



University of Toronto  
Division of Vascular Surgery

# VASCULAR SURGERY RESEARCH DAY

Friday May 4<sup>th</sup>, 2018

University Club of Toronto  
380 University Avenue  
Toronto, Ontario



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Division of Vascular Surgery

## Chair's Welcome



It is with great pleasure that I welcome you to the Annual University of Toronto Vascular Surgery Research Day. 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. This year's Research Day has several returning features, including Researcher's Forum sessions, a Rapid Fire session and many very interesting abstract presentations.

The highlight of the day will be the 7<sup>th</sup> Annual *K. Wayne Johnston Visiting Lecture in Vascular Surgery*. We are privileged to have Dr. Julie Freischlag from Wake Forest as our guest. I'm sure her talks 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: Drs. Thomas Lindsay (Division Head, UHN), Mohammed Al-Omran (Division Head, St. Michael's), Andrew Dueck (Division Head, Sunnybrook), Marc Pope (Division Head, Trillium), Kerry Graybiel (Division Head, Humber River), Gus Azoubel (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  
*Professor & Chair, Division of Vascular Surgery*  
*University of Toronto*



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## 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.

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



## Previous K. Wayne Johnston Lecturers

2012	Joseph L. Mills	University of Arizona
2013	Lewis B. Schwartz	University of Chicago
2014	Philip P. Goodney	Dartmouth
2015	Ronald L. Dalman	Stanford University
2016	Melina R. Kibbe	Northwestern University
2017	Marc Schermerhorn	BIDMC, Harvard University



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## 2018 K. Wayne Johnston Visiting Lecturer in Vascular Surgery

Julie Freischlag, MD  
Chief Executive Officer  
Wake Forest Baptist Medical Center  
Winston-Salem, North Carolina



Dr. Freischlag is currently CEO of Wake Forest Baptist Medical Center. Prior to this she was Vice Chancellor for Human Health Sciences and Dean of the School of Medicine at the University of California Davis (UC Davis) where she directed UC Davis' academic, research and clinical programs, which include a 627-bed acute care hospital, a 1,000 physician private practice group, a school of nursing and a staff of 10,000 employees. As a vascular surgeon with 30 years of experience at top academic medical centers, Dr. Freischlag is nationally recognized as a leader in the advancement of medical education and training, the expansion of research opportunities and the improvement in patient and family-centered care. Dr. Freischlag is also a member of the National Academy of Medicine, considered the highest recognition of professional achievement and commitment to volunteer service in medicine, as determined by her peers through election. Prior to her career at UC Davis, Dr. Freischlag served as the first female Chair of the Department of Surgery and Surgeon-in-Chief at Johns Hopkins Medical Institutions and earlier as Professor and Chief of Vascular Surgery at University of California Los Angeles (UCLA). She received an undergraduate degree in biology from the University of Illinois, her medical degree from Rush University Medical College in Chicago and completed a surgical residency and vascular fellowship at UCLA. Dr. Freischlag has served in multiple national leadership roles, including immediate past President of the Society for Vascular Surgery Foundation, past Chair of the Board of Regents of the American College of Surgeons, past President of the Society for Vascular Surgery and past President of the Association of VA Surgeons and the Society of Surgical Chairs.



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## 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 2018 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.





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## Sponsorship:

W.L. Gore and Associates has agreed to a five year commitment as sole sponsor to support the U of T Vascular Surgery Research Day through an education grant. Special thanks to David Grieco, Senior Development Officer in the Office of Advancement at the U of T Faculty of Medicine for stewarding this donation.

Marty Sylvain, Global Sales Leader for Gore says, “W.L. Gore & Associates has provided creative therapeutic solutions to complex medical problems for more than forty years. During that time, more than 35 million innovative 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, dedication to sharing knowledge with peers and patients, creating consensus within the medical community and the analysis of clinical outcomes”.





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## RESEARCH DAY AGENDA

May 4<sup>th</sup>, 2018  
University Club of Toronto  
380 University Avenue  
2<sup>nd</sup> Floor Main Dining Room

0730 – 0800: Continental Breakfast

0800 – 0815: Welcoming Remarks

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

0815 – 0930: **Morning Session** (10 minute presentations, 5 minutes questions)  
Moderator: Dr. George Oreopoulos (Residency Program Director)

0815 – 0830: *Acute and chronic renal dysfunction post open and endovascular abdominal aortic aneurysm repair.*  
Brandon Van Asseldonk, A El Zahabi, Naomi Eisenberg, Janice Montbriand, Graham Roche-Nagle.

0830 – 0845: *Knowing when not to intervene: a systematic review of non-operative management in blunt thoracic aortic injury.*  
Jean Jacob-Brassard, Konrad Salata, Ahmed Kayssi, Mohammed Hussain, Thomas L. Forbes, Mohammed Al-Omran, Charles de Mestral.

0845 – 0900: *Development of a planning method for fenestrated endovascular aneurysm repair.*  
Helen Genis, Sean A. Crawford, Matthew G. Doyle, Thomas F. Lindsay, Cristina H. Amon, Thomas L. Forbes.

0900 – 0915: *Pre-operative aneurysmal thrombus volume, but not density, predicts type 2 endoleak rate following endovascular aneurysm repair.*  
Ben Li, Janice Montbriand, Naomi Eisenberg, Graham Roche-Nagle, Kong Teng Tan, John Byrne.



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- 0915 – 0930: *c-Myb limits atherosclerosis through protective IgM production.*  
Cale C.J. Zavitz, E.A. Shikatani, R. Besla, S. Ensan, A. Li, J.M. Moreau, D. Thayaparan, H.S. Cheng, S. Pacheco, D. Smyth, C.M.T. Bauer, I. Hilgendorf, P. Libby, F.K. Swirski, J.L. Gommerman, J.E. Fish, M.R. Stampfli, M. Cybulsky, Barry B. Rubin, C.J. Paige, M. Husain, Clinton S. Robbins.
- 0930 - 1015: **7<sup>th</sup> Annual K. Wayne Johnston Lecturer**  
*Breakthrough to Brave*  
Dr. Julie Freischlag  
CEO, Wake Forest Baptist Medical Center, Winston-Salem, NC
- 1015 - 1045: **Refreshment Break**
- 1045 - 1100: **Researcher's Forum**  
*Current Challenges & Opportunities in Limb Preservation Research*  
Ahmed Kayssi\*, Division of Vascular Surgery, Sunnybrook Health Sciences Centre, Assistant Professor, Department of Surgery, University of Toronto  
  
\*Blair Early Career Professor in Vascular Surgery
- 1100 - 1215: **Surgeon-Scientist Training Program Forum**  
(10 minute presentations, 5 minutes questions)  
Moderator: Dr. Mohammed Al-Omran (Division Head, St. Michael's Hospital)
- 1100 - 1115: *Predicting infrainguinal arterial bypass outcomes using machine learning techniques.*  
Lauren Gordon, Mark D. Wheatcroft, T Grantcharov.
- 1115 - 1130: *The development and evaluation of a tool to assess competence in wound management.*  
Omar Selim, Allan Okrainec, Andrew Dueck, Catharine Walsh, Ryan Brydges.





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- 1130 - 1145: *The impact of randomized trial results on abdominal aortic aneurysm repair rates from 2003 to 2016.*  
Konrad Salata, Mohamad A. Hussain, Charles de Mestral, Elisa Greco, Muhammad Mamdani, Jack V Tu, Thomas L. Forbes, Deepak L. Bhatt, Subodh Verma, Mohammed Al-Omran.
- 1145 – 1200: *The influence of surgical technique on device rotation and fenestration alignment in advanced endovascular aneurysm repair.*  
Sean A. Crawford, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes.
- 1200 – 1215: *Temporal trends in lower extremity amputations for diabetes and peripheral artery disease.*  
Mohamad A. Hussain, Mohammed Al-Omran, Konrad Salata, Jack V. Tu, Atul Sivaswamy, Subodh Verma, Thomas L. Forbes, Ahmed Kayssi, Charles de Mestral.
- 1215 - 1300: Lunch
- 1300 - 1345: 7<sup>th</sup> Annual K. Wayne Johnston Lecturer  
*Controversies in the Treatment of Thoracic Outlet Syndrome*  
Dr. Julie Freischlag  
CEO, Wake Forest Baptist Medical Center, Winston-Salem, NC
- 1345 - 1500: **Afternoon Session** (10 minute presentations, 5 minutes questions)  
Moderator: Dr. Thomas Lindsay (Division Head, University Health Network)
- 1345 - 1400: *Meta-analysis: femoro-popliteal stenting with self-expandable nitinol stent versus angioplasty alone.*  
O. Abdulrahim, P. Dicker, Z. Martin.
- 1400 - 1415: *Preoperative anemia has gender based differences in immediate postoperative mortality.*  
Sneha Raju, Naomi Eisenberg, Janice Montbriand, Graham Roche-Nagle.
- 1515 - 1430: *Development and endovascular imaging of a porcine model of advanced carotid atherosclerosis.*  
Patrick Z. McVeigh, Corwyn Rowsell, Brian C. Wilson, Mark Wheatcroft.



