VIRTUAL

VASCULAR SURGERY RESEARCH DAY

Friday May 1st, 2020
It is with great pleasure that I welcome you to the Annual University of Toronto Vascular Surgery Research Day. This year is different obviously. The COVID-19 pandemic has put the world on hold and we’re not sure how long it’s effects will last. But today is a celebration of academics. It’s been another productive year and as we come to the end of the academic year we gather to celebrate the successes and research productivity of our faculty, students, residents, fellows and research trainees.

The highlight of the day will be the 9th Annual K. Wayne Johnston Visiting Lecture in Vascular Surgery. We are privileged to have Dr. Gilbert Upchurch Jr. from the University of Florida as our virtual guest. I’m sure his talk will be fascinating, informative and will inspire us to greater academic heights.

I’d like to extend specific thanks to the U of T Vascular Surgery Executive who made this day possible through their commitment to our academic mission. These surgeons include: Mohammed Al-Omran (Division Head, St. Michael’s), Andrew Dueck (Division Head, Sunnybrook), Christiane Werneck (Division Head, Trillium), Kerry Graybiel (Division Head, Humber River), John You (Division Head, Scarborough), George Oreopoulos (Residency Program Director), Mark Wheatcroft (Fellowship Program Director), Elisa Greco (Director of Undergraduate Medical Education) and Graham Roche-Nagle (Quality & Best Practices).

Special thanks to Michelle Paiva, our Division’s Administrative Assistant, without who this day would not have been possible.

Also, we appreciate the generosity and commitment of W.L. Gore & Associates who are the premier sponsor of this event through an unrestricted education grant.

Welcome and I hope you enjoy the University of Toronto Vascular Surgery Research Day.

Sincerely,

Thomas L. Forbes, MD, FRCSC, FACS
R. Fraser Elliott Chair & Head, Division of Vascular Surgery, UHN
Sprott Department of Surgery, Peter Munk Cardiac Centre
Professor & Chair, Division of Vascular Surgery, University of Toronto
K. Wayne Johnston Visiting Lecturer in Vascular Surgery

In recognition of Dr. Johnston’s unprecedented contributions to our specialty of Vascular Surgery and the University of Toronto an annual lecture began in his name. Dr. Johnston was a founding member and President of the Canadian Society for Vascular Surgery and later became President of the Society for Vascular Surgery. He is a pre-eminent academic surgeon who served as Editor-in-Chief of the Journal of Vascular Surgery and Co-Editor of two editions of Rutherford’s Textbook of Vascular Surgery. No other Canadian, and few internationally, have contributed more to academic vascular surgery than Dr. Johnston. In 2009 he was honored with the Lifetime Achievement Award by the Society for Vascular Surgery. In 2018 Dr. Johnston was honored as a Member of the Order of Canada for his outstanding achievement, dedication to the community and service to the nation.

This lectureship was made possible through the generous donations of faculty, students and alumni.

Previous K. Wayne Johnston Lecturers

<table>
<thead>
<tr>
<th>Year</th>
<th>Lecturer</th>
<th>Institution</th>
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<tbody>
<tr>
<td>2012</td>
<td>Joseph L. Mills</td>
<td>University of Arizona</td>
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<td>2013</td>
<td>Lewis B. Schwartz</td>
<td>University of Chicago</td>
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<tr>
<td>2014</td>
<td>Philip P. Goodney</td>
<td>Dartmouth University</td>
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<td>2015</td>
<td>Ronald L. Dalman</td>
<td>Stanford University</td>
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<td>2016</td>
<td>Melina R. Kibbe</td>
<td>Northwestern University</td>
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<td>2017</td>
<td>Marc Schermerhorn</td>
<td>BIDMC, Harvard University</td>
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<tr>
<td>2018</td>
<td>Julie Freischlag</td>
<td>Wake Forest Baptist Medical Center</td>
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<tr>
<td>2019</td>
<td>A. Ross Naylor</td>
<td>Leicester Vascular Institute</td>
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Gilbert R. Upchurch, Jr., MD
Edward R. Woodward Professor of Surgery
Chairman, Department of Surgery
University of Florida
Gainesville, Florida

Gilbert R. Upchurch Jr., MD, is the Chairman of the University of Florida Department of Surgery, as well as the Edward R. Woodward Professor of Surgery. He joined UF in 2017 with an international reputation as an acclaimed clinician, researcher and educator in the study and treatment of aortic and vascular disease. He is an exemplary teacher, having received many teaching awards over the course of his career. Prior to joining UF, Dr. Upchurch served as the Chief of Vascular and Endovascular Surgery in the Department of Surgery and the Medical Director of the Heart and Vascular Center at the University of Virginia Medical Center in Charlottesville, Virginia. He was also the William H. Muller Jr. Professor of Surgery as well as a Professor in the Department of Molecular Physiology and Biological Physics. Earning his medical degree at the University of North Carolina Chapel Hill and training at Harvard University, Boston University and the Cleveland Clinic, Dr. Upchurch maintains active roles on numerous peer-reviewed journals and professional organizations. He serves on the editorial boards of many prestigious publications, including the Annals of Surgery, Surgery, the Journal of the American College of Surgeons, JAMA Surgery, the Journal of Vascular Surgery, the Journal of Endovascular Therapy, AORTA, and the Annals of Vascular Surgery. He has also served as editor or associate editor for more than 10 books, including “Greenfield’s Surgery: Scientific Principles & Practice,” “Fischer’s Mastery of Surgery” and “Rutherford’s Vascular Surgery.” Dr. Upchurch is a fellow of the American College of Surgeons and the American Heart Association, and a Distinguished Fellow of the Society of Vascular Surgery. He is a member of numerous medical associations, including the American Surgical Society, the Southern Surgical Association, the Society for Vascular Surgery and the Southern Association of Vascular Surgery.
Objectives:

1. To obtain new knowledge regarding advances in basic science and clinical research in the field of vascular surgery.
2. For vascular surgery trainees, to have an opportunity to present their research work and to obtain feedback and questions from their peers.
3. To obtain new knowledge regarding the pathophysiology of abdominal aortic aneurysms.
4. To understand the value of continuing quality assurance in surgical practice.
5. To have an opportunity to learn and collaborate with colleagues within and without the University of Toronto.

Accreditation:

The 2020 University of Toronto Division of Vascular Surgery Annual Research Day is a self-approved group learning activity (Section 1) as defined by the Maintenance of Certification Program of the Royal College of Physicians and Surgeons of Canada

Certificates of Attendance and Evaluation Forms will be sent to attendees following the meeting.
Sponsorship:

We’d like to thank W.L. Gore and Associates who have agreed to a multi-year commitment as sole sponsor to support the U of T Vascular Surgery Research Day through an education grant. Special thanks to Effy Ordon, Senior Development Officer in the Office of Advancement at the U of T Faculty of Medicine for stewarding this donation.

Eric Zacharias, Gore Medical Products Division Leader for Gore says, “Our commitment to improving lives has driven us for more than 60 years as an Enterprise -- demonstrated thru our innovative therapeutic solutions to complex medical problems for more than 45 years within the Medical Products Division. During that time, more than 45 million Gore Medical Devices have been implanted, saving and improving the quality of lives worldwide. W. L. Gore & Associates is committed to advancing vascular surgical and endovascular therapy and as a result is pleased to be able to provide educational grant support to the University of Toronto, Division of Vascular Surgery. It is our hope that through this educational grant we will be able to support the University of Toronto in some of our shared values including commitment to ongoing learning and innovation, dedication to sharing knowledge with peers and patients, creating consensus within the medical community and the analysis of clinical outcomes.”
RESEARCH DAY AGENDA

0800 – 0830: Welcoming Remarks
Dr. James Rutka
*R.S. McLaughlin Professor & Chair, Department of Surgery, University of Toronto*

Dr. Thomas L. Forbes
*Professor & Chair, Division of Vascular Surgery, University of Toronto*

0830 - 1115: Morning Session (10 minute presentations, 5 minutes questions)
Moderator: Dr. Thomas Forbes

0830 – 0845: Status of NT-ProBNP in peripheral artery disease patients in the absence of symptomatic coronary artery disease
Bader Alsuwailem, Abdelrahman Zamzam, Mohammad Qadura

0845 – 0900: An investigation of psoas muscle area as a predictor of outcomes in patients undergoing lower limb revascularization
Lyon Qiao, Andrew Brown, Naomi Eisenberg, Graham Roche-Nagle, Kong Teng Tan, John Byrne

0900 – 0915: Machine learning classification of doppler waveforms – preliminary results
Brandon Van Asseldonk, Mohammed Firdouse, Ahmed Kayssi

