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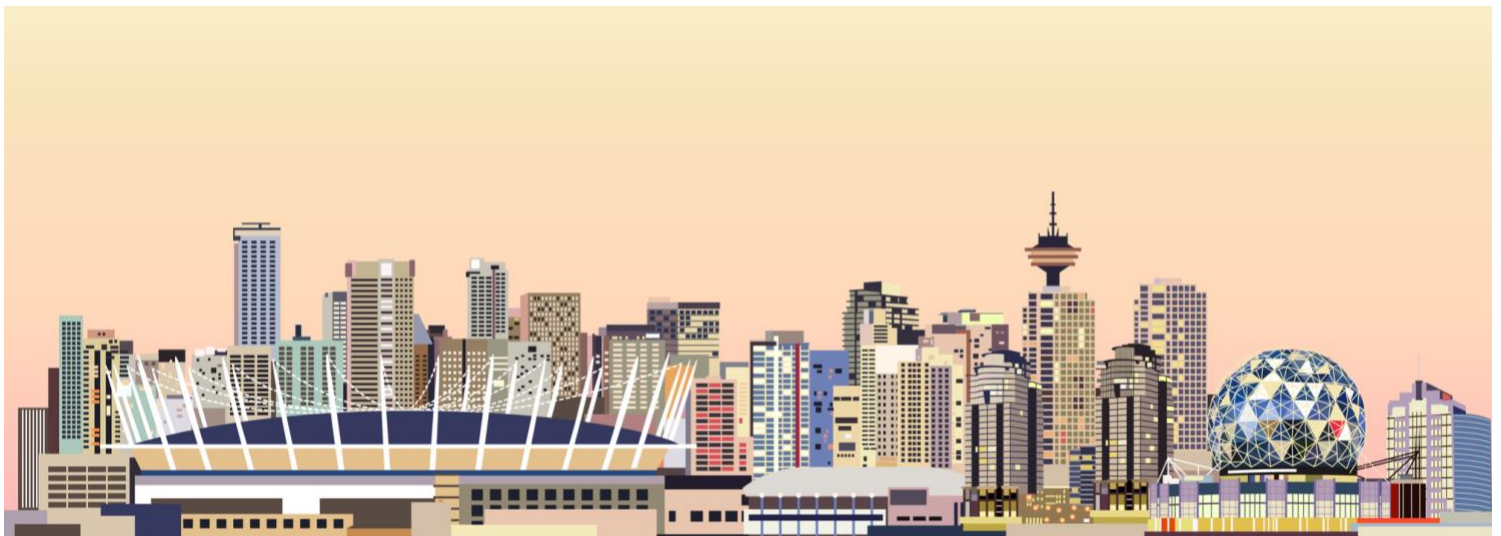
Canadian Society for Vascular Surgery

BOOK OF ABSTRACTS

CSVS 44TH ANNUAL MEETING ON VASCULAR SURGERY

September 9-10, 2022

Sheraton Vancouver Wall Centre | Vancouver, BC

Program Chair: Dr. Ivica Vucemilo
Assistant Program Chair: Dr. Virginia Gunn
Local Arrangement Chair: Dr. Kirk Lawlor

BOOK OF ABSTRACTS

ORAL PRESENTATIONS

SESSION I: PERIPHERAL ARTERY DISEASE 1

01_CSVS_2022
RETROPUBIC FEMORAL-FEMORAL BYPASSES HAVE SUPERIOR OUTCOMES WHEN COMPARED TO GRAFTS TUNNELLED SUBCUTANEOUSLY

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OBJECTIVE
A femoral-femoral bypass is often used to revascularize lower extremities or as an adjunct to endovascular aneurysm repair. We hypothesized that grafts tunneled retropubically in the space of Retzius would be more resistant to infection due to a deeper tunnel and have better long-term patency due to a linear course with less propensity for kinking, when compared to subcutaneously tunneled grafts.

METHODS
Retrospective review of a prospectively maintained database for all consecutive cases of femoral-femoral bypass from 2006-2019 for either aneurysmal or occlusive arterial disease. Perioperative and long-term outcomes were analyzed comparing retropubic to subcutaneous tunnel using univariate statistics. Logistic regression and Cox proportional hazard regression were used to adjust for confounding.

RESULTS
We analyzed the results of 672 procedures, with 354 performed for occlusive disease, and 318 performed during aorto-uniliac endovascular aneurysm repair. Average patient age was 70.2 years and 75% were male. Of those done for occlusive disease, 134 were for claudication (38%) with the other 220 (62%) being done for critical limb ischemia. Median follow-up time was 44 months. Overall, 541 grafts were tunneled retropubically and 131 were tunneled subcutaneously. There was no significant difference in mortality (2.2% vs 3.1%, P=0.81) wound infection (19.0% vs 20.8%), early graft thrombosis (1.5% vs 1.5% P=0.99) or early amputation (0.7% vs 0.8%, P=0.99). The rate of graft infection at 90 days was significantly lower in the retrobupic group at 2.2% vs 9.2% (P<0.001), even after adjustment for indication, redo-status, and acuity (OR 3.6; 95% CI 1.5-8.5). Primary patency at 5 years was 84% for retropubic tunneled grafts versus 60% for subcutaneous tunneled (hazard ratio 1.62; 95% CI 1.1-2.6; P=0.001; Figure 1). Similarly, freedom from major adverse limb events at 5 years was significantly greater for grafts tunneled retropubically (82% vs 66%, hazard ratio 1.64; 95% CI 1.1-2.4, P=0.03; Figure 2).

CONCLUSIONS
Femoral-femoral bypass grafts when tunneled retropubically are associated with lower rates of graft infection, and better long-term patency and freedom from major adverse limb events when compared with subcutaneous tunnels. The retropubic tunnelling technique should be strongly considered when performing a femoral-femoral bypass.
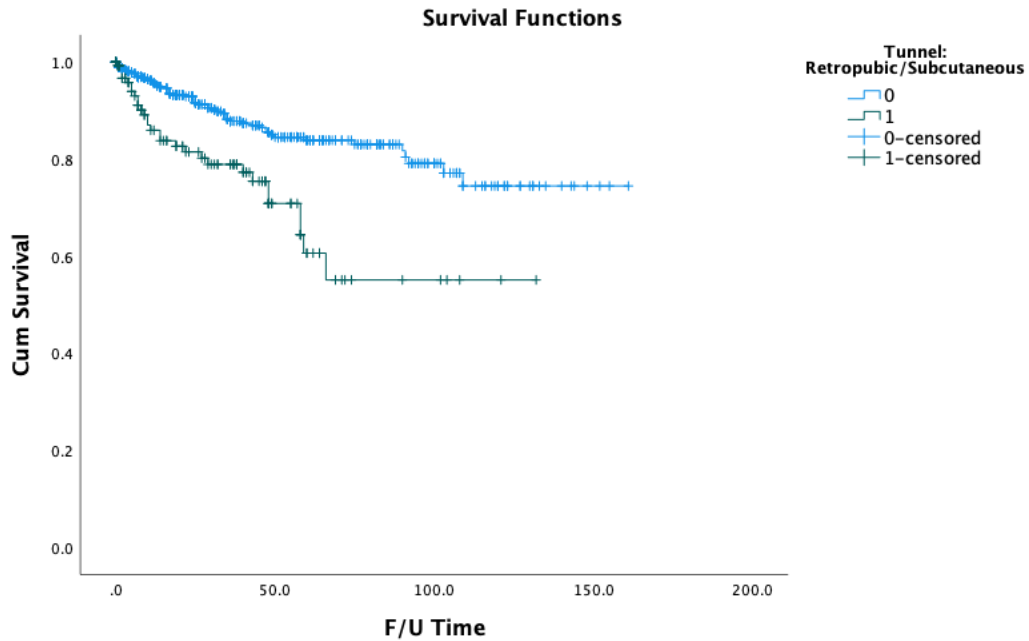
Figure 1. Kaplan-Meier curve of primary patency comparing femoral-femoral grafts tunneled retropubically (blue) to those tunneled subcutaneously (green)(log-rank P =0.01).
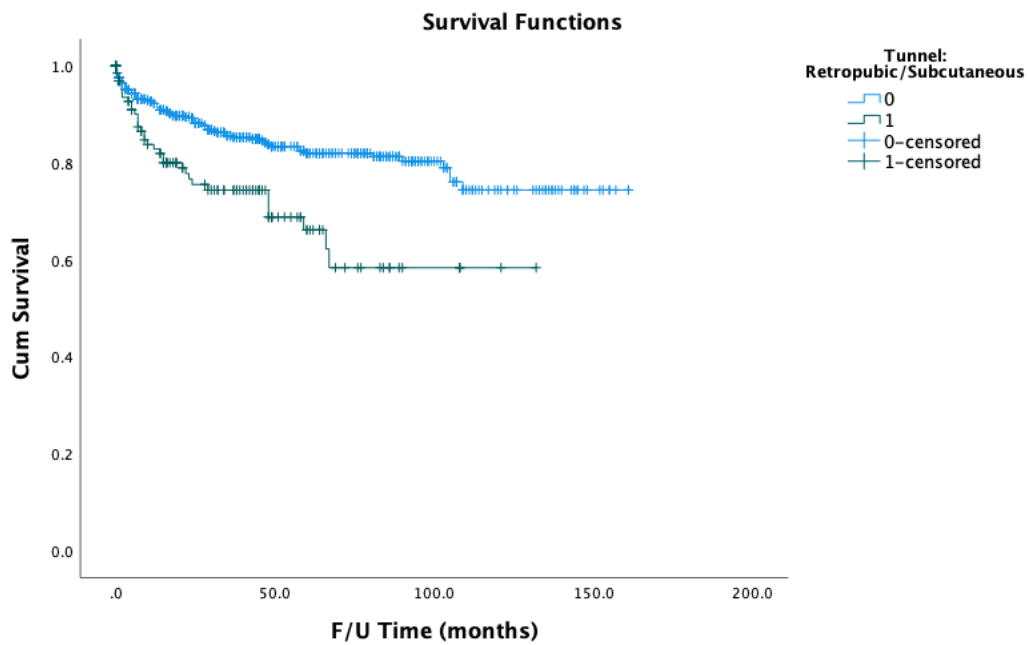

Figure 2. Kaplan-Meier curve of freedom from major adverse limb events comparing femoral-femoral grafts tunneled retropubically (blue) to those tunneled subcutaneously (green)(log-rank P =0.01).

EXPLORING PROGNOSTIC IMPLICATIONS OF RACE AND ETHNICITY IN PATIENTS WITH PERIPHERAL ARTERIAL DISEASE

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OBJECTIVES

This systematic review and meta-analysis sought to describe the prognostic implications of racial and ethnic status on clinical outcomes in patients undergoing vascular interventions for claudication and critical limb threatening ischemia (CLTI).

METHODS

Studies were systematically searched across 5 databases from inception to June 2021. Studies focused on patients with claudication or CLTI undergoing open, endovascular, or hybrid procedures. Studies were included if racial and ethnic status was documented and associated with a clinical outcome. Two independent reviewers selected studies for inclusion, extracted data, and assessed risk of bias using validated scales. Extracted data included study and clinical characteristics, demographics, interventions, outcome measured, and association of race or ethnicity with the clinical outcomes. Meta-analyses were performed using random effect models and reported pooled odds ratios with 95% confidence intervals.

RESULTS

Ninety-two studies addressed the impact of race and ethnicity in patients undergoing interventions for PAD. Seventeen studies evaluated the impact of Black vs White patients undergoing amputation as a primary intervention and were pooled in a meta-analysis with Black patients significantly having amputation as a primary intervention compared to White patients (pooled OR 1.89, 95% CI 1.53-2.25) (Fig. 1). A subsequent meta-analysis of 6 studies also demonstrated Black patients having significantly higher rates of amputation after revascularisation (pooled OR 1.50, 95% CI 1.23-1.77). Similar trends were seen in Hispanic and First Nations patients. A funnel plot suggested a low risk of bias. There were trends in racial disparities pertaining to graft patency, secondary interventions, post-operative complications, length of stay, re-admission, 30-day and overall mortality.

CONCLUSIONS

Black, Hispanic and First Nations patients undergo primary major amputation significantly more than White patients and are significantly more likely to undergo amputation following attempts at revascularisation. Reasons for these disparities should be explored to identify solutions for decreasing and eliminating these health inequities.
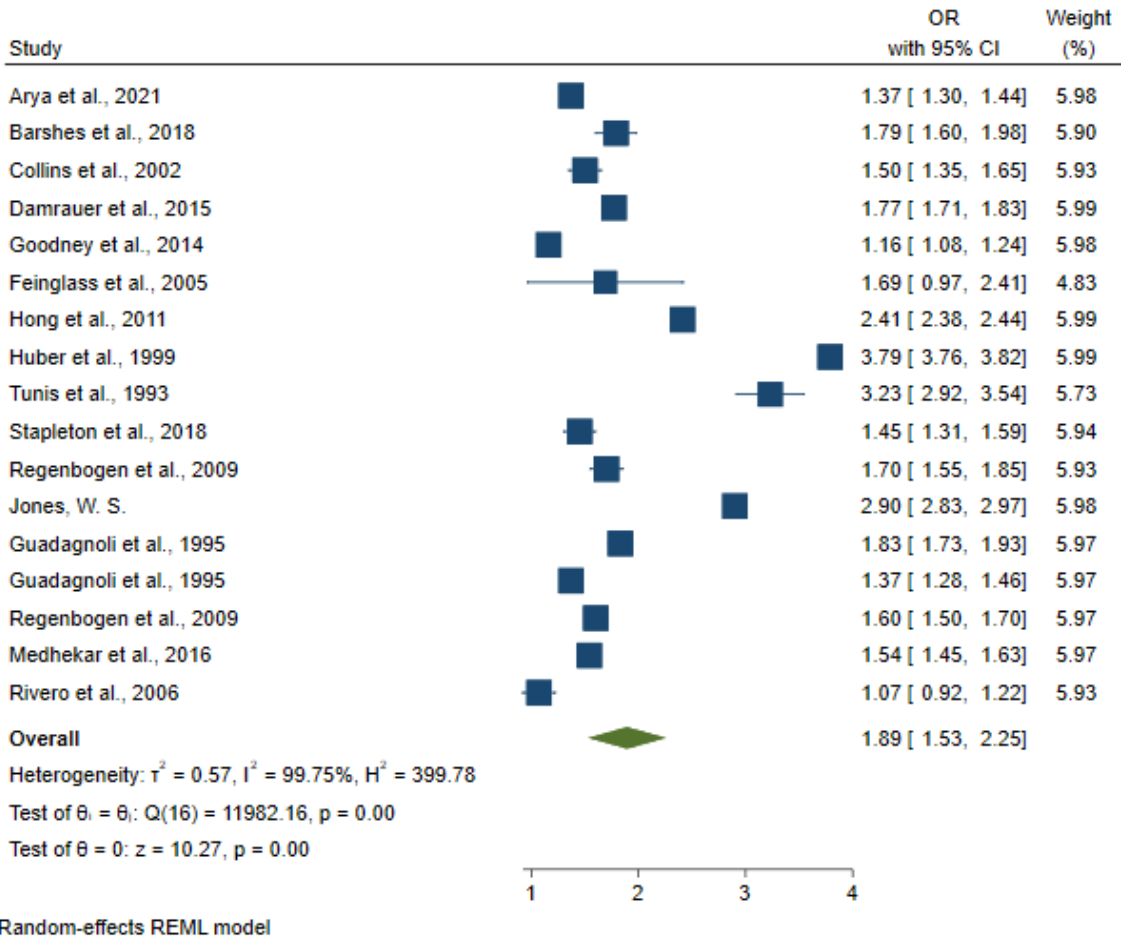
Figure 1. Pooled OR from 17 studies evaluating the rate of amputation as a primary intervention in Black vs White patients with PAD.

LONG-TERM OUTCOMES OF ENDOVASCULAR AND OPEN SURGICAL REVASCULARIZATION FOR PERIPHERAL ARTERY DISEASE: A POPULATION-BASED RETROSPECTIVE COHORT STUDY

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OBJECTIVE

To compare the long-term outcomes of endovascular and open revascularization for PAD.

METHODS

We conducted a population-based retrospective cohort study including all Ontarians 40 years or older revascularized for PAD between April 1st, 2005 and March 31st, 2020, through an endovascular or open approach. The primary outcome was amputation-free survival (AFS: death or major [above-ankle] amputation). Secondary outcomes included major amputation, death, major adverse limb events (MALE: major amputation or reintervention), major adverse cardiovascular events (MACE: death, myocardial infarct or stroke). Cox proportional hazards models were used to compare patients undergoing endovascular vs. open revascularization, with weighting by propensity score-based overlap weights to account for baseline characteristics. Analyses were repeated for pre-specified subgroups: diabetes, isolated infrainguinal disease, tissue loss.
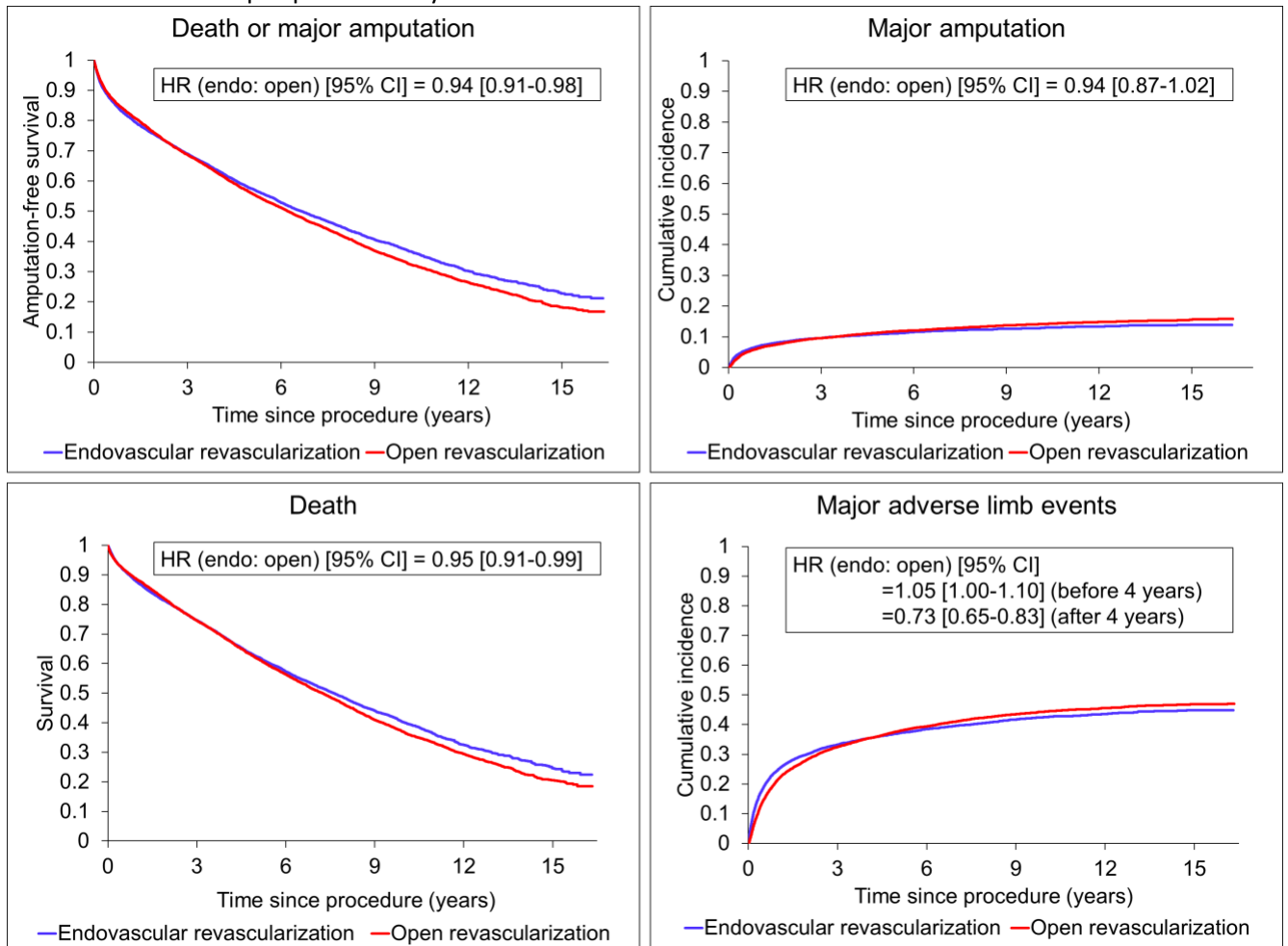
RESULTS

We identified 28,864 patients revascularized for PAD, of which 39% (N=11,203) underwent endovascular revascularization. The median follow-up time was 4.42 years (IQR=2.18-7.70). In the full cohort weighted analyses, endovascular revascularization was associated with better AFS (HR [95% CI]= 0.94 [0.91-0.98]), no difference in major amputation (HR [95% CI]= 0.94 [0.87-1.02]), lower mortality (HR [95% CI]= 0.95 [0.92-0.99]), and lower hazard of MALE after 4 years (HR at 4-years [95% CI]= 1.05 [1.00-1.10], HR after 4-years [95% CI]= 0.73 [0.65-0.83]) (Fig 1). There were no differences in MACE (HR [95% CI]= 0.96 [0.93-1.00]). Among subgroups, there were no differences in AFS, major amputation or death. Endovascular revascularization resulted in lower long-term MALE for those with infrainguinal disease only and those with tissue loss. There was no difference in MACE.

CONCLUSION

Among real-world patients with PAD eligible for both revascularization strategies, endovascular revascularization is associated with superior or not significantly different outcomes relative to open revascularization. Open revascularization may not offer a long-term benefit over endovascular revascularization.

Fig. 1. Propensity score overlap weighted long-term outcomes of endovascular and open revascularization for peripheral artery disease

Death or major amputation

HR (endo: open) [95% CI] = 0.94 [0.91-0.98]

Amputation-free survival / Time since procedure (years)

—Endovascular revascularization —Open revascularization

Major amputation

HR (endo: open) [95% CI] = 0.94 [0.87-1.02]

Cumulative incidence / Time since procedure (years)

—Endovascular revascularization —Open revascularization

Death

HR (endo: open) [95% CI] = 0.95 [0.91-0.99]

Survival / Time since procedure (years)

—Endovascular revascularization —Open revascularization

Major adverse limb events

HR (endo: open) [95% CI]
=1.05 [1.00-1.10] (before 4 years)
=0.73 [0.65-0.83] (after 4 years)

Cumulative incidence / Time since procedure (years)

—Endovascular revascularization —Open revascularization

Endo: endovascular; Major adverse limb events: major amputation or reintervention; endo: endovascular.

ILIAC ARTERY ENDOFIBROSIS: POST-OPERATIVE QOL OUTCOMES FOR AN ELUSIVE DISEASE IN HIGH-PERFORMANCE ATHLETES

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To determine the diagnostic, surgical, and long-term quality of life outcomes for patients with iliac artery endofibrosis, an underrecognized disease that impacts performance and well-being in elite endurance athletes.

METHODS

A retrospective chart review of all patients who underwent surgical intervention for iliac artery endofibrosis or kinking at a single tertiary care institution was performed. Demographics, competition and training history, radiological findings, surgical technique, and complications were recorded. Clinical, non-invasive testing and patency outcomes were analyzed. Modified vascQoL-6 survey was administered to determine quality of life outcomes pre- and post- intervention.

