School of Biomedical Engineering

Research Day 2025

Scientific Program

DALHOUSIE UNIVERSITY

Dear Colleagues,

Welcome to the 2025 School of Biomedical Engineering Research Day! We're excited to come together once again to celebrate the remarkable achievements and discoveries of our talented graduate students. Today is also a valuable opportunity to strengthen collaboration and exchange ideas across our department.

This year's Research Day promises to be an exceptional event, showcasing the breadth and depth of our department's cutting-edge research. Research Day is more than just a presentation of projects—it's a platform to share insights, spark meaningful discussions, and foster a culture of research excellence that propels our department forward. I encourage everyone to engage fully, ask questions, and embrace the diversity of expertise represented here. By sharing perspectives across disciplines, we can unlock new ideas and drive impactful innovation.

I also have the distinct pleasure to welcome our Distinguished Keynote Speaker for this year's event, Dr. Eli Vlaisavljevich, a leading authority in focused ultrasound technologies. His talk will highlight advances in therapeutic ultrasound and its application to non-invasive tissue ablation. We are also excited to host a career panel featuring leaders from local biomedical startups – several of whom are SBME alumni. The panel members will share their entrepreneurial journeys and shed light on the wide range of career paths available to biomedical engineering graduates.

Finally, I would like to extend a heartfelt thank you to the students who contributed to this booklet, and to the organizing committee and admin staff for their tireless efforts in making this event possible. Lastly, I would like to express our appreciation to our esteemed guests for their support. Your participation and enthusiasm make this event possible and meaningful.

I hope you find today to be both inspiring and enriching. Let's celebrate our achievements, build new connections, and continue pushing the boundaries of biomedical research together.

With warm regards,
Rob Adamson
Director, School of Biomedical Engineering

School of Biomedical Engineering

Research Day 2025

DISTINGUISHED ACADEMIC LECTURE

Eli Vlaisavljevich, Ph.D

Associate Professor of Biomedical Engineering and Mechanics, Virginia Tech

Dr. Eli Vlaisavljevich is an Associate Professor of Biomedical Engineering and Mechanics at Virginia Tech. His research interests include focused ultrasound, non-invasive tissue ablation (HIFU, histotripsy), cavitation physics, nanoparticle-mediated histotripsy, biomaterials, tissue regeneration, cancer, and clinical translation. Vlaisavljevich has led the development of histotripsy from bench-to-bedside, with his work resulting in the THERESA study, a first-in-human clinical trial named after Vlaisavljevich's mother who died of liver cancer. A second clinical trial (#Hope4Liver) resulted in the FDA approval of histotripsy for the treatment of liver tumors in October 2023. Vlaisavljevich's group continues to lead the development of histotripsy for new applications including pancreatic cancer, soft tissue sarcoma, bone cancer, brain cancer, oral tumors, breast cancer, uterine fibroids, biomaterial-associated biofilms, and many other applications.

“Image-guided Non-invasive Tissue Ablation using Histotripsy:

THERESA to Edison and Beyond”

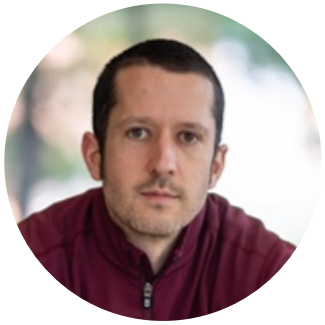
Eli Vlaisavljevich, Ph.D
Associate Professor,
Biomedical Engineering and Mechanics,
Virginia Tech