0915 – 0930: Contemporary vascular surgery training in Canada – Is there adequate exposure to open surgery?
Mohamad A. Hussain, Musaad AlHamzah, Thomas L. Forbes, Mark Wheatcroft, Elisa Greco, Jean Jacob-Brassard, Abdelrahman Zamzam, Mohammed Al-Omran

0930 – 0945: Comparison of two clinical scales to assess the post thrombotic syndrome – secondary analysis of a multicenter randomized trial of pharmacomechanical catheter directed thrombolysis for deep vein thrombosis
Angela Lee, Chu-Shu Gu, Vedantham Suresh, Clive Kearon, Mark Blostein, Susan Kahn

0945 – 1000: The burden of academic spam
Asha Behdinan, Naomi Eisenberg, Graham Roche-Nagle

*United in a Tradition of Leadership, Discovery & Excellence*
1000 – 1015: Optimizing preoperative cardiac risk stratification for aortic surgery
Caleb C.J. Zavitz, Naomi Eisenberg, Graham Roche-Nagle

1015 – 1030: The effect of statin therapy on outcomes of elective abdominal aortic aneurysm repair
Konrad Salata, Mohamad A. Hussain, Charles de Mestral, Elisa Greco, Muhammad Mamdani, Thomas L. Forbes, Subodh Verma, Mohammed Al-Omran

1030 – 1045: Variations in vascular surgery practice for abdominal aortic aneurysm repair between Canada and the United States
Philippe Rizkallah, Naomi Eisenberg, Graham Roche-Nagle

1045 – 1100: Risk factors for long term mortality and complications following thoracoabdominal aortic aneurysm repair
Rodolfo Rocha, Maral Ouzounian, Daniyal Nasir, Douglas S. Lee, Peter C. Austin, Justin Chan, Jennifer Chung, Thomas L. Forbes, Thomas F. Lindsay

1100 – 1115: Long term follow-up following advanced endovascular thoracoabdominal aortic aneurysm repair – a single center experience
Daniyal N. Mahmood, Rodolfo Rocha, Maral Ouzounian, Kong Teng Tan, Thomas F. Lindsay

1115 – 1215: 9th Annual K. Wayne Johnston Lecturer

“Joyin” Discovery
Dr. Gilbert R. Upchurch, Jr
University of Florida, Gainesville, Florida
1215 - 1315: Surgeon-Scientist Training Program Forum
(10 minute presentations, 5 minutes questions)
Moderator: Dr. Mohammed Al-Omran (Division Head, St. Michael’s Hospital)

1215 - 1230: Management and In-Hospital mortality of 2,230 patients with traumatic intimal tear of the thoracic aorta
Jean Jacob-Brassard, Mohammed Al-Omran, Thomas L. Forbes, Avery Nathens, Charles de Mestral

1230 - 1245: Comprehensive operative assessment in peripheral endovascular procedures: development and pilot of the ENDORATE-PVI framework and the endovascular OR black box
Lauren Gordon, B Doyen, J Sunavsky, Mark Wheatcroft, Charles de Mestral, V Palter, Teodor Grantcharov, I Van Herzeele on behalf of the ENDORATE-PVI Consortium

1245 - 1300: Carotid plaque-derived extracellular vesicle microRNA content differs between symptomatic and asymptomatic stenosis
Sneha Raju, Dakota Gustafson, Jason E. Fish, Kathryn L. Howe

1300 - 1315: A scoping review of computer-based cognitive behavioural therapy in patients with chronic illness or disabilities: use in patients with vascular risk factors or disease
Monica Abdelmasih, Jacqueline Nestico, Leslie Summers deLuca, Ahmed Kayssi

1330 - 1500: Rapid Fire Presentations (5 minute presentations, 3 minutes questions)
Moderator: Dr. George Oreopoulos (Residency Program Director)

1330 - 1340: Prediction of bird-beak configuration formation in TEVAR using computational models
Negin Shahbazian, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes

1340 - 1350: Lymphatic complications and their management following vascular surgery – case series
Mohammed Firdouse, Graham Roche-Nagle

1350 - 1400: Automated stent graft planning – in less than five minutes
Sean A. Crawford, Kong Teng Tan, Thomas F. Lindsay, Thomas L. Forbes
<table>
<thead>
<tr>
<th>Time</th>
<th>Presentation</th>
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<tr>
<td>1400 - 1410:</td>
<td><strong>The effect of addition of pharmacomechanical thrombolysis to anticoagulation therapy for iliofemoral DVT on prevention of post thrombotic syndrome – a literature review</strong>&lt;br&gt;Zeyad Khoshhal, Christiane Werneck</td>
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<tr>
<td>1410 - 1420:</td>
<td><strong>Computational fluid dynamics simulations of CTA-derived patient specific FEVAR hemodynamics</strong>&lt;br&gt;WC Patrick Lin, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes</td>
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<td>1420 - 1430:</td>
<td><strong>The development of a national curriculum in wound management using the Delphi consensus process</strong>&lt;br&gt;Mekki Medani, Omar Selim, Catharine Walsh, Allan Okraineck, Andrew Dueck, Ahmed Kayss</td>
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<tr>
<td>1430 – 1440:</td>
<td><strong>Development of an infrared imaging catheter for guidance of complex endovascular interventions</strong>&lt;br&gt;Patrick Z. McVeigh, Sean A. Crawford, Brian C. Wilson, Graham Roche-Nagle, Mark Wheatcroft</td>
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<tr>
<td>1440 – 1450:</td>
<td><strong>Iliac limb re-interventions following endovascular aortic repair</strong>&lt;br&gt;Elena Saremi, Naomi Eisenberg, Graham Roche-Nagle</td>
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<td>1450 – 1500:</td>
<td><strong>Development of a computational fluid dynamics model of ascending aortic hemodynamics</strong>&lt;br&gt;Davis B. McClarty, Matthew G. Doyle, Thomas L. Forbes, Jennifer Chung, Cristina H. Amon</td>
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<tr>
<td>1500:</td>
<td><strong>Adjournment</strong></td>
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**Awards Presentation (to be announced later)**
Best Presentation by a Junior Resident (PGY1 & 2)<br>Best Presentation by a Senior Resident or Fellow<br>Alumni Award for Best Presentation by a SSTP Resident
## Previous Research Day Award Winners

<table>
<thead>
<tr>
<th>Year</th>
<th>Best Presentation by a Junior Resident (PGY1 &amp; 2)</th>
<th>Best Presentation by a Senior Resident or Fellow</th>
<th>Alumni Award for Best Presentation by a SSTP Resident</th>
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<tbody>
<tr>
<td>2015</td>
<td>Patrick McVeigh</td>
<td>Ahmed Kayssi</td>
<td>Mohamad Hussain</td>
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<tr>
<td>2016</td>
<td>Caleb Zavitz</td>
<td>Ahmed Kayssi</td>
<td>Trisha Roy</td>
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<tr>
<td>2017</td>
<td>Caleb Zavitz</td>
<td>Charles de Mestral</td>
<td>Konrad Salata</td>
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<tr>
<td>2018</td>
<td>Sneha Raju</td>
<td>Omer Abdulrahim</td>
<td>Sean Crawford</td>
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<tr>
<td>2019</td>
<td>Sneha Raju</td>
<td>Sean Crawford</td>
<td>Omar Selim</td>
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## Previous Teaching Award Winners

<table>
<thead>
<tr>
<th>Year</th>
<th>Most Outstanding Teacher – Resident or Fellow (as voted on by residents and fellows)</th>
<th>Most Outstanding Teacher – Faculty (as voted on by residents and fellows)</th>
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<tbody>
<tr>
<td>2016</td>
<td>Ahmed Kayssi</td>
<td>Andrew Dueck</td>
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<tr>
<td>2017</td>
<td>Charles de Mestral</td>
<td>Mark Wheatcroft</td>
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<tr>
<td>2018</td>
<td>Miranda Witheford</td>
<td>Thomas Lindsay</td>
</tr>
<tr>
<td>2019</td>
<td>Husain Al-Mubarak</td>
<td>George Oreopoulos</td>
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Status of NT-ProBNP in peripheral artery disease patients in the absence of symptomatic coronary artery disease

Bader Alsuwailem, Abdelrahman Zamam, Mohammad Qadura

Objective: The coexistence of coronary artery disease (CAD) and peripheral artery disease (PAD) cannot be overstated. Yet, major societal guidelines discourage screening peripheral artery disease patients with intermittent claudication for cardiovascular risk in the absence of cardiac symptoms. The aim of this study is to assess the status of N-terminal pro-BNP levels in PAD patients with Rutherford class I-III in the absence of CAD symptoms.

Methods: We conducted a cross-sectional study of 505 participants. Patients were stratified on the basis of their clinical history and ankle-brachial index into non-PAD patients or PAD patients with ABI in the mild, moderate or severe range. Enzyme-linked immunosorbent assay was used to measure Nt-proBNP.