RESULTS

A total of 14 procedures on 12 limbs in 10 patients with iliac artery endofibrosis or kinking were performed between 2010 and 2022. The cohort included mostly females (70%), mean age of 43.4 years, and an average of 16.5 hrs/wk, 355 km/wk, and 21.6 years of endurance training prior to intervention. All patients competed in elite (provincial, national or international) cycling, running or triathlon. The most common presenting symptoms were unilateral lower extremity exertional weakness and numbness. B-mode ultrasound and CT imaging were often reported as normal (40%). Procedures included iliac artery adhesiolysis (n=1), inguinal ligament release (n=2), aorto-iliac shortening (n=3), and long vein patch arterioplasty (CIA/EIA/femoral, n=9). There were no MALE events, except one brachial artery thrombosis following pre-operative diagnostic angiography. Resting ABIs were normal pre and post intervention. Mean post-exercise ABI was 0.61 pre-intervention vs 1.08 post-intervention (p=0.002). Longterm primary patency remains 100%, however symptom recurrence has occurred in 2 limbs with a mean follow up of 5.4 years [1.2-12.2 years]. Modified VascQoL-6 demonstrated significant improvement following intervention in the domains physical, emotional, and social functioning (mean score 11.2 vs 23.2 p= 0.0002).

CONCLUSIONS

Iliac artery endofibrosis and kinking is an elusive disease affecting elite, experienced, endurance athletes. Diagnosis is challenging due to underrecognized symptoms, normal physical examination, and normal radiological findings, necessitating protocolized post-exercise pressure measurements. Surgical repair (aortoiliac shortening and long-vein patch arterioplasty) demonstrates excellent long-term patency with significant improvement in physiologic and quality of life outcomes.

IMPACT OF HOSPITAL TRANSFER ON ACUTE LIMB ISCHEMIA OUTCOMES AND TIME TO REVASCULARIZATION

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OBJECTIVE

To evaluate the role of hospital transfer and delayed presentation of acute limb ischemia (ALI) on time to revascularization, type of intervention and patient outcomes.

METHODS

A retrospective review of all cases with lower extremity ALI was conducted on patients presenting to our tertiary hospital between 2010 and 2019. Patient data was collected on patients who were direct admission from our emergency department or admission following hospital transfer from a peripheral hospital. This data was compared to evaluate time to revascularization, interventions performed, and postoperative outcomes of patients with direct admission versus patients who were transferred to our hospital.

RESULTS

173 patients were identified, 80 of which were direct admits while 93 were transfers from peripheral hospitals. The median transfer distance was 91.3km. Transfer patients had a significantly higher time of initial assessment to revascularization (9.83 hours vs. 6.04, p=0.012), however time of symptom onset to revascularization was not significantly different between the two groups (24.92 vs. 20.75, p=0.28). Thromboembolectomy was the most common treatment intervention for direct admit and transfer patients, 91.3% and 89.25%, respectively. There was no significant difference in intra-operative fasciotomy between direct admit and transfer patients (31.3% vs. 38.7%, p=0.31). In the post-operative period, direct admit patients had a higher percentage of full recovery with no documented limb deficits at discharge compared to transfer patients (78.8% vs. 57%, p=0.0024). Transferred patients experienced higher rates of major limb amputation (8.6% vs. 2.5%, p=0.039), discharge to another hospital (35.5% vs. 10% p<0.0001) and mortality (16.1% vs. 8.8%, p<0.0001).

CONCLUSION

Patients with ALI who required transfer to our hospital from a peripheral site suffered from increased major limb amputation and mortality despite comparable total ischemic time, interventions and hospital stay, compared to patients who present and are admitted directly from our emergency department.

SESSION II: ABDOMINAL AORTIC ANEURYSM 1

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THE IMPACT OF RACE ON OUTCOMES FOLLOWING RUPTURED ABDOMINAL AORTIC ANEURYSM REPAIR

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OBJECTIVE

To assess racial differences in outcomes following ruptured abdominal aortic aneurysm (rAAA) repair.

METHODS

The Vascular Quality Initiative (VQI) database was used to identify all black and white patients who underwent endovascular or open rAAA repair between 2003-2019. Demographic, clinical, and procedural characteristics were recorded and differences between groups were assessed using independent t-test and chi-square test. The primary outcomes were in-hospital and 8-year mortality. Associations between race and outcomes were analyzed using univariate/multivariate logistic regression and Cox proportional hazards analysis.

RESULTS

310 black patients and 4,679 white patients underwent rAAA repair during the study period. A greater proportion of black patients received endovascular repair (73.2% vs. 56.1%). Black patients were younger and more likely to be female, with a greater proportion being uninsured (4.8% vs. 3.3%). Although black patients were more likely to have cardiovascular comorbidities, they were not more likely to receive risk reduction medications. The time from hospital admission to intervention was higher for black patients (median 168 vs. 78 minutes). After adjusting for differences in demographic, clinical, and procedural characteristics, in-hospital mortality was similar for black and white patients (adjusted OR 0.58 [95% CI 0.30-1.07], p = 0.09, Table I). There was no difference in 8-year survival between black and white patients (50.4% vs. 46.6%, HR 0.85 [95% CI 0.57-1.26], p = 0.42, Fig 1), which persisted when stratified by endovascular and open repair.

CONCLUSIONS

There are important racial differences in demographic, clinical, and procedural characteristics for patients undergoing rAAA repair. In particular, the door-to-intervention time for black patients of 168 minutes does not meet the Society for Vascular Surgery recommendation of 90 minutes. Despite these differences, 8-year mortality is similar for black and white patients. Future studies should assess reasons for these disparities and opportunities exist to improve rAAA care for black patients.

Table I: In-hospital outcomes following endovascular and open repair of ruptured abdominal aortic aneurysm for black and white patients

	Black (n = 310)	White (n = 4,679)	OR (95% CI)	Adjusted OR (95% CI)*	P value
Mortality	62 (20.0)	1,339 (28.6)	0.63 (0.47 – 0.83)	0.58 (0.30 – 1.07)	0.09
Myocardial infarction	10 (3.2)	252 (5.4)	0.57 (0.28 – 1.03)	0.59 (0.12 – 1.99)	0.45
Stroke	9 (2.9)	107 (2.3)	1.16 (0.54 – 2.19)	1.07 (0.21 – 3.72)	0.93
Dysrhythmia	40 (12.9)	802 (17.1)	0.69 (0.49 – 0.96)	1.03 (0.52 – 1.91)	0.93
CHF exacerbation	13 (4.2)	284 (6.1)	0.66 (0.35 – 1.12)	0.91 (0.29 – 2.32)	0.85
Respiratory complication	79 (25.5)	1,241 (26.5)	0.92 (0.70 – 1.19)	0.85 (0.47 – 1.49)	0.58
Renal failure	54 (17.4)	947 (20.2)	1.22 (0.85 – 1.73)	1.05 (0.60 – 1.79)	0.87
Lower extremity ischemia	24 (7.7)	233 (5.0)	1.62 (1.16 – 2.18)	1.49 (0.60 – 3.38)	0.36
Bowel ischemia	29 (9.4)	397 (8.5)	1.04 (0.83 – 1.25)	1.33 (0.77 – 2.17)	0.27
Surgical site infection	16 (5.2)	226 (4.8)	1.04 (0.60 – 1.70)	0.87 (0.31 – 2.19)	0.78
Return to operating room	79 (25.5)	1,004 (21.5)	1.22 (0.93 – 1.59)	1.20 (0.64 – 2.21)	0.56

Values are reported as No. (%) unless otherwise indicated.

*Adjusted for demographics (age, gender, body mass index, primary insurer, pre-operative living status, region), comorbidities (hypertension, diabetes, smoking status, family history of abdominal aortic aneurysm, coronary artery disease, prior coronary artery bypass graft, prior percutaneous coronary intervention, congestive heart failure, chronic obstructive pulmonary disease, chronic kidney disease, dialysis, prior abdominal aortic aneurysm repair, prior carotid endarterectomy/stent, prior peripheral artery bypass, prior peripheral artery angioplasty/stent, prior major amputation), medications (acetylsalicylic acid, P2Y12 antagonist, statin, beta blocker, angiotensin converting enzyme inhibitor, anticoagulant), clinical presentation (transfer from another hospital, lowest pre-intubation blood pressure, heart rate on arrival to operating room, highest intra-operative heart rate, mental status, cardiac arrest, pre-operative hemoglobin, aneurysm diameter, concomitant iliac artery aneurysm), and operative characteristics (time from symptom onset to incision or access, time from hospital admission to incision or access, procedure time, procedure year, repair type).

Abbreviations: OR (odds ratio), CI (confidence interval), CHF (congestive heart failure).
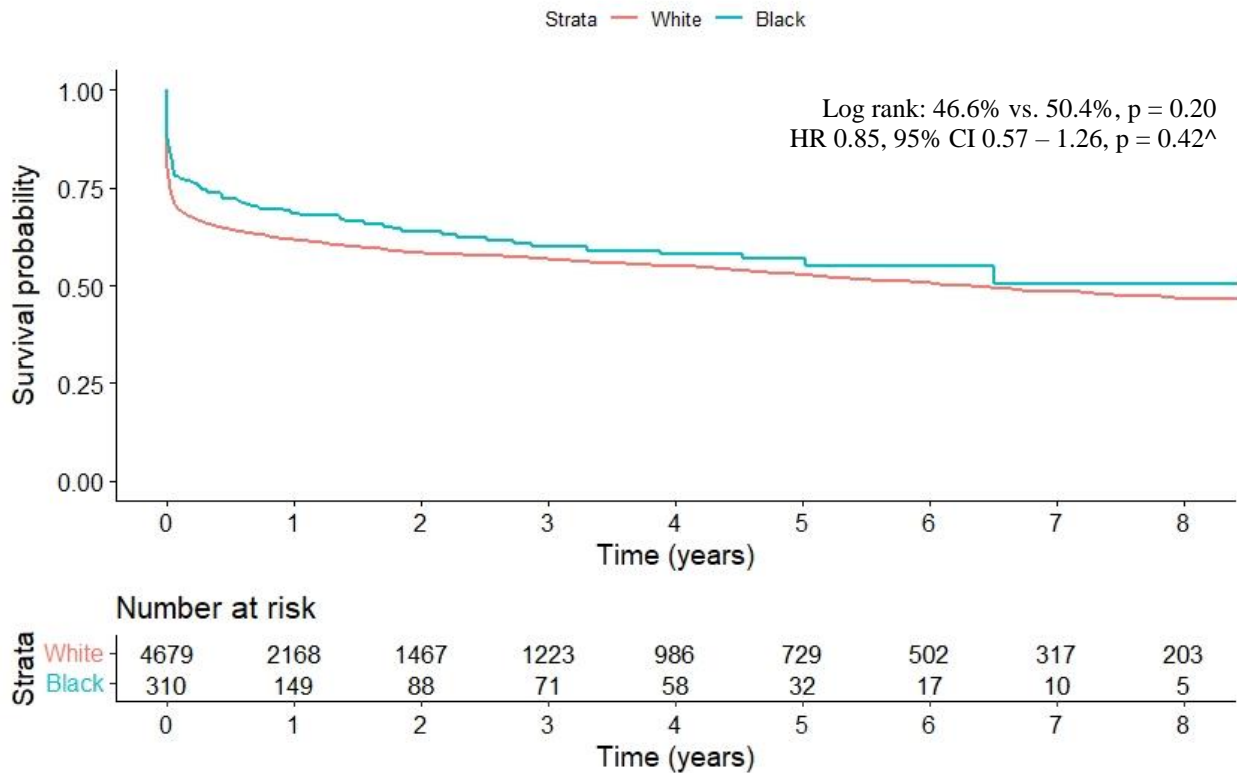
Fig 1. Long-term (8-year) survival following ruptured abdominal aortic aneurysm repair in black and white patients.

^Adjusted for demographics (age, gender, body mass index, primary insurer, pre-operative living status, region), comorbidities (hypertension, diabetes, smoking status, family history of abdominal aortic aneurysm, coronary artery disease, prior coronary artery bypass graft, prior percutaneous coronary intervention, congestive heart failure, chronic obstructive pulmonary disease, chronic kidney disease, dialysis, prior abdominal aortic aneurysm repair, prior carotid endarterectomy/stent, prior peripheral artery bypass, prior peripheral artery angioplasty/stent, prior major amputation), medications (acetylsalicylic acid, P2Y12 antagonist, statin, beta blocker, angiotensin converting enzyme inhibitor, anticoagulant), clinical presentation (transfer from another hospital, lowest pre-intubation blood pressure, heart rate on arrival to operating room, highest intra-operative heart rate, mental status, cardiac arrest, pre-operative hemoglobin, aneurysm diameter, concomitant iliac artery aneurysm), and operative characteristics (time from symptom onset to incision or access, time from hospital admission to incision or access, procedure time, procedure year).

Abbreviations: HR (hazard ratio), CI (confidence interval).

MORTALITY AND RISK FACTORS FOR ABDOMINAL AORTIC ANEURYSM RUPTURE AFTER EVAR (RARE)

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OBJECTIVE

To characterize risk factors for infrarenal abdominal aortic aneurysm rupture after endovascular repair (rARE) and evaluate 30-day mortality in comparison to primary rAAA.

METHODS

A retrospective review of all patients with an infrarenal rAAA who presented to the Peter Lougheed Centre between February 11, 2006, and December 31, 2018, was performed. rARE patients (previous index endovascular repair) were identified, descriptive statistics and overall 30-day mortality were analyzed.

RESULTS

267 patients with an infrarenal rAAA were identified between 2006 and 2018, eleven of which had rARE after index EVAR. Overall 30-day mortality was 31.8%. For rAAA patients who received intervention, the 30-day mortality was 28.6% for primary rAAA and 11.1% for rARE following index EVAR (Table 1). Summary statistics are described in Table 2. Four rARE patients were lost to follow-up prior to their rAAA. Seven rARE patients went on to have a rAAA despite appropriate imaging surveillance according to the SVS guidelines. Of these, four patients had ongoing AAA sac expansion with associated endoleak (type 2 and type 1b) while three patients had AAA sac stability and no identifiable cause leading to rupture. Average time from index endovascular repair to rARE was 4.9 +/- 2.9 years, and average aneurysm sac growth from index repair to rARE was 2.3 +/- 3.1cm. All patients had an endoleak at time of rupture with nine out of eleven having direct inline flow to the aneurysm sac via a type 1 or type 3 endoleak.

CONCLUSION

This small case series demonstrated rAAA after index EVAR (rARE) was associated with a lower 30-day mortality rate relative to primary rAAA. Loss to follow-up, as well as AAA sac expansion with untreated endoleak were risk factors for rARE. Prompt treatment of endoleak in the setting of sac expansion may prevent the development of type 1 or type 3 endoleaks and reduce rARE. Despite appropriate follow-up and no clear risk factors, rARE may still occur, suggesting that the specific mechanisms for post EVAR sac failure remain elusive.

Table 1: Overall 30-day mortality of patients with infrarenal rAAA

	30-day mortality of operative intervention	Palliative care
Primary rAAA	28.6% (70/245)	11
rAAA after EVAR (rARE)	11.1% (1/9)	2

Table 2: Case details and descriptive statistics for rAAA patients after index endovascular repair (rARE). Continuous measures are presented as mean +/- standard deviation, and categorical or binary measures as counts with percentages.

	Sex	Age at index repair	Age at rAAA	Initial AAA size	Indication for repair	Secondary interventions	Time from last scan to rupture (days)	Time to rupture (days)	Average number of surveillance scans per year	rAAA size	AAA growth at time of rupture	Intervention at time of rAAA	Endoleak at time of rupture	30-day mortality	Imaging findings on last surveillance scan	Risk factor for rAAA
1	M	77	82	9.4	Elective	Open repair of type 1b endoleak	130	2172	0.85	8.9	-0.5	EVAR	Type 3		CTA demonstrated AAA sac regression, no endoleak	No cause identified
2	F	79	81	5.2	Elective	Embolization of type 2 endoleak	1	816	0.45	12.7	7.5	Open	Type 2		CTA on day before rupture, AAA sac expansion with a type 2 endoleak	Untreated type 2 endoleak with ongoing AAA sac expansion
3	M	80	84	5.6	Elective	None	694	1791	1.23	5.6	0	EVAR	Type 3		CTA demonstrated AAA sac	Lost to follow-up

															stable, no endoleak. Subsequently lost to follow-up.	
4	M	71	75	8.6	Symptomatic	None	258	1406	1.93	7.8	-0.8	Open	Type 1a		US demonstrated AAA sac regression, no endoleak	No cause identified
5	M	77	81	8.4	Elective	None	1009	1612	1.10	13	4.6	EVAR	Type 1a		CTA demonstrated AAA sac expansion, no endoleak. Subsequently lost to follow-up.	Lost to follow-up
6	M	61	66	7.2	Elective	None	247	1828	1.25	8.4	1.2	EVAR	Type 1b		US demonstrated AAA sac regressio	No cause identified

															n, no endoleak	
7	M	75	79	8.4	Rupture	2x embolization of type 1b endoleak from internal iliac artery, followed by bilateral distal limb extension for short landing zone	1	1459	0.44	9.6	1.2	EVAR	Type 1b		CTA on day before rupture demonstrated AAA sac expansion, type 1b endoleak	AAA sac expansion with no endoleak identified
8	M	62	65	7.7	Elective	None	526	907	1.24	6.9	-0.8	EVAR	Type 1b	Died	CTA demonstrated AAA sac regression, no endoleak, short left limb landing zone. Subsequently lost	Lost to follow-up

																to follow-up.	
9	M	69	82	5.0	Elective	Embolization of type 2 endoleak	44	4799.00	0.94	11.1	6.1	EVAR	Type 3 and type 2		CTA demonstrated AAA sac expansion, type 2 endoleak	Untreated type 2 endoleak with ongoing AAA sac expansion
10	M	82	87	11.1	Rupture	None	44	1639	3.53	12.7	1.6	Palliative	Type 2	Died	CTA demonstrated AAA sac expansion, type 2 endoleak	Untreated type 2 endoleak with ongoing AAA sac expansion
11	F	94	98	6.3	Rupture	None	No imaging after index	1307	0.00	12	5.7	Palliative	Type 1a	Died	No follow-up imaging	Lost to follow-up

							repair								
Summary statistics	**81.8% male**	**74 +/- 9.2 years**	**80 +/- 9.2 years**	**7.5 +/- 1.9 cm**			**295 +/- 342 days**	**1794 +/- 1071 days**	**0.94 +/- 0.5 scans per year**	**9.9 +/- 2.57 cm**	**2.3 +/- 3.1 cm**				

ONE-TIME POPULATION-BASED SCREENING FOR ABDOMINAL AORTIC ANEURYSMS IN CANADA: A MODEL-BASED COST-UTILITY ANALYSIS

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OBJECTIVE

The aim of this study was to determine the effectiveness and cost-utility of ultrasound screening for abdominal aortic aneurysms (AAA) in Canada.

METHODS

One-time AAA screening in men and women aged 65 years was compared to no screening using a Markov model with a lifetime horizon (**Figure 1**) to estimate: life-years, quality-adjusted life-years (QALYs), AAA-related deaths, number needed to screen (NNS) to prevent one AAA-related death, and cost from the perspective of the Ministry of Health. Patients who developed large AAAs, identified through positive screening or incidental diagnosis, underwent scheduled open or endovascular repair. Model inputs were retrieved from literature, Statistics Canada, and the Ontario Case Costing Initiative. Parameter uncertainty was evaluated though probabilistic sensitivity analysis and all analyses were also repeated for men and women aged 75 years.

RESULTS

Compared to no screening, screening resulted in 0.15 (18.89 vs. 18.74) additional life-years, 0.10 (14.89 vs. 14.79) additional QALYs, and an absolute reduction of 1.47% (0.66% vs 2.13%) in AAA-related deaths among 65-year-old men (**Table 1**). In 65-year-old women, screening resulted in 0.06 (21.20 vs. 21.14) additional life-years, 0.05 (16.17 vs 16.12) additional QALYs, and an absolute reduction of 0.51% (0.31% vs 0.82%) in AAA-related deaths. The NNS for 65-year-old men (68) and women (196) were lower than those for common cancer screening programs (**Table 2**). At a willingness-to-pay threshold of CA$50,000/year, screening was preferred over no screening for men and women in 100% of model iterations on probabilistic sensitivity analysis. In 75-year-old men and women, lower clinical effectiveness and cost-utility were observed (**Table 1**).

CONCLUSION

Screening for AAA in men and women in Canada is associated with greater QALYs and fewer AAA-related deaths while being cost-effective in men and women aged 65 and 75 years.

Table 1. Base-case analyses comparing screening to no screening for abdominal aortic aneurysms (AAAs) over a lifetime. All values represent average (per individual) findings. *CI = Confidence interval; ICER = Incremental cost-effectiveness ratio; QALY = Quality-adjusted life year; SD = Standard deviation.* Note: costs were adjusted to 2022 Canadian Dollars, and costs and outcomes were discounted at 1.5% per year.

	Screening (95%CI)	No Screening (95%CI)	Absolute Difference
65-year-old Canadian man			
Life-years	18.89 (18.80-18.94)	18.74 (18.54-18.89)	0.15
QALYs	14.89 (14.82-14.93)	14.79 (14.64-14.90)	0.10
Cost (CA$)	1,216.71 (472.25-2,317.13)	960.84 (373.92-1,836.88)	255.87
AAA-related deaths, %	0.66	2.13	-1.47
Number needed to screen to prevent one AAA-related death	68		
ICER (CA$/QALY)	2,461.07		
65-year-old Canadian woman			
Life-years	21.20 (21.09-21.25)	21.14 (20.90-21.25)	0.06
QALYs	16.17 (16.10-16.21)	16.12 (15.99-16.21)	0.05
Cost (CA$)	368.00 (30.97-1,091.14)	339.99 (28.15-993.46)65-	28.02
AAA-related deaths, %	0.31	0.82	-0.51
Number needed to screen to prevent one AAA-related death	196		
ICER (CA$/QALY)	552.31		
75-year-old Canadian man			
Life-years	12.01 (11.97-12.04)	11.96 (11.88-12.02)	0.05
QALYs	8.73 (8.71-8.75)	8.70 (8.65-8.74)	0.03
Cost (CA$)	939.18 (343.57-1,795.72)	625.17 (231.60-1,195.97)	314.01
AAA-related deaths, %	0.51	1.36	-0.85

Number needed to screen to prevent one AAA-related death	118		
ICER (CA$/QALY)	9,365.12		
75-year-old Canadian woman			
Life-years	13.94 (13.88-13.97)	13.91 (13.79-13.97)	0.03
QALYs	9.87 (9.82-9.88)	9.85 (9.76-9.88)	0.02
Cost (CA$)	327.50 (28.31-978.75)	282.93 (24.63-843.20)	44.57
AAA-related deaths, %	0.27	0.68	-0.41
Number needed to screen to prevent one AAA-related death	244		
ICER (CA$/QALY)	2,065.60		

Table 2. Comparison of number needed to screen for different common conditions. Values for cancer screening programs were derived from the literature. *CI = Confidence interval*.

