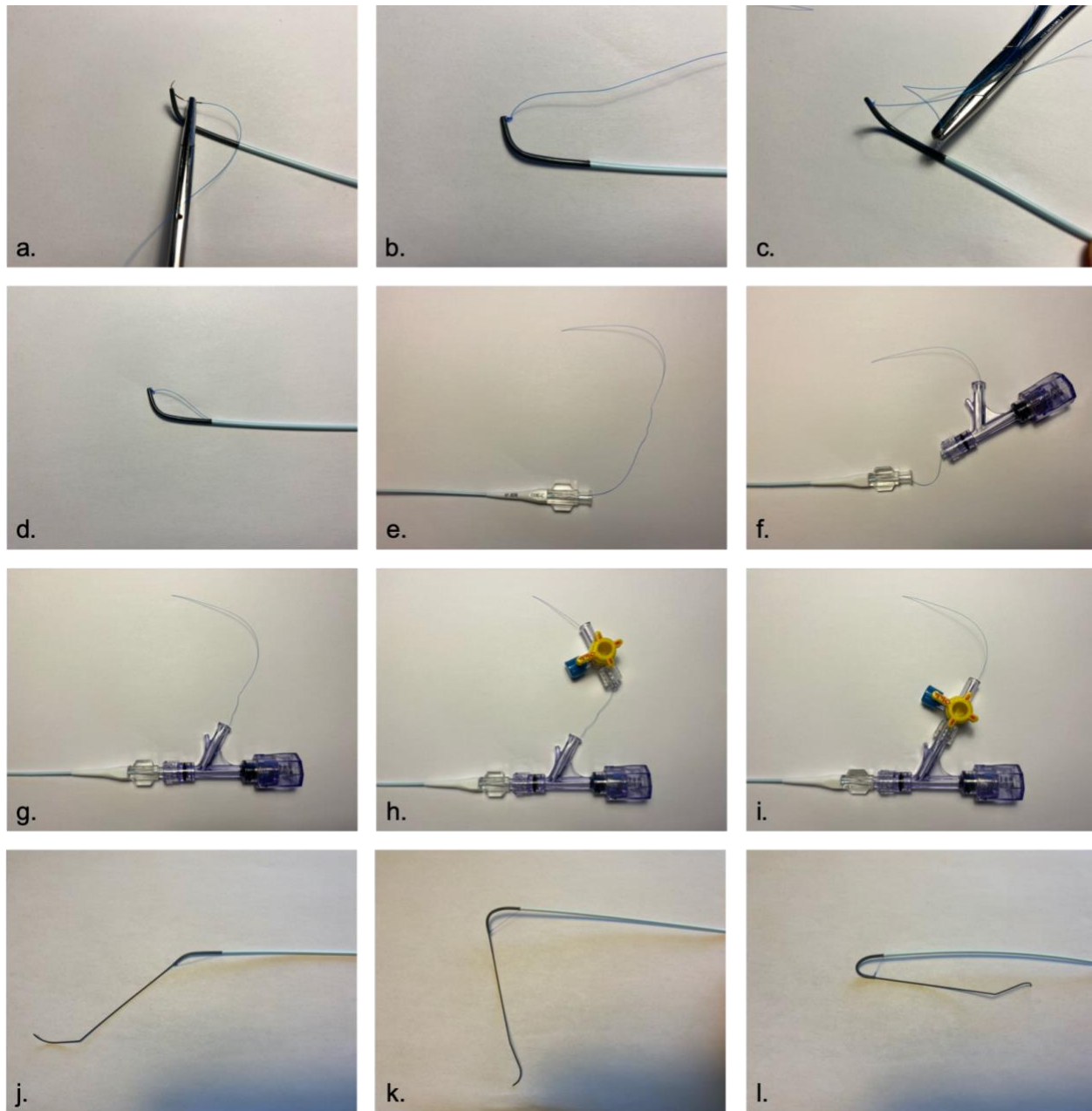


Figure 1: Steerable endovascular catheter modification. A 4-0 prolene suture (36") is secured to the catheter tip and introduced into the central lumen of the catheter using the suture needle (a-e). The free end of the suture was then passed through the oblique channel of a copilot device and secured using a three-way valve mechanism (f-i). Images j-l demonstrate the modified catheter in neutral, mid, and extreme flexion.