Results: The study cohort included 391 (77.4%) PAD patients and 114 (22.6%) non-PAD controls. Nt-proBNP levels were significantly higher in PAD patients with ABI in the severe range compared to patients without PAD (median = 374.3; IQR = 423.6; p-value < 0.001). We found significant association between levels of NT-pro BNP and PAD patients with ABI in severe (OR: 2.77; 95%CI: 1.99 – 6.55) and moderate (OR: 1.69; 95% CI, 1.06 – 2.69) range when compared with non-PAD controls. Age, smoking and stable CAD were significantly correlated with higher NT-pro BNP concentrations (p-value = 0.001, 0.015 and 0.042), respectively. However, in subgroup analysis of PAD patients with ABI in the severe range, this correlation became statistically insignificant.

Conclusions: Nt-pro BNP are elevated in patients with PAD (Rutherford class I-III) in whom ABI is in the severe range. This association remained significant even after adjusting for known confounding factors. Such correlation may have future implications in intensifying risk reduction therapy in this patient group and may warrants further evaluation for cardiovascular disease.
An investigation of psoas muscle area as a predictor of outcomes in patients undergoing lower limb revascularization

Lyon Qiao, Andrew Brown, Naomi Eisenberg, Graham Roche-Nagle, Kong Teng Tan, John Byrne

Objective: To investigate if total psoas area (TPA) measured at mid-L3, distal-L3, and proximal-L4 can be used to predict postoperative outcomes in patients undergoing open revascularization procedures for critical limb ischemia.

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

Results: 141 patients, who underwent infra-inguinal bypass (n = 73), supra-inguinal bypass (n = 54), or both concomitantly (n = 14), were included in this analysis (86 male, 55 female). Patients that experienced mortality by 6, 12, and 60-months postoperatively had significantly lower TPA measured at mid-L3 (two-tailed p = 0.0007, 0.0005, 0.0101, respectively) than survivors. These differences were independent of sex and procedure. Patients suffering major limb amputation did not have significant differences in TPA measured at any level. Finally, patients who experienced losses in baseline amputation after 12 and 60-months postoperatively had significantly lower proximal-L4 TPA (two-tailed p = 0.029, 0.02).

Conclusions: The presence of significant differences in mid-L3 TPA between patients who experience mortality and those surviving suggests that biomarkers, like TPA, may be clinically useful in predicting the risk of such complications following revascularization. Further analysis is necessary to determine the precise mid-L3 TPA and proximal-L4 TPA cut-offs to more effectively predict risk of postoperative complications in patients with critical limb ischemia prior to undergoing open revascularization procedures.
Machine learning classification of doppler waveforms – preliminary results

Brandon Van Asseldonk, Mohammed Firdouse, Ahmed Kayssi

**Objective:** The vascular lab including the arterial duplex ultrasound (US) is a non-invasive and readily available test which plays an important role in the diagnosis and surveillance of peripheral arterial disease (PAD). A component of the duplex US interpretation includes classification of the doppler waveforms into triphasic, biphasic and monophasic, the later which is considered abnormal. Typically, this classification is done by the vascular technologist or reporting physician. The authors sought to use machine learning techniques to automate the classification of doppler waveforms into triphasic, biphasic and monophasic categories.

**Methods:** Publicly available lower extremity arterial doppler waveform images were extracted from multiple online publications. 112 images were extracted and classified by an RPVI credentialed physician into monophasic and multiphasic (triphasic or biphasic). 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 power. 80% (n=90) of the images were used to train the model and the remaining 20% (n=22) were used to test the results of the model.

**Results:** The neural network was trained for a total of 10 cycles with an error rate of 22%. The learning rate was optimized, and training was continued for 10 more cycles. An error rate of 13% was achieved which represented 3 misclassified waveforms from the 22 testing waveforms. The confusion matrix and a sample of interpreted images are shown in the below figures.

**Conclusions:** Our neural network was trained on a relatively small number of images (112), however we achieved satisfactory results with an error rate of 13% using a pretrained trained neural network and transfer learning approach. Similar machine learning problems with much larger datasets have error rates in the 2-5% percent range which we hope to achieve using 1000s of vascular lab studies extracted from a local vascular lab database. A refined and more accurate model could be integrated into ultrasound technology to provide an automated interpretation similar to ECG.
Figure 1: Confusion Matrix

Figure 2: Sample of Interpreted Images
Contemporary vascular surgery training in Canada – Is there adequate exposure to open surgery?

Mohamad A. Hussain, Musaad AlHamzah, Thomas L. Forbes, Mark Wheatcroft, Elisa Greco, Jean Jacob-Brassard, Abdelrahman Zamzam, Mohammed Al-Omran

Objective: To evaluate the trends in exposure of open vascular surgery procedures among graduates of Canadian vascular surgery training programs.

Methods: A survey was administered to graduates of Canadian Royal College-accredited Vascular Fellowships and Integrated Vascular Surgery Residency programs between 2007 and 2019. Participants were asked to list the number of cases they performed during their two-year fellowships or during the last two years of their residency training using case logs. Procedures of interest were open abdominal aortic aneurysm (AAA) repair, open thoracic/thoracoabdominal aortic (TAA/TAAA) repair, lower extremity bypass (LEB), and carotid endarterectomy (CEA). Cases of endovascular abdominal, thoracoabdominal, or thoracic aortic repair (EVAR, advanced EVAR, or TEVAR), and lower extremity endovascular interventions were also collected to compare the trends of open and endovascular procedures during the study period.

Results: The average number of open cases performed by graduates (n = 42) of Canadian vascular surgery programs over the 13-year period was 61 open AAA, 11 open TAA/TAAA, 76 LEB, and 46 CEA. Overall, there was a decline in open vascular surgery exposure during the study period (Figure). After the introduction of Integrated Vascular Surgery Residency programs in 2012, the average case volumes between 2013 and 2019 were 48 open AAA, 10 open TAA/TAAA, 61 LEB, and 40 CEA. The mean volume of endovascular procedures during the study period were 62 EVAR, 14 TEVAR, and 87 lower extremity interventions.

Conclusions: Despite a declining trend in open surgery, Canadian vascular surgery training programs continue to equip their trainees with adequate exposure to both open and endovascular procedures to help them provide comprehensive vascular care for their patients.
Figure 1. Average case volumes logged by vascular surgery residents in their last 2 years of training and vascular surgery fellows during their 2-year fellowship (2007-2019).
Comparison of two clinical scales to assess the post thrombotic syndrome – secondary analysis of a multicenter randomized trial of pharmacomechanical catheter directed thrombolysis for deep vein thrombosis

Angela Lee, Chu-Shu Gu, Vedantham Suresh, Clive Kearon, Mark Blostein, Susan Kahn

Objective: Post-thrombotic syndrome (PTS) occurs in 20-50% of patients following proximal deep vein thrombosis (DVT), despite anticoagulation treatment. The International Society on Thrombosis and Haemostasis recommends using the Villalta scale to standardize the diagnosis of PTS and to quantify its severity. However, many investigators use the Venous Clinical Severity Score (VCSS) to assess PTS. Different to the Villalta score, the VCSS was developed as a measure for chronic venous disease and not PTS specifically. The aim of the study was to determine which of Villalta and VCSS best captures clinically important PTS and PTS severity by analyzing the relationship of each to QoL scores in the Acute Venous Thrombosis: Thrombus Removal with Adjunctive Catheter-Directed Thrombolysis (ATTRACT) trial study population.

Methods: A secondary analysis of the ATTRACT randomized controlled clinical trial was conducted. 621 ATTRACT patients with symptomatic proximal DVT are included in this analysis. The relationship between the Villalta and VCSS scores and severity categories were examined. Correlations of the Villalta and VCSS scores with QoL scores (Short-Form Health Survey-36 physical component score/mental component score [SF-36 PCS/MCS]; the Venous Insufficiency Epidemiological and Economic Study-QoL/Symptoms [VEINES-QoL/Sym] questionnaire) were examined at study visits.

Results: The mean VCSS score was determined by Villalta severity group. Mild disease as per the Villalta would be categorized as no disease as per the VCSS given the mean VCSS score of 3 points. Conversely, the mean Villalta score by VCSS severity demonstrated that severe disease as per the VCSS would be categorized as moderate disease given its mean Villalta score was less than 15 points. The Villalta Scale and the VCSS had a correlation coefficient of greater than or equal to 0.70. Between the clinical scales and the QoL scores, the Villalta/VEINES-QoL was the only pairing which had a correlation coefficient greater than - 0.70. The mean VEINES-QoL score consistently decreased by 10 points for every increase in Villalta severity category. This relationship was not found with the VEINES-QoL and VCSS severity categories.