Condition	Number Needed to Screen (95%CI)
Abdominal aortic aneurysms (our model)	
• Men aged 65	68
• Women aged 65	196
• Men aged 75	118
• Women aged 75	244
Breast cancer	1,724 (1,176-3,704)
Colorectal cancer	
• Fecal occult blood test	377 (249-887)
• Flexible sigmoidoscopy	864 (672-1,266)
Prostate cancer	1,410 (1,142-1,721)

Figure 1. Markov model state transition diagram. *AAA = Abdominal aortic aneurysm; EVAR = Endovascular aortic repair.* Small AAA = 3.0-4.4cm for men, 3.0-3.9cm for women; Medium AAA = 4.5-5.4cm for men, 4.0-4.9cm for women; Large AAA = ≥5.5cm for men, ≥5.0cm for women.

ASSOCIATION BETWEEN BODY MASS INDEX AND OUTCOMES FOLLOWING ENDOVASCULAR ANEURYSM REPAIR

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OBJECTIVE

This study aims to assess the association between body mass index (BMI) and outcomes in patients undergoing endovascular aneurysm repair (EVAR) for infrarenal abdominal aortic aneurysm (AAA).

METHODS

A retrospective analysis of consecutive patients undergoing EVAR for AAA between January 1998 and December 2019. Normal weight, overweight and obese patients were compared. Primary outcome was 30 day mortality and mortality during follow-up. Secondary outcomes were freedom from reintervention and sac regression. Continuous variables were compared using one step analysis of variance (ANOVA). Univariate analysis compared cohorts against normal. weight as reference using Chi square test. All-cause mortality and freedom from reintervention were compared between cohorts using Kaplan-Meier survival estimates. Sac regression was measured using mixed model ANOVA with pair-wise comparison using Bonferroni post-hoc test.

RESULTS

The study consisted of 515 patients with 83% males and mean age of 77± 8 years. Mean follow up was 45±34 months. Underweight, normal weight, overweight, obese and morbidly obese patients made up 2.1%, 32.4%, 41.6% and 21.2% and 2.7% of the study population respectively. Obese patients had more diabetes mellitus (33.3% vs 10.6%) and dyslipidemia (82.4% vs 60.9%) compared to normal weight (table I). There were no difference in perioperative mortality. Kaplan-Meier survival estimates showed no differences in survival, or freedom from reintervention. Normal weight (57.3+/-8.7 to 54.7 +/- 10.2, p=.009) and overweight (58.4 +/-9.3 to 56.4 +/-10.8, p=.026) patients had significant sac regression which was not evident in obese patients (58.1 +/-9.4 to 58.5 +/-12.4. p=.786) on follow up (figure 1).

CONCLUSION

Obese patients were less likely to experience aneurysm sac regression on follow up compared to normal weight and overweight patients. There was no association between obesity and increased mortality or reintervention in patients undergoing EVAR for AAA.

Log rank p=.438
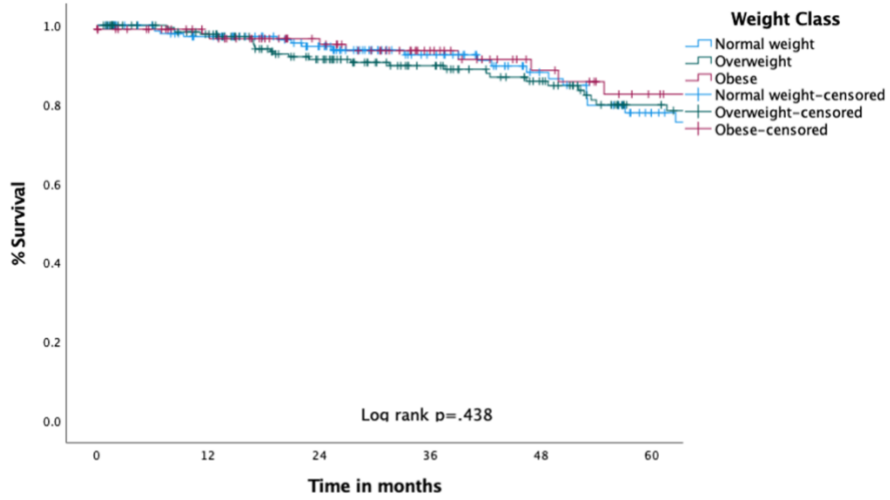
Number at risk

Normal weight	153	132	106	74	54	35
Overweight	194	169	132	102	80	55
Obese	100	83	66	47	32	23

P=0.786

P=0.026

P=0.009
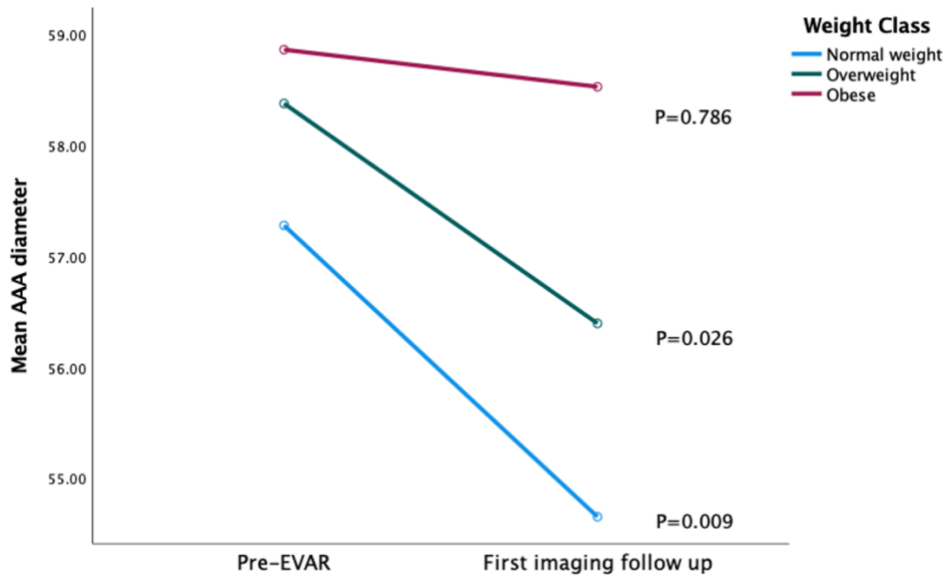
	Normal weight (n=167) [Reference]	Overweight (n=214)	P-value	Obese (n=109)	p value
Age	79.8 (7.5)	76.6 (7.8)	<0.001	74.8 (7.6)	<.001
Male sex	137 (82.0%)	178 (83.2%)	0.770	94 (86.2%)	.356
Mean BMI	22.8 (1.7)	27.4 (1.5)	<0.001	33.7 (3.9)	<.001
AAA diameter	57.1 (8.9)	58.5 (9.3)	0.308	58.6 (10.0)	.357
Comorbidities					
Cardiac	82 (54.3%)	108 (55.1%)	0.882	58 (56.9%)	.688
Respiratory	54 (35.8%)	52 (26.7%)	0.069	37 (36.3%)	.934
Renal	25 (16.7%)	36 (18.5%)	0.665	15 (14.7)	.676
DM	16 (10.6%)	44 (22.6%)	0.004	34 (33.3%)	<.001
HTN	117 (77.5%)	157 (80.1%)	0.553	80 (78.4%)	.859
Dyslipidemia	92 (60.9%)	135 (68.9%)	0.123	84 (82.4%)	<.001
Neurological	17 (11.3%)	21 (10.0%)	0.895	8 (7.8%)	.363
PAD	19 (12.7%)	30 (15.4%)	0.473	15 (14.7%)	.642
Cancer	35 (23.3%)	32 (16.6%)	0.118	12 (11.8%)	.021
Previous aortic interventions	2 (1.5%)	0 (0%)	0.098	3 (3.1%)	.432
Tobacco use					
None	35 (23.3%)	28 (14.9%)	0.048	18 (17.8%)	.294
Previous use	74 (49.3%)	117 (62.2%)	0.017	66 (64.7%)	.016
Current use	42 (27.8%)	45 (23.4%)	0.355	19 (18.8%)	.102
Preoperative creatinine	96.3 (47.0)	100.6 (67.6)	0.740	92 (25)	.800
Medications					
Beta blockers	59 (39.6%)	83 (43.5%)	0.474	55 (54.5%)	.021
ACE/ARB	69 (46.6%)	97 (50.5%)	0.476	49 (48.0%)	.825
CCB	47 (31.5%)	66 (34.6%)	0.559	31 (30.4%)	.846
Statin	93 (62.4%)	129 (67.5%)	0.325	85 (83.3%)	<.001
Antiplatelets	90 (60.0%)	126 (64.6%)	0.380	67 (65.7%)	.361
Anticoagulation	22 (14.7%)	24 (12.4%)	0.547	13 (12.7%)	.665

Table I – Baseline characteristics of NW, OW and Ob patients undergoing EVAR

DEVELOPMENT OF AN ARTIFICAL INTELLIGENCE TOOL FOR INTRAOPERATIVE GUIDANCE DURING ENDOVASCULAR ANEURSYM REPAIR

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OBJECTIVES

This study aims to train and test the performance of a deep learning artificial intelligence model that can identify inappropriate landing zones on fluoroscopy during endovascular aneurysm repair (EVAR).

METHODS

A deep learning model was trained to identify a "No-Go" landing zone (zone 8, Society for Vascular Surgery reporting guidelines for type B dissections), as defined by coverage of the lowest renal artery during EVAR. Fluoroscopic images from elective EVAR procedures from a single institution and from open access sources formed the dataset. Annotations of the "No-Go" zone were performed by trained annotators. A 10-fold cross-validation technique, where the dataset was divided randomly into 10 partitions with nine being used for training and the tenth being used for testing, was used to evaluate the performance of the model against human annotations. Primary outcomes were intersection-over-union (IOU) and F1 score (validated spatial overlap indices) and secondary outcomes were pixel-wise accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

RESULTS

The AI model was trained using 369 images procured from 110 different patients/videos. Overall, 18 patients/videos (44 images) were obtained from open access sources. For the primary outcomes, IOU and F1 were 0.43 (standard deviation ±0.29) and 0.53 (±0.32) respectively. For the secondary outcomes, accuracy, sensitivity, specificity, NPV, and PPV were 0.97 (±0.002), 0.51 (±0.34), 0.99 (±0.001). 0.99 (±0.002), and 0.62 (±0.34) respectively. An example of the segmented No-Go zone is shown in figure 1.

CONCLUSIONS

AI can effectively identify sub-optimal areas of stent deployment during EVAR. This model has the potential to augment intraoperative decision-making and minimize the risk of adverse events associated with endovascular stent graft deployment. Further directions include validating the model on datasets from other institutions and assessing its ability to predict optimal stent graft placement and clinical outcomes.
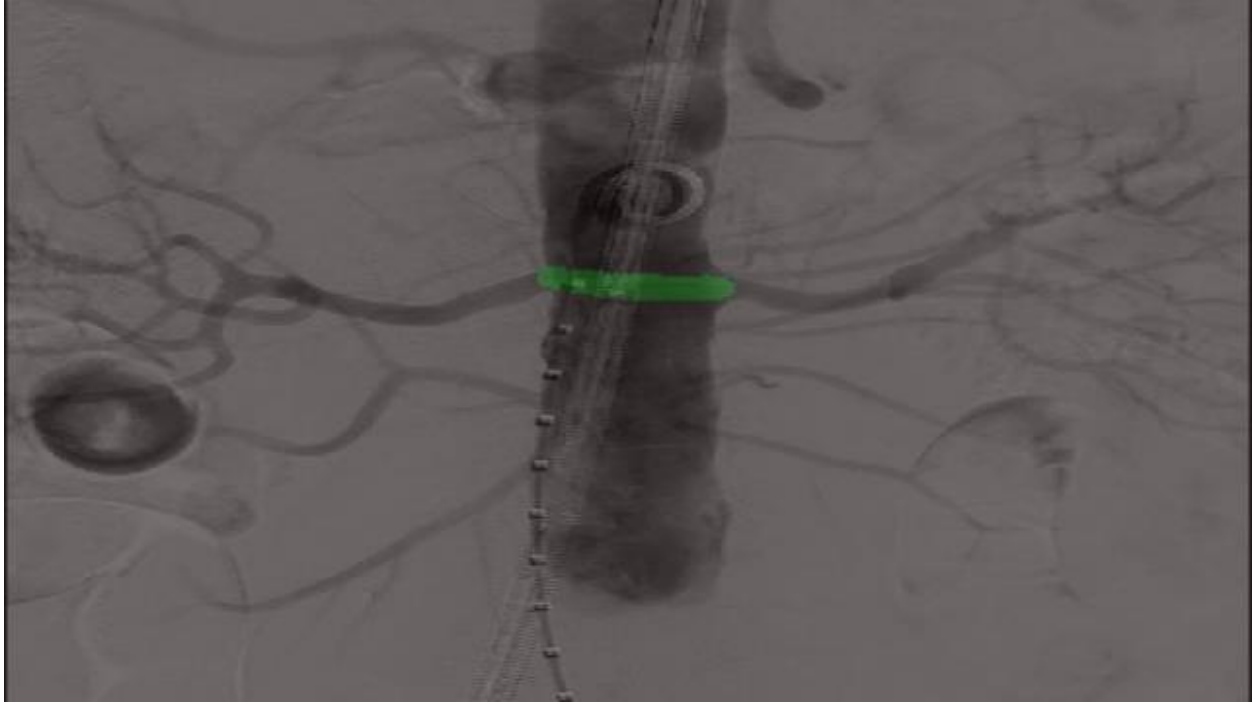
Figure 1. Prediction of the "No-go" zone (green) by the AI model.

SESSION III: THORACOABDOMINAL AORTIC ANEURYSM REPAIR

11_CSVS_2022
OUTCOMES OF SPINAL DRAIN PLACEMENT FOR AORTIC SURGERY AT MCGILL

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BACKGROUND
Spinal drains (SD) are an important adjunct for spinal cord protection during aortic surgery. However, SDs can lead to severe complications. We sought to evaluate the outcomes of SD placement at two McGill University-affiliated hospitals.

METHODS
Patients who underwent aortic repair between 2014 and 2020 at the Royal Victoria and Jewish General Hospitals were identified and grouped based on SD placement at the time of surgery. A retrospective chart review was performed and patient, operative and complication data were analyzed.

RESULTS
Ninety-one patients (62.8%) underwent SD placement and 54 patients (37.2%) underwent aortic repair without SD placement. Patients who did not undergo SD placement were more likely to present with ruptured aneurysms (p < 0.001) or traumatic aortic injuries (p < 0.001) and to undergo TEVAR (p = 0.01). Post-operatively, 10 (11.0%) of patients developed drain-related complications, including two patients (2.2%) who developed intra-cerebral hemorrhages without long-term sequelae. Overall, there was no difference in post-operative rates of spinal cord ischemia between the groups (p = 0.412), however a total of eight patients (8.8%) in the SD group experienced either transient (N = 4, 4.4%) or permanent (N = 4, 4.4%) paraplegia (p = 0.046). These patients all presented with thoracoabdominal aneurysms and underwent open repair or F/BEVAR. Transient episodes were associated with hypotension or low SD output and resolved with medical optimization of cerebral perfusion. Permanent paraplegia was attributed to spinal cord ischemia in 3 (3.3%) of patients.

CONCLUSIONS
SD-related complications occurred in 11.0% of patients, with only 2.2% experiencing severe complications. SD insertion therefore remains a safe practice despite variation in Anesthesia across our institution. All spinal cord complications occurred in thoracoabdominal patients who underwent open repair or F/BEVAR. Aortic repair without SD may therefore be safe in select patients with isolated thoracic disease or undergoing stand-alone TEVAR.

ADJUNCTIVE HYPERBARIC OXYGEN THERAPY FOR SPINAL CORD ISCHEMIA AFTER COMPLEX AORTIC REPAIR

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OBJECTIVE
To review our center's experience with hyperbaric oxygen therapy (HBOT) in addition to standard treatment in spinal cord ischemia (SCI) post-complex aortic repair (CAR).

METHODS
A retrospective review of the Hyperbaric Medicine Unit database identified SCI patients post-CAR treated with HBOT between January 2013 and June 2021. Mean estimates of overall motor function scores were determined for pre-HBOT and final assessment using a linear mixed model. A subgroup analysis compared the mean estimates of overall motor function scores between improvement and non-improvement groups at given timepoints. Improvement of motor function was defined as either a $\geq$ 2-point increase in overall muscle function score in patients with paraparesis or an upward change in motor deficit categorization (MDC: para/monoplegia, paraparesis and no deficit). To account for multiple testing, a two-sided p-value of ≤ 0.01 was used to assess statistical significance.

RESULTS
Thirty patients were treated for SCI (Table I). Pre-HBOT, the MDC was 10 paraplegia, 3 monoplegia, 16 paraparesis and 1 unable to assess (Table II). At the final assessment, 14 patients demonstrated variable degrees of motor function improvement; eight patients demonstrated full motor function recovery. Seven of the ten patients with paraplegia remained paraplegic despite HBOT. The estimated mean of overall muscle function score for pre-HBOT was 16.6±2.9 (95%CI: 10.9, 22.3) and for final assessment was 23.4±2.9 (95%CI: 17.7, 29.1). The estimated mean difference between pre-HBOT and final assessment overall muscle function score was 6.7±3.1 (95%CI: 0.6, 16.1). The estimated mean difference of the overall muscle function score between pre-HBOT and final assessment for the improved group was 16.6±3.5 (95%CI: 7.5, 25.7) vs. -4.9±4.2 (95%CI: -16.0, 6.2) for the non-improved group.

CONCLUSION
HBOT in addition to standard treatment may potentially improve recovery in spinal cord function following SCI post-CAR. However, the potential benefits of HBOT are not equally distributed amongst subgroups.

Table 1: Patient demographics

	Overall (n=30 cases)
Age (mean (SD))	65.60 (12.17)
BMI (mean (SD))	28.50 (7.11)
Gender = Male (%)	22 (73.3)
Priority of surgery (%)	
Elective	13 (43.3)
Emergency	8 (26.7)
Urgent	9 (30.0)
ASA	
ASA 4 (%)	29 (96.7)
ASA 5 (%)	1 (3.3)
Type of surgery = Open (%)	17 (56.7)
CSF drain insertion (%)	
Preop	19 (63.3)

Table 2: Hyperbaric oxygen therapy details and response

	Overall (n=30 cases)
Mean HBOT per SCI event (SD)	5.23 (2.62)
Total HBOT sessions	157
HBOT complications (% of HBOT session)	
Seizure	2 (1.27)
Middle ear barotrauma	2 (1.27)
Pneumothorax	1 (0.64)
Pre-HBOT motor deficit categorization	
Paraplegia	10
Monoplegia	3
Paraparesis	16
Unable to assess (a)	1

Final assessment motor deficit categorization	
Paraplegia	9
Monoplegia	1
Paraparesis	10
No motor deficit	8
Unable to assess (b)	2
Response to HBOT - Motor function improvement	
No response	11
Partial response	17
Full recover	8
Unable to assess	2

a) Taken to HBOT immediately post-operatively for failure to recover motor evoked potentials intra-operatively
b) Rupture aortic aneurysm following HBOT

EVALUATING BRANCH CHARACTERISTICS OF OFF-THE-SHELF T-BRANCH AND CUSTOM-MADE STENT GRAFTS IN ENDOVASCULAR REPAIR OF THORACOABDOMINAL AORTIC ANEURYSMS

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OBJECTIVE

To evaluate the branch characteristics of off-the-shelf T-branch and custom-made stent grafts used for thoracoabdominal endovascular aortic repair (TA-EVAR).

METHODS

A retrospective single-centre review of consecutive patients who underwent TA-EVAR from November 2007 to July 2021. Three-dimensional computed tomography reconstructions (AquariusNET software, TeraRecon) of patients' first postoperative CT scan were used to measure branch total length (TL), vertical length (VL), tortuosity index (TI) and average curvature for the visceral arteries. Our outcomes of interest included branch instability measures (endoleaks, branch occlusions and reinterventions) and branch-related clinical outcomes (mesenteric ischemia and permanent dialysis).

RESULTS

Eighty-nine custom-made (all males; mean age 73.3 ± 7.3 years) and fifteen T-branch stent grafts (8 males, 7 females; mean age 72.5 ± 10.6 years) were implanted. The majority of custom repairs were elective (82/89, 92%), whereas most T-branch repairs were urgent/emergent (10/15, 67%). Ten patients suffered in-hospital mortality (10/104, 10%). Ninety-four patients completed clinical follow-up and 85 (85/94, 90%) of those completed surveillance imaging. Twelve patients suffered branch occlusions, primarily occurring in the renal arteries (8/10, 67%); Table 1. None suffered mesenteric ischemia or required dialysis. Post-implantation analysis included 181 down-going vessels from 60 patient CT scans (Table 2). The lengths of the renal branches were on average longer for T-branch versus custom grafts, with the LR being the most variable. Interestingly, TI and average curvature were similar across branches regardless of graft type, with the renal branches demonstrating the greatest tortuosity compared to the celiac and SMA.

CONCLUSION

The similar branch characteristics across groups and our low numbers of branch-related adverse outcomes, when stratified by vessel, makes drawing statistical conclusions regarding the effect of branch characteristics on branch stability difficult. Further research is required to elucidate the impact of branch characteristics on TA-EVAR outcomes, which would greatly influence graft choice, planning and implementation.

Table 1. Post-discharge branch-related adverse outcomes detected on surveillance imaging for patients who underwent TA-EVAR

	Custom (n=75)	Off-The-Shelf (n=10)	Total (n=85)
Outcomes, no. (%)			
Endoleak[e]			
Type I	15[b] (20)	3 (30)	18 (21)
Type III	21[c] (28)	5 (5)	26 (31)
Branch Occlusion	9[a] (12)	3 (30)	12 (14)
Graft Kink	5 (6.7)	1 (10)	6 (7.1)
Aneurysm sac size[d]			
Stable	26 (35)	4 (40)	30 (35)
Increased	13 (17)	3 (30)	16 (19)
Decreased	35 (47)	3 (30)	38 (45)

Abbreviations: SMA = superior mesenteric artery; RR = right renal; LR = left renal; TL = total length; VL = vertical length

[a]RR = 3, LR = 2, SMA = 1, Celiac = 3.

[b]1a = 3, 1b = 8, 1c = 1. Three endoleaks Type 1 are not specified whether type a, b or c.

[c]RR = 3, LR = 1, SMA = 4, Celiac = 3, Celiac/SMA = 2, Thoracic graft (overlap) = 2, Thoracic graft (aorta) = 1, Left stent dislocation = 1, 4 = no details available.

[d]Aneurysm sac size unknown for one custom patient.

[e]No. custom cases requiring reintervention: Type I = 11, Type III = 18. No. off-the-shelf cases requiring reintervention: Type I = 2 (SMA, RR); Type III = 3 (Celiac, SMA, RR).