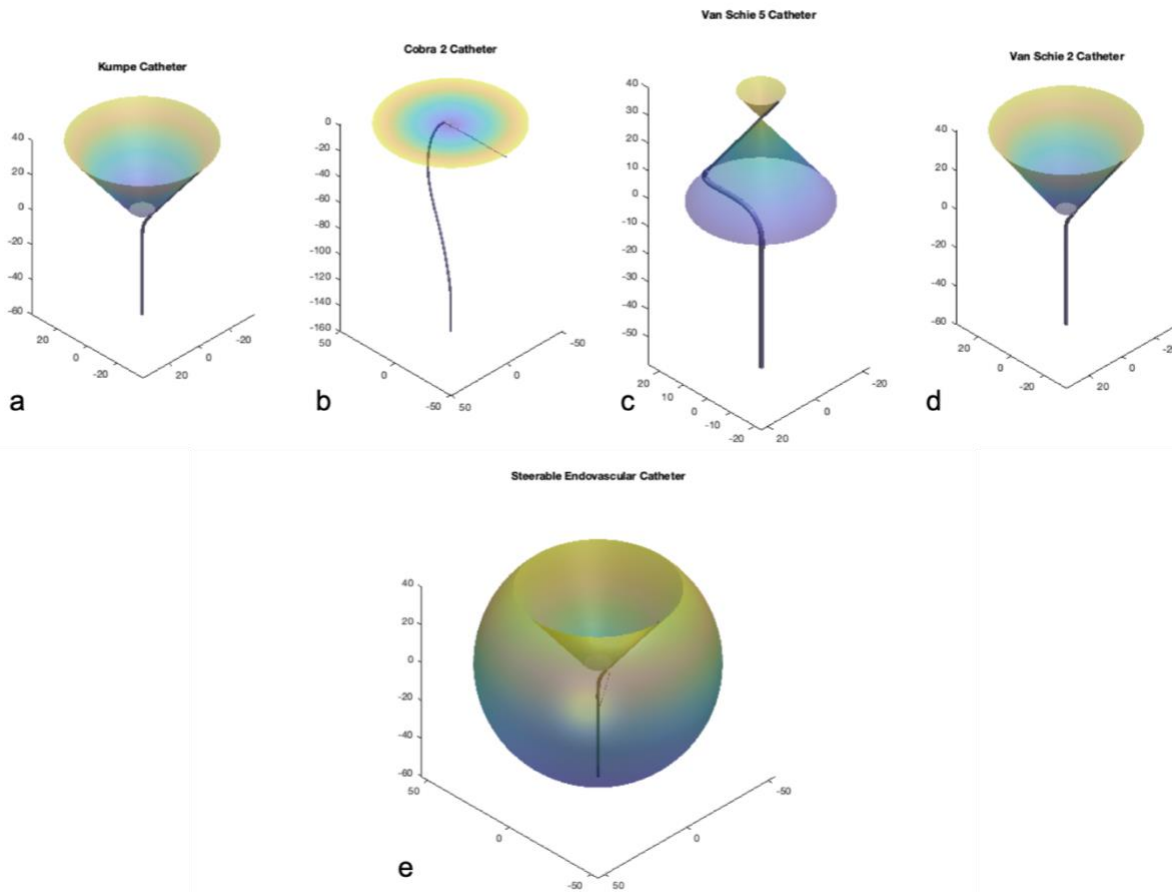


Figure 2: Three-dimensional visualization of the range of four commonly used 5F endovascular catheters, Kumpe (a), Cobra 2 (b), Van Schie 5 (c), Van Schie 2 (d), and the steerable endovascular catheter (e). The shape of the corresponding endovascular catheter with 5 centimeters of extruding guidewire are superimposed. Axes are measured in millimeters.

## **The Vascular eConsult. An efficient, useful, and economical tool for primary care physicians to interact with a vascular specialist, for proper care of the vascular patient**

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C. Liddy, MD, MSc, FCFP U of Ottawa ; Amir Afkham, BEng (Hnrs); Erin Keely, MD, FRCPC U of Ottawa

### **Introduction**

Electronic consultation (eConsult), a secure web-based tool that allows patient-specific, asynchronous communication between primary care providers (PCPs) and specialists, has demonstrated ability to improve access to specialist advice in primary care and for older adults. The benefits would be to impact the increasing wait time to see a specialist, obtain a quick answer to what might be a simple question and potentially avoid unnecessary face to face consultation. This would potentially lessen the financial impact on the system, the patients and their families. The objective of this study was to conduct a review of the usefulness of vascular surgery eConsults.

### **Method**

We reviewed our data for eConsults submitted to vascular surgery in Ottawa, since joining the growing number of specialists in 2014. We analyzed the survey questions that required mandatory completion by the PCP prior to the case closure. These included, overall usefulness of the response by the vascular specialist, as well as the impact on patient care i.e.: new test or treatment plan instituted, whether face to face consultation was advised, or cancelled. Finally, we compared the remuneration from eConsults rendered, to the potential fee for service for a face to face consultation.

### **Results**

Completed data was available from 2014 to 2019. A total of 846 cases were submitted for a vascular eConsult . Mean response time was 19 hrs. with a median of 5.9 hrs. In 424 cases (50%) the PCP was able to confirm a course of action originally had in mind. In 386 cases (45%) "Got good advice for new course of action". 526 face to face referrals were initially contemplated by the PCP. 349 (66%) were no longer needed. 288 face to face referrals were not contemplated, but 32 (11%) now needed. 772 (92%) PCPs found the overall eConsult experience to be helpful or very helpful and educational , and 531(62%) deemed their topic as a clinical problem worthy of CME event.

### **Conclusion**

The vascular eConsult proved to be a popular tool for PCPs to address the vascular care of their patients. The number of users grew steadily over the years since inception. It was deemed to be useful by 92% of the users. It was fast and efficient in providing quick answers to the PCPs, and avoided a substantial number of unnecessary face to face consultations (66%), saving time, travel and expense to both: patients and the medical system. An added benefit, would be identifying common topics of interest that can be addressed at regular CMEs, and designing the teaching curriculum in med schools.

## **Intraoperative Simultaneous Limb Perfusion Monitoring (INSTANT) Study**

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4. School of Epidemiology and Public Health, Cardiovascular Research Methods Centre, University of Ottawa Heart Institute, Ottawa, K1Y4W7, Canada

### **Objectives**

The primary objective of this study is to determine if the magnitude of change of intraoperative toe-brachial index (TBI) during endovascular procedures for atherosclerotic peripheral vascular disease (PVD) is associated with major adverse limb events (MALE) within 1 year post-procedure.