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- 1430 – 1445: *The economic burden of treating inpatient diabetic foot ulcers in Toronto, Canada.*  
Muzammil H. Syed, Konrad Salata, Mohamad A. Hussain, Charles de Mestral, Subodh Verma, Mark Wheatcroft, John Harlock, Amol Verma, Fahad Razak, Mohammed Al-Omran.
- 1445 – 1500: *Persistent opioid use following vascular surgery.*  
V. Rohas-Luengas, Naomi Eisenberg, Janice Montbriand, Graham Roche-Nagle.
- 1500 - 1530: Refreshment Break
- 1530 - 1545: Researcher's Forum
- Improvement begins with I*
- Graham Roche-Nagle, Division of Vascular Surgery, Peter Munk Cardiac Centre, University Health Network, Associate Professor, Department of Surgery, University of Toronto
- 1545 - 1625: **Rapid Fire Presentations** (5 minute presentations, 3 minutes questions)  
Moderator: Dr. Andrew Dueck (Division Head, Sunnybrook Health Sciences Centre)
- 1545 – 1553: *Measurement of frictional and mechanical properties of stent grafts and their delivery systems.*  
Tianhao Chen, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes.
- 1553 – 1601: *Comparing preventative strategies for contrast-induced nephropathy in vascular surgery patients: a systematic review and meta-analysis.*  
Musaad AlHamzah, Khalid Alayed, Mina Garas, Muzammil H. Syed, Konrad Salata, Mohamad A. Hussain, Mohammed Al-Omran.
- 1601 – 1609: *Vascular surgery boot camp: developing a primer for competency based training.*  
Husain A. Al-Mubarek, Luis Figueroa, Mark Wheatcroft, George Oreopoulos.
- 1609 – 1617: *Adherence to recommended imaging surveillance of acutely presenting Stanford type B aortic dissections.*  
Sachin Doshi, Naomi Eisenberg, Shawn Bailey, Ganesan Annamalai, Graham Roche-Nagle.



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1617 – 1625: *Incidence of Finding Abdominal Aortic Aneurysm in Abdominal Computed Tomography Scan and Its Implication on Its Prevalence in Saudi Arabia.*  
Husain Aljawad, Mohammed Alshehri, Jaffar Alshahri, Mohammed Owais Alzwadi, Faris Alomran.

1625: **Awards Presentation**

Best Presentation by a Junior Resident (PGY1 & 2)

Best Presentation by a Senior Resident or Fellow

Alumni Award for Best Presentation by a SSTP Resident

**Adjournment**

**Previous Research Day Award Winners**

	Best Presentation by a Junior Resident (PGY1 & 2)	Best Presentation by a Senior Resident or Fellow	Alumni Award for Best Presentation by a SSTP Resident
2015	Patrick McVeigh	Ahmed Kayssi	Mohamad Hussain
2016	Caleb Zavitz	Ahmed Kayssi	Trisha Roy
2017	Caleb Zavitz	Charles de Mestral	Konrad Salata

**Previous Teaching Award Winners**

	Most Outstanding Teacher – Resident or Fellow (as voted on by residents and fellows)	Most Outstanding Teacher – Faculty (as voted on by residents and fellows)
2016	Ahmed Kayssi	Andrew Dueck
2017	Charles de Mestral	Mark Wheatcroft



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0815 – 0930: Morning Session

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

Brandon Van Asseldonk<sup>1</sup>, A El Zahabi<sup>2</sup>, Naomi Eisenberg<sup>1</sup>, Janice Montbriand<sup>1,3</sup>, Graham Roche-Nagle<sup>1</sup>

<sup>1</sup>Division of Vascular Surgery, Toronto General Hospital, University Health Network

<sup>2</sup>University of Saskatchewan, Department of Anesthesia

<sup>3</sup>Department of Anesthesia, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada

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

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

**Results:** Following application of exclusion criteria which included preoperative dialysis or kidney transplant, any absent primary outcome, a total of 521 patients remained. Repair urgency included elective, symptomatic and rupture. Group comparison is included in table 1. Preoperative creatinine values were not significantly different between the groups ( $p=.11$ ). There was a significantly higher than expected number of patients in the open group ( $n= 30, 20.1\%$ ) compared to the EVAR group ( $n= 21, 5.6\%$ ) who experienced acute renal dysfunction ( $p < 0.0002, \chi^2=25.3$ ) which was defined as a creatinine increase of  $>44.2 \mu\text{mol/L}$  or dialysis. In this group, new permanent dialysis was required in 2 (0.5%) EVAR repair patients, 2 (1.3%) open repair patients and temporary dialysis in 1 (0.7%) open patient. Follow up creatinine was obtained at a mean 1283 days postoperatively. Change in creatinine (preoperative to follow up) was significantly greater at  $31.8 \mu\text{mol/L}$  in the EVAR group vs  $16.7 \mu\text{mol/L}$  in the open group ( $p = .0006, \text{MWU}=23430$ ).

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



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Table 1: EVAR and Open Group Comparison

	Method of Repair (sd)		Statistical test (if appropriate)	P value
	Open	EVAR		
N	149	372		
Average Age at Repair yrs	68.3 (8.0)	76.0 (7.4)	t-test equal variances assumed	p < 0.0002
Percent Male (%)	119 (79.9)	312 (83.9%)	Chi square test	p =0.27
Average Preoperative Creatinine (μmol/L)	89.0 (31.8 )	94.9 (38.0 )	MWU	p =0.11
Urgency			Chi square test	p( $\chi^2=8.0, = .018$ )
Elective	117 (78.5)	327 (87.9)		<ul style="list-style-type: none"> <li>• A higher than expected number of elective surgeries in the EVAR group</li> <li>• A higher than expected number of ruptured surgeries in the open group.</li> </ul>
Symptomatic	13 (8.7)	22 (5.9)		
Rupture	19 (12.8)	23 (6.2)		



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

Jean Jacob-Brassard, Konrad Salata, Ahmed Kayssi, Mohammed Hussain, Thomas Forbes, Mohammed Al-Omran, Charles de Mestral

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

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

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

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



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**Development of a Planning Method for Fenestrated Endovascular Aneurysm Repair**

Helen Genis<sup>1</sup>, Sean A Crawford<sup>1,2</sup>, Matthew G Doyle<sup>1,3</sup>, Thomas F Lindsay<sup>1</sup>,  
Cristina H Amon<sup>2,3</sup>, and Thomas L Forbes<sup>1</sup>

<sup>1</sup>Division of Vascular Surgery, University Health Network, Peter Munk Cardiac Centre, University of Toronto

<sup>2</sup>Institute of Biomaterials and Biomedical Engineering, University of Toronto

<sup>3</sup>Department of Mechanical and Industrial Engineering, University of Toronto  
Toronto, ON, Canada

**Objective:** To create a fenestrated stent graft planning tool that incorporates the aortoiliac deformation caused by the insertion of the stent graft delivery system to reduce the occurrence of fenestration misalignment and its associated complications.

**Methods:** Preoperative CTAs were obtained from a prospectively maintained advanced EVAR database. Aortoiliac geometries including the branching vessel origins were segmented using VMTK. Vascular deformation in response to the insertion of the delivery system was modeled using the finite element solver LS-DYNA. The simulated delivery system was initialized inside the aorta using its centerline and the simulation was terminated when the delivery system and vessel reached an equilibrium position. The position of the delivery system was validated through a rigid 2D-3D image registration using intraoperative fluoroscopic images. A custom MATLAB algorithm simulated stent graft expansion within the deformed geometry and calculated new fenestration positions. These enhanced plans were compared with the original clinical plans.