Table 2. Post-implantation branch characteristics of off-the-shelf T-branch and custom-made stent grafts for TA-EVAR

T-Branch				
	Celiac (n=9)	SMA (n=10)	RR (n=9)	LR (n=11)
TL (mm)	57.72 ± 17.58	60.80 ± 16.21	60.32 ± 23.49	73.42 ± 22.11
VL (mm)	18.09 ± 9.12	52.87 ± 16.58	54.77 ± 22.52	67.56 ± 22.58
Tortuosity Index	1.16 ± 0.24	1.06 ± 0.03	1.43 ± 0.38	1.44 ± 0.43
Avg Curvature (cm^{-1})	0.46 ± 0.15	0.37 ± 0.13	0.49 ± 0.09	0.43 ± 0.09
Custom				
	Celiac (n=35)	SMA (n=46)	RR (n=33)	LR (n=28)
TL (mm)	54.25 ± 15.65	57.44 ± 19.37	55.86 ± 18.65	53.12 ± 16.37
VL (mm)	18.64 ± 13.30	46.89 ± 20.55	48.19 ± 20.87	46.58 ± 15.87
Tortuosity Index	1.15 ± 0.19	1.07 ± 0.06	1.35 ± 0.20	1.34 ± 0.30
Avg Curvature (cm^{-1})	0.43 ± 0.14	0.36 ± 0.14	0.54 ± 0.14	0.55 ± 0.20
Total Cohort				
	Celiac (n=44)	SMA (n=56)	RR (n=42)	LR (n=39)
TL (mm)	55.24 ± 15.84	58.32 ± 18.68	56.61 ± 19.27	60.05 ± 19.56
VL (mm)	18.30 ± 12.42	47.95 ± 19.90	44.30 ± 30.57	50.61 ± 26.86

Tortuosity Index	1.15 ± 0.19	1.07 ± 0.06	1.36 ± 0.24	1.41 ± 0.42
Avg Curvature (cm⁻¹)	0.43 ± 0.14[a]	0.36 ± 0.14[b]	0.54 ± 0.14[c]	0.52 ± 0.19[d]

Abbreviations: SMA = superior mesenteric artery; RR = right renal; LR = left renal; TL = total length; VL = vertical length

A total of 60 patient CT scans were included: 50 custom, 10 T-branch.

[a]The celiac average curvature was unable to be calculated for two patients: n=42.

[b]The SMA average curvature was unable to be calculated for five patients: n=51.

[c]The RR average curvature was unable to be calculated for one patient: n=41.

[d]The LR average curvature was unable to be calculated for one patient: n=38.

LONGER-TERM RATES OF SURVIVAL AND REINTERVENTION FOLLOWING THORACIC ENDOVASCULAR AORTIC REPAIR (TEVAR) FOR BLUNT AORTIC INJURY: A RETROSPECTIVE POPULATION-BASED COHORT STUDY FROM ONTARIO, CANADA

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OBJECTIVES

Blunt aortic injury (BAI) is associated with a high rate of mortality. Thoracic endovascular aortic repair (TEVAR) has emerged as the preferred treatment option for BAI patients. In this study we compare the longer-term outcomes of patients receiving TEVAR with other treatment options for BAI.

METHODS

We conducted a retrospective cohort study using administrative health data on BAI patients in Ontario, Canada between 2009 and 2020. Patients with BAI and who survived at least 24-hours following hospital admission were identified using diagnostic codes. We classified patients as having received TEVAR, open surgical, hybrid repair, or medical management as their initial treatment approach based on procedure codes. The primary outcome was survival to maximum follow-up. Secondary outcomes included aorta-related mortality or aortic reintervention. Cox's proportional hazards models were used to estimate the effect of TEVAR on survival.

RESULTS

427 patients with BAI were followed for a median of three years (IQR: 1-6 years), with 348 patients (81.5%) surviving. Survival to maximum follow-up did not differ between treatment groups: TEVAR: 79%, surgical repair: 63.6%, hybrid repair: 85.7%, medical management: 83.3% (P = 0.10). In adjusted analyses, TEVAR was not associated with improved survival compared to surgical repair (HR: 0.6, 95% CI: 0.3 - 1.6), hybrid repair (HR: 1.4, 95% CI: 0.5 - 3.6), or medical management (HR: 1.5, 95% CI: 0.8 - 2.6). Aortic reinterventions were required in only 2.6% of surviving patients but were significantly more common in the TEVAR group (P<0.01).

CONCLUSIONS

The longer-term survival from BAI appears highly favorable with low rates of reintervention and death in the years following injury, regardless of the initial treatment approach.

Level of Evidence: IV, Therapeutic study

LONG-TERM OUTCOMES OF FENESTRATED ENDOVASCULAR ANEURYSM REPAIR IN OCTOGENARIANS: A VQI DATABASE ANALYSIS

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OBJECTIVE

Our study examines postoperative and long-term outcomes of FEVAR in octogenarians: patient survival, complications, reinterventions, and target vessel patency.

METHODS

Retrospective analysis of the Vascular Quality Improvement (VQI) database was performed including procedures from 2012 to 2022. Included patients underwent elective endovascular aortic repair involving at least one visceral or renal artery, without arch involvement or subclavian repair. Patients were stratified into two groups: younger than 80 years and those 80 and older. These groups were compared based on preoperative, intraoperative, and postoperative factors. Descriptive statistics were performed using a t-test for continuous and a chi-square test for categorical variables. Postoperative outcomes of interest included technical success, postoperative bowel ischemia, postoperative spinal cord ischemia, length of stay and length of ICU stay. Long-term survival up to 9 years was modelled using Cox proportional hazards analysis.

RESULTS

A total of 6231 patients (n= 4920, <80 years and n=1311, >80 years) who underwent advanced branched or fenestrated endovascular aortic procedures were included. No significant difference was found in technical success, postoperative length of stay, length of ICU stay, postoperative bowel ischemia and spinal cord ischemia. Multivariate cox proportional hazards analysis demonstrated that age > 80 was a significant predictor for death even after adjustment for other patient and procedural covariates (HR 1.6 [95% CI 1.4-1.9], P< 0.001). Factors associated with poorer long-term survival included celiac artery branch or fenestration (HR 1.5 [95%CI 1.2-1.7]) and functional dependence (dependent for self-care or bed-bound) (HR 2.2 [95%CI 1.6-3.2]).

CONCLUSION

Our findings suggest that FEVAR in octogenarians is associated with equivalent peri-procedural outcomes to younger patients and a higher long-term risk of death. Long-term mortality was also associated with celiac artery branch or fenestration, and in patients who are frailer at baseline.

16_CSVS_2022
TIMING OF COMPLICATIONS FOLLOWING CAROTID ENDARTERECTOMY FOR SYMPTOMATIC AND ASYMPTOMATIC CAROTID ARTERY STENOSIS

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OBJECTIVE
The objective of this study was to examine the time to early postoperative complications and identify risk factors of early complications to assess the safety of implementing same-day discharge following carotid endarterectomy.

METHODS
A retrospective cohort study was performed including patients undergoing carotid endarterectomy from 2009 to 2020 at two academic hospitals (n = 732). Detailed information regarding patient demographics, clinical characteristics, primary complications including 30-day and 1-year death, stroke or transient ischemic attack (TIA), and secondary complications including 30-day myocardial infarction (MI), other cardiac complications, and return to the operating room were extracted. Multivariate logistic regression analysis was used to identify independent clinical characteristics associated with early complications.

RESULTS
Of 732 patients, 597 (81.6%) patients presented with symptomatic carotid artery stenosis. There was no mortality within 30-days postoperatively and death within 1-year occurred in 4 (0.5%) patients. The overall incidence of 30-day and 1-year stroke/TIA was 9 (1.2%) and 11 (1.5%). Within 30 days postoperatively, MI occurred in 3 (0.4%), other cardiac complications in 2 (0.3%), and return to the operating room in 16 (2.2%) patients. Stroke/TIA within 24 hours involved 5 patients, of which 1 (20.0%), 3 (60.0%), and 1 (20.0%) occurred within the first 6 hours, 7-12 hour, and 13-24 hour intervals respectively. MI occurred once within 6 hours and another within 13-24 hours. All other cardiac complications (n = 2) and return to the operating room (n = 10) within the 24-hour window occurred in the first 6 hours. Multivariate analysis demonstrated degree of stenosis to be associated with 30-day stroke/TIA and return to the operating room.

CONCLUSION
Majority of complications occur within the first 12 hours postoperatively and it may be unsafe to discharge patients before that window. Patients with high-degree carotid artery stenosis may be at risk of 30-day postoperative stroke/TIA and reintervention.

POST-OPERATIVE COMPLICATIONS AFTER CAROTID ENDARTERECTOMY FOR FREE FLOATING THROMBUS

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OBJECTIVE
To examine patient outcomes after carotid endarterectomy (CEA) for symptomatic carotid artery stenosis with free floating thrombus (FFT).

METHODOLOGY
A retrospective review of patients in a prospectively collected database was conducted on all patients who underwent CEA for symptomatic carotid artery stenosis at a single institution from 2010-2020. Patients with FFT were identified after review of computed tomography (CT) angiography at admission. Time from admission to procedure, medical management options and post-operative complication rates were analyzed.

RESULTS
During the study period 802 CEA were performed, of which 47 patients had FFT. Patients in this cohort presented more frequently with stroke, as opposed to transient ischemic attacks, and experienced higher rates of post-operative stroke (4.4% vs. 1.6%). The incidence of hematoma formation or cranial nerve damage were equal (8.8% vs. 10.1%). The FFT cohort were also less likely to be discharged home (82.3% vs. 95.8%). 13/45 (29%) had complete resolution of the FFT with preoperative heparinization and an additional 9 (20%) cases demonstrated significant reduction in thrombus size.

CONCLUSIONS
FFT is a high-risk phenotype of carotid stenosis associated with a threefold risk of postoperative stroke. Heparinization was associated with significant reduction in size of the FFT.

MACHINE LEARNING CLASSIFICATION OF DOPPLER WAVEFORMS

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OBJECTIVE

Arterial duplex US is a non-invasive and readily available test which plays an important role in the diagnosis and surveillance of PAD. A component of the duplex US interpretation includes classification of the doppler waveforms into triphasic, biphasic, monophasic and occluded; the latter two which are considered abnormal. The authors sought to use machine learning techniques to automate the classification of doppler waveforms.

METHODS

REB approval was granted from Sunnybrook hospital for the retrieval of images from the Sunnybrook vascular lab database (https://vasc.surgidex.com/). Web scraping methods were applied to automate the retrieval of 3208 images. All images were classified by a RPVI credentialed physician into occluded, monophasic, biphasic and triphasic categories. The python programming language (https://www.python.org/) with a 50 layer pretrained neural network (ResNet-50) was trained using Paperspace (https://www.paperspace.com/) which offers cloud-based computing. 80% (n=2567) of the images were used to train the model and the remaining 20% (n=641) were used to test.

RESULTS

Our neural network was trained and optimized. Of the 641 images used to test the model, 44 were misclassified for an error rate of 7%, giving an accuracy of 93%. For the machine learning model, the most challenging classification was distinguishing biphasic and triphasic. The resulting confusion matrix is shown in the below Figure 1. An example of two misclassified waveforms is shown in Figure 2.

CONCLUSION

Our neural network has been trained on a moderate sized database with good results and a low error rate of 7%. The algorithm performs quite well for monophasic and occluded waveforms however, differentiating triphasic and biphasic waveforms is more challenging. This highlights the subtle graphical differences between the two. Real-world applications of this algorithm could include the development of a mobile application to turn auditory pencil doppler input into a waveform and then subsequent waveform classification.
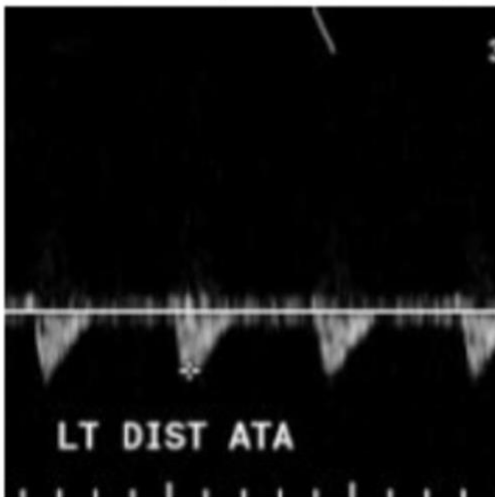
Figure 1: Confusion Matrix

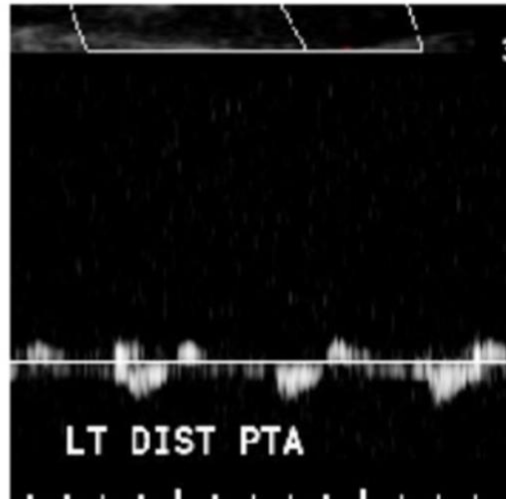

Figure 2: Sample Misclassified Waveforms (Prediction/Actual)

COMPREHENSIVE NETWORK META-ANALYSIS OF OUTCOMES FOR THE TREATMENT OF EXTRACRANIAL CAROTID ARTERY ANEURYSMS

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OBJECTIVES

Untreated extracranial carotid artery aneurysms (ECCAs) increase stroke and mortality risk. Current studies only evaluate surgical management. We compared outcomes between (1) conservative treatment (2) open repair and (3) endovascular repair of ECCAs through a network meta-analysis.

METHODS

Our study systematically searched Ovid MEDLINE and MEDLINE Daily, including e-publications, in progress, and non-indexed citations, Embase, and CENTRAL for articles published between inception to 2021 that had reported major outcomes (30-day major cardiac event, cranial nerve injury and overall mortality) after conservative, open and endovascular repair of ECCAs. Individual pairwise analysis and network meta-analysis was then performed on eligible studies to evaluate the three treatment group differences major outcomes with odds ratios (OR) and 95% confidence intervals (95%CI).

RESULTS

Thirteen studies were included—three of which were three-arm studies (n=380) for conservative management (n=31), open repair (n=225) and endovascular repair (n=124) (Table 1). In network meta-analysis conservative management (OR 4.87, 95%CI 0.92-25.78) and endovascular repair (OR 0.42, 95%CI 0.16-1.05) showed similar 30-day major adverse cardiac event rates compared to open surgery. Endovascular repair was associated with a lower incidence of cranial nerve injury (OR 0.18, 95%CI 0.06-0.53) compared to conservative and open management. Overall mortality was significantly decreased in endovascular repair (OR 0.28, 95%CI 0.08-0.96) when compared to open but not conservative management (OR 2.74, 95%CI 0.58-12.89) (Figure 1).
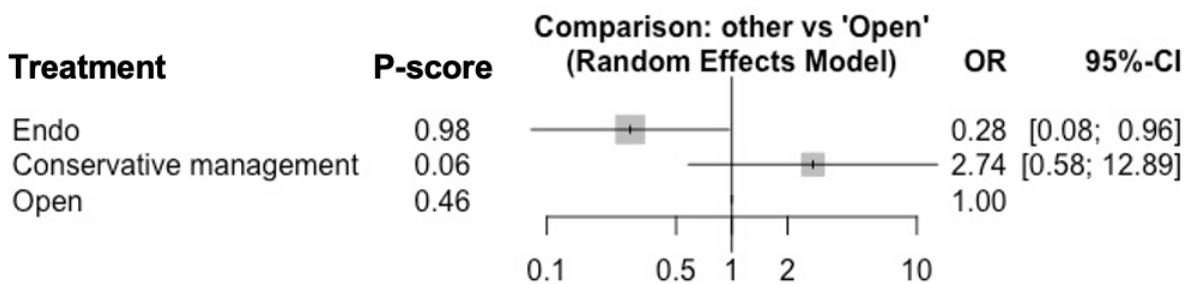
CONCLUSIONS

This is the first network meta-analysis performed for ECCA treatment. Open and endovascular repair is associated with comparable low incidence of mortality and cerebrovascular events. Not surprisingly, open surgical repair is associated with an increased risk of cranial nerve injury. Our findings suggest that endovascular repair would be a viable option for patients with distal aneurysms that require extensive dissection and high-risk comorbid patients. Furthermore, conservative management is viable for patients who fail candidacy for open or endovascular repair.

Table 1: Summary of Effect Estimates in Network Meta-Analysis

	Open Surgery (Reference)	Conservative Management	Endovascular Management
30-Day Major Adverse Cardiac Event	1.00	OR 4.87, 95%CI 0.92-25.78	OR 0.42, 95%CI 0.16-1.05
30-Day Cranial Nerve Injury	1.00	--	OR 0.18, 95%CI 0.06-0.53
30-Day Mortality	1.00	OR 2.74, 95%CI 0.58-12.89	OR 0.28, 95%CI 0.08-0.96

Figure 1: Network Meta-Analysis for the Outcome of 30-day Overall Mortality

Treatment	P-score	Comparison: other vs 'Open' (Random Effects Model)	OR	95%-CI
Endo	0.98		0.28	[0.08; 0.96]
Conservative management	0.06		2.74	[0.58; 12.89]
Open	0.46		1.00	

IMPACT OF USE OF IAC VS SRU CAROTID INTERPRETATION CRITERIA ON PATIENT MANAGEMENT

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INTRODUCTION

IAC recently introduced modified criteria for carotid duplex interpretation. The most significant change, compared to SRU criteria, involves re-defining <50% and 50-69% ranges. Definitions of 70-99%, near-occlusion and occlusion are unchanged. Patients identified in <50% vs 50-69% ranges may face different disease severity assignments, surveillance protocols, medical management approaches and access to intervention (if symptomatic); facilities may experience altered payment coverage, logistical issues of staff training and referring physician expectations. Aim: To assess the impact of re-defining ranges using the IAC criteria.

METHODS

Anonymized bilateral carotid data from 1000 patients, using standard protocols, in a quality improvement format. The data was analyzed in an electronic database separately using the IAC and the SRU criteria. Patients with normal arteries, previous intervention, trauma, dissection or vasculitis were excluded. The numbers and % of patients were assigned to each group, by IAC and SRU criteria (PSV or PSV+Ratio).

RESULTS

850 patients met eligibility criteria. The findings were as follows: Right carotid, 242 (28.5%) showed a change and 608 (71.5%) showed no change in categorization. Left side, 228 (27%) changed and 622 (73%) no change. All changes were from 50-69% range to < 50%. Analysis using PSV Ratios showed re-assignment of 53 (22% of changed, 6% of total cohort) patients to the higher range for the right side and 48 (21% of changed, 5.6% of total cohort) on the left. The impact on patients was determined with 27% re-assigned by PSV and 21% by the combination of PSV and PSV Ratio.

CONCLUSIONS

Implementation of the IAC criteria results in patients being re-assigned to lower stenosis categories. The impact of these changes on patient care and facility logistics need careful consideration.

SESSION V: ABDOMINAL AORTIC ANEURYSM 2

21_CSVS_2022
THE EFFECT OF AFTER HOURS PRESENTATION IN RUPTURED ABDOMINAL AORTIC ANEURYSM

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OBJECTIVE
To evaluate the outcomes of patients presenting with Ruptured Abdominal Aortic Aneurysms (RAAA) after hours, where "on call" teams are primarily responsible for patient care, compared to during the workday.

METHODS
A retrospective cohort study of RAAAs in Nova Scotia between 2005 and 2015 was performed through linkage of the Discharge Abstract Database, physician billings and Vital Statistics databases. Patients presenting after hours (6pm and 6am and on weekends) were compared to workday (Monday through Friday, 6am-6pm). 30-day mortality, mortality at home and operative mortality were compared between groups using multivariable logistic regression, adjusting for clinically significant factors on univariable analysis.

RESULTS
406 patients with RAAA were identified from 2005-2015, of which 147 (36.2%) presented during the workday and 259 (63.8%) after hours. Patients in both groups had similar age, sex, co-morbidities and operative approaches (Table 1). Overall 30-day mortality was 62.5% and was similar during workday (57.1%) and after hours (61.4%) (p=0.231). During the workday, Overall Chance of Survival (OCS) was 42.9%, 51.2% if traveled tertiary care and 68.5% if received surgery. After hours, OCS was 38.6%, 48.5% if traveled to a tertiary care center and 63.7% if received surgery (Figure 1). Patients who presented with RAAA after hours had similar adjusted odds of dying at home (OR 1.21, 95% CI 0.67-2.19), of receiving an operation (OR 0.85, 95% CI 0.54-1.33) and 30-day mortality (OR 1.36, 95% CI 0.85-2.18). In the 249 (61.3%) patients who underwent surgery, 30-day mortality was 37.4% overall: 34.8% during the workday and 38.9% after hours (Figure 1). Patients who underwent RAA repair after hours had similar adjusted odds of 30-day mortality (OR1.28, 95% CI 0.71-2.30).

CONCLUSIONS
RAAAs after hours have similar odds of dying at home, surgery, 30-day overall and operative mortality compared to patients presenting during the workday.

Figure 1: Flow chart of ruptured AAA with overall chances of survival at home, at a tertiary care centre and after surgery during the workday vs after hours
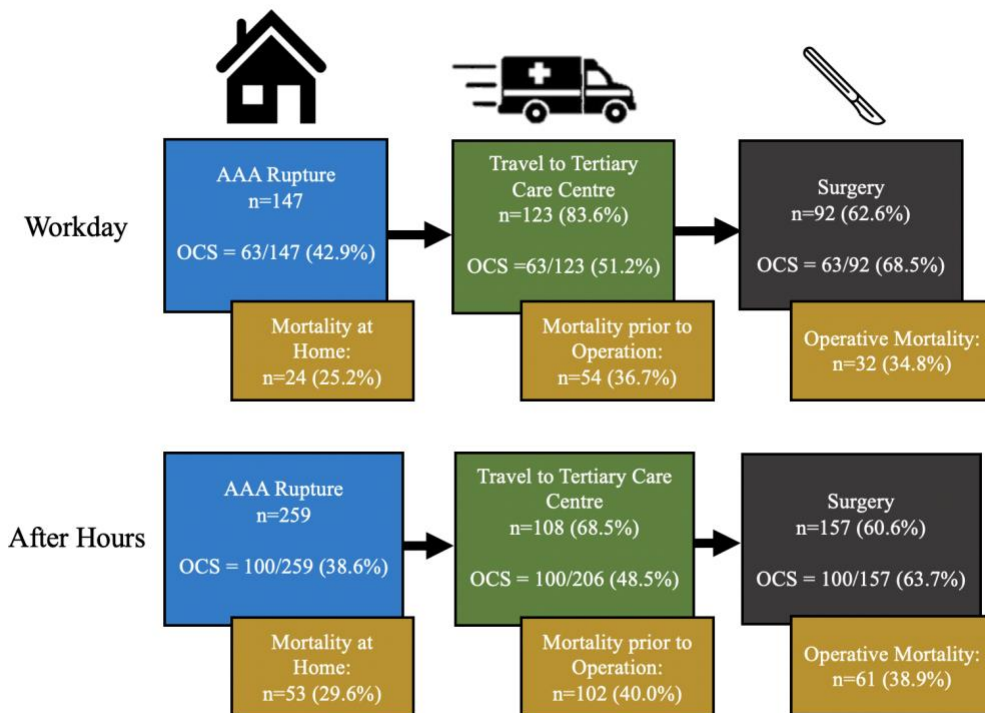
AAA=Abdominal Aortic Aneurysm. OCS= Overall Chance of Survival.