### **Methods**

We performed a prospective, operator-blinded and blinded endpoint-adjudicated observational cohort study. The TBI was serially assessed at multiple time points before, during, and after endovascular procedures for symptomatic PVD (Figure 1). The association between intraoperative change in TBI and postoperative outcomes were analyzed with Cox Proportional Hazards, accounting for clustering of legs within subjects, accounting for the competing risk of mortality, and adjusted for baseline clinical status of limb ischemia and vascular level of intervention. The ideal threshold of intraoperative TBI improvement to predict freedom from MALE was calculated using Youden's method to maximize sensitivity and specificity. This study is registered on ClinicalTrials.gov (NTC 03875846) and a-priori protocol is published (*BMJ Open* 2019;9:e030456).

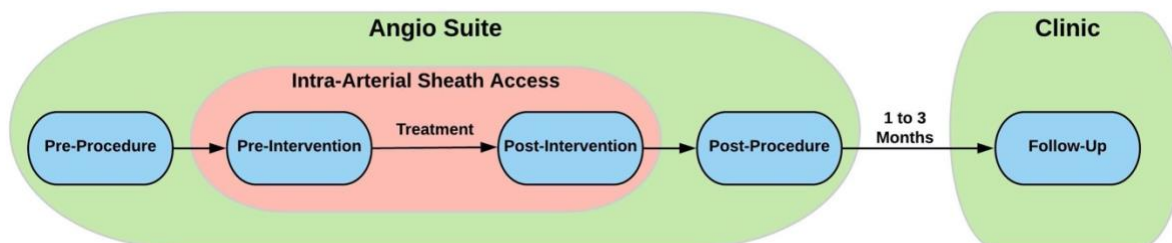
### **Results**

80 limbs of 67 patients were enrolled. Intraoperative TBI measurements with intra-arterial sheaths in-situ were feasible and reliably correlated with outpatient measurements ( $r=0.74$   $p<0.01$ ,  $ICC=0.78$ ). During one year follow-up, MALE occurred in 21% of limbs. The magnitude of change in the intraoperative TBI measurements before and after intervention was strongly associated with clinical outcomes such as MALE (Adj HR = 0.19 [95% CI 0.07 – 0.49],  $p < 0.01$ , per change in TBI of 0.1) (Table 1). The ideal threshold of improvement in intraoperative TBI is 0.08 (Positive LR = 2.14, Negative LR = 0.20).

### **Conclusion**

Intraoperative TBI assessment during endovascular procedures for PVD is reliable and strongly correlated with postoperative clinical outcomes such as MALE. These findings suggest that intraoperative perfusion assessment may be a useful tool in guiding intraoperative decision making, which should be evaluated with a randomized clinical trial.

## Figures



**Figure 1:** Toe-brachial index measurement time points.

	Unadjusted HR [95% CI]	p-value	Adjusted HR [95% CI]	p-value
<b>Primary Outcome</b>				
Major Adverse Limb Event	0.25 [0.10 – 0.66]	< 0.01	0.19 [0.07 – 0.49]	< 0.01
<b>Secondary Outcomes</b>				
Target Limb Reintervention	0.09 [0.03 – 0.32]	< 0.01	0.09 [0.02 – 0.32]	< 0.01
Target Vessel Patency				
Primary	0.09 [0.03 – 0.32]	< 0.01	0.08 [0.02 – 0.32]	< 0.01
Primary Assisted	0.06 [0.01 – 0.43]	< 0.01	0.07 [0.01 – 0.66]	< 0.01
Secondary	0.06 [0.01 – 0.47]	< 0.01	0.08 [0.01 – 0.59]	< 0.01
Amputation				
Minor	0.22 [0.05 – 0.96]	0.04	0.17 [0.04 – 0.69]	0.02
Major	0.59 [0.18 – 1.95]	0.39	0.32 [0.10 – 1.08]	0.07
Mortality	1.29 [0.15 – 11.29]	0.82	1.09 [0.16 – 7.29]	0.93
Amputation Free Survival	0.52 [0.18 – 1.54]	0.24	0.33 [0.11 – 0.97]	0.04
	Unadjusted OR [95% CI]	p-value	Adjusted OR [95% CI]	p-value
Lack of Clinical Improvement	0.12 [0.03 – 0.45]	< 0.01	0.09 [0.02 – 0.38]	< 0.01

**Table 1:** Univariate and multivariate associations between intraoperative increase in TBI (by 0.10) and clinical outcomes. Multivariate models were adjusted for the pre-specified variables of critical limb ischemia and infrainguinal level of intervention.



## **Evaluation of Hydrophilic Polymer Embolization from Endovascular Sheath devices in an *in vitro* Perfusion System**

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### **Objectives**

This study's objective is to quantify and compare the amount of hydrophilic polymer delamination from commercially available hydrophilic sheaths.

### **Methods**

We constructed an *in vitro* vascular model with 1.25-inch flexible vinyl tubing connected in a loop to a pulse generating pump (Harvard Apparatus Series 1400) simulating intra-arterial conditions. Cook Zenith Alpha stent grafts, Gore DrySeal sheaths, and Medtronic Sentrant Introducer sheaths were tested. Each sheath was inserted to a length equating to a pre-set surface area. The circuit was flushed with 1 L of buffered Ringer's fluid (RL) for 30 minutes prior to each sheath run. Following sheath insertion, a fresh 1 L of RL was used to run the circuit for 150 mins at a simulated cardiac output of 3 L/min. A flush wash with RL was subsequently collected. Six sheaths of each manufacturer were tested, and 3 non-coated Cook Check-Flo Performer Introducer sheaths were tested as controls.