**Results:** Enhanced stent graft plans were generated for 28 patients. The mean discrepancy between the simulated and actual delivery system was  $2.1 \pm 0.9$  mm. The median differences in the fenestration positions between the enhanced and original plans are presented in Table 1. Sixty-one percent of the enhanced plans had one or more vessels that were at least  $15^\circ$  or 4 mm different from the original plan. In these patients, the mean contrast volume used was  $171 \pm 59$  mL, compared to  $122 \pm 34$  mL in patients with unaffected plans ( $P < .05$ ). Patients with significantly different plans also had trends towards a higher incidence of severe complications (24% vs 9%) and longer lengths of hospital stay (5.8 vs 3.8 days).

**Conclusions:** This study proposes a new, objective method for fenestrated stent graft planning that incorporates the intraoperative deformation of the arterial tree to reduce fenestration misalignment.



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**Table 1.** Differences in fenestration position of new plans vs original plans (median [IQR]).

<b>Vessel</b>	<b>Difference in Angle (°)</b>	<b>Difference in Vertical Position (mm)</b>
Celiac	9.1 [1.8-7.2]	2.5 [1.8-3.9]
Superior Mesenteric	5.5 [2.3-9.0]	-
Left Renal	5.9 [2.9-12.2]	1.6 [0.5-2.9]
Right Renal	7.2 [5.4-15.2]	3.2 [1.5-6.3]





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**Pre-operative aneurysmal thrombus volume, but not density, predicts type 2 endoleak rate following endovascular aneurysm repair**

Ben Li<sup>1,2</sup>, Janice Montbriand<sup>2</sup>, Naomi Eisenberg<sup>2</sup>, Graham Roche-Nagle<sup>2,3</sup>, Kong Teng Tan<sup>3</sup>, John Byrne<sup>2</sup>

<sup>1</sup> MD Program, University of Toronto, Toronto, Ontario, Canada

<sup>2</sup> Division of Vascular Surgery, Department of Surgery, Toronto General Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada

<sup>3</sup> Division of Vascular and Interventional Radiology, Department of Medical Imaging, Toronto General Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada

**Objective:** To determine the impact of pre-operative aneurysmal thrombus volume and density on the incidence of type 2 endoleak following endovascular aneurysm repair (EVAR) for infrarenal abdominal aortic aneurysm (AAA).

**Methods:** A retrospective analysis was completed on all patients who underwent standard EVAR at Toronto General Hospital between May 1, 2010 and June 1, 2016 with a minimum follow-up period of 12 months. The final analysis included 170 patients. Thrombus volume and density were determined by analyzing pre-operative computed tomography angiography (CTA) scans using the TeraRecon plaque analysis module. The number and diameter of patent infrarenal aortic branch vessels were also identified. Type 2 endoleak was diagnosed by post-operative CTA, duplex ultrasound, or angiography.

**Results:** Over a median follow-up period of 29 months, 88 (51.8%) of 170 patients had a type 2 endoleak. The thrombus volume as a proportion of the infrarenal aorta volume was significantly lower in patients with type 2 endoleak (OR 0.034, 95% CI 0.005 to 0.291,  $P = 0.002$ ). The number of patent lumbar arteries was significantly greater in patients with type 2 endoleak (OR 1.45, 95% CI 1.16 to 1.56,  $P < 0.0005$ ). Both variables independently predicted the incidence of type 2 endoleak in a multivariate analysis. Thrombus density was not related to type 2 endoleak rate.

**Conclusions:** A lower ratio of thrombus volume / infrarenal aorta volume and a higher number of patent lumbar arteries were associated with an increased incidence of type 2 endoleak. A multivariate logistic regression model was generated to pre-operatively predict the risk of type 2 endoleak. This model can guide the stratification of patients for intensity of endoleak surveillance following EVAR and consideration of pre-operative treatment.



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**c-Myb limits atherosclerosis through protective IgM production**

CCJ Zavitz, EA Shikatani, R Besla, S Ensan, A Li, N Degousee, JM Moreau, D Thayaparan, HS Cheng, S Pacheco, D Smyth, CMT Bauer, I Hilgendorf, P Libby, FK Swirski, JL Gommerman, JE Fish, MR Stampfli, M Cybulsky, BB Rubin, CJ Paige M Husain, and CS Robbins

**Introduction:** Atherosclerosis is a systemic inflammatory disease characterized by a buildup of subintimal plaque, leading to life- and limb-threatening ischemic and embolic sequelae. Although its consequences are devastating, atherosclerosis itself should be viewed as a comprehensible response of the host immune system to an endogenous threat. The role of adaptive immunity in this host defense response remains enigmatic, with studies pointing to both pathogenic and protective functions. c-myb is a transcription factor implicated in atherosclerosis through the use of transgenic murine models, and is involved in the development and regulation of the adaptive immune system.

**Objective:** To define c-myb's role in adaptive immunity to experimental atherosclerosis.

**Methods:** c-myb hypomorph (c-myb<sup>h</sup>) mice were crossed with Ldlr<sup>-/-</sup> mice genetically predisposed to atherosclerosis, or with Blimp-1-YFP mice which have a Plasma B-cell specific yellow fluorescent protein tag. Mice were given a diet high in fat and cholesterol (HCD) or standard feed. Cell populations were determined by flow cytometry and ELISpot assays. Antibody responses were determined by ELISA.

**Results:** Ldlr<sup>-/-</sup>c-myb<sup>h/h</sup> HCD mice had fewer peripheral B cells and similar levels of serum IgG to Ldlr<sup>-/-</sup> HCD animals, but increased levels of IgM regardless of diet. Anti-CuOxLDL IgM levels were increased in Ldlr<sup>-/-</sup>c-myb<sup>h/h</sup> HCD mice, as were the number and function of peripheral IgM antibody secreting cells. Increased IgM plasma cell numbers were confirmed in c-myb<sup>h/h</sup>Blimp-1<sup>yfp</sup> reporter mice, and by flow cytometry of intracellular IgM in CD138<sup>+</sup> B-cells of Ldlr<sup>-/-</sup>c-myb<sup>h/h</sup> mice. Further characterization of IgM plasma cells revealed them to be B1-cell derived.

**Conclusions:** c-myb limits protective IgM responses in atherosclerosis. Targeted attenuation of c-myb activity might improve atherosclerosis protection, without the off-target effects of global B-cell blockade.



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1045 - 1100: **Researcher's Forum**

Ahmed Kayssi\*, Division of Vascular Surgery, Sunnybrook Health Sciences Centre, Assistant Professor, Department of Surgery, University of Toronto

\*Blair Early Career Professor in Vascular Surgery

Current Challenges & Opportunities in Limb Preservation Research



Dr. Kayssi is a vascular surgeon at Sunnybrook Health Sciences Centre and a wound care physician at Women's College Hospital. He obtained his medical degree from Queen's University in Kingston, Ontario, before relocating to Toronto to pursue training in general and vascular surgery. He subsequently completed a fellowship in limb preservation and wound care under the supervision of Dr. Richard Neville in Fairfax, Virginia. Dr. Kayssi is a graduate of the Harvard School of Public Health, where he obtained a Master's of Public Health focusing on quantitative methods, and is currently pursuing a Doctorate of Public Health in Health Policy and Management from the Johns Hopkins School of Public Health under the supervision of Dr. Ellen MacKenzie.



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## 1100 - 1215: Surgeon-Scientist Training Program Forum

### **Predicting infrainguinal arterial bypass outcomes using machine learning techniques**

Lauren Gordon, M.D., M.Sc<sup>1</sup>, Supervisors: Dr. Mark Wheatcroft<sup>1</sup>, Dr. Teodor Grantcharov<sup>2</sup>

<sup>1</sup>Division of Vascular Surgery, University of Toronto

<sup>2</sup>Division of General Surgery, University of Toronto

**Objective:** There is increasing interest in using machine learning models to predict risk and provide clinical decision support. In this proof-of-concept study, we have used interpretable machine learning techniques to predict 30-day graft failure in infrainguinal bypass patients in the NSQIP database.