Table 1: Clinical and operative characteristics for patients with Ruptured Abdominal Aortic Aneurysms presenting on workday vs after hours

Clinical Characteristics	Workday n=147 (36)	After Hours n=259 (64)	p-value
Age, years (mean ±SD)	78 (9.3)	76 (10.0)	0.12
Female Sex	45 (30.6)	70 (27.0)	0.48
Hypertension	109 (74.2)	175 (67.6)	0.16
Diabetes	32 (21.8)	49 (18.9)	0.49
Coronary Artery Disease	26 (17.7)	53 (20.5)	0.50
Chronic Obstructive Pulmonary Disease	52 (35.4)	85 (32.8)	0.60
Peripheral Vascular Disease	22 (15.0)	43 (16.6)	0.67
Cerebrovascular Disease	20 (13.6)	31 (12.0)	0.63
Endovascular Repair	10 (10.9)	22 (14.0)	0.47

Characteristics represented as n (%) unless otherwise noted.

TRENDS IN INCIDENCE OF ABDOMINAL AORTIC ANEURYSM RUPTURE, REPAIR AND MORTALITY: 2005-2015

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OBJECTIVE

To examine whether trends in incidence of Elective Abdominal Aortic Aneurysm (EAAA) repair, Rupture Abdominal Aortic Aneurysm (RAAA), RAAA repair and AAA-related mortality have changed with the evolution of aneurysm screening and treatment.

METHODS

A retrospective cohort study of patients from 2005-2015 with AAA was conducted. Rates of EAAA repair and RAAA and mortality were obtained through linking of provincial administrative databases. The age-adjusted incidence of EAAA repair, overall rate of RAAA, RAAA repair, and AAA-related mortality was calculated for each sex based on 2012 Canadian census. Weighted linear regression was performed to analyze trends in incidence over time.

RESULTS

The annual age-adjusted incidence of EAAA repair was 18.9 per 100,000 person-years (95%CI 18.1-19.8) overall, with an unchanged trend (p=0.053). The incidence was 29.3 per 100,000 (95%CI 27.8-30.8) for males with a decreasing trend (p=0.04) and 9.2 per 100,000 (95%CI 8.3-10.0) for females with an unchanged trend (p=0.07). The incidence of open EAAA repair was 10.5 per 100,000 (95%CI 9.9-11.1) with a decreasing trend (p<0.001) and endovascular EAAA repair was 9.0 per 100,000 (95%CI 8.5-9.6) with an increasing trend (p<0.001) (Figure 1).

The age-adjusted incidence of RAAA was 5.4 per 100,000 (95%CI 5.0-5.9) overall with a decreasing trend (p<0.001). The incidence was 8.0 per 100,000 (95%CI 7.3-8.8) for males and 3.1 per 100,000 (95%CI 2.6-3.5) for females, both with decreasing trends (p=0.001).

The age-adjusted incidence of AAA-related mortality was 6.3 per 100,000 (95%CI 5.8-6.8) overall, 8.6 per 100,000 (95%CI 7.8-9.4) for males and 4.2 per 100,000 (95%CI 3.6-4.8) for females, with a decreasing trend (p<0.001) (Figure 2).

CONCLUSIONS

The age-adjusted incidence of AAA repair is decreasing in males but not females, whereas the incidence of RAAA has decreased in all. This translated into reduced incidence of AAA-related mortality in both sexes.
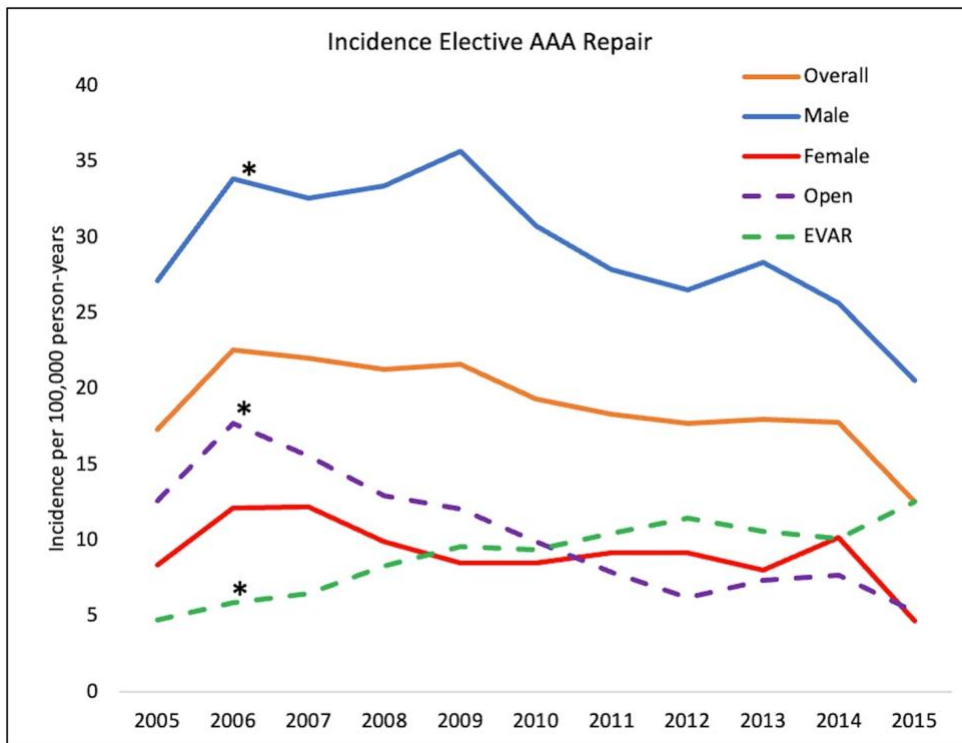
Figure 1: Incidence of Elective AAA Repair, 2005-2015

Incidence Elective AAA Repair

Asterisks (*) represent statistically significant trend coefficients at the 95% confidence interval.
Abbreviations: AAA: Abdominal Aortic Aneurysm. EVAR: Endovascular Aneurysm Repair.

Figure 2: Incidence of AAA Related Mortality
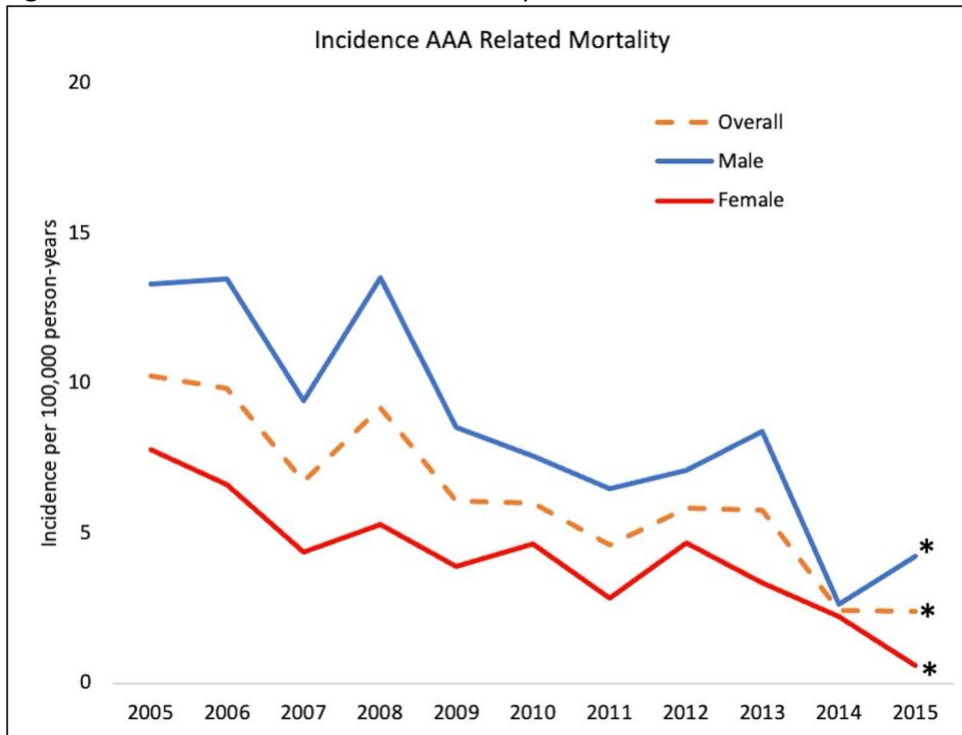
Incidence AAA Related Mortality

Asterisks (*) represent statistically significant trend coefficients at the 95% confidence interval.
Abbreviations: AAA: Abdominal Aortic Aneurysm

URINARY CYSTATIN C HAS PROGNOSTIC VALUE IN PERIPHERAL ARTERY DISEASE

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OBJECTIVE

Despite its association with adverse outcomes, peripheral artery disease (PAD) remains undertreated. This is partly because there lacks a validated biomarker for PAD prognosis. Cystatin C is elevated in patients with renal disease and may be a marker of cardiovascular disease. We examined the prognostic ability of urinary Cystatin C (uCystatinC) in predicting adverse PAD-related events.

METHODS

In this prospective case-control study, urine samples were collected from patients with PAD (n=121) and without PAD (n=77). The cohort was followed for 2 years. uCystatinC was normalized to urinary creatinine (uCr) (uCystatinC/uCr; µg/g). The primary outcome was major adverse limb event (MALE; composite of vascular intervention [open or endovascular] or major limb amputation). The secondary outcome was worsening PAD status (drop in ABI≥0.15). Multivariable Cox regression and Kaplan-Meier analyses were performed to assess the prognostic value of uCystatinC/uCr with regards to predicting MALE and worsening PAD status.

RESULTS

Patients with PAD had significantly higher median [IQR] uCystatinC/uCr levels (24.9 µg/g [14.2 – 32.9] vs. 20.9 µg/g [11.1 – 27.8], p = 0.018). Worsening PAD status and MALE were observed in 39 (20%) and 34 (17%) patients, respectively. uCystatinC/uCr predicted worsening PAD status with a hazard ratio (HR) of 1.78 (95% CI 1.12 – 2.83, p = 0.015), which persisted after controlling for baseline demographic and clinical characteristics (adjusted HR 1.79 [95% CI 1.11 – 2.87], p = 0.017). Patients with high uCystatinC/uCr had a lower 2-year freedom from MALE (77% vs. 89%, p = 0.025) and worsening PAD status (63% vs. 87%, p = 0.001) (Fig. 1).

CONCLUSIONS

Higher uCystatinC/uCr levels are associated with adverse PAD-related events and have prognostic value in risk-stratifying individuals for further diagnostic vascular evaluation or aggressive medical management.
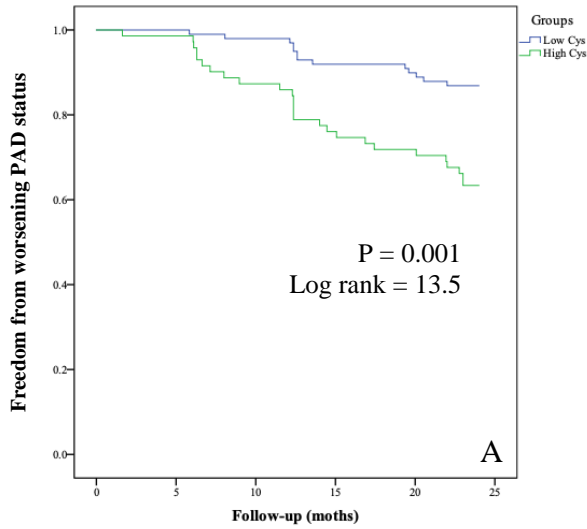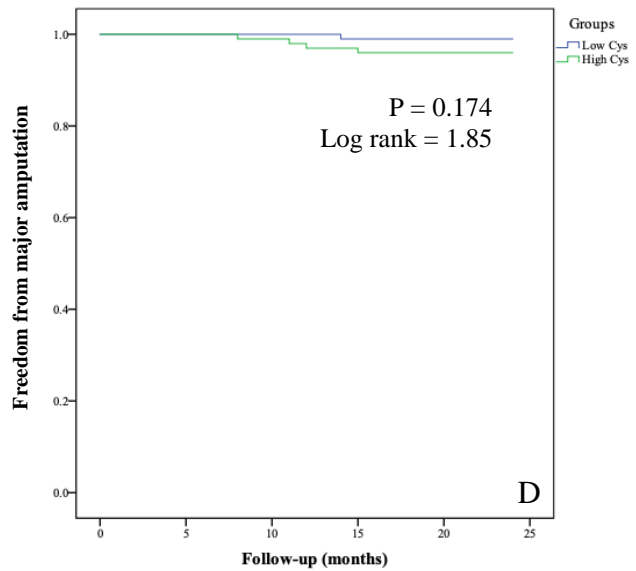
	Year	Freedom from worsening PAD status	SE
Low uCystatinC/uCr	1	95%	.022
	2	87%	.034
High uCystatinC/uCr	1	85%	.043
	2	63%	.057
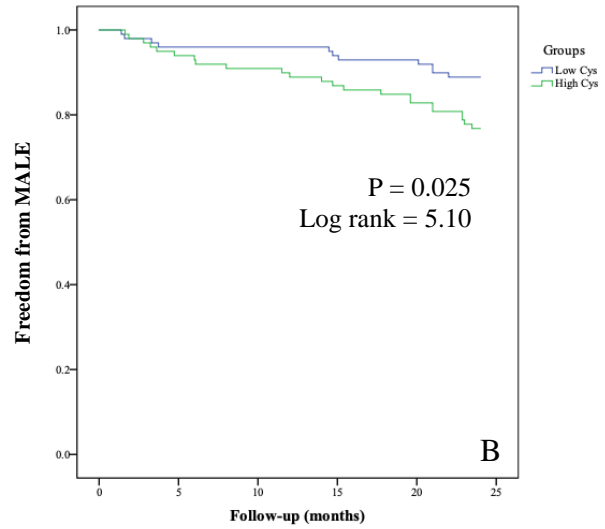
	Year	Freedom from MALE	SE
Low uCystatinC/uCr	1	96%	.020
	2	89%	.032
High uCystatinC/uCr	1	89%	.034
	2	77%	.042
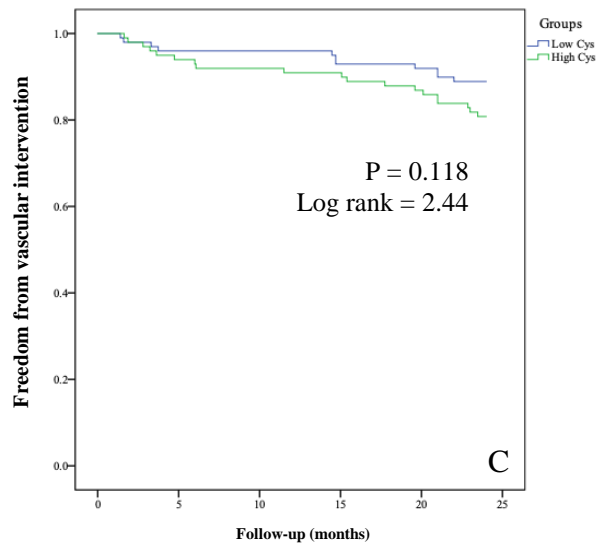
	Year	Freedom from vascular intervention	SE
Low uCystatinC/uCr	1	96%	.022
	2	89%	.032
High uCystatinC/uCr	1	92%	.027
	2	81%	.040

	Year	Freedom from major amputation	SE
Low uCystatinC/uCr	1	99%	.010
	2	99%	.010
High uCystatinC/uCr	1	97%	.014
	2	96%	.020

Fig. 1. Kaplan-Meier analysis of event free survival rates in patients with low vs. high urinary Cystatin C normalized to urinary creatinine (uCystatinC/uCr) for A) worsening PAD (ankle brachial index drop ≥ 0.15), B) MALE (major adverse limb event), C) vascular intervention, D) major amputation. SE (standard error).

USE OF TELEMEDICINE AND VIRTUAL CONSULTATIONS FOR PATIENT CARE IN THE COVID-19 ERA AND BEYOND FOR VASCULAR SURGERY PRACTICE: A SYSTEMATIC REVIEW AND META-ANALYSIS

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OBJECTIVES

The objective of this study is to conduct a systematic review and meta-analysis of all papers evaluating virtual consultations for patient care in a vascular surgery practice.

METHODS

EMBASE, MEDLINE, CINAHL, and CENTRAL were searched from inception to October of 2021. All primary studies evaluating virtual consultations in vascular surgery practice reporting any quantitative outcomes were included. Screening and data extraction were conducted in duplicate. Pooled estimates were calculated via random-effects meta-analysis. A p-value of 0.05 was statistically significant. A narrative synthesis was conducted where a meta-analysis was not possible.

RESULTS

Overall, 22 studies involving 20,014 patients were included (Figure 1). Three RCTs evaluating diabetic foot care were included in a meta-analysis. There was no difference in ulcer healing (OR 0.96; 95% CI: 0.67-1.38, P = 0.82, Figure 2), amputation rates (OR 0.61, 95% CI: 0.36 - 1.05, P = 0.08), or mortality (OR 2.30, 95% CI: 0.28 - 19.07, P = 0.44).

In the narrative synthesis, there was no statistically significant difference in postoperative readmission rates (4 studies), post-operative surgical site infection (one study), or compliance rates for lifestyle changes and smoking cessation (two studies). Among seven studies evaluating patient satisfaction, patients generally felt telemedicine was either comparable or better than in-person visits. Three studies noted that between 5-11% patients were switched from virtual to in-person visits due to worsening of symptoms, however, no comparison was made to worsening of symptoms to patients in the in-person care group.

CONCLUSIONS

In general, clinical, process, and patient satisfaction outcomes with virtual consultations are comparable to care received in-person. Telemedicine has the potential to augment vascular surgery practice while reducing resource use for patients and providers alike. Additional high-quality evidence comparing telemedicine to in-person clinical encounters is required to further elucidate the effect that telemedicine and virtual consultations have on clinical outcomes.
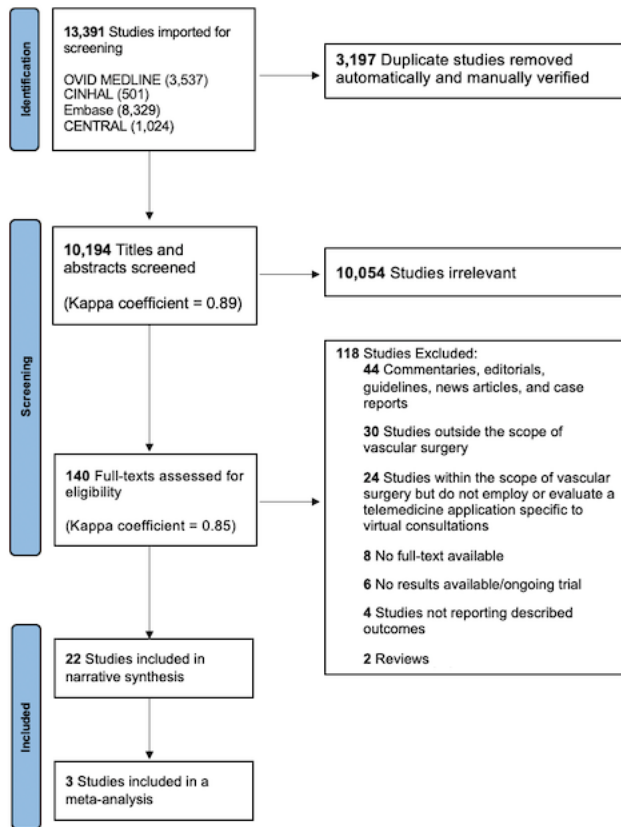
Figure 1. PRISMA Diagram from initial literature search to final number of studies included in narrative synthesis and meta-analysis
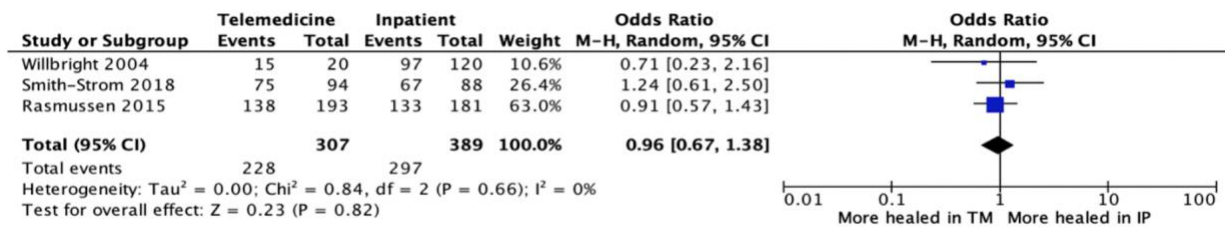
Figure 2. Random effects meta-analysis forest plot comparing effect of telemedicine virtual consultations vs. in-person appointments on healing of diabetic foot ulcers

OPEN AND ENDOVASCULAR REPAIR FOR SPLENIC ARTERY ANEURYSM: 20 YEAR EXPERIENCE AT TORONTO GENERAL HOSPITAL

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OBJECTIVE

Splenic artery aneurysms (SAAs) are uncommon aneurysms that are being diagnosed with increasing frequency over the past few years. The recently published Society for Vascular Surgery (SVS) clinical practice guidelines on the management of visceral aneurysms, revised the previous recommended size threshold for repair of non-ruptured true aneurysms from 2 cm to 3cm, while continuing to recommend treating any SAAs diagnosed in women of childbearing age or any pseudoaneurysms. The purpose of this study is to evaluate and analyze data and outcomes of patient who underwent open and endovascular repair of splenic artery aneurysm at Toronto General Hospital (TGH), and compare the size threshold for repair with the recently published SVS guidelines.

METHODS

A retrospective chart review was conducted to identify patients who underwent open or endovascular repair for SAA from Jan 2000 to June 2020 at TGH.

RESULTS

40 patients who underwent SAA repair were identified. Mean age at repair was 52. 8 presented with a rupture (20%). 3 of the 8 ruptured cases were pseudoaneurysms (37.5%), while one case had a rupture during late pregnancy. In total, 44 interventions were performed. Mean size for repair in non-childbearing age patients with true aneurysms patients was 3.8cm. Technical success was achieved in 41 out the 44 interventions (93.18%). There were no reported 30-day mortality in all patients with intact aneurysms following repair. In patients with ruptured aneurysms, there was no reported 30-day mortality, however there were 2 reported fetal mortalities, and 2 patients who had late in hospital mortality within 1 year.

CONCLUSION

Open and endovascular repair of SAA is safe with high reported technical success rate and low rate of reintervention. There were no reported ruptures in patient with true aneurysm less than 3cm which is in keeping with the new SVS guidelines recommendations.

26_CSVS_2022
PATCHLESS PROXIMAL PROFUNDOPLASTY AND COMMON FEMORAL ENDARTERECTOMY

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OBJECTIVE
Evaluate the feasibility of a surgical technique for common femoral endarterectomy and patchless proximal profundoplasty.

METHODS
Single-centre retrospective cohort study, over a 1 year period, of patients that underwent procedure which consisted of transection of the superficial femoral artery (SFA) off of the femoral bifurcation in a bevelled manner; eversion endarterectomy of the SFA; remote-type endarterectomy of the common femoral artery (CFA); direct visualization of the end point in the profunda femoris artery (PFA) with a longitudinal arteriotomy extension if needed; and then reimplantation of the SFA hood as a patch.

RESULTS
Ten patients were identified. Indications for repair included tissue loss (3), rest pain (2), claudication (3), and establishing access for other procedures (2). Five of the cases utilized PFA arteriotomy extensions. Six cases included simultaneous iliac or infrainguinal revascularization. All cases were technically successful. There was 1 intraoperative complication of remote tibial balloon angioplasty tear. Mean followup time was 199 days (29-381 days). There were zero surgical site infections. All patients were asymptomatic with patent CFAs at last followup. There was 1 surgical site restenosis. There was 1 reintervention for a remote stenosis. Average increase in ankle and toe indices were 44% and 75%, respectively (0.22 and 0.18). There was 1 readmission for gastrointestinal bleeding. There was 1 cardiac death on postoperative day 34.