Conclusion: The Villalta Scale has a substantially higher correlation with QoL, with a consistent incremental change in VEINES-QoL scores associated with a change in severity category. Our findings support the use of the Villalta Scale to assess PTS in preference to VCSS, as it better captures the impact of PTS on patient reported QoL, a key consideration in patients with chronic PTS.
The burden of academic spam

Asha Behdinan, Naomi Eisenberg, Graham Roche-Nagle

Objective: Researchers and physicians often receive academic invitations that are unsolicited, from unknown senders, and do not relate to their field of study. This study aims to determine the prevalence and impact of academic spam amongst physicians in a Canadian academic centre.

Methods: Staff and residents were voluntarily recruited for this study through email invitation. The participants were asked daily to direct all emails considered to be “academic spam” to the research team for the duration of 1 week. The criteria for spam includes: Invitations for academic activities that are unsolicited; AND do not pertain to the recipient’s area of work/research; OR that are from illegitimate sources. These emails were accepted or rejected for the study based on this criteria. These submissions were then analyzed for type, congruence, cost, repetition, and suppressibility.

Results: A total of 549 emails not intercepted by the institutional spam filter from 15 participants were forwarded to the research team, accounting for 70 total days. The average number of spam emails received per week was 59, ranging from one to 30 emails per day with daily mean of seven to eight emails. Out of 538 submissions deemed to be spam, 46.3% were notifications from journals, 21.8% were invitations to conferences, 7.8% were invitations to serve on an editorial board, 9.7% were newsletter alerts, 5.9% were invitations for webinars/courses, 5.4% were paid products/services, and 3.5% were other academic invitations or requests. The majority of academic spam originated from open access publications. A total of 12.8% of spam emails referenced a fee, largely related to processing costs for publications, ranging from “waived” to “GBP $650”. Only 13% of the spam collected remotely mirrored the participants’ academic interests. Data obtained from the institution’s information technology team indicated that 75% of all incoming emails are blocked, illustrating that the true burden of academic spam may be up to four-fold greater than study results show.

Conclusions: Academic spam invitations are common and irritating, often duplicates, and of little relevance to the recipient.
Optimizing preoperative cardiac risk stratification for aortic surgery

Caleb C.J. Zavitz, Naomi Eisenberg, Graham Roche-Nagle

Objective: This study was designed to describe current preoperative cardiac risk stratification practice at a tertiary vascular centre, evaluate these schemes in real world practice, and propose an optimized approach.

Methods: We conducted a retrospective analysis of prospectively collected data from our Vascular Quality Initiative (VQI) database from 2010-2017. Open surgical abdominal aortic aneurysm repairs (OSRs) were queried, and adverse cardiac events (myocardial infarction, myocardial injury after noncardiac surgery (MINS), new arrhythmia, new CHF, or cardiovascular death) along with preoperative cardiac testing results were studied. A selective retrospective chart review was then conducted to investigate details not captured in the VQI database.

Results: 178 OSRs were identified, including 129 elective cases. The majority (62%) of elective patients had preoperative cardiac stress testing. 79% of these stress tests were negative, yet 33% of these patients (vs 48% of those with positive stress tests) experienced an adverse cardiac event. Upon further review, many patients who sustained unanticipated cardiac events had irreversible defects on their stress testing or untreated coronary disease on coronary angiography.

Conclusions: Preoperative cardiac risk stratification with stress testing was only modestly protective against adverse cardiac events undergoing open AAA repair. Alternative strategies including biomarker use or coronary angiography warrant further real-world investigation.
The effect of statin therapy on outcomes of elective abdominal aortic aneurysm repair

Konrad Salata, Mohamad A. Hussain, Charles de Mestral, Elisa Greco, Muhammad Mamdani, Thomas L. Forbes, Subodh Verma, Mohammed Al-Omran

Objective: The objective of this study was to assess the effect of statin therapy on outcomes following elective open and endovascular repair of an abdominal aortic aneurysm (AAA).

Methods: A retrospective population-based cohort study was conducted using linked administrative health data from Ontario, Canada from 2003 to 2016. Elective open or endovascular AAA repair ≥65 years of age were identified using validated procedure and billing codes. The outcomes of interest included all-cause mortality and major adverse cardiovascular events (MACE). Patients were inversely weighted on the propensity score for baseline statin use, and Cox regression was used to analyze the outcomes of interest. Subgroup analyses for repair approach, age, sex, and intensity of statin therapy were conducted. Sensitivity analyses included restriction to compliers only, and treatment of statin use as a time-varying exposure.

Results: Out of 14,664 elective AAA repairs, 66% (9,648/14,664) were taking statins at baseline. Mean and maximum follow-up was 5.3 years (SD 3.5) and 14.0 years, respectively. Median survival was 9.0 and 7.7 years for statin users and non-users, respectively. Baseline statin use was associated with lower hazards for all-cause mortality (HR 0.92, 95% CI 0.89-0.95, p<0.01, Figure 1) and MACE (HR 0.84, 95% CI 0.79-0.89, p<0.01). Similar magnitudes of hazard reduction were observed when investigating the hazards by repair approach, age, sex, and statin intensity. Restriction of analyses to compliers only (HR 0.74, 95% CI 0.67-0.83, p<0.01), and coding of statin use as a time-varying covariate (HR 0.41, 95% CI 0.39-0.44, p<0.01) confirmed findings from the primary analysis.

Conclusions: Statin therapy is associated with statistically significant reductions in all-cause mortality and MACE following elective AAA repair. Considering the low cost and safety of statin therapy, these findings support expansion of statin indications to patients with AAA.
Variations in vascular surgery practice for abdominal aortic aneurysm repair between Canada and the United States

Philippe Rizkallah, Naomi Eisenberg, Graham Roche-Nagle

Objective: The therapeutic decision about whether to repair an abdominal aortic aneurysm (AAA) or to choose a conservative management requires multiple considerations of a balance of risk. The same decision process applies in the choice of the procedure. The objective of this study was to compare diameters of intact aneurysms (non-ruptured and asymptomatic) at the time of repair between Canada and United States (USA). We were also searching for differences in the technique used to repair elective AAA between the two countries.

Methods: The Vascular Quality Initiative (VQI) database was used to identify all patients undergoing open abdominal aortic aneurysm repair or endovascular aneurysm repair (EVAR) from January 2003 to December 2019 in 544 centers in Canada and the USA. Only elective AAA repairs were studied. We compared practice differences between USA and Canada relative to the aneurysm diameters at the time of repair, the procedure (EVAR vs open aortic repair) and demographic characteristics of patients receiving the appropriate surgical management. According to the type of variable, $X^2$ and t-test analysis were used to assess for differences between the two countries.

Results: We identified 52,395 patients who had an elective AAA repair in Canada (n = 1446) and the USA (n = 50,949). The mean size of the AAA at the time of repair was slightly smaller in the USA compared to Canada (Canada: 59 mm vs USA: 56 mm; $p < .001$). Of these patients, 46% had an aneurysm < 55 mm in the USA compared to 20% in Canada ($p < .001$). A higher proportion of patients had an open abdominal aortic aneurysm repair in Canada for an intact aneurysm (Canada: 31% vs USA: 15%) compared to an EVAR (Canada: 69% vs USA: 85%; $p < .001$). Overall, patient demographic characteristics and risk factors for AAA were similar in both countries.

Conclusions: In conclusion, variations were observed between Canada and USA centers in the proportion of asymptomatic AAA < 55 mm that were repaired electively in circumstances where best practice guidelines exist. We also found differences in the surgical technique used for these cases. Further studies are warranted to assess the underlying reasons for the regional variations and the clinical impact that it may have.
Risk factors for long term mortality and complications following thoracoabdominal aortic aneurysm repair

Rodolfo Rocha, Maral Ouzounian, Daniyal Nasir, Douglas S. Lee, Peter C. Austin, Justin Chan, Jennifer Chung, Thomas L. Forbes, Thomas F. Lindsay

Objective: To determine the risk factors for late mortality or complications (Thoracoabdominal aortic Aneurysm Life-altering Events (TALE): composite of mortality, permanent paraplegia, permanent dialysis, and stroke) in patients undergoing thoracoabdominal aortic aneurysm (TAAA) repair.

Methods: Patients that underwent TAAA repair in Ontario from 2006 to 2017 (n=664) were identified. Cox hazards model examined the association of baseline risk factors with long-term complications.