Fluid samples were quantified using vacuum filtration, drying, and weighing. The composition of products were qualified using infrared spectroscopy by attenuated total reflectance (ATR).

### **Results**

ATR analysis found the composition of hydrophilic polymer residue from coated sheaths identical with a characteristic wavenumber between 1600-1700/cm. Particle size differed between the Cook Zenith Alpha ( $2363 \pm 374$  nm), Gore DrySeal ( $1388 \pm 646$  nm) and Medtronic Sentrant ( $1388 \pm 646$ ). Coated sheaths had significantly higher residue weight than the control ( $0.175 \pm 0.02$  g/L;  $p < 0.01$ ). Cook Zenith Alpha ( $11.7 \pm 0.4$  g/L) had more residue than Gore DrySeal ( $6.4 \pm 0.1$ ;  $p < 0.01$ ) and Metronc Sentrant ( $5.9 \pm 0.1$ ;  $p < 0.01$ ). There was no significant difference in residues between the Gore DrySeal and Medtronic Sentrant sheaths.

### **Conclusion**

Hydrophilic polymer shedding occurred in all coated sheaths. Composition between the shed material is fairly consistent among the tested sheaths, however particle size and total quantity vary.

## **Vascular Complications with Extracorporeal Membrane Oxygenation (ECMO)**

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<sup>e</sup> Toronto General Hospital, Department of Cardiology, Toronto, Canada

### **Objective**

Extracorporeal membrane oxygenation (ECMO) is a life-saving modality that improves the survival of patients, but the potential for associated vascular complications continues to affect the patient's mortality and morbidity. This research aims to determine the frequency, nature and risk factors for vascular complications associated with peripheral venoarterial (VA) ECMO.

### **Methods**

This study is a retrospective review of patients who received peripheral VA ECMO between 2014 and 2018. Data on demographics, comorbidities, indications, type and complications were extracted from electronic and paper medical records.

### **Results**

110 ECMO patients were identified, 65 of whom underwent peripheral VA ECMO. The mean age was 48 ( $\pm 13.3$ ) years and the majority were males (65% n=42). Right sided peripheral arterial cannulations were more common (65%, n=42). Vascular complications composed of 20 (31%) instances of limb ischemia and 5 (8%) strokes. Nearly half developed renal failure requiring dialysis (46%, n=30). The majority of limb ischemic complications were treated with open vascular procedures (85%, n=17). The majority consisting of local repair +/- embolectomy +/- fasciotomy (70%, n=14). Five required fasciotomies alone (25%, n=5) and suffered an amputation (5%, n=1). Three were treated conservatively. This population had a mean hospital stay of 28.1 ( $\pm 34.3$ ) days. The overall rates of ECMO survival and survival to discharge were 61% (n=40) and 51% (n=33), respectively. ECMO survival of patients with limb ischemia to discharge was 15% (n=10).

### **Conclusion**

The incidence of ischaemic vascular complications is frequent in VA ECMO patients and contributes to increased mortality and morbidity. Open surgical treatment options are the cornerstone for managing vascular complications of ECMO.

## **PAPER SESSION 4: MEDICAL VASCULAR SURGERY**

### **Burnout and career satisfaction amongst Canadian vascular surgeons: A cross-sectional study**

Dr. Giuseppe Papia; Sunnybrook Health Sciences Centre, Department of Surgery at the University of Toronto

Ms. Joanna Giddens; Department of Surgery at the University of Toronto

#### **Objectives**

To determine the scope and severity of burnout in Canadian vascular surgeons

#### **Methods**

A survey was developed containing the Maslach Burnout Inventory, Primary Medical Evaluation of Mental Disorders, Short Form Health Study, and questions surrounding demographics, medical errors, and coping behaviours. REB approval was attained and it was confidentially administered to all active members of the CSVS. Responses were anonymously recorded through open-text, Likert scales, and multiple choice and presented in aggregate form. Primary outcome variables included burnout scope, severity, stressors, and correlation to medical errors. Secondary variables included measurements of burnout criteria and work-life balance.

#### **Results**

210 CSVS members were surveyed with a 34% response rate. Respondents were 89% male, predominantly Caucasian and married with children. 60% of surgeons worked in academic hospitals and 40% in community hospitals. Burnout was reported in 34% of respondents. Symptoms of emotional exhaustion were present in 50%, depersonalization in 25% and reduced sense of accomplishment in 35%. 71% reported the ability to separate stress from providing high-quality care, while 29% felt poor emotional health rendered them less able to do so. 53% reported symptoms of depression and loss of interest in previously enjoyed things. 30% reported increased callousness towards others, and 10% experienced panic attacks within the six months. Commonly cited stressors included poor work-life balance, lack of support systems, and unrealistic job expectations. No significant admission in correlation to medical errors or substance-dependency was found.

#### **Conclusion**

This study confirms that burnout, depression, and job dissatisfaction are major issues in Canadian vascular surgeons. Burnout is primarily attributed to infrastructural limitations and conflicting institutional demands, citing a lack of collegial and administrative support. Respondents derive great purpose from their careers yet would not recommend it to others. Further investigation into specific environments and individual practice is warranted to inform effective interventions.

## **A Comparison of Outcomes Between Open and Endovascular Arteriovenous Access Creation for Hemodialysis**

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### **Objectives**

Preliminary outcomes for percutaneous endovascular autogenous access (endoAVF) show promising results; however, comparisons with surgical cohorts are lacking. This study compares autogenous arteriovenous access created with the EverlinQ endoAVF system with conventional surgical technique.