Abstract: Histotripsy is the first completely non-invasive, non-ionizing, and non-thermal ablation technology. Guided by real-time imaging, histotripsy uses focused ultrasound pulses delivered from outside the body in order to mechanically destroy tissue through the precise generation of acoustic cavitation. Unlike thermally ablative forms of focused ultrasound, histotripsy relies on the mechanical action of the generated cavitation bubble clouds to achieve clouds to achieve precise and tissue-selective tumor ablation. While acoustic bubble activity is often characterized as chaotic, the short-duration histotripsy pulses produce a unique and consistent type of cavitation that renders the targeted tissue into acellular debris with high precision and tissue selectivity. After treatment, histotripsy ablation zones can be immediately visualized using standard imaging modalities including ultrasound, CT, and MRI. The material in the histotripsy ablation regions is rapidly absorbed by the body, often within 1-2 months depending on the size of the ablation zone, leaving a minimal remnant scar. Histotripsy has been investigated for a wide range of applications in preclinical studies and early clinical trials, including the treatment of cancer, neurological diseases, and cardiovascular diseases. In this talk, Dr. Vlaisavljevich will discuss his research investigating the physical mechanisms underlying histotripsy tissue ablation as well as the development of histotripsy for the treatment of liver cancer and other emerging clinical applications.

School of Biomedical Engineering

Research Day 2025

Industry Panel



Eli Vlaisavljevich, Ph.D *Associate Professor of Biomedical Engineering and Mechanics, Virginia Tech*

Dr. Eli Vlaisavljevich specializes in focused ultrasound and non-invasive tissue ablation technologies such as histotripsy. He has played a leading role in translating histotripsy from lab to clinic, culminating in the FDA-approved #Hope4Liver trial for liver cancer and the earlier THERESA study, named in memory of his mother. His research spans cavitation physics, cancer treatment, biomaterials, and tissue regeneration, with ongoing work targeting a broad range of cancers and other conditions.

Courtney O'Brien, MASc, P. Eng. *Product Development Lead, ClearDynamic Inc.*

Courtney O'Brien is a Professional Engineer and graduate of the Dalhousie University School of Biomedical Engineering with a Master of Applied Science in Biomedical Engineering as a member of Dr. Brendan Leung's lab. She also holds a Bachelor of Engineering in Chemical Engineering from Dalhousie University. Since completing her master's degree, she has been working as Product Development Lead at ClearDynamic Inc., focusing on the design and development of innovative medical devices.

Chris Samson, Ph.D *Systems and Software Engineering Manager, Daxsonics Ultrasound Inc.*

Dr. Chris Samson is the Systems and Software Engineering Manager at Daxsonics Ultrasound Inc., where he develops commercially viable ultrasonic systems by bridging hardware and software. He has collaborated with over 20 companies and holds 5 patents and 14 academic publications. Dr. Samson earned his Ph.D. in Biomedical Engineering in 2020 and previously received the Dalhousie University Medal for Electrical and Computer Engineering. He looks forward to engaging with emerging researchers at the Biomedical Engineering Research Day.

Gurkaran Chowdhry, MSc *Director of Business Development, 3DBioFibR Inc*

Gurkaran Chowdhry is the Director of Business Development at 3DBioFibR Inc., a biomaterials company producing scalable, high-quality biopolymer fibers for medical and industrial use. With a background in physics and graduate research at Dalhousie University, he co-developed a novel fiber-spinning technology that led to the company's founding in 2020. His work spans R&D, IP, financing, and commercialization, giving him a broad perspective on biotech innovation. Gurkaran is passionate about scientific communication and the role of ECM-based scaffolds in regenerative medicine and non-animal testing.