Results: At 10-years, survival and freedom from TALE were 33% and 26%, respectively (Figure 1a and b). Older age (p<0.01) and preexisting peripheral artery disease (p=0.04), hypertension (p=0.04), heart failure (p<0.01), and urgent procedures (p<0.01) were associated with higher risk of mortality, whereas previous coronary revascularization (p=0.03) and repair at high volume institutions (> 60 TAAA repairs during the study period) (p=0.01) were associated with lower risk of mortality on multivariate analysis. Older age (p<0.01), chronic kidney disease (p=0.02), congestive heart failure (p=0.01), and urgent procedures (p<0.01) were associated with higher risk of TALE. There were no differences in risk of late mortality (p=0.90) or TALE (p=0.80) among patients undergoing open vs. endovascular TAAA repair.

Conclusions: TAAA repair is associated with poor long-term outcomes regardless of mode of treatment. Previous coronary revascularization and procedure performed at high volume institutions were associated with improved late outcomes in patients undergoing TAAA repair.
Figure 1
Kaplan-Meier curves for long-term freedom from mortality and TALE following TAAA repair

Fig 1a. Freedom from mortality

Fig 1b. Freedom from TALE

TAAA: ThoracoAbdominal Aortic Aneurysm; TALE: Thoracoabdominal aortic Aneurysm Life-altering Events
Long term follow-up following advanced endovascular thoracoabdominal aortic aneurysm repair – a single center experience

Daniyal N. Mahmood, Rodolfo Rocha, Maral Ouzounian, Kong Teng Tan, Thomas F. Lindsay

Objective: We reviewed short and long-term outcomes of patients with thoracoabdominal aortic aneurysms (TAAA) repaired using branched or fenestrated endovascular devices (B/FEVAR).

Methods: Data was collected both prospectively and retrospectively with institutional ethics approval.

Results: Seventy-eight consecutive patients underwent endovascular TAAA repair using B/FEVAR stent-grafts at our institution from June 2008 to July 2019 (47 males; mean age 74 ± 7 years) with a median follow-up for 3.1 years [interquartile range (IQR), 1.3-5.4]. Graft deployment was successful in all patients. Intraoperative target vessel revascularization was successful in 276 of 290 (95.2%) vessels: 57/65 celiac arteries (87.7%), 76/76 superior mesenteric arteries (100%), 74 of 76 right renal arteries (97.4%), and 69 of 73 left renal arteries (94.5%). Postoperatively, 16/78 (20.5%) patients required additional unplanned procedures in the operating room (branch occlusion, endoleaks, target vessel realignment) during their hospital stay. In-hospital mortality was 8/78 (10.3%) and 16/78 (20.5%) patients developed spinal cord ischemia. Postoperative in-hospital complications included stroke (5/78, 6.4%), acute myocardial infarction (6/78, 7.7%), and bowel ischemia (3/78, 3.8%). Follow-up imaging was obtained in 67/70 (95.7%) patients that survived to hospital discharge, with a median length of 1.3 years [IQR, 0.58-3.12]. Twenty-four endoleaks were identified, with 18/24 (75%) being type II. At 8-years, cumulative incidence of TAAA-related re-intervention was 48.1% (95% confidence interval (CI), 36.1-60.2)) and overall survival was 39.6% (95% CI; 0.27-0.59, Fig 1). There were no deaths related to aneurysm rupture during follow-up.

Conclusions: Endovascular repair of TAAAs was associated with a high rate of technical success. While the rate of early mortality and morbidity is low, secondary reintervention rates indicate the need for further improvements and continuous patient follow-up.
Fig 1. Kaplan-Meier survival curve for 78 consecutive patients after endovascular TAAA repair.
Management and In-Hospital mortality of 2,230 patients with traumatic intimal tear of the thoracic aorta

Jean Jacob-Brassard, Mohammed Al-Omran, Thomas L. Forbes, Avery Nathens, Charles de Mestral

**Objective:** The evidence basis for non-operative expectant management of traumatic intimal tear (IT) of the thoracic aorta remains weak. Our goal was to describe contemporary management and in-hospital mortality associated with blunt thoracic aortic IT within the American College of Surgeons Trauma Quality Improvement Program.

**Methods:** All adult patients who sustained a thoracic aortic IT following blunt trauma from 2010 to 2017 were captured. For each patient, we extracted demographics, injury characteristics, the timing and approach of thoracic aortic repair and, in-hospital mortality. Mortality attributable to IT was calculated by comparing IT patients to a propensity-score matched control cohort of severely injured blunt trauma patients without aortic injury.

**Results:** There were 2,230 IT patients across 330 facilities. Injury most often resulted from motor vehicle collision (75%). At total of 763 patients (34%) underwent operative management, with 94% (N=714) of repairs performed via an endovascular approach. The frequency of operative management was higher in patients without traumatic brain injury (TBI) (35%, n=679) compared with those with TBI (28%, n=84) (p=0.017). Median time to surgery was 11 hours (IQR 4-40). Compared to controls, IT was not associated with additional in-hospital mortality (10.8% for IT vs. 11.0% for no IT, absolute risk difference: -0.3%, 95%CI: -2.1% to 1.6%).

**Conclusions:** The majority of blunt thoracic IT are managed non-operatively and do not confer additional in-hospital mortality risk. Future studies should focus on the risk of injury progression.
Table. Comparison of patient baseline characteristics based on management strategy

<table>
<thead>
<tr>
<th></th>
<th>Non-Operative (N=1467)</th>
<th>Operative (N=763)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age – Mean +/- Std. Dev.</td>
<td>47.9 +/- 18.6</td>
<td>43.3 +/- 18.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Male sex – N (%)</td>
<td>1018 (69.4)</td>
<td>576 (75.49)</td>
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<tr>
<td>Race – N (%)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>White</td>
<td>1047 (71.4)</td>
<td>512 (67.1)</td>
<td>0.09</td>
</tr>
<tr>
<td>Black</td>
<td>198 (13.5)</td>
<td>111 (35.9)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>222 (15.1)</td>
<td>140 (18.4)</td>
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</tr>
<tr>
<td>Insurance – N (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial Insurance</td>
<td>703 (47.9)</td>
<td>385 (50.5)</td>
<td></td>
</tr>
<tr>
<td>Non-commercial Insurance</td>
<td>415 (28.3)</td>
<td>224 (29.4)</td>
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<tr>
<td>Self-pay</td>
<td>203 (13.8)</td>
<td>97 (12.7)</td>
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</tr>
<tr>
<td>Unknown</td>
<td>146 (10.0)</td>
<td>57 (7.5)</td>
<td></td>
</tr>
<tr>
<td>Comorbidities – N (%)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cardiovascular and Pulmonary</td>
<td>691 (47.1)</td>
<td>332 (43.5)</td>
<td>0.11</td>
</tr>
<tr>
<td>Diabetes or Chronic Kidney Disease</td>
<td>133 (9.1)</td>
<td>62 (8.1)</td>
<td>0.46</td>
</tr>
<tr>
<td>Substance Abuse</td>
<td>221 (15.1)</td>
<td>112 (14.7)</td>
<td>0.81</td>
</tr>
<tr>
<td>Other Comorbidity</td>
<td>203 (13.8)</td>
<td>80 (10.5)</td>
<td>0.02</td>
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<tr>
<td>Bleeding Disorder</td>
<td>69 (4.70)</td>
<td>21 (2.8)</td>
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<td>Psychiatric Disorder</td>
<td>127 (8.7)</td>
<td>61 (8.0)</td>
<td>0.59</td>
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<tr>
<td>Functionally Dependent</td>
<td>29 (2.00)</td>
<td>9 (1.1)</td>
<td>0.10</td>
</tr>
<tr>
<td>Mechanism – N (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Vehicle Transport - Occupant</td>
<td>879 (59.9)</td>
<td>493 (64.6)</td>
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</tr>
<tr>
<td>Motor Vehicle Transport - Motorcyclist</td>
<td>202 (13.8)</td>
<td>94 (12.3)</td>
<td></td>
</tr>
<tr>
<td>Pedestrian or Cyclist</td>
<td>154 (10.5)</td>
<td>81 (10.6)</td>
<td>0.18</td>
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<tr>
<td>Fall</td>
<td>140 (9.5)</td>
<td>56 (7.3)</td>
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<tr>
<td>Other Blunt</td>
<td>75 (5.1)</td>
<td>35 (4.6)</td>
<td></td>
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<tr>
<td>Struck by or Against</td>
<td>17 (1.2)</td>
<td>4 (0.5)</td>
<td></td>
</tr>
<tr>
<td>Transfer In – N (%)</td>
<td>397 (27.1)</td>
<td>270 (35.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Severe Injury (Abbreviated Injury Scale ≥ 3) – N (%)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Severe Head Injury</td>
<td>433 (29.5)</td>
<td>183 (24.0)</td>
<td>0.006</td>
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<tr>
<td>Severe Chest Injury</td>
<td>1467 (100)</td>
<td>763 (100)</td>
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<tr>
<td>Severe Abdomen Injury</td>
<td>448 (30.5)</td>
<td>216 (28.3)</td>
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<td>Severe Spine Injury</td>
<td>199 (13.5)</td>
<td>94 (12.3)</td>
<td>0.41</td>
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<tr>
<td>Severe Upper Extremity Injury</td>
<td>87 (5.9)</td>
<td>40 (5.2)</td>
<td>0.51</td>
</tr>
<tr>
<td>Condition</td>
<td>N (%)</td>
<td>N (%)</td>
<td>p-value</td>
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<tr>
<td>-----------------------------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>Severe Lower Extremity Injury</td>
<td>513 (35.0)</td>
<td>298 (39.1)</td>
<td>0.057</td>
</tr>
<tr>
<td>Traumatic Brain Injury – N (%)*</td>
<td>215 (14.7)</td>
<td>84 (11.0)</td>
<td>0.017</td>
</tr>
<tr>
<td>Shock in Emergency Department – N (%)</td>
<td>149 (10.2)</td>
<td>75 (9.8)</td>
<td>0.81</td>
</tr>
<tr>
<td>Tachycardia in Emergency Department – N (%)</td>
<td>667 (45.5)</td>
<td>349 (45.7)</td>
<td>0.90</td>
</tr>
<tr>
<td>Mortality – N (%)</td>
<td>200 (13.6)</td>
<td>45 (5.9)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Traumatic brain injury: total Glasgow Coma Scale in the Emergency Department ≤8 and Severe head injury
Comprehensive operative assessment in peripheral endovascular procedures: development and pilot of the ENDORATE-PVI framework and the endovascular OR black box