### **Methods**

This is a multicenter, retrospective review of autogenous arteriovenous accesses entered into a prospective database. Patients receiving radiocephalic, brachiocephalic, or endoAVF arteriovenous accesses between 2014 –2019 were included. Autogenous access maturation, primary patency, secondary patency, steal syndrome, and re-interventions were analyzed using standard statistical and survival analyses.

### **Results**

A total of 369 accesses were created during the study period; 61 endoAVF, 171 radiocephalic, and 137 brachiocephalic (Median follow-up 17 months; range 0 - 71 months). Maturation failure at the end of follow-up was 26.5±6%, 27.0±5%, and 18.4±4% for endovascular, radiocephalic, and brachiocephalic accesses respectively ( $p = 0.049$  for brachiocephalic vs. endovascular accesses). Primary patencies at 12 and 24 months were 42±5% and 32±7% for endoAVF, 43±4% and 24±4% for radiocephalic accesses, and 42±4% and 29±4% for brachiocephalic accesses ( $p = \text{NS}$ ). Secondary patencies at 12 and 24 months were 68±6% and 61±7% for endoAVF, 75±3% and 67±4% for radiocephalic accesses, and 87±3% and 81±4% for brachiocephalic accesses ( $p = 0.019$  for brachiocephalic vs. endovascular accesses). There were no statistically significant differences in ischemic steal syndrome (3.3%, 4.1% and 8.0%;  $p = 0.229$ ) or total reinterventions/year (0.8±2.0, 0.9±1.6, and 1.2±1.7;  $p = 0.120$ ) for endovascular, radiocephalic, or brachiocephalic arteriovenous accesses, respectively.

### **Conclusions**

EndoAVF compare favorably with respect to maturation and patency compared with surgically created accesses in a real-world cohort. Outcomes and reintervention rates are similar to conventional radiocephalic arteriovenous accesses but are inferior with respect to patency and maturation to brachiocephalic accesses.

## **Revascularization versus best medical therapy for the management of asymptomatic carotid artery stenosis in females: a systematic review and meta-analysis**

Shira A. Strauss<sup>1,2</sup>, Chau Huynh<sup>1,3</sup>, Baies Haqani<sup>1,3</sup>, Na Zeng<sup>1,3</sup>, Prasad Jetty<sup>2</sup>

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### **Objective**

To define the role of revascularization and best medical therapy in females with asymptomatic carotid stenosis  $\geq 60\%$  with respect to perioperative and long-term rates of stroke and death.

### **Methods**

We systematically reviewed MEDLINE, EMBASE, and CENTRAL for randomized controlled trials comparing CEA, CAS, and/or BMT in patients with asymptomatic carotid stenosis. Four reviewers identified and extracted data from trials that met inclusion criteria. Authors were contacted to obtain unpublished sex-stratified composite stroke and death outcomes. Risk of bias was assessed using the Cochrane bias assessment tool. Meta-analyses were performed using a random effects model. Treatment effect was measured using odds ratio (OR) or risk difference (RD) [95% CI]. This review was submitted for registration with PROSPERO.

### **Results**

Of 1323 abstracts reviewed, four randomized controlled trials met inclusion criteria (figure 1), reporting on a total of 2182 females. Two studies compared CEA to BMT, one compared CEA to CAS, and one compared CEA, CAS, and BMT. Revascularization (CEA and/or CAS) significantly increased the risk of perioperative stroke and death (RD 3% [95% CI 0.01, 0.04]), with no long-term benefit over BMT (OR 0.91 [95% CI 0.61, 1.37], figure 2). When stratified by type of revascularization, CEA demonstrated a modest increase in perioperative risk of stroke and death compared to BMT (RD 3% [95% CI 0.01, 0.04]). There was no difference in the risk of perioperative stroke or death between CEA vs. CAS or CAS vs. BMT, and no difference in long-term stroke or death rates between CEA vs. BMT, CEA vs. CAS, or CAS vs. BMT.

### **Conclusion**

Revascularization for the treatment of asymptomatic carotid stenosis  $\geq 60\%$  in females conferred no benefit over BMT with respect to long-term rates of stroke and death, and modestly increased perioperative (30-day) stroke and death risk.