Previous Winners of the Community Builder Prize in Biomedical Engineering

2008
Marianne Ariganello

2011
Adrian West

2013
J. Michael Lee

2015
Eleanor Seaman-Bolton

2017
Rishma Agarwal

2018
Kristin Robin Ko

2019
Tyler Herold

2020
Meaghan Martin

2021
Alyne Texeira

2023
Mady Thompson, Sandra Pereira

Previous Winners of the Annual Teaching Prize in Biomedical Engineering

2008
Geoff Maksym

2009
J. Michael Lee

2010
Jeremy Brown

2011
Paul Gratzer

2012
Rob Adamson

2013
Janie Astephen-Wilson

2015
Daniel Boyd

2016
Sarah Wells

2017
Jeremy Brown

2018
John Frampton

2022
Sarah Wells

2024
Lindsey Power

Previous Winners of the George W. Holbrook Prize in Biomedical Engineering

2010
Richard Roda

2011
Graeme Harding

2013
Matthew Walker

2014
Pouya Amiri

2015
Lauren Kiri

2016
Brandon Scott

2017
Kristin Robin Ko

2018
Rishima Agarwal

2020
Nicky Tam

2021
Lindsey Power

2022
Mireya Cervantes Gonzalez

2023
Ally Klassen

Previous Winners of the Allan E. Marble Prizes in Biomedical Engineering

2002
Sean Margueratt

2003
Anna Dion

2005
Doctoral: Mark Glazebrook
Pre-doctoral: Carolyn Lall

2006
Doctoral: Scott Landry
Pre-doctoral: Scott Maclean

2007
Doctoral: Janie Astephen
Pre-doctoral: Andrew Moeller

2008
Doctoral: Marianne Ariganello
Pre-doctoral: Vargha Talebi

2009
Doctoral: Jack Fairbank
Pre-doctoral: Jennifer Krausher

2010
Derek Rutherford

2012
Del Leary

2013
Andre Bezanson

2014
Caitlin Pierlot

2015
Arash Momeni Boroujeni

2016
Dan MacDougal

2017
Brett Dickey

2019
Alyne Teixeira

2020
Katherine Latham

2021
Kathryn Young-Shand

2022
Matthew Mallay

2023
Ahmed Ramadan

2024
Meghan Martin & Nick Campbell

School of Biomedical Engineering

Research Day 2025 Scientific Program

Thursday, May 29th, 2025

Irving Oil Auditorium, Richard Murray Design Building

Morning Session

8:00 am to 8:45 am	**Student and Faculty Check In**
8:45 am to 9:00 am	**Welcome & Opening Remarks: Dr. Rob Adamson, Director, SBME**

Distinguished Speaker

9:00 am to 10:00 am	**Eli Vlaisavljevich, PhD** **Associate Professor of Biomedical Engineering and Mechanics** **Virginia Tech University** ***"Image-guided Non-invasive Tissue Ablation using Histotripsy: THERESA to Edison and Beyond"***

Coffee Break (10:00 am – 10:15 am)

Scientific Session 1 – Chairs: Brianna Samson & Jana Sewidan

10:15 am to 10:30 am	***"ANTI-FIBROTIC FUNCTION OF ITACONATE-BASED DEGRADABLE POLYESTER MATERIALS"*** Zachary Froom (PhD Student), K. Medd, B. Wheeler, N. Osborne, C. Rempe, K. Woodworth, C. Charron and Locke Davenport Huyer
10:30 am to 10:45 am	***"METAL ION-RELEASING GLASS PARTICLES TO ENHANCE ANTIBIOTIC EFFICACY AGAINST CYSTIC FIBROSIS INFECTION"*** Max Wolverton (MASc Student) and Brendan Leung
10:45 am to 11:00 am	***"MODELLING SYNTHESIS-PROPERTY RELATIONSHIPS IN DEGRADABLE ROCOP POLYESTERS VIA DESIGN OF EXPERIMENTS"*** Sara Murrin (MASc Student) and Locke Davenport Huyer

11:00 am to 11:15am	***"AUTOMATED FABRICATION OF A COLLAGEN FIBER SCAFFOLD WITH TUNABLE STRUCTURE FOR TISSUE ENGINEERING"*** Janna Albarda (MASc Student) and John Frampton
11:15 am to 11:30 am	***"A TUNABLE CO-CULTURE MODEL FOR INVESTIGATING MICROBE-DRIVEN LUNG IMMUNE RESPONSES"*** Sarah Spencer (PhD Student), Karla Valenzuela and Brendan Leung
11:30 am to 11:45 am	***"INVESTIGATING SHOE-DEPENDENT CHANGES IN RUNNING BIOMECHANICS IN A NATURAL ENVIRONMENT"*** Ben MacDonald (MASc Student), J. Outerleys, K. Shutte, N. Tam, B. Lane, S. Civiero, A. Dorrance and Janie Astephen Wilson

Catered Lunch (11:45 am – 1:00 pm)