Lauren Gordon, B Doyen, J Sunavsky, Mark Wheatcroft, Charles de Mestral, V Palter, Teodor Grantcharov, I Van Herzeel on behalf of the ENDORATE-PVI Consortium

Objective: Comprehensive operative capture, which continuously records and synchronizes multiple sources of intraoperative data, allows for detailed assessment of efficiency and technical performance in endovascular procedures. The objective of this study was to develop a detailed analysis framework, ENDORATE-PVI, to assess steps, errors and adverse intraoperative events in peripheral endovascular procedures (PVI), apply this tool to evaluate cases recorded using a comprehensive operative capture platform.

Methods: Experts were identified from vascular surgery, interventional radiology, cardiology and angiology based on their publication and presentation record, or position on the editorial board of a journal in the field. A modified Delphi consensus process was conducted to identify steps, errors and events in iliofemoropopliteal interventions. Rounds were continued until the pre-defined consensus threshold was reached (Cronbach’s alpha>0.7). Concurrently, percutaneous iliofemoropopliteal procedures were collected using an intraoperative data capture system (OR Black Box, Surgical Safety Technologies, Inc.) installed in the hybrid angiosuite at Ghent University Hospital.

Results: 29 proceduralists were recruited for the expert consensus panel. The Delphi process was terminated after three rounds (Cronbach’s alpha>0.79), with 15, 26 and 18 items included in the final step, error and event frameworks, respectively. A pilot sample of five PVIs was analyzed using the ENDORATE-PVI evaluation tool. 10 iliofemoral and femoropopliteal lesions were treated over the 5 procedures. Steps, errors and events were, where applicable, recorded by one reviewer. Case duration was a mean (SD) of 76 (21) minutes. The longest step was closure, representing 24% of time per case (mean = 19[3] min), followed by lesion treatment (18% of case duration, mean = 17[7] min) and choice of interventional plan (10% of case duration, mean = 8[4] min) (Figure 1). Delays constituted 4% of each case. Over the five procedures, 71 errors (14.2[5.0] errors per procedure, range=9-21) and 4 events (0.8[1.3] events per procedure, range=0-3) were noted (Table 1). The most common errors observed were excessive radiation dose with 26 noted instances, including 2m50s of hands visible on fluoroscopy (34[30]s per procedure), and 24 instances of inadvertent wire advancement or withdrawal.

Conclusions: This pilot study establishes that comprehensive operative capture can facilitate detailed assessment of peripheral vascular procedures using the ENDORATE-PVI framework. Although the sample size is limited, the error and event rates appear to be similar to, or less than, reported rates in advanced laparoscopic surgery. This detailed assessment and team feedback may facilitate reduction in error and event rates and improvement to patient safety.
Table 1. Errors by category and procedural step

<table>
<thead>
<tr>
<th>Category</th>
<th>Access Site</th>
<th>Device Related</th>
<th>Imaging</th>
<th>Navigation</th>
<th>Judgement</th>
<th>Other</th>
<th>TOTAL by Step</th>
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</thead>
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<tr>
<td>Pre-procedure planning</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Access</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
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<tr>
<td>Heparinization</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<tr>
<td>Sheath Introduction</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Navigation to Lesion</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>16</td>
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<tr>
<td>Diagnostic Angiography</td>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Choice of Interventional Plan</td>
<td>0</td>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Placement of Working Sheath</td>
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<td>0</td>
<td>10</td>
<td>3</td>
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<td>Crossing Lesion</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
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<tr>
<td>Confirm Crossing</td>
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<td>1</td>
<td>0</td>
<td>0</td>
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<td>1</td>
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<td>Vessel preparation</td>
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<td>Lesion Treatment</td>
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<td>0</td>
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<td>Removal of Devices</td>
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<td>No Progress</td>
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<td>0</td>
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<td>3</td>
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<tr>
<td><strong>TOTAL by Category</strong></td>
<td><strong>2</strong></td>
<td><strong>3</strong></td>
<td><strong>36</strong></td>
<td><strong>26</strong></td>
<td><strong>0</strong></td>
<td><strong>5</strong></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1. Percent of case duration by procedural step

Diagram showing the distribution of case duration by procedural step.
**Carotid plaque-derived extracellular vesicle microRNA content differs between symptomatic and asymptomatic stenosis**

**Sneha Raju, Dakota Gustafson, Jason E. Fish, Kathryn L. Howe**

**Objective:** Elucidating the biological processes that drive asymptomatic plaque to become symptomatic is important for the development of therapeutics to stabilize carotid plaque and prevent stroke. Given that extracellular vesicle (EV)-derived microRNAs (miRNA) mediate cellular communication, we hypothesized that their cargo will differ in symptomatic versus asymptomatic plaque.

**Methods:** EVs from carotid plaque necrotic cores were isolated from endarterectomy specimens by digestion and homogenization with Collagenase type I (Worthington, Lake Wood, NJ, USA), and mortar and pestle pulverization. EVs were enriched from the supernatant by size exclusion chromatography (qEVoriginal columns, 70 nm; Izon Science Ltd, Christchurch, NZ). Next generation sequencing was performed on EVs (HTG Molecular Diagnostics Inc., Tucson, AZ, USA) and differential miRNA expression evaluated using Partek Genomics Suite software (version 8.0).

**Results:** Six carotid endarterectomy specimens (four asymptomatic and two symptomatic plaques) were collected. The average age of the cohort was 67.8±6.7 years. All patients had severe stenoses with an average peak systolic velocity of 381.3±140.7 cm/sec and similar ICA:CCA ratios (asymptomatic 5.3±1.1 vs. symptomatic 8.0±7.1; p=0.44). Symptomatic patients were treated within 30 days of the last neurologic event, while asymptomatic patients were treated for disease progression (N=2) or new diagnosis of severe stenosis (N=2). Principle component and heatmap analysis of miRNA sequencing data revealed symptomatic carotid plaques clustered together, while asymptomatic plaques were either starkly different (N=2) or approximated the symptomatic plaque profiles (N=2), suggesting a disease gradient. When symptomatic carotid EV-miRNA profiles were compared to the more distinct asymptomatic specimens, several miRNA were found to be dysregulated, including upregulation of miRNA 22-3p and miRNA 149-3p, and downregulation of miRNA 33a-5p, respectively (p<0.05, FDR<0.05, fold-change -1.5< or >1.5).

**Conclusions:** Symptomatic carotid plaques display differential EV-miRNA expression compared to patients with asymptomatic plaques, with moderate profiles likely representing disease progression. The most significantly dysregulated EV cargo include miRNA known to affect vascular smooth muscle cell function and may provide new targets to prevent stroke.
A scoping review of computer-based cognitive behavioural therapy in patients with chronic illness or disabilities: use in patients with vascular risk factors or disease

Monica Abdelmasih, Jacqueline Nestico, Leslie Summers deLuca, Ahmed Kayssi

Objective: Major lower limb amputation is associated with significant morbidity and is a substantially life-altering event. Depression among patients with peripheral arterial disease (PAD) is high and interventions addressing peri-operative mental health in patients undergoing amputation have not been well explored. Computer-based cognitive behavioural therapy (cCBT) has been shown to reduce depression and anxiety and to improve reported quality of life. The utility of cCBT in patients with lower limb amputations is unknown based on the current literature. To perform a scoping review of the effect of cCBT on outcomes in patients with chronic illnesses or disabilities and within a subset of patients with vascular risk factors or disease.