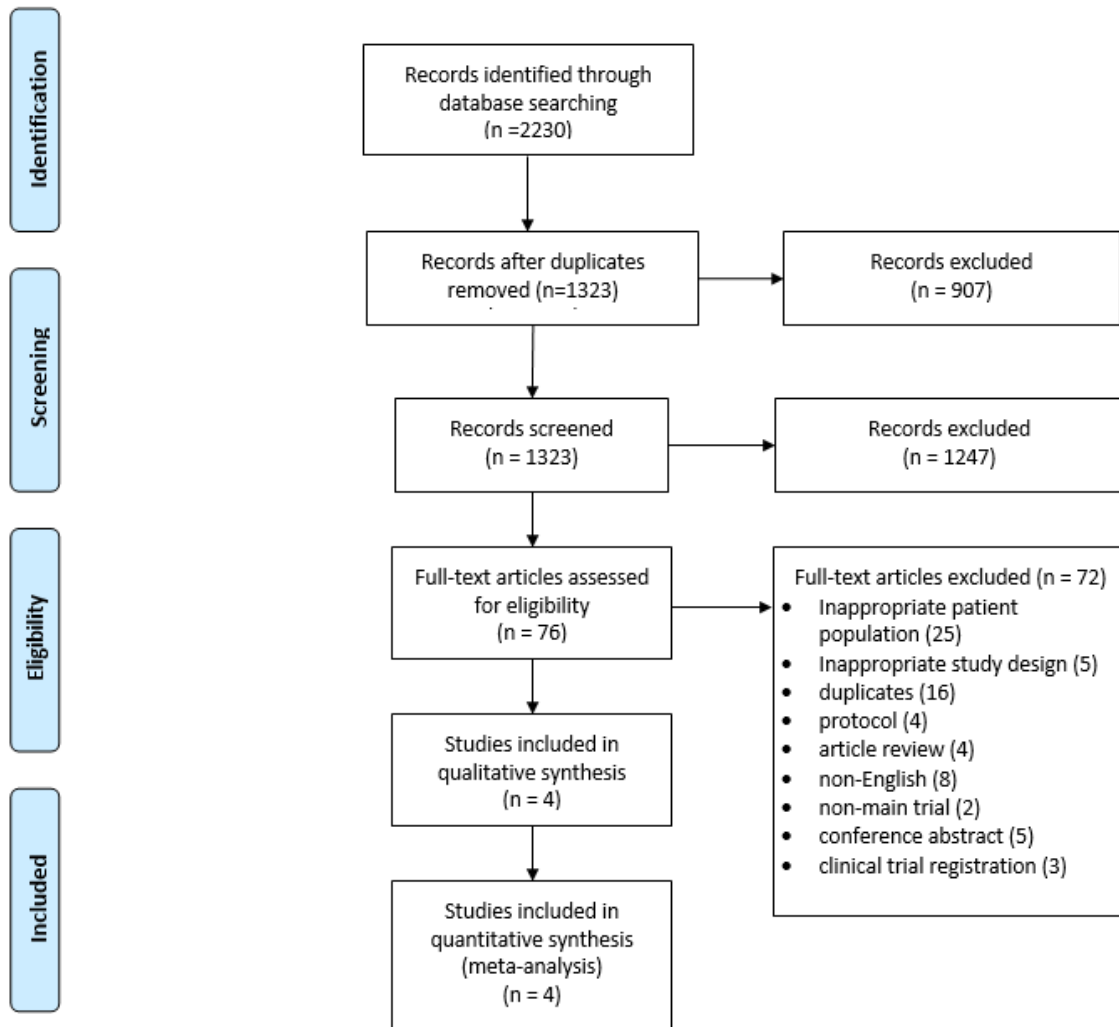


Figure 1. PRISMA Flow Diagram

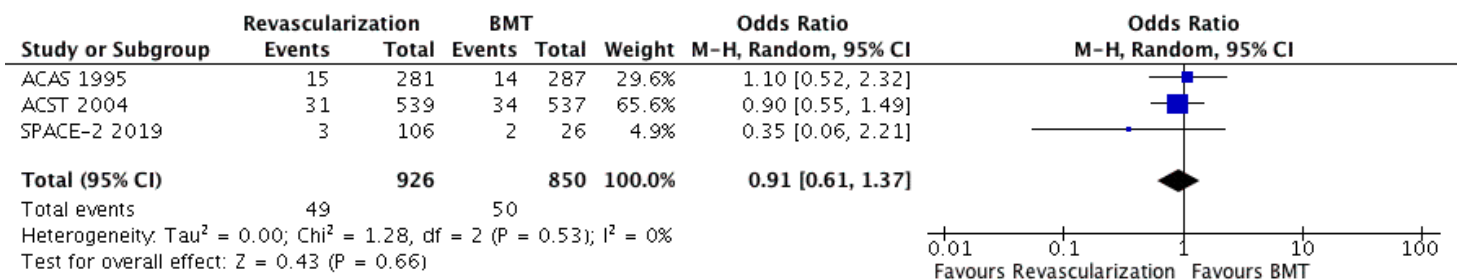


Figure 2. Forest plot of long-term stroke and death outcomes in randomized control trials comparing revascularization [CEA &/or CAS] and best medical therapy (BMT).

ACAS= Asymptomatic Carotid Atherosclerosis Study; ACST= Asymptomatic Carotid Surgery Trial; SPACE-2= Stent-Protected Angioplasty versus Carotid Endarterectomy; CI, confidence interval; OR odds ratio

## **Cannabis Use Disorder and Perioperative Outcomes in Vascular Surgery**

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### **Introduction**

Heavy cannabis use is known to have an adverse impact on cardiovascular and cerebrovascular outcomes in the general population. The objective of this study was to determine the peri-operative risk of cannabis use disorder (CUD) in vascular surgery patients.