CONCLUSIONS
The patchless profundoplasty technique is feasible and results in an autologous anatomic repair for CFA disease without the need for vein, and allows direct visualization and tacking sutures of the proximal PFA.

*NB: Since the submission of this abstract to CSVS, the manuscript has been accepted for publication in the Canadian Journal of Surgery.

THE IMPACT OF OBESITY IN PERIPHERAL ARTERIAL DISEASE PATIENTS UNDERGOING REVASCULARIZATION: A SYSTEMATIC REVIEW AND META-ANALYSIS

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OBJECTIVE

To evaluate the association between obesity and outcomes in patients with peripheral arterial disease undergoing either endovascular or open lower extremity revascularization.

METHODS

A systematic review and meta-analysis were performed using the following databases: MEDLINE, EMBASE, CINAHL, Web of Science, and Cochrane Library from inception until November 2021. Studies were included if they described a peripheral arterial disease (PAD) cohort undergoing open or endovascular lower extremity revascularization, compared cohorts by body mass index (BMI), and described the following outcomes: mortality, major adverse cardiovascular events (MACE), major adverse limb events (MALE), and endovascular access site complications. Count data were extracted and meta-analyzed with a random-effects model.

RESULTS

8 studies were included and detailed 171,648 patients (44,100 obese and 127,548 non-obese). Obese patients (BMI≥30) were more likely to be women, diabetic, and have more cardiovascular comorbidities despite being younger. There was no association between obesity and PAD severity. Obesity was associated with an overall 22% decreased mortality risk after lower extremity revascularization (RR 0.78, 95% CI [0.71,0.85], $p<0.01$, I^2=0%). Subgroup analysis by intervention type showed similar findings (Endovascular RR 0.79, 95% CI [0.71,0.87], $p<0.001$, I^2=0%; Open RR 0.70, 95% CI [0.51,0.95], $p=0.02$, I^2=43%). Obesity was associated with a 14% decreased risk in MACE for open surgery only (RR 0.86, 95% CI [0.76,0.98], $p=0.021$, I^2=0%). There was no association between obesity and MALE (RR 1.02, 95% CI [0.93,1.13], $p=0.65$, I^2=31%) or endovascular access site complications (RR 1.73, 95% CI [0.68,4.38], $p=0.25$, I^2=97%).

CONCLUSION

Obesity was associated with reduced mortality risk regardless of revascularization type whereas obesity was only associated with reduced MACE risk in open revascularization. Obesity was not associated with a significantly different risk for MALE or endovascular access site complications. These results suggest a survival benefit in obese patients undergoing revascularization despite having more cardiovascular comorbidities.

HOSPITAL-, ANESTHESIOLOGIST-, SURGEON- AND PATIENT-LEVEL VARIATION IN NEURAXIAL ANESTHESIA USE FOR LOWER LIMB REVASCULARIZATION SURGERY: A POPULATION-BASED CROSS-SECTIONAL STUDY

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OBJECTIVE
Small randomized trials and larger cohort studies suggest improved patient outcomes with use of neuraxial anesthesia for lower limb revascularization surgery. Our objective was to estimate variation in neuraxial (versus general) anesthesia use for these surgeries at the hospital-, anesthesiologist-, surgeon- and patient-level, which could inform strategies to increase uptake.

METHODS
Following protocol registration, we conducted a cross-sectional study of population-based linked health administrative data in Ontario, Canada. All adults undergoing lower limb revascularization surgery between 2009 to 2018 were identified. Multilevel logistic regression models were used to estimate variation in neuraxial anesthesia use at the hospital-, anesthesiologist-, surgeon- and patient-level using variance partition coefficients and median odds ratios. Patient- and hospital-level predictors of neuraxial anesthesia use were identified.

RESULTS
We identified 11,849 patients; 3,489 (29.4%) received neuraxial anesthesia. The largest proportion of variation was attributable to the hospital-level (47%), followed by the patient-level (46%); anesthesiologists and surgeons had small attributable variation (6% and 1%, respectively) (Table 1). The median odds ratio suggested that two similar patients would experience a 5.7-fold difference in their odds of receiving a neuraxial anesthetic were they randomly sent to two different hospitals (Figure 1). Results were consistent in sensitivity analyses, including inclusion of prescription anticoagulant and antiplatelet usage.

CONCLUSIONS
In contrast to other high-variation perioperative practices, neuraxial anesthesia use primarily varies at the hospital-level. While neuraxial anesthesia was provided to 15% of patients in the median hospital, the 95% probability interval varied from 4% to 87%. This unwarranted variation is likely due to preference-sensitive factors and may be associated with adverse patient outcomes. As previous studies suggest improved outcomes with neuraxial anesthesia, efforts to promote use of neuraxial anesthesia for lower limb revascularization should likely focus on the hospital context.

Table 1 - Variance Partition Coefficients describing attributable variation in neuraxial anesthesia use

	Hospital	Anesthesiologist	Surgeon	Patient
Unadjusted	51.5%	10.8%	7.2%	30.5%
95%CI	35.9 to 73.2	8.9 to 13.8	3.9 to 17.3	
Adjusted	50.3%	11.3%	2.8%	35.7%
95%CI	35.0 to 71.8	9.1 to 14.4	1.4 to 7.2	
Adjusted-PVD only	47.2%	8.6%	0.4%	43.9%
95%CI	30.9 to 72.1	4.8 to 19.0	NE	
Adjusted->65 years with prescription adjustment	53.3%	10.3%	2.0%	34.5%
95%CI	37.8 to 74.8	7.8 to 14.0	0.9 to 6.7	

Figure 1 – Median odds ratios quantifying cluster-level variation in neuraxial anesthesia use
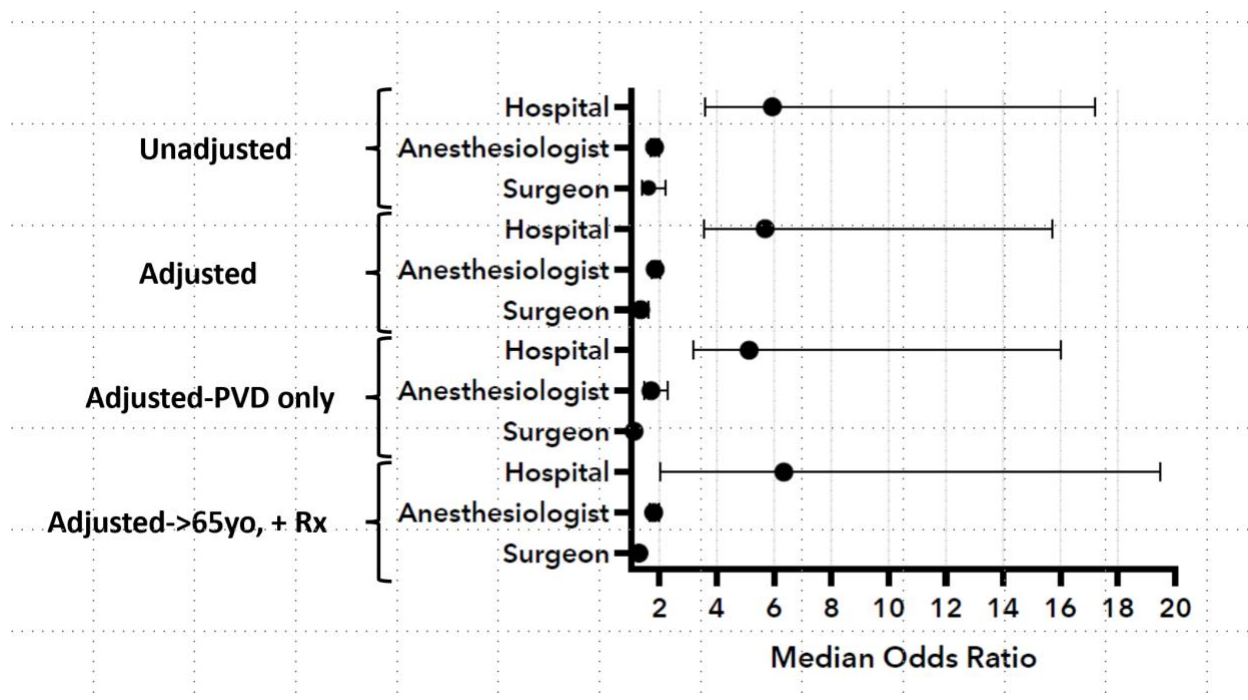
A PILOT STUDY OF CLINICAL RISK PREDICTION OF 90-DAY REINTERVENTION FOLLOWING LOWER EXTREMITY ANGIOPLASTY

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OBJECTIVE

To develop a simple approach to clinical risk prediction of 90-day reintervention following lower extremity angioplasty.

METHODS

Data from the St. Michael's Hospital Vascular Quality Improvement Program was used to identify all patients who underwent a lower limb angioplasty +/- stenting from Jan 1-Dec 31, 2020. Demographic, clinical presentation, and angiographic data were collected from medical records. The cohort was classified by likelihood of 90-day endovascular or surgical reintervention based on clinical presentation and angiographic result, as defined a priori: (i) *Definite,* where part of established treatment plan, *(ii) Unlikely,* where no limb-threatening ischemia and successful target lesion revascularization without iatrogenic complication, (iii) *Possible*, all others. The frequency and type of reintervention within 90 days were captured and considered across clinical risk prediction groups.

RESULTS

In 2020, 65 patients were treated with lower limb angioplasty +/- stenting (Table 1). A total of 14 (21.5%) required reintervention within 90 days: 3 of 3 (100%) in the *definite* risk group, 10 of 43 (23.3%) in the *possible* risk group and 1 of 19 (5.3%) in the *unlikely* risk group. Patients in the *definite* risk group underwent 2 minor amputations for infection control and 1 open surgical revascularization. In the *possible* group, reinterventions included 3 major amputations, 4 minor amputations, 2 open revascularizations and 1 endovascular revascularization. In contrast, there were no amputations or revascularizations in the *unlikely* group, with only 1 patient undergoing reintervention to correct a pseudoaneurysm.

CONCLUSIONS

Simple risk stratification based on clinical presentation and angiographic result may provide reliable prediction of 90-day re-intervention risk following lower-extremity angioplasty. Further investigation is warranted to understand the added value to clinical practice from advanced risk prediction analytics such as machine learning algorithms.

Table 1. Cohort characteristics

Characteristic	Lower Extremity Endovascular Revascularization N=65
Age – Mean (SD)	70.9 (10.2)
Male sex – N (%)	45 (63.1)
Diabetes – N (%)	61.5%
Smoking – N (%)	30.8%
Scheduled intervention – N (%)	51 (78.4)
Indication – N (%)	
Chronic Limb-Threatening Ischemia	42(60.9%)
Claudication	15 (21.7%)
Bypass stenosis	6 (8.6%)
Acute Limb Ischemia	2(2.9%)
Target Lesion(s) – N (%)	
Aortoiliac	48 (73.8%)
Femoropopliteal	29 (44.6%)
Tibial	17 (26.2%)

SEVERE INFRAMALLEOLAR DISEASE IS AN INDEPENDENT PREDICTOR OF ADVERSE LIMB OUTCOMES AFTER REVASCULARIZATION IN PATIENTS WITH CHRONIC LIMB-THREATENING ISCHEMIA

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OBJECTIVE

This study aims to evaluate the impact of inframalleolar disease (IM) on major adverse limb events (MALE) in patients undergoing endovascular revascularization (ER) for CLTI.

METHODS

Patients undergoing ER for CLTI with severe IM (pedal score of 2) were retrospectively compared to mild/moderate IM (score of 0 or 1) based on the Global Vascular Guidelines (GVG) between 2015 and 2019. The primary outcome was MALE (open revascularization), major amputation or minor amputation. Secondary outcomes were mortality, reintervention and limb-based patency (LBP). Kaplan-Meier estimates were used to compare the primary outcome and Cox proportion hazard model to assess impact of IM.

RESULTS

The study included 167 limbs in 149 patients (36% females). Severe IM was identified in 43% (n=71) of the limbs studied. There was no difference in baseline characteristics (table 1) except for a higher prevalence of dyslipidemia in patients with severe IM (66% vs 43%, p=.003). Most patients in both groups had WIFI 3/4 (86% in both groups, p=.462) and GLASS II/III (78% in severe IM and 79% in mild/moderate IM, p=.752). During follow up, severe IM patients had similar mortality (27% vs 31%, p=.567), reintervention (42% vs 38%, p=.608) and LBP (78% vs 85%, p=.391) to mild/moderate IM. Kaplan-Meier estimates (figure 1) showed that severe IM was associated with lower freedom from MALE or amputations (47% vs 65%, p=.019). Cox proportion hazard regression model showed that severe IM was an independent predictor of increased MALE and amputations risk (HR 1.716 [95% CI 1.019 – 2.889], p=.042) after adjusting for covariates.

CONCLUSION

Severe IM was prevalent in 43% of limbs undergoing endovascular revascularization for CLTI. It was associated with lower freedom from major adverse limb events and amputations. Severe IM also independently increased the hazard of adverse limb outcomes in patients with CLTI by 72%.

	Mild/moderate IM (n=96)	Severe IM (n=71)	p value

Age	73 (11)	74 (12)	.546
Female sex	32% (31)	41% (29)	.255
DM	67% (64)	72% (51)	.538
HTN	80% (76)	83% (59)	.612
Dyslipidemia	**43% (41)**	**66% (47)**	**.003**
ESKD	10% (9)	17% (12)	.170
CAD	43% (41)	47% (33)	.670
CVA	17% (16)	17% (12)	.992
Pulmonary	33% (31)	25% (18)	.309
Active or previous cancer	20% (19)	23% (16)	.692
Current smoker	28% (24)	18% (11)	.127
Poor baseline function	26% (25)	17% (12)	.149
Medications			
ASA	68% (61)	53% (37)	.055
Clopidogrel	19% (17)	14% (10)	.441
Statins	59% (52)	65% (46)	.463
WIFI class			.462
Very low	5% (4)	2% (1)	
Low	9% (7)	13% (8)	
Moderate	29% (22)	22% (14)	
High	57% (44)	64% (41)	
GLASS stage			.752
I	22% (21)	21% (15)	
II	30% (28)	25% (18)	
III	48% (45)	54% (38)	
Inflow disease	6% (6)	6% (4)	.873
Successful TAP treatment	41% (39)	31% (22)	.201

Table 1 – Baseline characteristics of patients
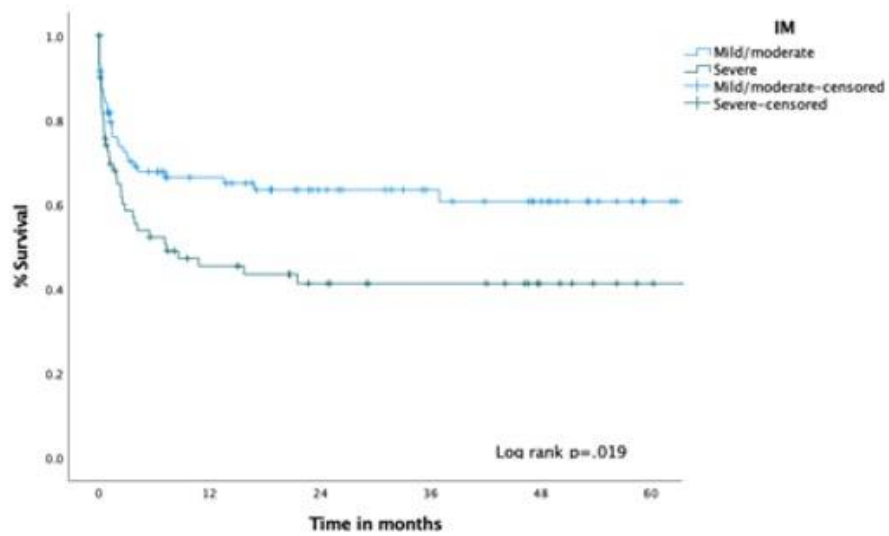
Figure 1 – Kaplan-Meier survival estimates for MALE and amputations

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ASSOCIATION BETWEEN COMPLICATIONS AFTER VASCULAR SURGERY AND PROLONGED POSTOPERATIVE OPIOID USE

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OBJECTIVE

Few studies have looked at the long-term risk of opioid use following major vascular surgery and no study has investigated the potential association between major complications and prolonged opioid use. We analyzed a population-based database linked to a prescription database to investigate factors associated with prolonged opioid use following major vascular surgery.

METHODS

This population-based cohort study included all adults who underwent open lower extremity revascularization (LER) or non-ruptured abdominal aortic aneurysm repair (open [AAA] and endovascular [EVAR]) in the province of Ontario, Canada, between 2013-2018. Prolonged opioid use was defined as 2 or more opioid prescriptions filled 6-12 months following surgery. Potential predictors of prolonged use were explored using modified Poisson regression with a generalized estimating equation (GEE) approach to account for the clustering of patients within physicians and institutions.

RESULTS

This study included a total of 11,104 patients with 5,652 patients undergoing open LER, 3,285 patients undergoing EVAR, and 2,167 patients undergoing AAA. The rates of prior opioid use were 35.4% for LER, 15.8% for AAA and 14.3% for EVAR. Major complication rates following each procedure were 59.5% for AAA, 35.1% for LER, and 21.0% for EVAR. Following surgery, prolonged opioid use was identified in 26.1% of LER, 13.2% of AAA, and 11.6% of EVAR patients. The strongest predictor of prolonged opioid use was prior use with an OR of 13.27 (95%CI10.63-16.57) for AAA, 11.24 (95%CI 9.18-13.75) for EVAR, and 4.69 (95%CI 4.16-5.29) for LER. The occurrence of a major complication was only associated with prolonged opioid use for patients undergoing LER (OR 1.10; 95% CI:1.03-1.19), while it had a reverse effect on patients undergoing EVAR (OR 0.83; 95% CI 0.69-0.99) and no association for patients undergoing open AAA repair (OR 1.11; 95% CI: 0.95-1.29).

CONCLUSIONS

Prolonged opioid use is common following major vascular surgery, occurring in over 10% of patients undergoing either open or endovascular aneurysm repair and over 25% of patients undergoing open lower extremity revascularization. Prior opioid use is the strongest predictor for prolonged use, while the occurrence of postoperative complications is associated with a slight increased risk of prolonged use in patients undergoing lower extremity revascularization. These patient populations should be targeted for multimodal methods of opioid reduction following their procedures.

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THE EMOTIONAL IMPACT AND COPING MECHANISMS FOLLOWING ADVERSE PATIENT EVENTS AMONG CANADIAN VASCULAR SURGEONS AND TRAINEES

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OBJECTIVE

This study's objective is to evaluate the emotional experiences, coping mechanisms, and support resources for Canadian vascular surgeons and trainees following an adverse patient event or a near miss.

METHODS

This is a cross-sectional survey study of all Canadian Society for Vascular Surgery (CSVS) members from October to November 2021 with questions about their experiences with adverse events and about their perceptions on optimal support resources. A separate survey was also sent to all Canadian residency program directors asking about the existence of mentorship programs. Responses were analyzed.

RESULTS

Sixty-six CSVS members responded to the survey. The majority (77%) had experiences with adverse events causing serious patient harm. The most common associated negative experiences included feelings of negativity towards oneself, general distress, and anxiety about potential for future errors (Table 1). Sixty-two percent of respondents felt determined to improve. The most common coping mechanism was seeking advice from a mentor or close colleague (Table 2). Peers (82%) and senior colleagues (59%) were the most preferred sources of support. Most of the respondents would reach out to a mentor if they had one, but 30% reported having no mentor or close colleague for support. Sixty percent of this group would use a peer support program if offered through a professional organization like the CSVS. A survey of all Canadian training programs yielded a 67% response rate and 67% reported having a formal mentorship program.

CONCLUSION

Adverse patient events and near misses have a serious negative impact on the lives of Canadian vascular surgeons and trainees. Peers and senior colleagues are the most desired sources for support, but this is not universally available. Organized efforts are needed to raise awareness in our vascular surgery community on the detrimental effects of adverse events and our mutual need for peer support.

Table 1. Emotional and behavioural experiences of Canadian vascular surgeon and trainees after adverse events.

Emotional and Behavioural Experiences	Total (n = 66)
Negative	
Feeling negative towards oneself	47 (71%)
Feeling generally distressed	38 (58%)
Feeling anxious about potential for future errors	34 (52%)
Reduced job satisfaction	24 (36%)
Difficulty sleeping	22 (33%)
Negatively affected personal life	16 (24%)
Lower confidence in abilities as a vascular surgeon	15 (23%)
Negatively affected relationships with colleagues	8 (12%)
Damaged professional reputation	6 (9%)
Positive	
Feeling determined to improve	41 (62%)
Value relationship with colleagues more	11 (17%)
Feeling more confident in own abilities	2 (3%)

Table 2. Coping mechanisms of Canadian vascular surgeon and trainees after adverse events.

Thoughts/Activity after Adverse Event	Total (n = 66)
Seek advice from mentor or close colleague	51 (77%)
Speak to your friends and family	32 (49%)
Exercise	30 (46%)
Positive reappraisal	17 (26%)
Criticizing or lecturing oneself	15 (23%)
Sleep	14 (21%)
Avoidance of certain procedures, situations, or patients	12 (18%)
Meditation/prayer	7 (11%)
Contact lawyer or CMPA	7 (11%)
Following policies and guidelines more accurately and closely	5 (8%)
Use of alcohol, medications, recreational drugs	4 (6%)
Take time off work	3 (5%)

EFFICACY AND SAFETY OF SECONDARY PROCEDURES FOR MAINTAINING ARTERIOVENOUS HEMODIALYSIS ACCESS: A SYSTEMATIC REVIEW AND BAYESIAN NETWORK META-ANALYSIS

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OBJECTIVES

Randomized trials have compared a variety of different endovascular therapies for treating patients with a failing arteriovenous (AV) hemodialysis access. However, many clinically relevant therapies have never been compared head-to-head in clinical trials. This network meta-analysis (NMA) evaluates the relative effectiveness of multiple endovascular therapies to maintain AV hemodialysis access based on all available evidence.

METHODS

We performed a systematic review and NMA following best practices. We searched EMBASE, MEDLINE, and CENTRAL databases for randomized trials comparing interventions to maintain primary patency of failing AV access. Two investigators independently reviewed and abstracted data according to pre-specified criteria. The primary outcome was 6-month primary access circuit patency. Secondary outcomes included technical success and mortality. We analyzed the results using Bayesian NMA techniques with fixed and random effects, assessing fit to guide model selection.

RESULTS

We included 28 randomized trials (n=2,709 patients) that performed pairwise evaluation of six different treatment options (Figure 1). Regarding the primary outcome of 6-month AV access circuit primary patency, drug-coated balloons (OR=2.82 [95% CrI 1.73-4.45]) and covered stents (OR=2.14 [95% CrI 1.16-4.52]) had a higher relative effectiveness over plain balloon angioplasty. There were no significant differences in improving the primary outcome when bare stents, drug eluting stents, or cutting balloons were compared to plain balloon angioplasty. Over 12 months, covered stents were the most effective option for improving primary access circuit patency (Probability best = 72%), while cutting balloons were the least effective option for improving this outcome (Probability last = 81%) (Figure 2). In terms of secondary outcomes, both covered and bare metal stents were superior to all non-stent treatment options for improving immediate technical success (Probability = 94%). Finally, there was no significant effect of drug eluting technology on mortality, including when comparing drug-coated balloons with plain balloon angioplasty (OR=0.75 [95% CrI 0.45-1.16]).