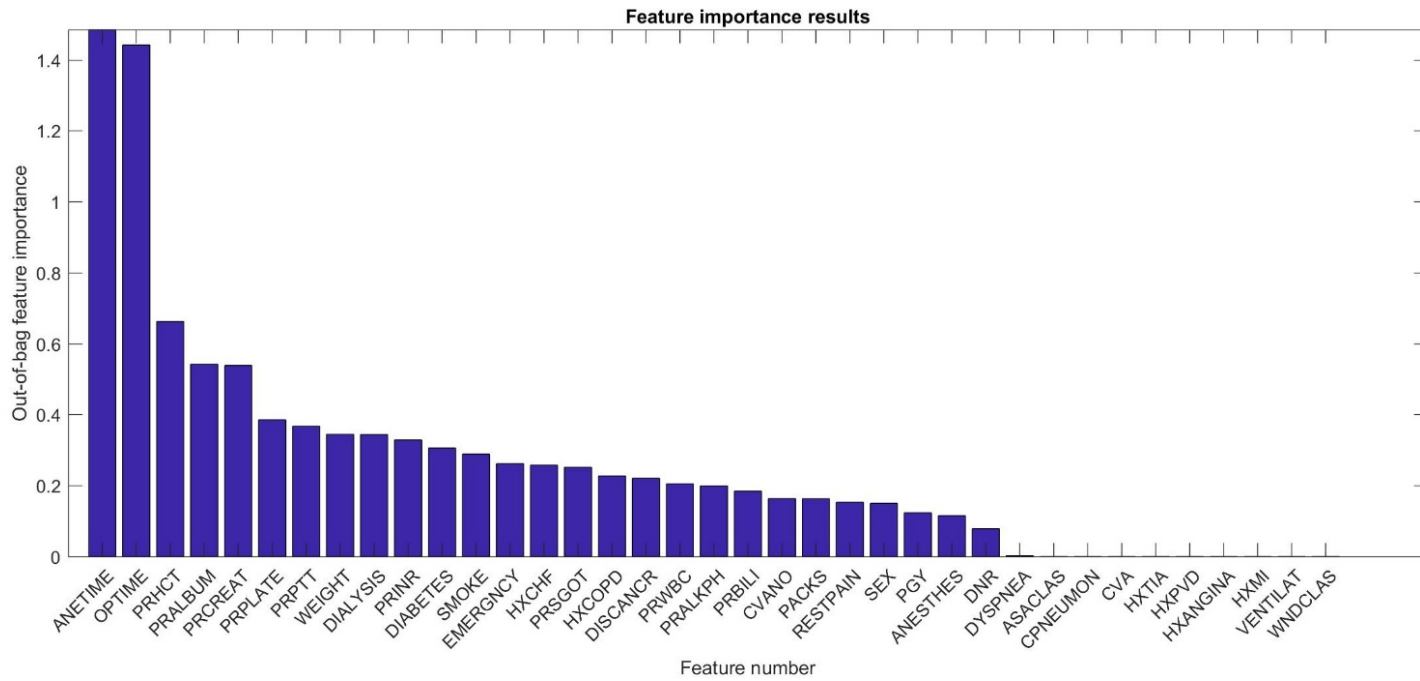
**Methods:** This study is a retrospective analysis of prospectively collected data from the NSQIP database. All bypass procedures from 2007 to 2010 were isolated using primary CPT code. 37 modifiable and non-modifiable comorbidities (sex, diabetes, disseminated cancer, etc.), laboratory values (INR, hematocrit, etc.), and procedural variables (ASA class, procedure time, etc.) were included in the model. A Random Forest model using an out-of-bag estimate and a Naïve Bayes model using cross validation were chosen to model 30-day graft failure, due to their interpretability. Variable selection was performed to reduce collinearity in the dataset for the Naïve Bayes model. The data was separated into training (70%) and validation (30%) sets.

**Results:** The NSQIP database identified 16132 patients who underwent infrainguinal bypass from 2007 to 2010. The primary outcome occurred in 4.9% of patients. The random forest model exhibited an accuracy of 98.5% and an AUC of 0.92. A Naïve Bayes model exhibited an accuracy of 88.4% and an AUC of 0.62. Sensitivity for the Random Forest model was 68.5% while specificity was 100%. The most important predictors in the Random Forest model were anesthesia time and operative time, followed by hematocrit, albumin, and creatinine.

**Conclusion:** The Random Forest technique performed effectively and efficiently to predict early graft failure. Operative and anesthesia time appear to be important predictors of an event, where they likely reflect encountered technical challenges. Further work is needed to compare machine learning models with the VQI and NSQIP risk calculator, and to include further perioperative details, including conduit type, in the risk analysis.



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**The Development and Evaluation of a Tool to Assess Competence in Wound Management**

Selim, Omar; Okrainec, Allan; Dueck, Andrew; Walsh, Catharine; Brydges, Ryan.

**Objective/ Background:** There has been an exponential rise in rates of diabetes in Canada. Of its many complications, diabetic foot wounds levy the highest economic and personal toll. It accounts for up to a third of healthcare expenditure on diabetic care, and is the largest cause of extremity amputation in Canada. There is a dearth of literature on the optimal way to teach and assess the management of these patients. In fact, what literature exists suggests that the management of diabetic and lower extremity wounds is given short shrift in medical curricula. Furthermore, a review of English language literature indicates that no educational tool exists for the assessment of knowledge and skill in diabetic wound management. The effective implementation of Competency by Design relies on assessment tools with a strong base of validity evidence, of which none currently exist for diabetic wound management. The proposed study aims to fill this gap.

**Methods:** A tool to assess skill in wound management will be developed by an interdisciplinary committee of Canadian wound care experts. The Nominal Group Technique will be used to achieve consensus on the assessment tool items. Once this phase of the study is complete, we will test our tool on medical students, residents and faculty at the University of Toronto, split a priori into groups according to case experience. Utilizing the Kane validity framework, we will prioritize the scoring, generalization and extrapolation assumptions during our testing. This will be done by assessing for inter-rater reliability, inter-item reliability and by conducting a known groups comparison. Furthermore, we will assess for reliability between video-conferenced raters and those directly rating trainees. Thus, our study also has implications for the development of telementoring programs in wound management, particularly in under-resourced settings, as well as allowing educators to ensure medical training is appropriately responsive to societal needs.

**Results:** In progress.

**Conclusion:** In progress.



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**THE IMPACT OF RANDOMIZED TRIAL RESULTS ON ABDOMINAL AORTIC ANEURYSM REPAIR RATES FROM 2003 TO 2016**

Konrad Salata<sup>a,b</sup> MD; Mohamad A. Hussain<sup>a,b</sup> MD, PhD; Charles de Mestral<sup>a,b</sup> MD, PhD; Elisa Greco<sup>a,b</sup> MD, MEd; Muhammad Mamdani PharmD<sup>c,d,e,h,i</sup> MPH, MA; Jack V. Tuf<sup>g,h,i</sup> MD, PhD, MSc; Thomas L. Forbes<sup>a,j</sup> MD; Deepak L. Bhatt<sup>k,l</sup> MD, MPH; Subodh Verma<sup>m,n</sup> MD, PhD; Mohammed Al-Omran<sup>a,b,o</sup> MD, MSc.

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**Objective:** To examine the trends in open (OSR) and endovascular (EVAR) repair of elective (eAAA) and ruptured abdominal aortic aneurysms (rAAA), and to examine the effects of randomized trial publications on elective OSR and EVAR rates.

**Methods:** We conducted a population-based time-series analysis of eAAA and rAAA repairs in Ontario, Canada from 2003 to 2016. Quarterly rates of OSR and EVAR per 100,000 Ontarians  $\geq 40$  years old were calculated. We fit exponential smoothing models to examine the changes in overall and approach specific rates of eAAA and rAAA repair. Interventional autoregressive integrated moving average models were fit for the eAAA approach specific rates to examine the impact of the publication of the Dutch Randomized Endovascular Aneurysm Management (DREAM) 2010, EVAR-1 2010, and Open Versus Endovascular Repair (OVER) 2012 trial results on these rates.