### **Methods**

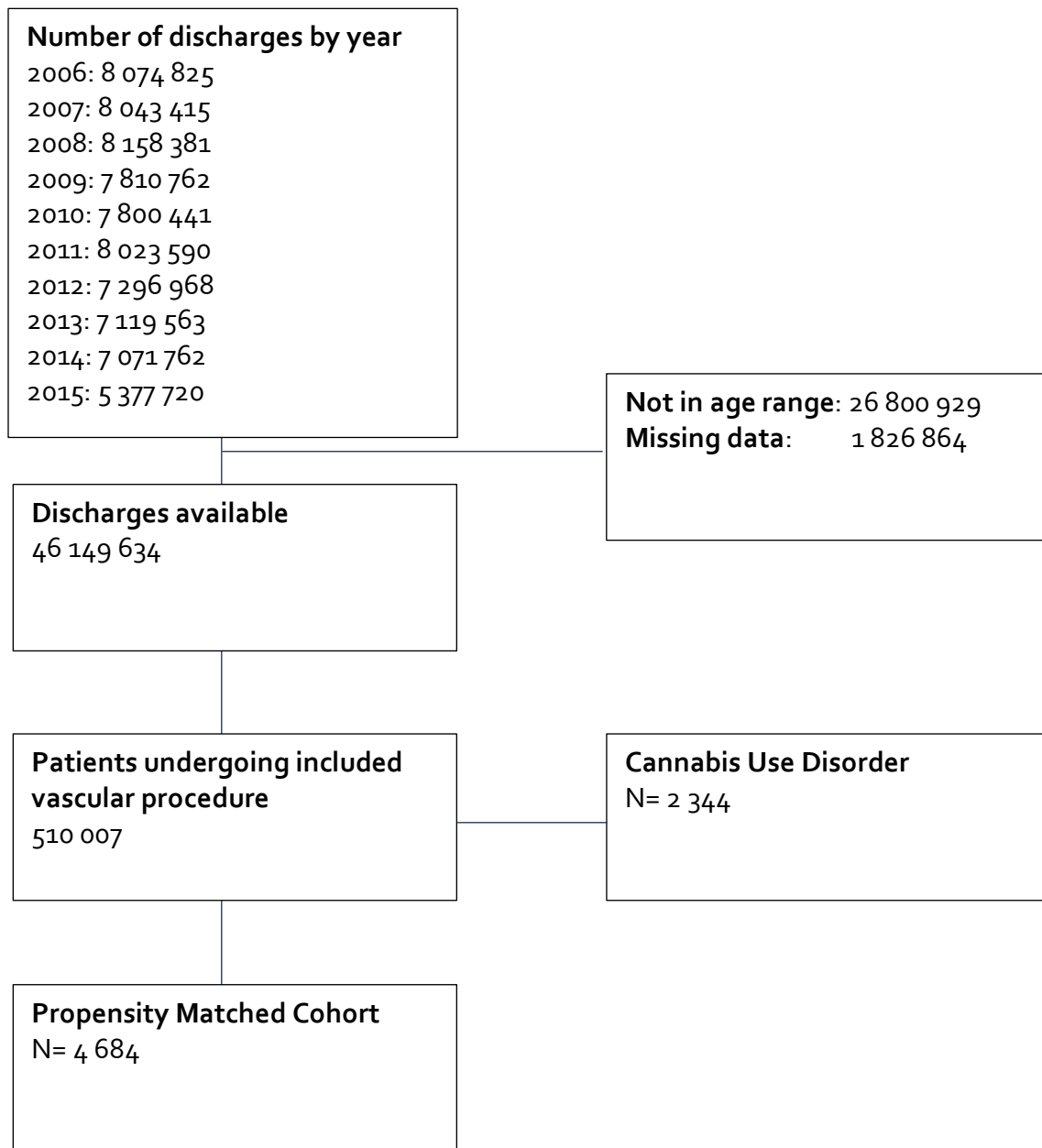
Utilizing the National Inpatient Sample (2006-2015), we conducted a retrospective cohort study involving those undergoing one of six elective and emergent vascular surgical procedures. Patients with active CUD were matched to patients without CUD in a 1:1 ratio using propensity scores. The primary outcome was peri-operative myocardial infarction (MI). Secondary outcomes include stroke, sepsis, deep vein thrombosis, pulmonary embolus, acute kidney injury, respiratory failure, mortality, total cost and length of stay.

### **Results**

We identified a total cohort of 510 007 patients. Over the study period, the recorded prevalence of CUD increased from 1.3/1 000 to 10.3/1 000 admissions (Figure 1)( $p < 0.001$ ). After propensity score matching the cohort consisted of 4 684 patients. Those with CUD had a higher incidence of peri-operative MI (3.3%vs2.1% OR:1.56; 95%CI:1.09-2.24;  $p = 0.016$ ) and peri-operative stroke (5.5%vs3.5% OR:1.59; 95%CI:1.20-2.12;  $p = 0.0013$ ) than patients without CUD (Table 1). The higher incidence of perioperative stroke was primarily seen among those undergoing carotid endarterectomy (CEA). Patients with CUD had a lower incidence of sepsis (3.3%vs5.1% OR:0.64; 95%CI:0.47-0.85;  $p = 0.0024$ ). We obtained similar results in a sensitivity analysis that included the complete unmatched cohort and adjusted for confounding using logistic regression models accounting for the survey design, though the endpoints of sepsis and stroke failed to reach statistical significance after correcting for multiple testing.

### **Conclusions**

CUD was associated with a significantly higher incidence of peri-operative MI in vascular surgery patients. Those with CUD had a greater incidence of peri-operative stroke when undergoing CEA, though due to limitations in administrative data this could reflect a true effect or a selection bias.



**Figure 1.** Flowchart demonstrating cohort formation.



**Table I.** Association Between Cannabis Use Disorder and the Primary and Peri-operative Clinical Outcomes Among Patients Undergoing Major Vascular Surgical Procedures in a Propensity-Matched Cohort (Nationwide Inpatient Sample, 2006- 2015).