CONCLUSIONS

This study suggests that covered stents and drug-coated balloons are more effective at improving AV access circuit patency than alternate endovascular therapies. However, these two treatments have never been directly compared, indicating the need for a head-to-head trial. Cutting balloon angioplasty is the least effective treatment option. Contrary to recent meta-analyses regarding peripheral artery disease, use of drug eluting technology was not significantly associated with mortality.

Registration: PROSPERO CRD42020148224
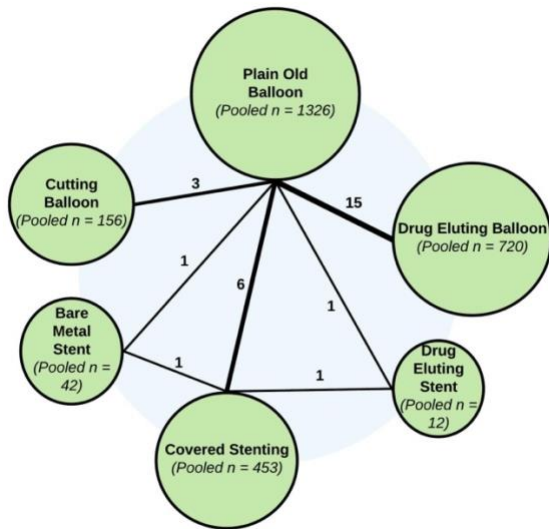
Figure 1: Network node diagram summarizing the trials included in the meta-analysis. Numbers adjacent to the lines reflect the number of studies comparing the respective treatments, and the pooled numbers reflect the total number of patients receiving each treatment in all included studies.
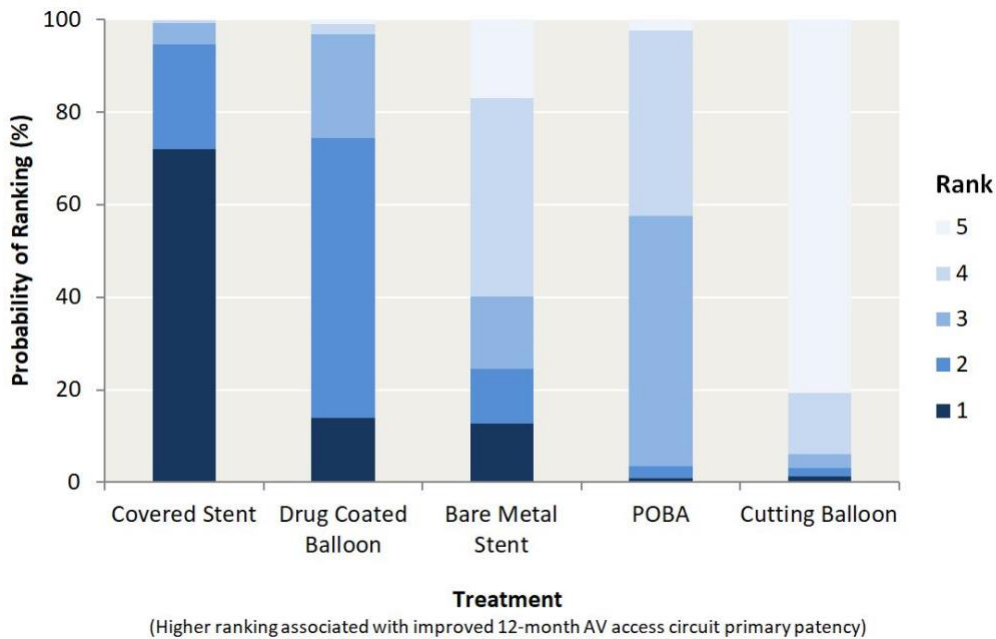
Figure 2: Rankogram depicting the probability of each treatment option's relative rank, when evaluating 12-month AV access circuit primary patency.

YOUTUBE AS A SOURCE OF PATIENT AND TRAINEE EDUCATION IN VASCULAR SURGERY

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OBJECTIVE

The objective of this systematic review is to characterize the peer-reviewed literature investigating YouTube as a source of patient and trainee education in vascular surgery.

METHODS

A comprehensive literature search was conducted using EMBASE, MEDLINE, and Ovid from inception to December of 2021. Study screening and data extraction occurred in duplicate. All primary studies and conference abstracts evaluating YouTube as a source of patient or trainee education relating to any vascular surgery pathology were included. Descriptive statistics were used to describe data in aggregate.

RESULTS

Among 6,453 citations, 20 studies were identified that examined 2894 videos (2672 patient education, 222 trainee education) with 46.2 hours of content and 19.3 million views (17.3 million views patient education, 2.0 million views trainee education). Studies examined YouTube videos that mainly pertained to diabetic foot care (5), peripheral arterial disease (4), carotid artery stenosis (3), and varicose veins (3) (Figure 1). Six studies examined videos intended for trainee education, while 14 studies examined videos intended for patient education. Among 14 studies that evaluated educational quality of the videos, 17 quality assessment tools were used, of which 5 were externally validated, with each study using a mean of 1.5 assessment tools (Table 1). Per global quality assessment ratings, 6/14 studies (43%) concluded that the overall quality of educational content was poor and 8/14 studies (57%) indicated that it was fair.

CONCLUSIONS

There has been emerging literature evaluating YouTube for patient and trainee education across a breadth of vascular surgery pathologies. The overall educational content of these videos is lacking and there is significant heterogeneity in the quality assessment tools used in their evaluation. A standardized approach to online education with a consistent quality assessment tool is required to better support online patient and trainee education in vascular surgery.
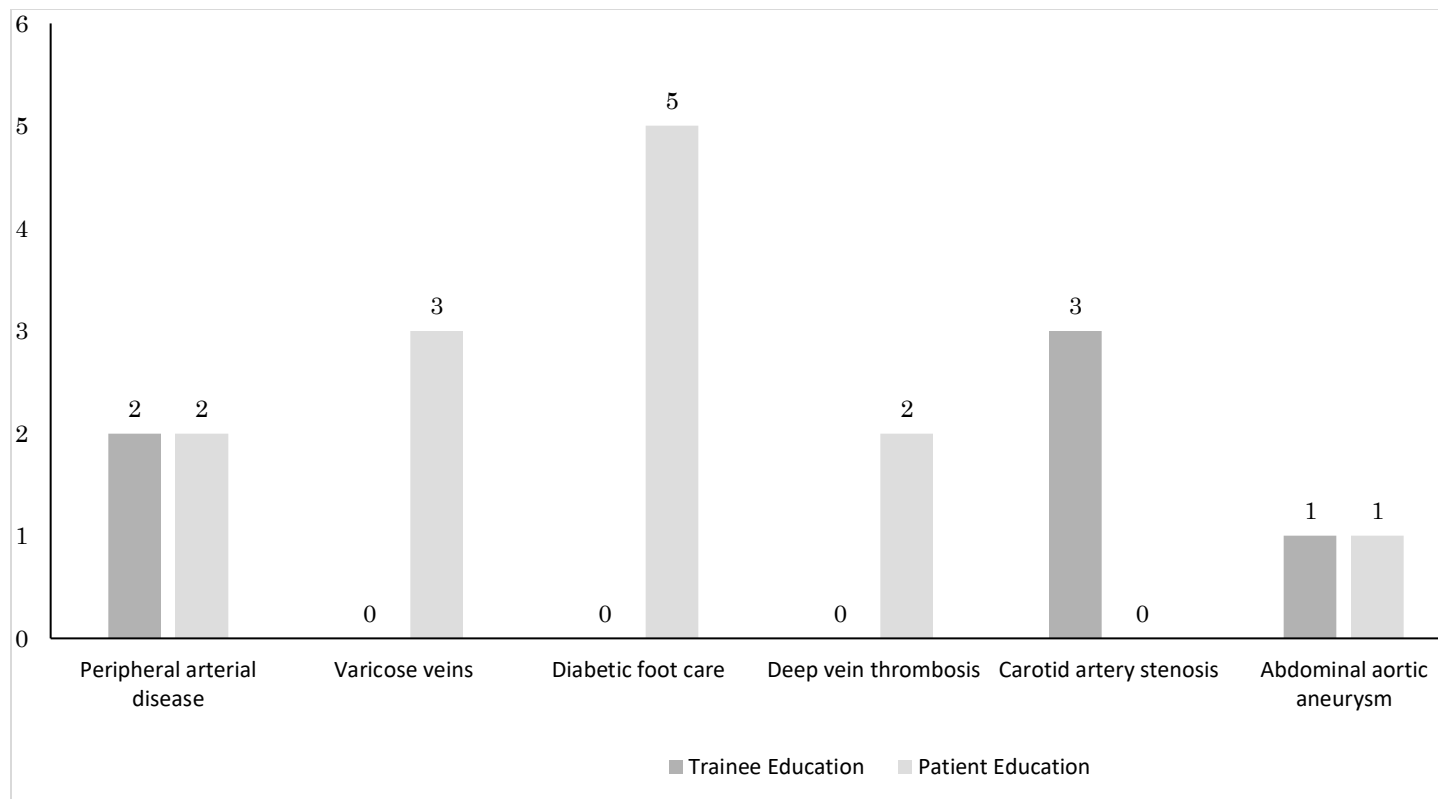
Figure 1. Breakdown of studies examining YouTube videos for trainee and patient education across multiple vascular surgery pathologies

Quality Assessment Tool (Maximum Score)	Number of Studies (%)	Mean Score (SD)
Modified DISCERN Instrument (5)	3 (15%)	2.28 (1.02)
JAMA Score (4)	2 (10%)	1.85 (0.76)
Global Quality Scale (5)	2 (10%)	2.04 (0.88)
HONCode (8)	1 (5%)	NR
Medical Information and Content Index (MICI) (5)	1 (5%)	3.7 (1.4)

Table 1. Externally validated and most used quality assessment utilized by the included studies and the mean scores of the YouTube videos assessed by these tools. SD: Standard Deviation. NR: Not reported

ASSESSMENT OF THE REVERSE FRAGILITY INDEX IN VASCULAR SURGERY RANDOMIZED CONTROLLED TRIALS WITH STATISTICALLLY NON-SIGNIFICANT PRIMARY OUTCOMES

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OBJECTIVES

The reverse fragility index (RFI) is an objective measure of robustness in the findings of statistically non-significant binary outcomes and is calculated by assessing the number of events needed to change the results from statistically non-significant to significant. The objective of this study was to assess the RFI of non-significant vascular surgery trials comparing endovascular to open surgery.

METHODS

MEDLINE and Embase were searched for vascular surgery trials comparing endovascular to open surgery with statistically non-significant primary outcomes. The primary outcome of this study was the median RFI. The RFI was calculated by subtracting events from the study arm with fewer events while adding non-events to the same arm until a two-tailed Fisher exact test produced a statistically significant result (Figure 1). Secondary outcomes included (1) the number of endpoints where the lost to follow-up was greater than the RFI, (2) association of the RFI to the study's funding source (commercial vs. non-commercial), study design (index trial or follow-up analysis), and type of endpoint used (single or composite), and (3) the correlation between sample size and the RFI.

RESULTS

4187 articles were captured with 49 studies reporting 101 different primary endpoints being included. The median RFI was 7 (interquartile range, 5 - 11). 39 (39%) endpoints had a loss to follow-up greater than its RFI. Mann–Whitney U test showed follow-up analyses and composite endpoints were significantly associated with higher RFIs but not funding source (Table 1). Sample size was positively correlated to RFI (Pearson r = 0.28, 95% CI: 0.09 to 0.4512, P<0.01).

CONCLUSION

A large portion of non-significant vascular surgery trials are fragile with a small number of event conversions (median 7) needed to change their primary outcomes. Close to a third of the literature was missing data that potentially could have reversed its findings.

Category	No. of endpoints	Median RFI (IQR)
Domain		
AAA*	33	10 (6-15.5)
CAS	47	6 (5-8)
PAD	21	7 (5.5 -10)
Study design		
Origin trial*	63	6 (5-10)

Follow-up study	38	9.5 (6.75 - 17.25)
Funding		
Commercial	27	9 (5-13)
Non-commercial	74	7 (5-10.25)
Endpoint		
Single	81	7 (5-10)
Composite*	20	9.5 (6.5-15.75)
Lost to follow-up		
<RFI	53	8 (5-11)
>RFI	41	7 (4-9)

Table 1. Reverse Fragility Index Characteristics
* P<0.05

Trial 2X2 Contingency Table		
	Event	No event
Surgery	A	B
Endovascular	C	D
Fisher's Exact Test p > 0.05		

Calculation of the RFI		
	Event	No Event
Surgery	A - *RFI*	B + *RFI*
Endovascular	C	D
Fisher's Exact Test p ≤ 0.05		

Figure 1. Two-by-two Contingency Tables Highlighting the Calculation of the RFI

BOOK OF ABSTRACTS

POSTER PRESENTATIONS

EXPLORATION of the use of non-verbal "trace" communication during vascular surgery procedures

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OBJECTIVES

Trace communication is a form of non-verbal communication that uses objects to influence another team member's behavior. As non-verbal communication within surgery has focused on body language and gestures, there is limited evidence of the value of other forms of non-verbal communication that are beneficial for teamwork. This study investigates the presence and impact of trace communication during vascular surgery procedures.

METHODS

Ethnographic observations were conducted of 10 vascular surgery operating teams. Teams in this study included 4 surgeons, 7 residents/fellows and 9 scrub nurses. The use of trace communication was recorded throughout the duration of the operation. Immediately following the operation, rapid interviews with each team member were conducted to gain insight on how trace communication was used. Observations and rapid interviews were analyzed to create a coding framework that specified: (1) type of traces, (2) the message conveyed from each trace. Formal interviews with each surgical lead were conducted to gain expert insight of the findings.

RESULTS

Trace communication was present across all possible team interactions (ie. surgeon-resident, resident-nurse, nurse-surgeon). Examples of traces included placing a tool nearby or providing a different one than requested. Traces were used for different purposes. For instance, purposefully providing a different tool than requested represented a trace used to discreetly suggest the next step in the operation. Trainee level, previous experience working together, and presence of teams from other specialties influenced the prevalence of trace use. Importantly, trace communication allowed residents to demonstrate their knowledge and understanding during an operation and experienced surgeons to assess a resident's ability.

CONCLUSION

While trace communication benefits surgical teams by maintaining efficiency and concentration, it also constitutes a unique pedagogical strategy. This study brings awareness to a previously unrecognized form of non-verbal communication that might play an important role in improving teamwork in surgery.

THE PROGNOSTIC ROLE OF PRE-OPERATIVE NUTRITION STATUS IN PATIENTS UNDERGOING INTERVENTIONS FOR PERIPHERAL ARTERY DISEASE

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OBJECTIVE

The role of pre-operative nutrition status in patients with peripheral arterial disease (PAD) is not well characterized, nor is it routinely implemented as part of the pre-operative vascular care in current clinical practice. This scoping review sought to describe the prevalence and prognostic implications of pre-operative nutrition status in patients undergoing vascular interventions for claudication and critical limb threatening ischemia (CLTI).

METHODS

Studies were systematically searched across 6 databases from inception to November 2021. Studies focusing on patients with claudication or CLTI undergoing open, endovascular, or hybrid procedures were included if pre-operative nutrition status was measured and associated with a clinical outcome. Two independent reviewers selected studies for inclusion, extracted data, and assessed risk of bias using ROBINS-I and Newcastle-Ottawa scales. Extracted data included study characteristics, demographics and clinical characteristics, nutritional tool used, pre-operative nutritional status, interventions performed, outcome measured, and association of nutritional status on outcomes.

RESULTS

Twenty-four studies addressed the prevalence or prognostic impact of malnutrition in patients undergoing interventions for PAD. The prevalence of pre-operative malnutrition ranged from 14.6% to 72%, and notably 7 different malnutrition assessments were used in these studies. Across all scales, pre-operative malnutrition was associated with at least one of the following outcomes: increased mortality, major adverse limb events, post-operative complications, length of stay, readmission, and poor wound healing.

CONCLUSIONS

There are a variety of heterogeneous tools to measure malnutrition in patients undergoing interventions for PAD. The prevalence of malnutrition varies by the scale used to measure it, as does its predictive value. Our qualitative findings suggest that pre-operative malnutrition is associated with adverse clinical outcomes in this population. Clinicians and surgeons should therefore be sensitized to the importance of assessing pre-operative malnutrition and view it as a preoperative target for patient optimization and decision making in adults undergoing interventions for PAD.

VARICOSE VEINS: A PHENOMENOLOGICAL STUDY TO EXPLORE PATIENT EXPECTATIONS AND REASONS FOR FRUSTRATION

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OBJECTIVE

This study aimed to identify patient expectations and areas of frustration among adults with varicose veins to improve patient satisfaction and quality of care.

METHODS

This was a phenomenological study. Forty-five adults with varicose veins were selected purposefully. Semi-structured interviews were conducted in a private setting in Ontario, Canada. The transcripts were based on conversations and/or audio recordings from the interview. Giorgi's phenomenology analysis was used during data analysis. A team consisting of vascular surgeons, a physician assistant, and students cooperated to ensure that the participants were accurately represented and that peer review had occurred.

RESULTS

Three themes were identified. The first theme suggests that (1) a difference between patient expectations and treatment outcomes results in patient frustration. Two subthemes indicate that frustration arises from differences in expectations regarding (a) the healing process and (b) aesthetic expectations. Additionally, the results indicate that (2) frustration arises from navigating the challenges associated with chronic illness. Two subthemes suggest the importance of stressing that (c) procedures will not rid one of disease and (d) that varicose veins can progress with time. The last theme proposes that (3) communication regarding expectations reduces frustration. Two subthemes indicate that (e) patients hesitate to initiate conversation regarding expectations, and (f) equipping patients with relevant tools may prevent misunderstandings.

CONCLUSIONS

The conclusions indicate that complaints stem from a lack of communication and understanding. The results suggest routinely encouraging patients to express expectations when discussing treatment options and clarifying whether procedures treat symptoms as opposed to the etiology of disease. In addition to standard information packages, the results suggest providing resources that address the psychological impact of varicose veins and the differences in expectations and knowledge gaps. Based on their experience, patients who utilized information packages and visual aids felt better equipped to engage in decision making.

A SYSTEMATIC REVIEW AND META-ANALYSIS OF THE ROLE OF SEALANTS FOR ACHIEVING ANASTOMOTIC HEMOSTASIS IN VASCULAR SURGERY

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[6]Inova Heart and Vascular Institute, Falls Church, Virginia USA

OBJECTIVE

This review evaluated sealant effectiveness in vascular surgical procedures for achieving hemostasis from bleeding anastomoses.

METHODS

We searched Cochrane Vascular Specialised Register, Cochrane Central Register of Controlled Trials, MEDLINE (from January 1946), Embase (from January 1974), CINAHL (from January 1982), World Health Organization International Clinical Trials Registry Platform, and ClinicalTrials.gov to March 14, 2022 for randomized controlled trials that compared fibrin/synthetic sealant use with alternatives for achieving anastomotic hemostasis in vascular surgery procedures. Primary outcomes were time to hemostasis, hemostatic intervention failure, and intraoperative blood loss. Secondary outcomes were operating time, death/postoperative bleeding/unplanned return to the operating room from bleeding complications up to 30 days, quality of life, and adverse events. Data was pooled and meta-analyses were performed using random-effects models.

RESULTS

28 non-duplicative studies met inclusion criteria for pooled analysis with 2612 patients. Sealants achieved significantly reduced time to hemostasis (standardized mean difference [SMD]-1.20, 95%CI -1.65 to -0.75, $p<0.00001$, $I^2=85\%$), which remained true when compared only to manual compression (SMD -1.98, 95%CI -2.46 to -1.50, $p<0.00001$, $I^2=93\%$), oxidized cellulose (SMD -1.60, 95%CI -1.97 to -1.23, $p<0.00001$, $I^2=95\%$), and gelatin sponge (SMD -0.91, 95%CI -1.14 to -0.68, $p<0.00001$, $I^2=79\%$). Hemostatic intervention failure (RR 0.46, 95%CI 0.35-0.60, $p<0.00001$, $I^2=62\%$) and operating time (-9.64 minutes, 95%CI -18.62 to -0.66, $p=0.04$, $I^2=0\%$) were also significantly less in sealants. Intraoperative blood loss, postoperative bleeding, and unplanned return to the operating room were not significantly different. No included studies reported death from bleeding or quality of life measures.

CONCLUSION

Time to hemostasis, hemostatic intervention failure, and operating time were significantly reduced with sealants, with no differences in intraoperative blood loss, postoperative bleeding, and unplanned return to the operating room. Death from bleeding and quality of life could not be analyzed. Major limitations of this review include the risk of bias in all included studies.

IDENTIFYING BARRIERS TO HEALTHCARE IN HIGH-RISK POPULATIONS

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BACKGROUND

Indigenous people living on Canadian reserves are overrepresented in non-traumatic lower extremity amputation (LEA) populations. These patients are more likely to be younger, have diabetic foot infections, and have no previous revascularization procedures when compared with non-Indigenous LEA populations. These amputations are associated with significant physical, emotional, and psychological co-morbidities as well as contribute to a major cost to the healthcare system.

OBJECTIVES

The aims of this project were to identify specific barriers preventing Indigenous patients in high-risk communities from accessing health care, as well as explore patient's experiences with healthcare systems and identify potential solutions.

METHODS

Five semi-structured focus groups were conducted with community healthcare teams and patients who were at risk for, or had previously undergone, a non-traumatic LEA.

RESULTS & CONCLUSIONS

Employing thematic analysis three major themes: Factors impacting healthcare access, impacts on patient care, and solutions were identified. Analysis of the patient's and community healthcare providers' perspectives indicated that a complex interplay of social, economic, and systemic issues feeding into a positive feedback loop perpetuating LEAs in Indigenous patients living on reserves (*Figure 1*). Findings of this project are consistent with Anderson and Newman's framework of healthcare utilization and access. Regional and systemic changes are needed to eliminate these barriers and create equitable access to healthcare for Indigenous patients at risk for lower extremity amputations.