**Results:** We identified 19,489 eAAA [12,232 OSR (63%) and 7,257 EVAR (37%)] and 2,732 rAAA [2,466 OSR (90%) and 266 EVAR (10%)] repairs from 2003 to 2016. The rate of eAAA repair declined from 6.39/100,000 in 2003 to 5.59/100,000 in 2016 (13 % decrease,  $p=0.17$ ) (Figure 1). The rate of elective

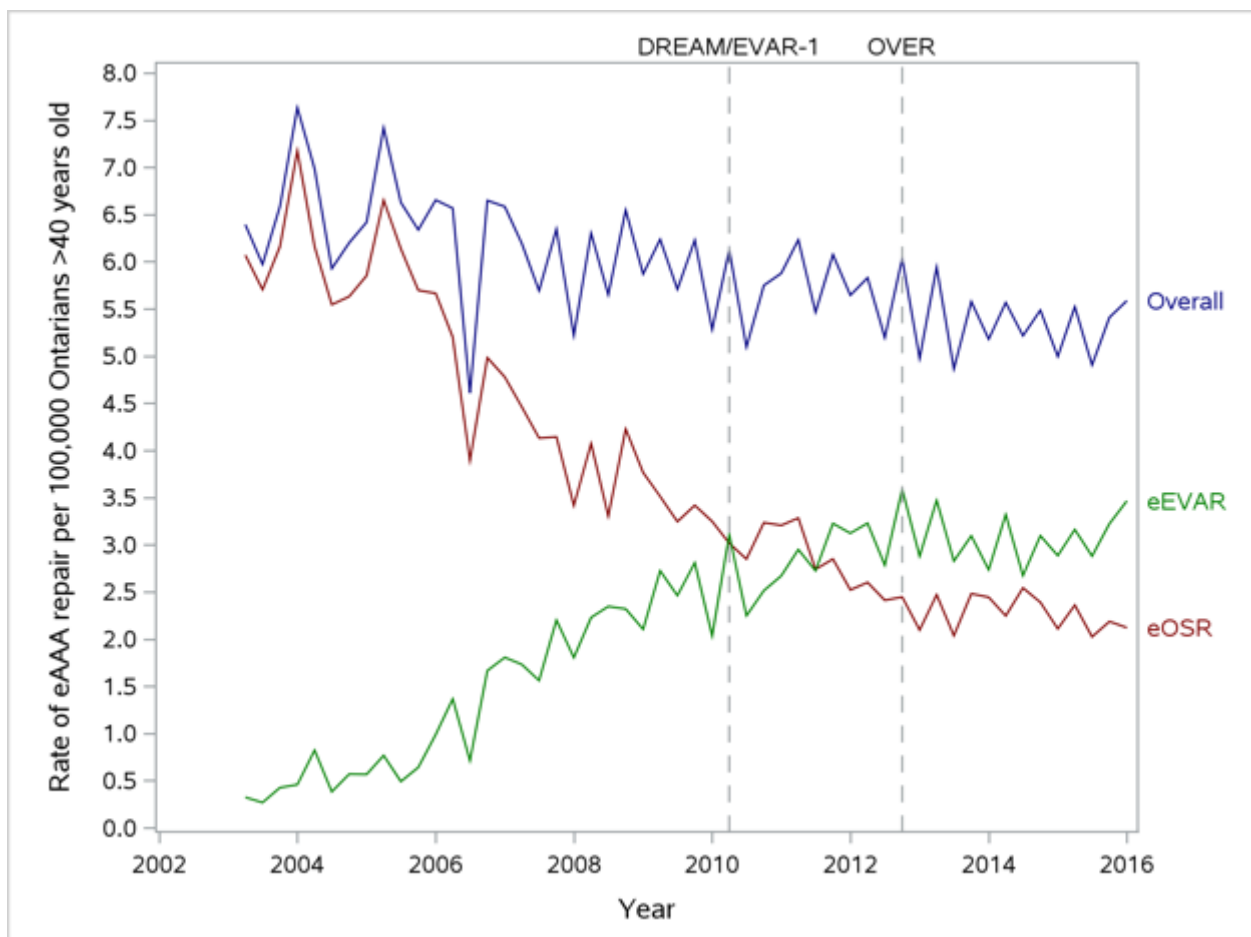


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OSR decreased nearly three-fold from 6.07/100,000 to 2.12/100,000 ( $p < 0.0001$ ), while elective EVAR increased approximately ten-fold (0.32/100,000 to 3.47/100,000,  $p < 0.0001$ ). The rate of ruptured OSR decreased from 1.62/100,000 to 0.37/100,000 ( $p < 0.44$ ), while ruptured EVAR uptake increased (0.00/100,000 to 0.12/100,000,  $p < 0.25$ ). The mid-term results of the DREAM and EVAR-1 trials were associated with a decrease in the rate of elective OSR decline after 2010 ( $p = 0.01$ ).

**Conclusion:** While elective OSR use has significantly decreased from 2003 to 2016, elective EVAR use has significantly increased. The DREAM and EVAR-1 results significantly impacted the observed rates of elective OSR only. The reasons for these trends require further characterization.

**Figure 1:** Overall and approach specific eAAA repair rates in Ontario from 2003 to 2016







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

Crawford, Sean A.<sup>1,2</sup>; Doyle, Matthew G.<sup>2,3</sup>; Amon, Cristina H.<sup>1,3</sup>; Forbes, Thomas L.<sup>2</sup>

<sup>1</sup>Institute of Biomaterials and Biomedical Engineering, University of Toronto

<sup>2</sup>Division of Vascular Surgery, University Health Network, Peter Munk Cardiac Centre, University of Toronto

<sup>3</sup>Department of Mechanical and Industrial Engineering, University of Toronto

**Objective:** To assess the interaction between operator insertion technique and iliac artery anatomy on the rotation of fenestrated endovascular devices.

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

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

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



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**Temporal Trends in Lower Extremity Amputations for Diabetes and Peripheral Artery Disease**

Mohamad A. Hussain, Mohammed Al-Omran, Konrad Salata, Jack V. Tu, Atul Sivaswamy, Subodh Verma, Thomas L. Forbes, Ahmed Kayssi, Charles de Mestral

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

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

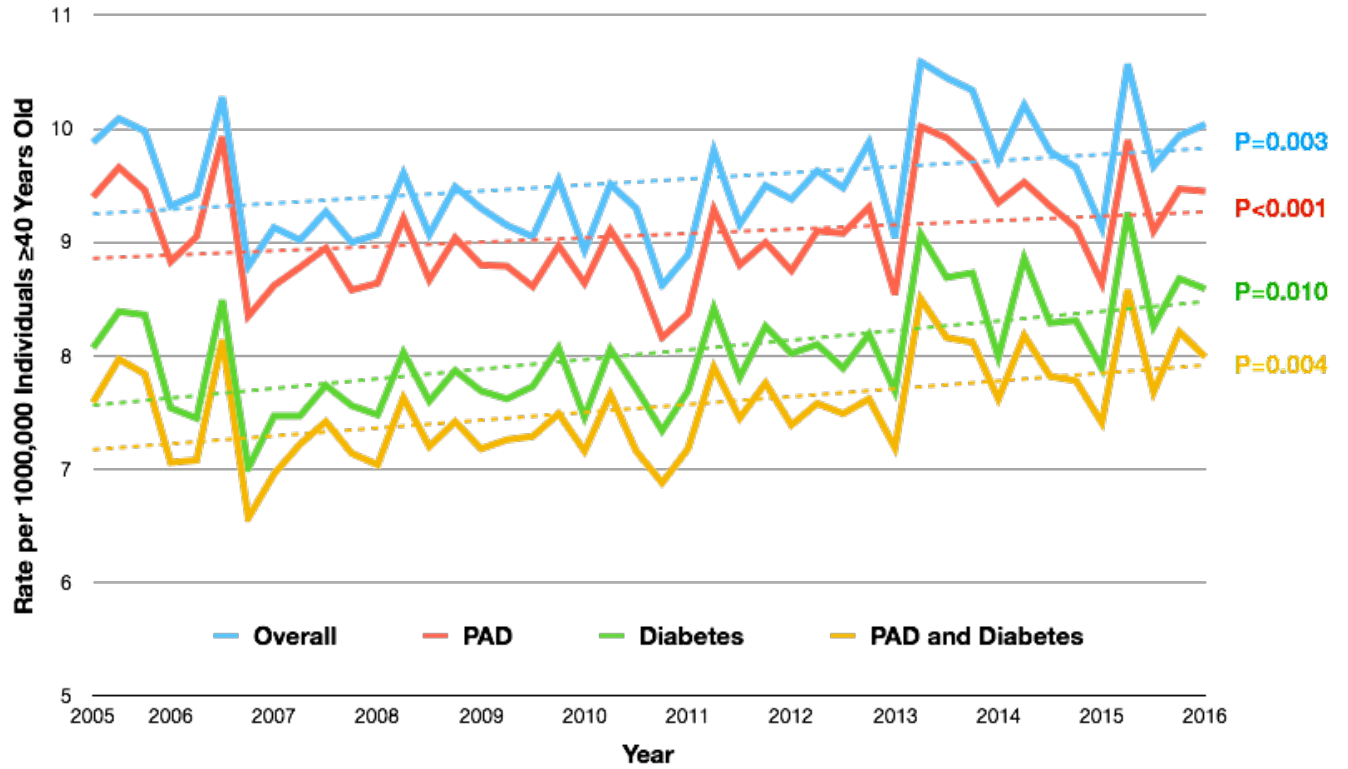
**RESULTS:** A total of 19,961 patients underwent minor or major lower extremity amputation(s), of which 12,755 (64%) underwent a major amputation. A total of 18,745 (94%) patients had PAD; 16,366 (82%) had diabetes; and 15,150 (76%) had both PAD and diabetes. The rate of any amputation initially declined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