	Unadjusted Analyses				Adjusted Analyses			
	Cannabis Use Disorder (n=2344) (%)	No Cannabis Use Disorder (n=507 725) (%)	Crude Odds Ratio (95% CI) (Cannabis Use Disorder vs. No Cannabis Use Disorder)	P-value	Cannabis Use Disorder (n=2342) (%)	No Cannabis Use Disorder (n=2342) (%)	Adjusted Odds Ratio (95% CI) (Cannabis Use Disorder vs. No Cannabis Use Disorder)	P-value
<b>Myocardial Infarction (%)</b>	77 (3.3)	12 400 (2.4)	1.36 (1.08-1.71)	0.0084	77 (3.3)	50 (2.1)	1.56 (1.09-2.24)	0.016
<b>Respiratory Failure (%)</b>	198 (8.5)	30 769 (6.1)	1.43 (1.24-1.66)	<0.001	197 (8.4)	202 (8.6)	0.97 (0.79-1.20)	0.79
<b>Acute Kidney Injury (%)</b>	242 (10.3)	39 717 (7.8)	1.36 (1.19-1.55)	<0.001	241 (10.3)	222 (9.5)	1.10 (0.90-1.33)	0.35
<b>VTE (%)</b>	124 (5.3)	17 262 (3.4)	1.59 (1.32-1.90)	<0.001	124 (5.3)	159 (6.8)	0.77 (0.60-0.98)	0.032
<b>Sepsis (%)</b>	77 (3.3)	18 827 (3.7)	0.88 (0.70-1.10)	0.2797	77 (3.3)	119 (5.1)	0.64 (0.47-0.85)	0.002
<b>Stroke(%)</b>	128 (5.5)	14 015 (2.8)	2.04 (1.70-2.44)	<0.001	128 (5.5)	82 (3.5)	1.59 (1.20-2.12)	0.001
<b>Mortality* (%)</b>	28 (1.2)	8 813 (1.7)	0.69 (0.47-1.00)	0.0481	28 (1.2)	40 (1.7)	0.70 (0.43-1.13)	0.146

Abbreviations: VTE, Venous Thromboembolism; 95%CI, 95% Confidence Interval; Survey weights were not used in this analysis. Significance defined as P<0.05 for the primary outcome and P<0.006 for the secondary outcomes.

\*Mortality data was missing for 202 patients in the unmatched cohort and 6 patients in the matched cohort.

## **Association Between Attempted Arteriovenous Fistula Creation and Mortality in Patients Starting Hemodialysis via a Catheter: A Multicenter, Canadian, Retrospective Cohort Study**

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### **Objective**

To examine the association between attempted arteriovenous fistula (AVF) creation in patients already receiving hemodialysis via a central venous catheter (CVC) and mortality. We hypothesized that attempting AVF creation (regardless of whether the AVF later becomes usable) in these patients would be associated with a lower mortality.

### **Methods**

We included patients aged 18-years and older who initiated hemodialysis via a CVC at one of five dialysis programs in Ontario, Manitoba, and Alberta between January 1, 2004 and May 31, 2012 and did not receive a previous attempt at AVF creation. We used a marginal structural model to determine the association between attempted AVF creation and death after accounting for confounding and immortal-time bias (the period of follow-up during which death cannot occur because of the study design).

### **Results**

In total, 3,145 patients initiated hemodialysis during the study period, and 61% did so via a CVC. Of the 1,832 who had no pre-dialysis AVF creation attempt, 565 (31%) underwent a subsequent attempt at AVF creation. Those that underwent an attempt at AVF creation were younger, had fewer comorbidities and a lower glomerular filtration rate, less often started dialysis as an inpatient, and more often received pre-dialysis care (**Table 1**). In a marginal structural model controlling for differences in age, gender, duration of pre-dialysis care, and a history of diabetes or cardiovascular disease, attempted AVF creation was associated with a significantly lower mortality [hazard ratio=0.53; 95% confidence interval=0.43-0.65]. This effect did not appear to be mediated by differences in the frequency of hospitalizations or subsequent procedures and remained robust in sensitivity analyses accounting for differences in between-group follow-up.

### **Conclusion**

In this multicenter, Canadian, retrospective cohort study, although most included patients initiated hemodialysis via a CVC, those who underwent a subsequent attempted AVF creation had a significantly reduced mortality.

**Table 1. Baseline Patient Characteristics.**

	No Fistula Attempt (n=1,267)	Fistula Attempt (n=565)	p-value	Catheter Cohort (N = 1,832)
Age, median (IQR)	68 (57, 78)	64 (53, 74)	<.001*	67 (56, 77)
BMI, median (IQR)	26.9 (23.4, 31.6)	26.3 (22.9, 31.4)	.18	26.7 (23.2, 31.5)
Male, n (%)	747 (59)	359 (64)	.06	1,106 (60)
Diabetes, n (%)	682 (54)	334 (59)	.03*	1,016 (55)
Cardiovascular disease (any), n (%)	777 (61)	292 (52)	<.001*	1,069 (58)
Coronary artery disease, n (%)	508 (40)	178 (32)	<.001*	686 (37)
Congestive heart failure, n (%)	447 (35)	135 (24)	<.001*	582 (32)
Cerebrovascular disease, n (%)	221 (17)	67 (12)	.002*	288 (16)
Peripheral vascular disease, n (%)	261 (21)	89 (16)	.02*	350 (19)
Cancer, n (%)	268 (21)	87 (15)	.004*	355 (19)
eGFR at the initiation of dialysis, median (IQR)	9.3 (6.4, 13.1)	8.4 (6.2, 11.4)	<.001*	8.9 (6.4, 12.6)
Started dialysis as inpatient, n (%)	941 (74)	331 (59)	<.001*	1,272 (69)
Any pre-dialysis care, n (%)	801 (63)	474 (84)	<.001*	1,275 (70)
Pre-dialysis care $\geq$ 4 months, n (%)	648 (51)	335 (59)	.001*	983 (54)
Pre-dialysis care $\geq$ 12 months, n (%)	516 (41)	244 (43)	.32	760 (42)

IQR: interquartile range; BMI: body mass index; eGFR: estimated glomerular filtration rate.