Industry Pannel – Chairs: Brenden Wheeler & Sara Murrin

1:00 pm to 2:00 pm	**Panelists:** **Eli Vlaisavljevich** **Courtney O'Brien** **Chris Samson** **Gurkaran (Karan) Chowdhry**

Coffee Break (2:00 pm – 2:15 pm)

Scientific Session 2 – Chairs: Linh Tran & Benjamin Sewidan

2:15 pm to 2:30 pm	***"PM2.5 CELLULAR UPTAKE, DISPERSION, AND LUNG CELL INTERACTIONS"*** Isabella Mendoza Montealegre (PhD Student), J. Salsman, Graham Dellaire and Geoffrey Maksym
2:30 pm to 2:45 pm	***"TEMPORAL EXPRESSIONS OF MATRIX METALLOPROTEASES ASSOCIATED WITH SUBCUTANEOUS POLYMER IMPLANTATION"*** Kyle Medd (MASc Student), L. Fong-Hollohan, C. Rempe, Z. Froom, N. Osborne and Locke Davenport Huyer

2:45 pm to 3:00 pm	***"IS THE STANDARD CLINICAL MRI PROTOCOL FOR CHOLESTEATOMA WRONG?"*** Rob Weaver (PhD Student), C. Bowen, J. Rioux, D. Morris and Steven Beyea
3:00 pm to 3:15 pm	***"A NOVEL IN VITRO MODEL FOR PERIPHERAL NERVE REGNERATION"*** Mady Thompson (PhD Student) and John Frampton
3:15 pm to 3:30 pm	***"IDENTIFYING CLINICALLY RELEVANT GAIT KINEMATIC CLUSTERS IN END-STAGE KNEE OSTEOARTHRITIS PATIENTS"*** Owen Falkenham (MASc Student), S. Civiero, M. Dunbar, J. Leighton, G. Richardson, D. Wilson, L. Roffe) and Janie Astephen Wilson
3:30 pm to 3:45 pm	***"THE OPTIMIZATION OF ULTRASOUND SONICATION FOR CREATING AN ACOUSTICALLY TRANSPARENT SKULL"*** Alyssa Forbes (PhD Student), T. Landry and Jeremy Brown

Closing

3:45 pm to 4:00 pm	**Closing Remarks** **Director: Dr. Rob Adamson**
6:00 pm	**DBES Annual Student Gala -** ***Sponsored by IR Scientific*** **Lot Six Restaurant - 1685 Argyle St**

School of Biomedical Engineering

Research Day 2025 Abstracts

SCIENTIFIC SESSION 1

ANTI-FIBROTIC FUNCTION OF ITACONATE-BASED DEGRADABLE POLYESTER MATERIALS

Z. Froom[1] K. Medd[1], B. Wheeler[1], N. Osborne[2], C. Rempe[2], K. Woodworth[1], C. Charron[3], and L. Davenport Huyer [1, 2, 4, 5]

[1]School of Biomedical Engineering, Dalhousie University; [2]Department of Microbiology & Immunology, Dalhousie University; [3]Department of Chemistry, Dalhousie University; [4]Department of Biomaterials & Applied Oral Sciences, Dalhousie University; [5]Nova Scotia Health, Halifax, NS

Fibrosis is a progressive and chronic disease characterized by the abnormal accumulation of extracellular matrix, contributing to significant morbidity and mortality worldwide. Despite its widespread impact, treatment options remain limited, in part due to the complex and reciprocal interactions between pro-fibrotic macrophages and fibroblasts that drive and maintain the fibrotic microenvironment. In this work, we present a novel therapeutic approach designed to disrupt this cellular interplay by harnessing the anti-fibrotic potential of itaconate (IA), an endogenous metabolite known to modulate inflammatory signaling. To achieve controlled and sustained release of IA in a manner suitable for chronic fibrotic conditions, we engineered a biodegradable polyester, poly(IA-DoD), with IA incorporated directly into its polymer backbone. Upon degradation, poly(IA-DoD) steadily releases free IA along with IA-containing oligomers. In cellular studies, the breakdown products of this polymer attenuated pro-fibrotic activation in both murine bone marrow-derived macrophages and human dermal fibroblasts. Macrophages exposed to these products exhibited diminished pro-fibrotic phenotypes, while fibroblasts demonstrated reduced proliferation and decreased expression of α-smooth muscle actin, a hallmark of myofibroblast differentiation. Together, these findings suggest that poly(IA-DoD) offers a promising platform for localized, long-term modulation of fibrosis by targeting the pathological macrophage-fibroblast signaling axis. This approach highlights a new direction in the development of biomaterial-based therapies for fibrotic disease.