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



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





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1345 - 1500: Afternoon Session

**Meta-analysis: Femoro-popliteal stenting with self-expandable Nitinol stent versus angioplasty alone**

O. Abdulrahim, P. Dicker, Z. Martin

**Background and aim:** Peripheral arterial disease (PAD) creates significant disability as it causes limb ischaemia which is a major risk factor for amputation. It mainly affects the femoropopliteal segment. The endovascular treatment of PAD remains highly controversial due to the wide variety of treatment procedures available and their varied outcomes. The aim of this meta-analysis is to compare the efficacy and safety of percutaneous transluminal angioplasty (PTA) alone to PTA with routine stenting with current nitinol stents for femoropopliteal occlusive disease by analyzing the overall results from all available randomized controlled trials.

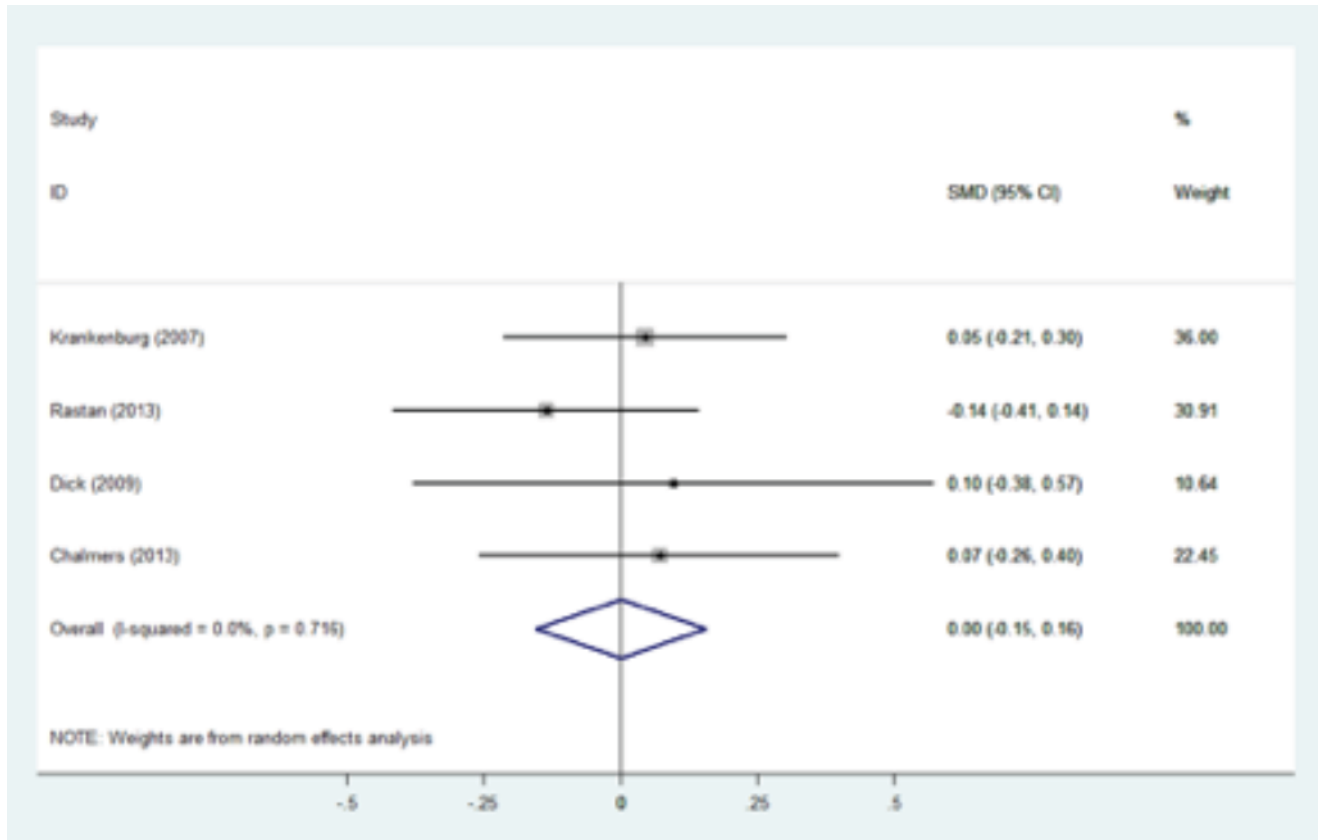
**Methods:** A bibliographic search of electronic medical databases (Cochrane databases, EBSCO, Cinahl, PubMed, EMBASE and Medline) was conducted to identify the randomized trials between 1990 to December 2013. Out of 451 retrieved published articles, six randomized controlled trials (RCTs) comparing PTA alone with stenting using self-expandable Nitinol stents were included in this study. Restenosis rate, symptoms improvement and ABPI are considered as endpoints. The results were reported with odd ratio (OR) with 95% confidence interval

**Result:** The study population was made up of 1,017 patients (487 PTA vs. 530 Stenting). 693 were male (68.1 %). The analysis showed a significant benefit for stenting over PTA (odds ratio, 0.54; 95% CI, 0.35–0.85). The analysis of the ABI showed no difference in ABI at 12 months in the stenting vs. PTA groups (standardised mean difference, 0.0; 95% CI, –0.15 to 0.16;  $P = 0.99$ )

**Conclusion:** Stenting provides a substantial benefit over PTA in terms of the proportion of patients showing restenosis at 12 months however there was no difference in the clinical endpoints of Rutherford category and ABI.



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Funnel plot for restenosis outcome



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**Preoperative Anemia has Gender Based Differences in Immediate Postoperative Mortality**

**Raju S<sup>1</sup>, Eisenberg N<sup>2</sup>, Montbriand J<sup>2</sup>, Roche-Nagle G<sup>2</sup>**

<sup>1</sup>Faculty of Medicine, University of Toronto

<sup>2</sup>Division of Vascular Surgery, Toronto General Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada.

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

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

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

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



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**Development and endovascular imaging of a porcine model of advanced carotid atherosclerosis**

Patrick Z McVeigh<sup>1</sup>, Corwyn Rowsell<sup>2</sup>, Brian C Wilson<sup>1</sup>, Mark Wheatcroft<sup>3</sup>

<sup>1</sup>Department of Medical Biophysics, University of Toronto, <sup>2</sup>Division of Diagnostic Pathology, St Michael's Hospital, <sup>3</sup> Division of Vascular Surgery, St Michael's Hospital

**Objective:** To develop a porcine model of advanced carotid atherosclerosis and visualize the endovascular appearance using a novel high-resolution optical imaging system.

**Methods:** Carotid atherosclerosis with vulnerable plaque features was created in swine using a surgical injury model combined with high-cholesterol diet and diabetes induced by administration of streptozotocin. Animals were maintained for 5 weeks on the atherogenic diet, with 2 weeks of hyperglycemia. Angiography and angioscopy were used to assess the lesions - technical elements such as depth of field, flush rates, and image resolution were recorded. Plaque features such as adherent thrombus, endothelial coverage, apparent lipid content, and degree of vessel stenosis were assessed to compare with ex-vivo pathology.

**Results:** Persistent hyperglycemia was successfully induced in 66% of animals (mean glucose 515mg/dL, base 87mg/dL). Serum cholesterol also increased following diabetes induction (mean >520mg/dL, base 105mg/dL). 5-week angiograms demonstrated a persistent induced stenosis and post-stenotic dilatation. Clear angioscopic images were obtained using a revised optical flushing system that utilizes smaller volumes of saline by increasing the tubing diameter connected to the imaging catheter and a volumetric infusion pump for precise rate control. In all cases the pre-stenotic region of the vessel wall had morphologic and color changes visible on angioscopy that were not observed on the corresponding conventional angiogram. Pathologic analysis of these regions demonstrated AHA grade III-Vc plaques with significant subintimal myoproliferation, calcification, and adherent thrombus.