Methods: With the aid of an expert librarian, an electronic search of 5 major databases including MEDLINE, EMBASE, CINAHL, PsychINFO, and Cochrane Central was performed. This search yielded 9770 articles after removal of duplicates which were initially screened. 304 articles assessing cCBT in chronic illnesses or disabilities were selected for full text review which is ongoing. A subset of studies focusing on patients with vascular risk factors or disease were identified.

Results: 17 articles were found investigating patients with the following conditions: diabetes (4), cardiovascular disease (3), patients with implantable cardioverter-defibrillators (ICDs) (3), end stage renal disease (ESRD) (2), hypertension (2), heart failure (1), stroke (1), and PAD (1). No articles were found assessing cCBT in patients with lower limb amputations. There were 13 randomized controlled trials (RCTs) and 4 within-group pre/post-intervention studies. Therapist guidance or support was incorporated in 7 studies. Significant change in outcomes were reported in 11 studies while the remaining studies did not find significant benefit from cCBT.

Conclusions: No studies were found investigating the use of cCBT in patients with major lower limb amputations. However, cCBT has been trialed in other patient populations with cardiovascular, cerebrovascular, and peripheral vascular disease with mixed results. A study exploring cCBT in amputee patients is needed to determine if there are any potential benefits in this population.
Prediction of bird-beak configuration formation in TEVAR using computational models

Negin Shahbazian, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes

Objective: During thoracic endovascular aortic repair (TEVAR) a wedge-shaped gap, called a bird-beak (BB) configuration, can occur at the stent graft (SG) proximal attachment site, which can lead to incomplete SG seal. BB directly correlates with complications such as type Ia endoleaks. This study uses finite element simulations of SG deployment to assess BB formation in different TEVAR landing zones.

Methods: Realistic computational models of the aorta, with and without aneurysm, and two Cook Zenith Alpha SGs with 0% and 5.5% oversizing were developed. Thirteen SG deployment scenarios were simulated using the two SGs in landing zones 0-3. The length and angle of BB were measured for each simulation (Fig. 1).

Results: Average BB length and angle were lower for 5.5% oversizing than 0% (3.6 mm vs. 7.5 mm and 9.5° vs. 25.6°). The largest BB length and angle were found for 0% oversizing (11.5 mm in zone 1 and 39.7° in zone 0). Relationships were established between the vessel centerline slope in the proximal landing position and the BB length and angle. There was a direct correlation between BB angle and the centreline slope in the proximal landing position and a direct correlation between BB length and the absolute value of the centreline slope at the proximal landing site, suggesting a relationship between the proximal landing location and BB size. Comparison of BB size between simulations with and without an aneurysm showed insignificant changes.

Conclusions: TEVAR SG deployments were simulated to measure BB configurations. Direct correlations were found between BB length and angle and the vessel centerline slope in the proximal landing position. BB length and angle have been shown to correlate with type Ia endoleaks. This work illustrates the potential of TEVAR computational simulations to predict BB formation and the risk of BB-related type Ia endoleaks. Validation of simulation results are ongoing using clinical data and patient geometries obtained from CT scans.
Figure 1: Sample simulation image of stent graft deployment in TEVAR landing zone 2 and a formed bird-beak configuration.
Lymphatic complications and their management following vascular surgery – case series

Mohammed Firdouse, Graham Roche-Nagle

Objective: Lymphatic complications in vascular surgery are common and can occur in any part of the body. It is important for vascular surgeons to be aware of the incidence rate, associated mortality and morbidity, and the various management options to deal with such complications. The objective of this study is to describe three cases of lymphatic complications post vascular surgery and review the most recent literature on this topic.

Methods: We describe three cases of lymphatic complications – chylothorax post first rib resection, chyloperitoneum post open abdominal aneurysm repair, and groin lymphocele post great saphenous vein harvest. Additionally, A comprehensive retrospective literature search of all publications from 1946 to 2019 was conducted by a librarian using the Medline database. The following search terms in addition to appropriate MeSH terms were used: “Vascular Surgery”, “Post-operative complications”, and “Lymph complications”. Publications that were duplicate, not in English, not in humans, or not related to the topic were excluded. Only studies pertinent to lymphatic complications post vascular surgery were included in the final synthesis.

Results: A total of 413 studies were found in the initial search of which 64 studies were not in English, 5 studies were not in humans, 260 studies were not related to the topic and 0 duplicate studies were identified. Consequently, a total of 64 studies were included in the final synthesis. These studies were used to describe the differential diagnosis, work-up, diagnostic criteria, investigations and management options available pertinent to the lymphatic complications described in our case series.

Conclusions: We describe three cases of lymphatic complications – chylothorax, chyloperitoneum, and groin lymphocele post vascular surgery. All three cases were managed differently – with conservative dietary modification, with open surgical repair, and with interventional radiology techniques respectively. Given that up to 18% of vascular procedures are complicated by lymphatic leaks, it is important for vascular surgeons to be able to identify and manage them effectively in a timely manner.
Automated stent graft planning – in less than five minutes

Sean A. Crawford, Kong Teng Tan, Thomas F. Lindsay, Thomas L. Forbes

Objective: To create an advanced stent graft (SG) planning tool that fits within the clinical workflow in order to reduce the occurrence of fenestration misalignment and its associated complications.

Methods: A custom application was developed within the MATLAB language framework. There are 5 key components: segmentation, centerline extraction, identification of vessel ostia, prediction of in-situ SG position, and finally the development of a SG plan. The vessels were segmented using a colliding fronts algorithm and centerlines were calculated using a method of geodesic descent. A modified centerline was created by applying a rigidity parameter and a soft boundary constraint (the vessel wall) to the centerline. A simulated stent graft was then expanded within the vessel lumen, perpendicular to the modified centerline and relative fenestration positions were calculated. Preoperative CTA data and stent graft plans for 10 advanced endovascular procedures were obtained from a prospectively maintained clinical database. The automated plans were compared to surgeon-derived plans.

Results: The mean computational time to generate each SG plan was 116±22 seconds. 50% of the automated plans had one or more fenestrations that was at least 15° or 4 mm different from the clinical plan. The automated plans had median differences in fenestration angles of 4.8±3.2°, 5.5±1.4°, 8.8±4.7°, 9.8±2.2° [Celiac, SMA, R Renal, L Renal], and a median differences in vertical fenestration positions of 3±1.5mm, 2.5±0.6mm, 3.5±0.7mm [Celiac, R Renal, L Renal] relative to the SMA. 3 out of the 5 cases with significantly different automated plans had significant bridging stent complications (1 SMA stenosis, 1 renal occlusion, and 1 celiac occlusion).

Conclusions: A significant contributing factor to fenestration misalignment is inaccuracies in custom stent graft planning. This pilot study provides promising initial data in support of the use of an automated tool to aid advanced stent graft planning.
The effect of addition of pharmacomechanical thrombolysis to anticoagulation therapy for iliofemoral DVT on prevention of post thrombotic syndrome – a literature review

Zeyad Khoshhal, Christiane Werneck

Objective: To summarize the current evidence of the addition of catheter directed thrombolysis to the standard anticoagulation treatment of proximal DVT to prevent post-thrombotic syndrome

Methods: Literature review of the randomized clinical trials examined the effect of thrombolysis on post-thrombotic syndrome. Only papers written in English were included

Results: Three major trials matched our inclusion criteria, ATTRACT Trial, CAVENT Trial and CAVA Trial. ATTRACT Trial reported no significant difference between the combined thrombolysis and anticoagulation group compared to the anticoagulation alone group in the rates of post-thrombotic syndrome (47% vs. 48%; P: 0.56). Patients were followed for 6-24 months. CAVA trial had similar results. During the 1-year follow up period, incidence of Post-thrombotic syndrome in patients undergoing thrombolysis in addition to standard anticoagulation treatment of ilio-femoral DVT was 29 % vs. 35% in patients with standard anticoagulation only (P: 0.42). Finally, CAVENT trial showed that at 5 years follow up, the thrombolysis + anticoagulation group had significantly lower occurrence of post-thrombotic syndrome compared to the standard anticoagulation group (43% vs. 71%; P: <0.0001).

Conclusions: The evidence is currently inconsistent regarding the addition of catheter directed thrombolysis to the standard anticoagulation therapy to prevent post-thrombotic syndrome in patients with ilio-femoral DVT. Further studies with larger number of patients and longer follow up are needed to determine the role thrombolysis on this population.
Computational fluid dynamics simulations of CTA-derived patient specific FEVAR hemodynamics

WC Patrick Lin, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes

Objective: Hemodynamic changes are known to occur following fenestrated endovascular aneurysm repair (FEVAR), but it is unclear whether these changes are associated with complications or other increased risk factors after repair. The objective of this study is to conduct computational fluid dynamics (CFD) simulations as a non-invasive method to evaluate these hemodynamic changes and to improve current understanding of post-FEVAR hemodynamics.