Figure 1. Interplay of social barriers causing positive feedback loop perpetuating diabetic foot complications and LEAs.
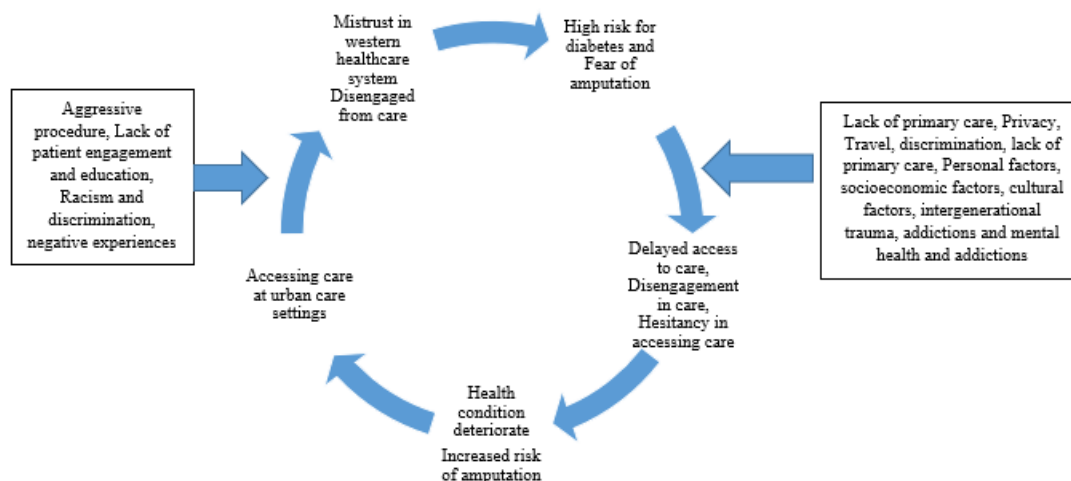
LESSONS LEARNED FROM MEDICO-LEGAL CASES ASSOCIATED WITH VASCULAR SURGERY IN CANADA BETWEEN 2001 AND 2020

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OBJECTIVE
To determine leading medico-legal risks and patterns related to Vascular Surgery in Canada between 2001 and 2020, compared to Sweden, United States (US), and the United Kingdom (UK).

METHODS
A review of all closed-cases involving Vascular Surgery was conducted by the Canadian Medical Protective Association between 2001 and 2020. This data was compared to literature involving key terms such as "vascular surgery", "negligence" and "litigation" in Sweden, US, and UK. Data was collected on allegations, common interventions involved, and factors contributing to medico-legal cases.

RESULTS
119 cases were identified in Canada with a declining linear trend of cases from 2001 to 2020. Similar trends have been noted in the UK between 2002-2019. In Sweden from 2005-2014, the number of endovascular procedures increased, however the number of claims remained stable. The most common area related to medico-legal cases in Canada was arterial 69%(82/119), involving bypass surgery in 33%(39/119) and AAA repair in 23%(27/119); while venous-related procedures made up 26%(32/119). This is comparable to US data from 1999 to 2014 with 65% cases being arterial and 10% venous. 79%(94/119) of Canadian cases had patients experience healthcare-related harm, impacting their health or quality of life. Looking at identifiable factors contributing to medico-legal cases, Canadian data identified 47%(56/119) cases with peer expert criticism. This analysis identified 80%(45/56) cases with provider-related factors, 43%(24/56) cases involving team factors, and 18%(10/56) cases involving system-related factors. Similar provider-related factors were also found to be a common cause of medico-legal cases in the US (84%) and UK (80%).

CONCLUSION
Vascular surgery medico-legal cases in Canada have steadily declined over the last 20 years. With similar causes of litigation in Sweden, US, and UK, Canadian Vascular surgeons would benefit on focusing on thorough clinical assessment, enhanced situational awareness, and improving communication and documentation with the patient and healthcare team members.

CONTRAINDICATIONS TO NEURAXIAL ANESTHESIA IN PATIENTS UNDERGOING LOWER LIMB REVASCULARIZATION SURGERY

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OBJECTIVE

We plan to design a Canadian randomized trial comparing neuraxial and general anesthesia for lower limb revascularization surgery. To assist in determining feasibility, we sought to identify the proportion of patients undergoing these surgeries who have contraindications to use of neuraxial anesthesia and to derive and validate a case ascertainment algorithm to identify individuals at high probability of having contraindications.

METHODS

We conducted a cross-sectional study of open lower limb revascularization surgery cases between June 2019 and May 2021 at The Ottawa Hospital. We reviewed patient charts and identified demographic, admission, and procedural variables and confirmed anesthesia technique, presence of clinical practice guideline-reported absolute or relative contraindications to neuraxial anesthesia, and any documented patient preferences for anesthesia technique. Case ascertainment algorithms were derived to predict the probability of absolute contraindication to neuraxial anesthesia; and internally validated using 5000 bootstrap samples.

RESULTS

We identified 340 cases. Mean age was 68 (standard deviation=11); 68% were male. Isolated general anesthesia was used in 219 (64.4%), isolated neuraxial (spinal and/or epidural) in 106 (31.2%) and neuraxial plus general in 15 (4.4%). Seventy-eight (22.9%, 95% confidence interval [CI]=18.8-27.7) patients had absolute contraindications to neuraxial anesthesia, primarily due to anticoagulation or antiplatelet medications (89.4%); 21 (6.2%, 95% CI=4.1-9.3) had a relative contraindication, primarily long anticipated duration of surgery (16/21, 76.2%). Three nested case-ascertainment algorithms were derived and validated (Figure 1). Using admission and procedure variables, discrimination was moderate, with moderately explained variance; calibration was inadequate for reliable use (Table 1). Two additional models that added patient comorbidities, and then lab values did not improve performance.

CONCLUSION

Most patients undergoing lower limb revascularization surgery do not have absolute contraindications to neuraxial anesthesia, but when present, they are typically related to anticoagulation. Admission, procedure, comorbidity and laboratory values do not provide adequate accuracy to ascertain contraindication status.

Table 1. Predictive accuracy of nested models to predict absolute contraindications.

Model	Derivation		Internal validation				
	C-statistic	R^2	C-statistic2	R23	Calibration intercept	Calibration slope	Emax
Admission and procedural factors	0.815	0.381	0.788	0.276	-0.181	0.848	0.071
Admission, procedural factors and comorbidities	0.815	0.348	0.788	0.278	-0.175	0.852	0.068
Admission, procedural factors, comorbidities and lab values	0.824	0.341	0.767	0.198	-0.314	0.699	0.142
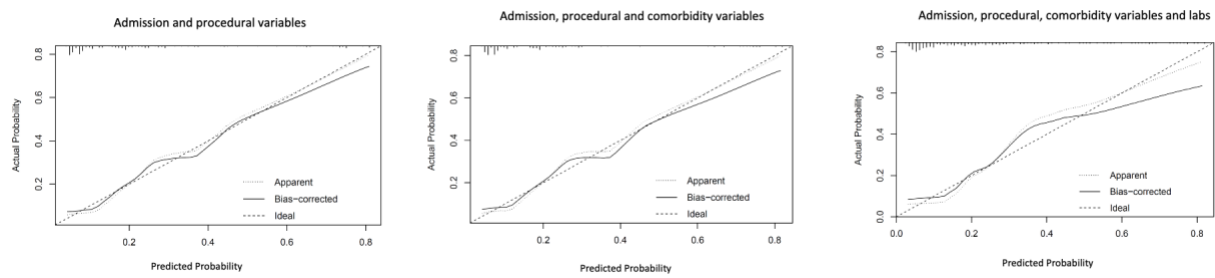
Figure 1. Calibration plots for nested models

THROMBOCYTOPENIA CORRELATES WITH THROMBUS BURDEN IN A MOUSE MODEL OF ACUTE DEEP VEIN THROMBOSIS

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OBJECTIVE

To investigate the effect of acute deep vein thrombosis on hematologic parameters in mice co-morbid with obesity.

METHODS

C57BL/6J male mice were fed either a 26% standard diet or 60% high fat diet for 2 weeks, previously shown to significantly increase weight, visceral adiposity and plasma cholesterol. DVT was induced by surgical ligation of the IVC immediately below the left renal vein around a 30-gauge needle spacer (approximate 90% stenosis). After 24 hours, thrombi were weighed, formalin-fixed and paraffin-embedded and sections were analyzed by immunohistochemistry (IHC). Retro-orbital samples were obtained pre-op and 24 hours post-op for CBC and plasma protein analysis. An anti-von Willebrand factor (VWF) antibody (an important platelet recruitment protein) was administered immediately before IVC ligation.

RESULTS

24 hours post-op all mice demonstrated relative anemia (-6%,$p=0.005$), granulocytosis (+142%,$p<0.0001$) thrombocytopenia (-45%,$p<0.0001$), increased mean platelet volume (MPV, +11%,$p<0.0001$) and increased VWF levels (+97%,$p<0.0001$). Obesity was associated with a more profound decease in platelet count compared to littermates (-53% vs.-35%,$p=0.03$). These changes could be attributed to either surgical insult or thrombogenesis. However, only platelet count ($r=-0.59$,$p=0.001$) and MPV ($r=+0.44$,$p=0.023$) were significantly correlated with thrombus burden by Spearman correlation analysis. The anti-VWF antibody reduced thrombus incidence and weight (-45%,$p=0.013$) and improved the associated thrombocytopenia (-53% vs.-30%,$p=0.02$). Quantitative IHC demonstrated that DVT were comprised of platelet-rich regions (Figure 1) and thrombus weight positively correlates with platelet staining (αCD41,$r=+0.85$,$p=0.0005$).

CONCLUSION

Following surgical induction of acute DVT, thrombus burden is associated with significant thrombocytopenia and in turn, enhanced platelet incorporation into the thrombus as visualized by IHC. This association was more profound with the underlying pro-inflammatory state of obesity. Targeting platelets in DVT may be an important adjunct to traditional anticoagulation. Serial platelet measurements may also be useful in detection of acute thrombus formation.
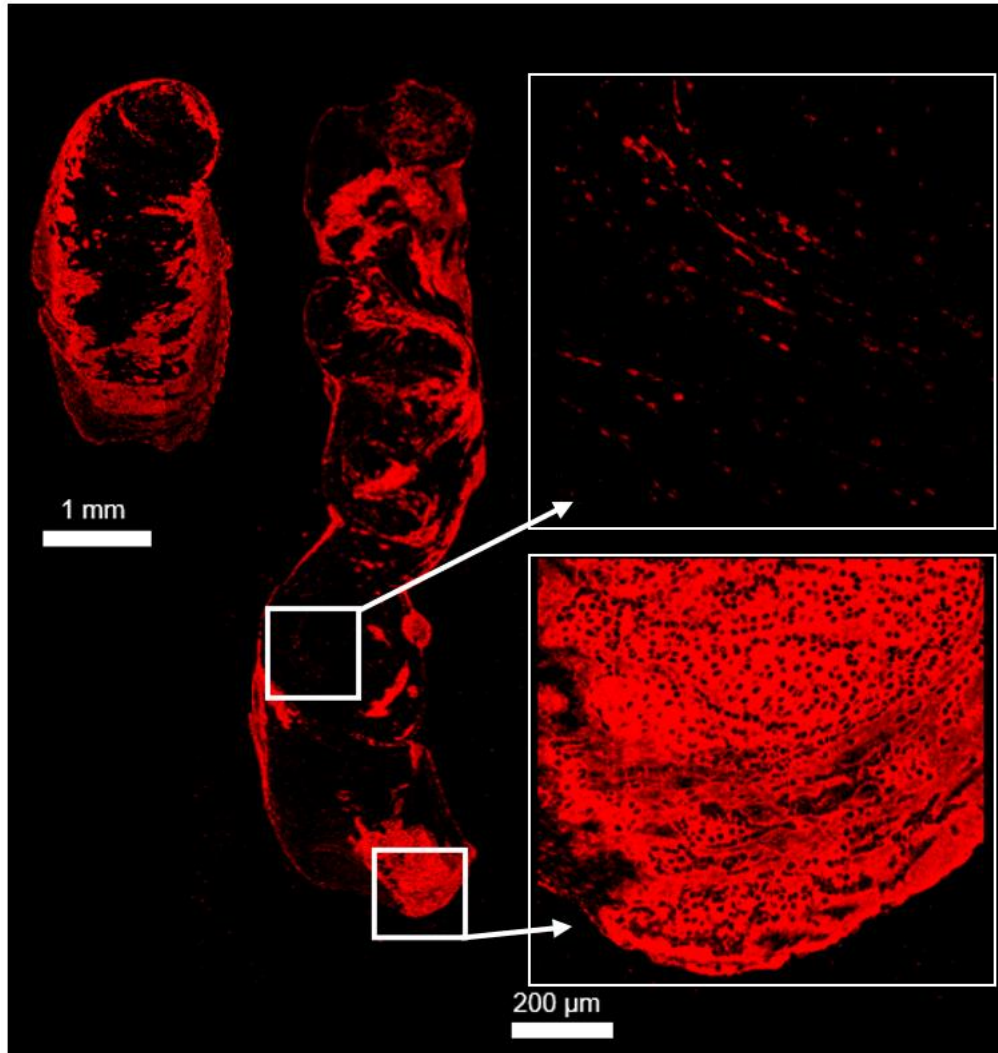
Figure 1. Platelet fluorescent immunohistochemical staining in two representative thrombi using an anti-CD41 antibody.

THE IMPACT OF STRICT PERIOPERATIVE GLYCEMIC CONTROL ON SURGICAL SITE INFECTIONS FOLLOWING LOWER EXTREMITY VASCULAR SURGERY: A SYSTEMATIC REVIEW

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OBJECTIVE
To evaluate the impact of a strict perioperative glycemic control intervention in patients undergoing open lower extremity vascular surgery on surgical wound complications.

METHODS
A systematic review was performed using the following databases: MEDLINE, EMBASE, CINAHL, Web of Science, Cochrane Library, and ClinicalTrials.gov from inception until November 2021. Studies were included if they described patients undergoing open lower extremity vascular surgery, received a perioperative intervention for glucose control, and reported on surgical wound complications and morbidity outcomes. Study characteristics and count data on demographic variables, medical comorbidities, and primary outcomes were reported in a narrative fashion. Risk of bias was assessed with the Cochrane ROBINS-I tool.

RESULTS
The search strategy yielded 8,354 articles which were assessed by title and abstract. Two studies that met eligibility criteria were included in the review. Both studies were prospective non-randomized trials, with one study (n=1, 50%) utilizing historical controls and the other study being a single-arm intervention (n=1, 50%). Both studies (n=2, 100%) utilized an intravenous insulin protocol to target a finger stick blood glucose level of 80-150 mg/dL. One study (n=1, 50%) reported a significant reduction in surgical site infection following the insulin infusion protocol compared to controls (4% vs. 11%, p=0.047), particularly in diabetic patients. The other (n=1, 50%) did not report a reduction in surgical site infections. Risk of bias was considered moderate for one study (n=1, 50%) and serious for the other study (n=1, 50%).

CONCLUSION
Despite hyperglycemia being a common occurrence after surgery and associated with increased risk of perioperative morbidity and mortality, few interventions have been developed to address this complication in vascular surgery. As the current literature on this topic is largely characterized by retrospective cohort data, future studies should devise randomized controlled trials to ascertain the effect of glucose control on wound complications.

THE STATUS OF WOUND CARE RESEARCH IN CANADA

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OBJECTIVE

To identify the characteristics of Canadian research on wound healing and prevention through a systematic approach using a scoping review methodology.

METHODS

We searched Medline, Embase, Cochrane Central, CINAHL and SCOPUS from inception to July 2021 for studies analysing wound care in the Canadian population by Canadian institution-affiliated authors. Interventional, observational cohort studies, pre-clinical or animal studies were also eligible. Study characteristics, outcomes and subcategories, and important findings were collected from each article and summarised. Thematic analysis was performed to identify wound care priorities.

RESULTS

Five hundred and sixty-five articles were included in our study. Physicians co-authored 86.7% of studies (n=490) and nurses contributed to 32.4% of studies. The top five themes identified were: wound prevention, management and treatment (n=241, 43%); surgical site infections (n=105, 19%); vascular and wound healing biology (n=100, 18%); healing apparatus and devices software (n=84, 15%); and models of follow-up care (n=83, 15%) (Table 1 and 2). Differences were found between authorship themes. Nurses more likely to co-author articles exploring themes related to direct patient wound care prevention, management, and treatment (Physicians: 147/241 [61.0%] vs Nurses: 154/241 [63.9%]). Physician specialties were more likely to co-author publications on surgical site infections (Physicians: 91/105 [86.7%] vs Nurses: 5/105 [4.7%]), wound healing milieu (Physicians: 79/100 [79.0%] vs Nurses: 7/100 [7.0%]) and advancing technologies (Physicians: 52/85 [61.2%] vs Nurses: 37/84 [44.0%]).

CONCLUSIONS

We mapped the scope of wound care research in Canada. Surgical wounds, pressure-injuries, diabetic foot ulcers and burns were the most reported exposures. Wound prevention, management and treatment was the most common priority followed by surgical site infections management and vascular and wound healing biology. We have provided data that supports potential high-yield themes. Our results will inform a Delphi process for a national consensus of stakeholders on wound care research priorities to accelerate improved patient outcomes.

Table 1: Thematic Analysis of Current Canadian Wound Care Research Priorities

Themes	Number of Articles Analysing the Theme	Percentage of Total Articles with Themes
Wound Prevention/Management/Treatment	241	43%
Surgical Site Infection	105	19%
Vascular and Wound Healing Biology	100	18%
Healing apparatus, Devices, Applications & AI	84	15%
Models of care to follow patients during therapy (e.g., nurse run clinic, surgeon follow up, home care, education)	83	15%
Assessment/diagnosis	80	14%
Pressure/Arterial/Venous Ulcer	67	12%
Time to Heal	66	12%
Wound Severity, Recurrence, Amputation Rate	64	11%
Patient risk factors (e.g., diabetes, elderly, smoker)	61	11%
Cost-analysis & Health Systems Policy	52	9%
Infection (General/Non-Surgical)	47	8%
Health-Related Quality of Life	40	7%
Surgical Wound Complications	38	7%
Technology (Diagnostic imaging/ Monitor therapy)	34	6%
Scarring	28	5%
Wound Type	11	2%
Surgical Wound Dehiscence	10	2%
Skin Tear	8	1%
Follow-up time	8	1%
Hematoma	2	0%
Seroma	1	0%

Table 2: Prevalence of Wound Care Research by Exposure

Type of Exposure	Number of Articles with Exposure	Percentage of Total Articles with Exposure
Surgical	158	28%
Pressure-Injury	87	15%
Diabetic Foot Ulcer	66	12%
Burn	57	10%
Unspecified	57	10%
Other	51	9%
Venous Leg Ulcer	49	9%
Peripheral Arterial Ulcers	22	4%
Skin Tear	16	3%
Malignant Wounds	12	2%
Trauma	12	2%
Moisture Associated Skin Damage	6	1%
Neuropathy	6	1%
Foot Deformity	4	1%

Note: Study exposures were categorized as "other" (e.g., epidermolysis, edema, radiation necrosis, pilonidal abscess, allergic reaction…etc.) as they were too variable and could not be categorized.

CATHEYE: DESIGN, DEVELOPMENTS, AND EVALUATION OF A FORWARD-LOOKING ULTRASOUND CATHETER

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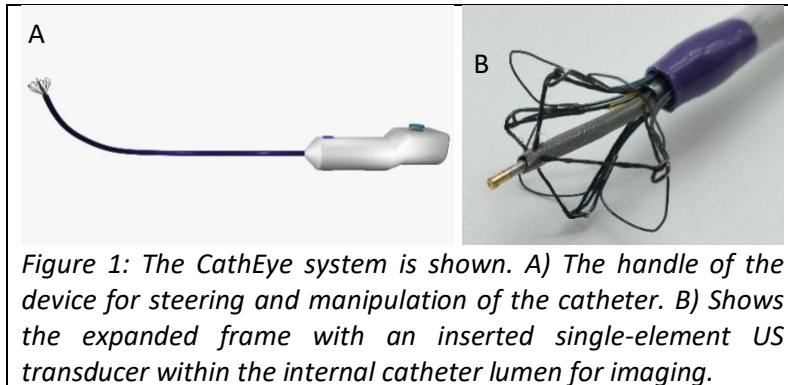[1]Sunnybrook Research Institute, Sunnybrook Health Sciences Centre, Toronto, ON

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OBJECTIVE Our goal is to develop a forward-looking ultrasound catheter for minimally invasive cardiovascular interventions and to assess feasability and perfromance with various access site tortuosity.

Figure 1: The CathEye system is shown. A) The handle of the device for steering and manipulation of the catheter. B) Shows the expanded frame with an inserted single-element US transducer within the internal catheter lumen for imaging.

METHODS The CathEye (Fig. 1) uses an expandable cable-driven parallel mechanism to provide for localized control of the distal tip of the catheter relative to the anatomy. The expanded frame provides a rigid reference for mechanical manipulation and tracking. By measuring the cable displacements made to actuate the catheter tip, its position can be tracked relative to the expandable frame. The average tracking error is below 0.45mm for all expansion sizes. Phantoms were made using agar (2%) and aluminum oxide (1%, 3μm) scatterers (Fig. 2A, 2C), and scanned with a forward looking 40MHz single element-PZT transducer mounted onto the catheter and manually steered with the CathEye. The transducer was steered to 200 positions with 20 signals acquired and averaged for each position. Time of flight and intensity data was taken from the signals and used to interpolate a 3D surface and overlaid across the surface. We repeated the experiments using three different tortuous path configurations to recreate the effects of the anatomy on tracking and imaging performance.

RESULTS The phantom surfaces were successfully reconstructed after scanning them with the CathEye regardless of the catheter path and shape. The three images each successfully resolve the surface features of the imaging phantom (Fig. 2B, 2D).

CONCLUSIONS The CathEye is able to image the workspace in front of it, regardless of path tortuosity. The images are created with respect to the frame and can be used with tracking data to visualize the position of an interventional device relative to the anatomy image and to precisely position and navigate the device to the target of interest.
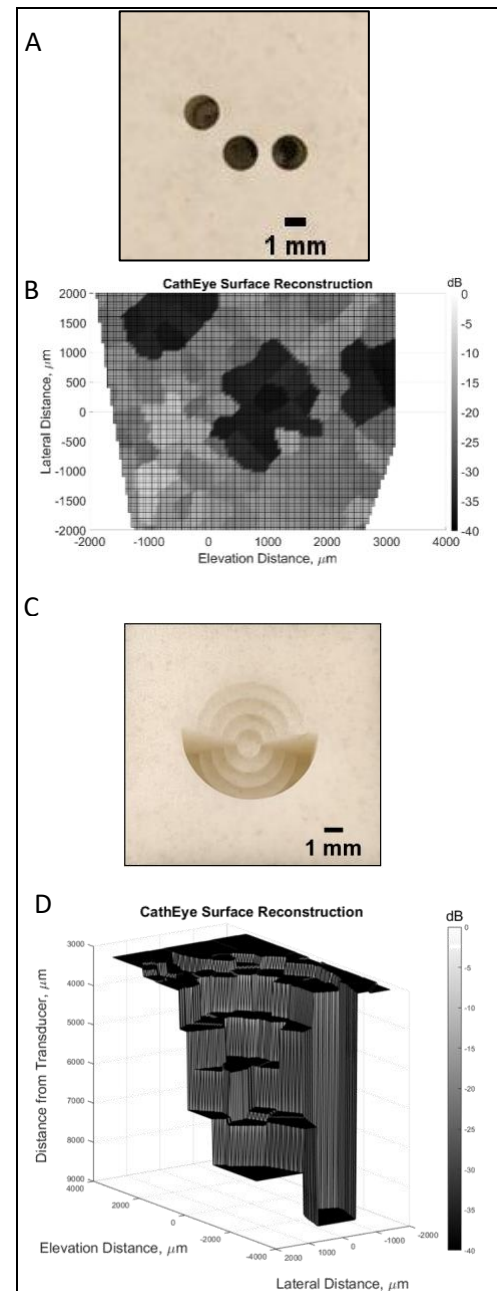

Figure 2: (A) Agar imaging phantom flat surface with 3 holes; (B) A surface reconstruction of "A" with intensity overlaid. (C) Agar imaging phantom with 3D profile; (D) 3D surface reconstruction of "C".