**Conclusions:** This carotid stenosis model produces atherosclerotic changes in swine at 1 month follow-up that is primarily concentrated in the pre-stenotic region of the artery. Plaque morphology and timeline to development is accelerated by the induction of diabetes, which also increased circulating cholesterol levels. Clear optical imaging is possible in such high-flow arteries without occlusion by making use of a higher pressure flush delivery system and low flow rates. Changes in endothelial appearance corresponding to areas of pathology are detectable using the angioscope that cannot be appreciated on conventional angiography.



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**THE ECONOMIC BURDEN OF TREATING INPATIENT DIABETIC FOOT ULCERS IN TORONTO, CANADA**

Muzammil H. Syed<sup>1</sup>; Konrad Salata<sup>2,3</sup>, MD; Mohamad A. Hussain<sup>2,3</sup>, MD, PhD; Charles de Mestral<sup>2,3</sup>, MDCM, PhD, FRCSC; Subodh Verma<sup>2,4</sup>, MD, PhD, FRCSC, FAHA; Mark Wheatcroft<sup>2,3</sup>, MBChB, MD, FRCSC; John Harlock<sup>5,6</sup>, MD, FRCSC; Amol Verma<sup>7</sup>, MD, MPhil; Fahad Razak<sup>7</sup>, MD, MSc; Mohammed Al-Omran<sup>2,3</sup>, MD, MSc, FRCSC

<sup>1</sup>Faculty of Science, McMaster University, Hamilton, Canada; <sup>2</sup>Department of Surgery, University of Toronto, Toronto, Canada; <sup>3</sup>Division of Vascular Surgery, St. Michael's Hospital, Toronto, Canada; <sup>4</sup>Division of Cardiac Surgery, St. Michael's Hospital, Toronto, Canada; <sup>5</sup>Department of Surgery, Hamilton General Hospital, Hamilton, Canada; <sup>6</sup>Division of Vascular Surgery, Hamilton General Hospital, Hamilton, Canada; <sup>7</sup>Division of General Internal Medicine, St. Michael's Hospital, Toronto, Canada

**Objective:** To re-assess the economic burden of inpatient Diabetic Foot Ulcer (DFU) treatment in Toronto, Canada.

**Methods:** A population-based study was conducted of all general internal medicine (GIM) patients with a diagnosis of DFU from 2010 – 2015 who were admitted to 7 hospitals based in Toronto. Data from the General Medicine Inpatient Initiative (GEMINI) was utilized, which contains information on all GIM admissions to the 7 Toronto hospitals. We conducted univariate analyses to compare the mean cost of care per DFU patient to the cost associated with admission for other diabetes-related complications, as well as to the top 5 most costly GIM hospitalizations (identified to be congestive heart failure, pneumonia, urinary tract infection, chronic obstructive pulmonary disease, and pneumonitis). Amputation rate and in-hospital length of stay between all 3 groups was also assessed using univariate analyses.

**Results:** 27,152 patients were studied overall, including 557 DFU patients, 2,939 with other diabetes related complications, and 23,656 with one of the top 5 most costly conditions. The highest mean cost per patient was incurred by DFU patients (\$22,754) in comparison to other diabetic admissions (\$8,350) and the top 5 most costly conditions (\$10,169). DFU patients also had a significantly higher amputation rate compared to non-DFU patients (22% vs 0.3%,  $p < 0.001$ ). With respect to in-hospital length of stay, DFU patients spent the longest time in-hospital (17 days) when compared to patients with non-DFU diabetic admission (7 days) and the top 5 most costly conditions (9 days) ( $p < 0.001$ ).

**Conclusion:** Patients with DFU had a significantly higher mean cost of care, number of amputations, and length of stay in-hospital versus patients with other diabetes related complications, as well as the top 5 most costly conditions. The results of this study can lead to major changes in healthcare policies.





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**PERSISTENT OPIOID USE FOLLOWING VASCULAR SURGERY**

V. Rojas-Luengas<sup>1</sup>, N. R. Eisenberg<sup>2</sup>, G. J. Montbriand<sup>3</sup>, G. Roche-Nagle<sup>1,2</sup>

<sup>1</sup>Faculty of Medicine, University of Toronto

<sup>2</sup> Division of Vascular Surgery, University Health Network, Toronto General Hospital

<sup>3</sup> Sunnybrook Health Sciences Centre

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

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

**Results:** 86 out of 157 screened patients were eligible for study enrollment. Patient age ranged from 65-98 years-of-age (mean =  $78 \pm 8.2$  years). Patient cohort consisted of 61 male and 25 female subjects. 48% (N=41) of patients were discharged with an opioid prescription and 11.4% (N=10) of patients continued to receive opioids for 1-year (271-365 days). Patients with opioid use for 1-year were found to have a significantly higher incidence of diabetes,  $\geq 3$  different opioid prescribers, and  $\geq 3$  opioid dispensing pharmacies. In addition, patients with 1-year opioid use had a significantly higher mean rank for duration of use of non-opioid pain medications (neuroleptics and benzodiazepines) compared to patients with opioid use up to 270 days post-discharge,  $\chi^2=31.8$ ,  $P<0.0005$  (Kruskal-Wallis test).

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



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1530 - 1545: Researcher's Forum

Graham Roche-Nagle, Division of Vascular Surgery, Peter Munk Cardiac Centre, University Health Network, Associate Professor, Department of Surgery, University of Toronto.

Improvement begins with I.



Dr Graham Roche-Nagle is a native of Waterford, Ireland. He received his medical degree from the Royal College of Surgeons in Ireland in 1998 and finished his clinical training on the Irish Senior Registrar Training Program. He then completed a 2 year fellowship in vascular surgery at Toronto General Hospital and St Michaels Hospital Toronto. He is certified in general vascular surgery from the Royal College of Surgeons in Ireland and also holds certification from the European Board for Vascular Surgery. Dr Roche-Nagle in addition has been awarded a MBA in Healthcare Management (University College Dublin) and a Masters in Medical Education (Queens University, Belfast).

He is an Associate Professor in the Department of Vascular Surgery UHN. His specialty interests include open/endovascular abdominal and thoracic aortic aneurysm repair, peripheral artery bypass/intervention, carotid artery surgery, arterio-venous fistula construction, venous disease as well as thoracic outlet syndrome.



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## 1545 – 1625: Rapid Fire Presentations

### Measurement of frictional and mechanical properties of stent grafts and their delivery systems

Tianhao Chen, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes

**Objective:** The objective of this study was to characterize the frictional and mechanical properties of three commercial stent graft and their delivery systems.

**Methods:** Three commercial stent grafts, the Zenith, the Endurant, and the Anaconda were obtained and separated into 3 parts, stents, graft fabric, and delivery sheath. Frictional properties, specifically the static and kinetic coefficients of friction (COFs), denoted as  $\mu_s$  and  $\mu_k$ , respectively, were measured using a custom-made friction apparatus. The COFs were measured between i) the stents and inner surface of the delivery sheath, ii) the graft fabric and inner surface of the sheath, iii) outer surface of sheath and inner surface of a porcine aorta, and iv) outer surface of the sheath and three different polyvinyl alcohol cryogels (PVA-c), which are used in our lab as a material for vascular phantom models. Mechanical properties, specifically the bending flexibility of the Zenith and Endurant stent grafts, defined as the deflection divided by the force applied, were assessed using 3-point bending tests.

**Results:** The COFs between the graft fabric and the sheath were higher than those between the stents and the sheath, as shown in Table 1. Good agreement was found between the frictional properties of the sheathes and the porcine aorta and the sheaths and the PVA-c phantoms. In particular, for the Anaconda the COFs for a 15%, 4 freeze-thaw-cycle PVA-c gel were  $\mu_s = 0.0483 \pm 0.00125$ ,  $\mu_k = 0.0455 \pm 0.00261$  compared to  $\mu_s = 0.0466 \pm 0.00356$ ,  $\mu_k = 0.0448 \pm 0.00250$  for the same device with the porcine aorta. This suggests that the phantoms provide a reasonable approximation for the *in vivo* frictional properties. Lastly, the bending flexibility for Endurant stent graft was found to be  $26.3 \pm 2.16$  mm/N, higher than the  $19.3 \pm 2.59$  mm/N obtained from Zenith stent graft.