METAL ION-RELEASING GLASS PARTICLES TO ENHANCE ANTIBIOTIC EFFICACY AGAINST CYSTIC FIBROSIS INFECTION

M. Wolverton[1], B. Leung[1,2]

[1]School of Biomedical Engineering, Dalhousie University; [2]Department of Applied Oral Sciences, Dalhousie University

Cystic fibrosis (CF) results in thickened airway mucus that impairs mucociliary clearance and leads to devastating chronic bacterial infections. Respiratory failure and lung damage caused by these infections are the leading causes of mortality in CF patients. The widespread use of antibiotics as the primary treatment option for CF bacterial airway infections has led to the development of antibiotic resistance in these bacteria. This project aims to evaluate if conventional antibiotic therapies can be made more effective in treating CF bacterial infections by combining them with antibacterial metal ions delivered via borate bioactive glasses. We have designed an in vitro airway infection model to mimic the CF airway microenvironment that consists of bronchial epithelial cells, a mucus-like hydrogel layer, and bacteria deposited using an aqueous two-phase system. This model was used to evaluate the combinations of antibiotics and bioactive glasses. The Zn2+ and Ga3+ containing bioactive glass formulations selected for this project showed various levels of additive and synergistic antibacterial properties toward Pseudomonas aeruginosa and Staphylococcus aureus when combined with conventional antibiotics, while maintaining bronchial epithelial cell viability. The antibiotic-glass combinations produced in this project have potential to improve outcomes for CF patients and those with predispositions to the development of devastating bacterial infections, while limiting the development of widespread antibiotic resistance.

MODELLING SYNTHESIS-PROPERTY RELATIONSHIPS IN DEGRADABLE ROCOP POLYESTERS VIA DESIGN OF EXPERIMENTS

S. Murrin[1], A. Scott[2], L. Davenport Huyer[1,3-5]

[1]School of Biomedical Engineering, Dalhousie University; [2]Department of Process Engineering and Applied Science, Dalhousie University; [3]Department of Biomaterials & Applied Oral Sciences, Dalhousie University; [4]Department of Microbiology & Immunology, Dalhousie University; [5]Department of Surgery, Nova Scotia Health

Degradable polyesters are leveraged widely in medicine, providing functionality for resorbable sutures, implantable devices, and drug delivery. Successful materials require precise degradation control: a predictable degree of polymerization (DP), narrow polydispersity (PDI), and diverse material properties to expand utility. Acid-alcohol copolymerization achieves wide ranging degradable polyester properties through monomer diversity, but is limited by poor predictability, limited DP control, and broad PDI. Ring-opening copolymerization (ROCOP) of cyclic anhydrides and epoxides offers an attractive alternative, providing precise and reproducible DP control, narrow PDI, and expanding monomer diversity.

Poly(cyclohexene succinate) (PCS) and poly(propylene succinate) (PPS) were synthesized via ROCOP according to a central composite design of experiments; varying comonomer ratios, monomer-catalyst ratios, polymerization time, and polymerization temperature. Resulting materials were characterized in terms of number-average molecular weight, PDI, ester bond formation, and bulk mass loss under accelerated hydrolytic degradation conditions.

Results illustrate modified material properties (responses), although relationships are limited to the specific synthesis systems. PCS and PPS response differences suggest that monomer selection is highly influential in degradation behaviour. This work highlights the potential of ROCOP to generate polyesters for biomaterial applications, with promising results in fine control of material property and degradation relationships that could be applied to specific applications.