Methods: CFD simulations were conducted using SimVascular to compare pre- and post-FEVAR hemodynamics. Patient geometries were segmented in VMTK from computed tomography angiography (CTA) images and repaired in Meshmixer. Segmentations include all major branch vessels from the celiac trunk to the iliac arteries. A physiologically realistic flow waveform from literature and 3-element Windkessel models were used as inlet and outlet boundary conditions, respectively. Simulations were run for 8 cardiac cycles with the last 4 cycles used for analysis.

Results: CFD results of pre/post-FEVAR cases show different oscillatory shear index (OSI) patterns. The internal vessel wall has a much higher roughness in the post-FEVAR geometry due to the stent-graft metal wire construction. As a result, the post-FEVAR case shows discretized OSI patterns in stent covered areas whereas the pre-FEVAR case shows a more uniform OSI pattern. In particular, the aorta region immediately upstream of the celiac trunk and the repaired aneurysm section in the post-FEVAR case illustrate this difference (Fig 1). Other notable changes include a higher mean pressure in the hepatic artery (pre: 96.4 mmHg vs post: 98.3 mmHg).

Conclusions: Simulations of FEVAR repaired patients show different OSI patterns compared to the unrepaired case in stent-graft covered areas. CFD results show that higher roughness from stent-graft wires can induce non-uniform OSI patterns. Work is ongoing to evaluate implications for thrombosis risks due to these OSI differences.
Figure 1. Oscillatory shear index (OSI) comparison between pre/post FEVAR cases.
The development of a national curriculum in wound management using the Delphi consensus process

Mekki Medani, Omar Selim, Catharine Walsh, Allan Okrainec, Andrew Dueck, Ahmed Kayssi

Objective: The prevalence of diabetes amongst Canadians is rising, and with it the rates of major amputations. Up to 25% or diabetics will suffer from a diabetic foot wound, with wound care playing a pivotal role in limb salvage. Yet, the principles of wound assessment and management have commonly received short rift in medical education. We aim to, in a phased manner, develop a wound management curriculum responsive to the Canadian context.

Methods: Our first stage of data collection consisted of item generation. Potential curricular items were generated from two sources: the first, a systematic review of the published literature on education in wound care and diabetic wound management, and the second a review of standard reference materials in the field such as Wound Canada and Society for Vascular Surgery guidelines. We reviewed the learning objectives related to wound prevention and management identified by the national qualifying exam. The second stage will be item reduction, where the panellists will be asked to evaluate the proposed curricular items with regards to their inclusion in a national diabetic wound management curriculum using the Delphi Consensus process.

Results: We completed a systematic search and created a description of wound care curriculums in undergraduate medical programs in the literature. We have also established our partnership with Wounds Canada, who will provide curriculum materials, networking opportunities, and a future platform to disseminate our curriculum. We have also partnered with a medical devices consultant who will source and create simulation models for our curriculum. While developing our learning objectives, it became clear that we needed to validate them through an academically robust process.

Conclusions: Wound management in the setting of the diabetic foot is critical in limb salvage, however, no curriculum exists to guide its learning. We have identified this gap in learning, and are endeavouring to address this issue by formulating a curriculum for teaching wound management, created in a systematic, scientific manner.
Development of an infrared imaging catheter for guidance of complex endovascular interventions

Patrick Z. McVeigh, Sean A. Crawford, Brian C. Wilson, Graham Roche-Nagle, Mark Wheatcroft

Objective: To develop a platform for, and demonstrate the feasibility of, infrared scanning fiber angioscopy for the guidance of complex endovascular procedures in-vivo.

Methods: A theoretical optical framework for infrared imaging in blood was developed based on Mie scattering and used to design a prototype scanning fiber endoscope (SFE) to provide monochrome imaging in the short-wave infrared (swIR). A prototype swIR scanning fiber endoscope was constructed and the optical performance characterized in blood-analogue optical phantoms. Proof-of-concept data was obtained using a 3d printed model of an infrarenal aortic aneurysm as well in-vivo trial data from a porcine model system.

Results: Optical imaging through blood with sufficient resolution for common endovascular tasks is feasible within several wavelength bands, with the window from (1550-1650nm) in the swIR providing the best theoretical balance of working distance and detection efficiency. Scanning fiber imaging is feasible over a distance of more than 10mm in air using this wavelength band and is primarily limited by detector noise at readout rates above 10MHz. In-vitro model tests with a swIR SFE revealed reasonable imaging to a standoff distance of 5mm through whole blood with scattering being the predominant factor limiting image resolution. This can be overcome by shifting to longer excitation wavelengths but will necessitate a revised detector substrate material. The present working distance is still sufficient for fenestration identification with current advanced EVAR graft designs.

Conclusions: Scanning fiber angioscopy in the swIR wavelength region is feasible and allows the operator to “see through blood” over relevant working distances. A next generation detector design will facilitate even longer working distances and will enable in-vivo endovascular optical imaging without the need for proximal flow occlusion.
Iliac limb re-interventions following endovascular aortic repair

Elena Saremi, Naomi Eisenberg, Graham Roche-Nagle

Objective: Iliac limb occlusion, stenosis, kinking, and dislocation caused by narrow or stenotic iliac arteries, tortuous iliac vessels, or progressive aneurysmal degeneration are common complications of endovascular aneurysm repair (EVAR). This study is aimed to determine the frequency of these complications in a local population.

Methods: Our local VQI follow up database was reviewed for iliac limb complications. Limb complications were defined as stenosis (narrowing equal or more than 50 percent of right or left or both graft limbs), occlusion, migration (movement of the endograft that requires treatment), and type Ib endoleak.

Results: Twenty-four patients required re-intervention for limb complications. The average age was 76 years and the majority were men. The three most common causes for limb complications were identified as: type Ib endoleak in 10 limbs, equal on right and left sides, occlusion in 8 limbs, and stenosis in 6 limbs. One patient had to have re-intervention for bilateral type 1b endoleaks occurring remotely from each other. There were no cases of infection or migration.

Conclusions: Limb complications rate have been reported to have an incidence of 3% to 5%. Our limb complication rates compare favorably with published series. Careful patient selection, preoperative identification of adverse anatomy, and adherence to stent graft manufacturer sizing guidelines are crucial first steps to ensure favorable outcomes.
Development of a computational fluid dynamics model of ascending aortic hemodynamics

Davis B. McClarty, Matthew G. Doyle, Thomas L. Forbes, Jennifer Chung, Cristina H. Amon

Objective: The role of hemodynamics in complications of ascending thoracic aortic aneurysms (ATAAs) is controversial. Development of a computational fluid dynamics (CFD) model of aortic hemodynamics would facilitate study of correlations between wall shear stress (WSS) and aortic wall mechanical properties. This study aims to validate CFD modeling against 4D flow MRI measurements.

Methods: One patient with an ATAA underwent preoperative magnetic resonance angiogram (MRA) and 4D flow scans. The patient-specific aortic model was segmented from the MRA scan for use in a CFD simulation. A volumetric pulsatile flow profile, based on 4D flow data, was used as an inlet boundary condition, while 3-element Windkessel resistance boundary conditions were applied at each outlet.

Results: Fig. 1 shows the velocity profile at two cross sections for both the 4D flow MRI and the CFD model. The figure shows qualitative agreement between the 4D flow and the CFD with clear areas of flow channeling in the descending thoracic aorta during peak systole. During early diastole the results diverge slightly, however, the same pattern of flow structures still exists. This divergence is likely because the small magnitudes of flow velocity are difficult for the 4D MRI to resolve. The volumetric flow rate through the cross sections was calculated from both the CFD model and the 4D flow MRI. In the ascending aorta, the 4D flow rate was 2.6% lower than the CFD flow rate (76 ml/cycle vs 78 ml/cycle). Similarly, in the descending aorta the 4D flow rate was 4.5% lower than the CFD flow rate (44 ml/cycle vs 46 ml/cycle).

Conclusions: This pilot work demonstrates good correlation between CFD modeling and 4D flow MRI in terms of their flow structures. Future work includes conducting a more comprehensive quantitative comparison through metrics such as flow eccentricity. This will lead to modeling patients with known aortic wall properties to better understand the link between hemodynamics and solid mechanics.
Figure 1: (i) Inlet volumetric pulse profile, with distinct timepoints labeled. (ii) Aortic geometry with cross-sectional planes shown (iii) Instantaneous velocity field at the distinct timepoints for both the 4D MRI and CFD model.