**Conclusion:** These results will provide a more accurate representation of the frictional and mechanical properties of stent grafts in computational models of stent graft delivery and deployment. This will in turn improve the accuracy of these models to predict the process of stent graft deployment in the abdominal aorta and estimate any resulting complications, such as device rotation.



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*Table 1:* Coefficient of frictions (COF) for stent-sheath and graft-sheath material pairs of Cook Zenith, Medtronic Endurant and Vascutek Anaconda stent grafts.

		<b>Axial</b>		<b>Circumferential</b>	
		Static COF ( $\mu_s$ )	Kinetic COF ( $\mu_k$ )	Static COF ( $\mu_s$ )	Kinetic COF ( $\mu_k$ )
<b>Cook Zenith</b>	Stent-Sheath	0.0676 ± 0.00406	0.0513 ± 0.00160	-	-
	Graft-Sheath	0.0939 ± 0.00335	0.0791 ± 0.00467	0.0953 ± 0.00326	0.0817 ± 0.00262
<b>Medtronic Endurant</b>	Stent-Sheath	0.0675 ± 0.00330	0.0558 ± 0.00333	-	-
	Graft-Sheath	0.0869 ± 0.00163	0.0751 ± 0.00366	0.0970 ± 0.00357	0.0830 ± 0.00753
<b>Vascutek Anaconda</b>	Stent-Sheath	-	-	-	-
	Graft-Sheath	0.0938 ± 0.00467	0.0743 ± 0.00266	0.0943 ± 0.00476	0.0746 ± 0.00290



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**Comparing Preventative Strategies for Contrast-induced Nephropathy in Vascular Surgery Patients: A Systematic Review and Meta-analysis**

Musaad AlHamzah, Khalid Alayed, Mina Garas, Muzammil H. Syed, Konrad Salata, Mohamad A. Hussain, and Mohammed Al-Omran

**Objectives:** To compare the efficacy of different prophylactic interventions against contrast-induced nephropathy (CIN) in vascular surgery patients undergoing non-coronary, non cerebral, invasive, contrast-based interventions.

**Methods:** We systematically searched MEDLINE, EMBASE, and the Cochrane Central Register of Controlled Trials (CENTRAL) databases from inception till 2017, followed by a manual review of citations in identified systematic reviews and studies. Interventions of interest included hydration (oral and intravenous), N-acetylcysteine, statins, sodium bicarbonate infusion, ascorbic acid, and loop diuretics, given alone or in combinations. Risk of bias was assessed using the Cochrane risk of bias tool for randomized controlled trials, and the Newcastle-Ottawa scale for observational studies. Pooled mean differences and odd ratios with 95% confidence intervals were calculated using random-effects models. I-squared statistic was used to quantify data heterogeneity.

**Results:** The search yielded 4519 studies, of which 81 underwent full text screening. Fourteen studies with a total of 14,630 patients were identified and included in the analysis. Inter-rater agreement ( $\kappa$ ) was 0.62. Of all the pre-procedural prophylactic interventions studied, none of them were found to have a protective effect against CIN.

**Conclusions:** In patients undergoing non-coronary, non-cerebral, invasive contrast-based vascular interventions, the studied pre-procedural interventions did not reduce the risk of CIN.



University of Toronto  
Division of Vascular Surgery

**Vascular Surgery Boot Camp: Developing a Primer for Competency Based Training**

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**Objectives:** Implementing a pre-clinical vascular surgery specific skills curriculum for residents enrolled in an integrated Vascular Surgery Residency program.

**Methods:** The vascular surgery boot camp curriculum was modeled after the University of Toronto's orthopedic surgery specialty-specific boot camp. Incoming vascular surgery residents enrolled in a Canadian Integrated Vascular surgery residency program were invited to participate. This study was conducted at Mt. Sinai Hospital's Surgical Skills Centre, using commercially available vascular models and standardized skills checklists. Data collected included: Resident demographics, task-specific assessments (open AAA and CEA), and program evaluation.

**Results:** After expanding the program Canada wide eight residents participated in the 2016 cycle. Residents were aged 25-34, 62.5% male, 87% right handed, prior surgical experience ranged from 0-5 years. The Overall lecture quality and quality of the models were the highest ranked items (4.75/5 and 4.37/5 respectively). The cohort unanimously rated the course with the highest possible mark. There were not any common themes on areas to improve upon. Specific feedback on the points mentioned, suggested the careful and thoughtful attitude in which the forms were answered.

**Conclusions:** The national expansion of the program was well received. Current evaluations were limited to single observations; protocols for longitudinal follow up would improve insight in skill acquisition and retention. These tools would serve as a guide in the development of a competency based training curriculum.



University of Toronto  
Division of Vascular Surgery

**Adherence to recommended imaging surveillance of acutely presenting Stanford Type B aortic dissections**

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**Objective:** Treatment of acutely presenting Stanford Type B aortic dissections (TBAD) requires lifelong imaging surveillance. Guidelines recommend imaging at 1, 3, 6, and 12 months following discharge from initial admission, and annually thereafter. This study aims to evaluate adherence to recommended surveillance for newly presenting TBAD patients.

**Methods:** A retrospective chart review of patients presenting with a new, acute TBAD between January 2010 and March 2017 was performed. TBAD diameters throughout follow up were measured by a single operator. Continuous follow-up (imaging every  $\leq 15$  months) and adherence to recommended surveillance were analyzed using Kaplan-Meier graphs. Log-rank analysis assessed factors increasing risk of poor follow-up and adherence to guidelines.

**Results:** Sixty-two patients (38M, 24F) were included. Kaplan-Meier analysis of continuous follow-up, censoring death and external follow-up, indicated rates of 87.1% (SE 4.3%) at 1 and 3 months, 85.2% (4.6%) at 6 months, 77.5% (5.6%) at 12 months, and 63.8% (8.1%) at 60 months. Similar analysis of adherence to recommended imaging intervals revealed compliance of 10.9% (SE 4.2%) at 3 months, 8.7% (3.9%) at 6 months, and 0.0% at 12 months. Log-rank analysis indicated that specialty arranging follow-up – medical (n=24) versus surgical (n=38) – did not influence results. Similarly, none of distance to hospital, intervention type, initial dissection size, smoking history, or demographics impacted outcomes.

**Conclusions:** Continuous follow-up of TBAD is satisfactory; however, frequency of imaging surveillance does not adhere to recommended guidelines. This concerns all TBAD patients and no subset in isolation. Imaging surveillance with stricter intervals can improve the quality of patient outcomes. This presents an opportunity for education on recommended guidelines. The implementation of a protocol to notify physicians of recommended imaging is justified.



University of Toronto  
Division of Vascular Surgery

**Incidence of Finding Abdominal Aortic Aneurysm in Abdominal Computed Tomography Scan and Its Implication on Its Prevalence in Saudi Arabia**

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**Objective:** The aim is to determine the prevalence of incidental abdominal aortic aneurysm (AAA) on routine abdominal computed tomography (CT) in the Kingdom of Saudi Arabia (KSA) and to discuss any possible need for AAA screening programs in KSA and the region.

**Methods:** A retrospective review of all abdominal CTs performed (both contrast and non-contrast studies) in our institution between January 1, 2011 and December 31, 2016 was conducted. Our target population was males aged between 65 and 75 years old. The CTs were reviewed by investigators trained in reviewing and measuring the aortic diameter. The maximal anterior-posterior diameter of the infra-renal abdominal aorta was measured on transverse cuts. The aortic diameter was recorded and the measurements were taken by 2 investigators independently for each CT scan. Any discrepancy of more than 15% was then reviewed by the primary investigator.

**Results:** After exclusion, the total number of reviewed CT scans was 2032. The mean age was 69,8±3,1 years and the mean aortic size was 1,9±0,3 cm. There were 2026 cases (99,7%) with sizes < 3 cm and the mean age was 69,8±3,1 years. There were 6 cases (0,3%) with sizes ≥ 3 cm and the mean age was 72,3±3,1 years. The only statistically significant factor for AAA was age; 69,8 vs. 72,3±3,1 years (P value: 0,0433).

**Conclusion:** Our data suggests that the incidence of AAA in our population is inferior to most international screening programs. An incidence this low may explain low rate of AAA diagnosis in KSA and there are a number of scientific theories to support this result. However, any inference from this data should be treated with caution since it is not a representation of the general population, and many risk factors for AAA were not available to us. A national pilot screening program in the non- hospital population would provide more robust evidence on the cost-effectiveness of an AAA screening program.