AUTOMATED FABRICATION OF A COLLAGEN FIBER SCAFFOLD WITH TUNABLE STRUCTURE FOR TISSUE ENGINEERING

J. A. Albarda[1], J. P. Frampton[1,2]

[1]School of Biomedical Engineering, Dalhousie University; [2]Department of Biochemistry & Molecular Biology, Dalhousie University

Artificial corneas have been under development for decades, but there has yet to be a design with the transparency and strength to rival natural corneal tissue. To replicate such a precise structure, instrumentation is required to automate production. Here, 3D modeling software was used to design custom components for a collagen fiber manufacturing system. These were then 3D printed and combined with prefabricated metal parts for reinforcement. When assembled, the system consists of two conveyor belts that meet at an apex and a collection plate at the base. One belt has a series of pins on its surface, and the other has a well that is filled with a solution of type I collagen and polyethylene oxide. When the pins contact the solution, liquid filaments form. The liquid filaments dry as the belts diverge, and dry collagen/polymer fibers are collected on the plate. Repeated rotations of the plate result in collection of fibers that are parallel and perpendicular to each other, approximating the orientation of collagen fibers in the corneal stroma. By driving all of the moving parts using gears and only one motor, all of the components remain synchronous. The speed at which the components of the manufacturing system move was validated by taking repeated measurements of the distance between the pins and the well as the system was operating. For additional customization, various gears can be replaced to alter the speed of the rotating belts or the rotation angle of the plate. The result is a device that can semi-autonomously create a scaffold consisting of a large number of collagen fibers at defined relative angles.

A TUNABLE CO-CULTURE MODEL FOR INVESTIGATING MICROBE-DRIVEN LUNG IMMUNE RESPONSES

S. Spencer[1], K. Valenzuela[2], B. Leung[1,2]

[1]School of Biomedical Engineering, Dalhousie University; 2. Department of Applied Oral Sciences, Dalhousie University

The lung microbiome exerts a critical influence on the immune landscape of the airway epithelium, modulating immune reactivity, and commensal dynamics. Crosstalk between epithelial surfaces and local immune cell populations plays a central role in determining inflammation, infection susceptibility, and tissue homeostasis. In vitro modeling of these interactions remains a significant challenge due to the limitations of conventional systems in sustaining long-term mammalian–microbial co-cultures and capturing polymicrobial complexity.

To address this, we established a hybrid co-culture platform incorporating human bronchial epithelial (16HBE) and endothelial (HUVEC) cells within a polyethylene glycol/dextran-based aqueous two-phase system (ATPS). This approach allows spatial partitioning of microbial populations into defined microenvironments, enabling extended co-culture durations and more physiologically relevant interactions. Integration of the ATPS into Transwell airway cultures preserved epithelial integrity, as confirmed by FITC-dextran permeability assays, immunostaining of junctional proteins (E-cadherin, ZO-1), and viability metrics.

The platform was tailored for both pathogenic and commensal lung microbes, including Pseudomonas aeruginosa and Streptococcus pneumoniae, supporting mono- and polymicrobial cultures as observed by brightfield microscopy. Downstream functional analyses assessed microbial impact on barrier integrity and epithelial disruption, while cytokine profiling via ELISA revealed differential host responses under varying microbial conditions.

This adaptable and physiologically model system offers a versatile tool for probing host-microbiome interactions in the airway, with potential extensions to include immune and tumor components for applications in infection biology, immunomodulation, and cancer research.

INVESTIGATING SHOE-DEPENDENT CHANGES IN RUNNING BIOMECHANICS IN A NATURAL ENVIRONMENT

B. MacDonald[1], J. Outerleys[2], K. Schutte[3], N. Tam[4], B. Lane[4], S. Civiero[1], A. Dorrance[1], J. Wilson[1]

[1]School of Biomedical Engineering, Dalhousie University; [2]Department of Mechanical and Materials Engineering, Queen's University; [3]Engineering, RunEasi.ai; [4]Sports Science, On Running

Runners seek shoes that optimize performance while preventing injury and maintaining comfort. Biomechanical data such as posture and stride characteristics provide insight into performance and injury mechanisms. However, most biomechanics studies are lab-based, limiting their real-world relevance. Advances in wearable sensors and computer vision enable high-fidelity biomechanical data collection in natural environments. This study examined how two versions of a running shoe with thermoplastic material influenced biomechanics outdoors; secondary outcomes included perceived cushioning, ride, propulsion, stability, and fit. Ten competitive recreational runners completed 6 × 500 m intervals (~15 km/h) on a gravel/dirt loop in Point Pleasant Park wearing the On Cloudmonster V1 (CM1) and V2 (CM2), after a 3 km warmup and control trials in habitual shoes. Sacrum-mounted inertial measurement units (IMUs) measured dynamic stability, impact magnitude, and duration. A 10-camera Theia Markerless system recorded lower limb joint posture near trial endpoints. One-way ANOVA (α=0.05) tested shoe differences; Pearson correlations examined relationships between IMU and posture variables. No significant differences were found between shoes ($P>0.05$). However, hip adduction correlated with impact magnitude ($r=–0.6$, $P=0.03$), ankle dorsiflexion with duration ($r=–0.7$, $P=0.01$), and knee flexion with both magnitude ($r=0.6$, $P=0.04$) and duration ($r=–0.7$, $P=0.005$). This study supports combining IMUs and markerless motion capture outdoors to assess stride impact characteristics, laying groundwork for real-world research to inform footwear design.

School of Biomedical Engineering

Research Day 2025 Abstracts

SCIENTIFIC SESSION 2

CHARACTERIZING PM2.5 AND ITS ROLE IN EARLY LUNG CANCER PATHOGENESIS

I. Mendoza Montealegre[1], J. Salsman[2], G. Dellaire[2] and G. Maksym[1]

[1]School of Biomedical Engineering, Dalhousie University; [2]Pathology, Dalhousie University

Environmental pollutants generated by urban expansion, climate change, and forest fires produce airborne particles that contribute to rising rates of cardiorespiratory disease. Particulate matter smaller than 2.5 microns (PM2.5) can penetrate deep into the lungs and damage the alveolar epithelium (AE). These particles carry a chemical signature specific to their source—such as urban pollution, forest fires, or industrial emissions. However, their physical properties, including size, morphology, and aggregation state, can also cause damage independent of their chemical composition. Characterizing the physical properties of PM2.5 prior to *in vitro* exposure is essential for understanding how particle structure influences deposition, cellular uptake, and biological responses—key processes in the early pathogenesis of lung injury, inflammation, and carcinogenesis.

We are physically characterizing PM2.5 using scanning electron microscopy (SEM), transmission electron microscopy (TEM), and *Morphologi* imaging to assess particle shape, size distribution, and surface features. A549, SAEC, and HBEC cells were then exposed to PM2.5, revealing cell-type-specific differences in particle association and internalization. TEM confirmed intracellular uptake in HBECs, while SEM showed variable clustering patterns across cell types, suggesting that uptake depends on epithelial phenotype and surface structures.

To model airway exposure more accurately, we are developing an air–liquid interface (ALI) system using SAECs and A549s. Preliminary SEM and immunofluorescence imaging confirm epithelial differentiation and tight junction formation. Alamar Blue assays indicated no acute cytotoxicity at 24 hours, underscoring the need to assess functional outcomes such as barrier integrity and inflammatory signaling. By integrating physical particle characterization with *in vitro* modeling, this work aims to clarify how PM2.5 disrupts epithelial homeostasis and contributes to early events in lung carcinogenesis.

TEMPORAL EXPRESSIONS OF MATRIX METALLOPROTEASES ASSOCIATED WITH SUBCUTANEOUS POLYMER IMPLANTATION

K. Medd[1] L. Fong-Hollohan[2], C. Rempe[2], Z. Froom[1], N. Osborne[2], L. Davenport Huyer[3]

[1]School of Biomedical Engineering, Dalhousie University; [2]Department of Microbiology and Immunology, Dalhousie University; [3]Department of Applied Oral Sciences, Dalhousie University

PIMDs illicit an inflammatory reaction called the foreign body response (FBR). Although acutely reparative, dysregulated FBR generates severe fibrosis which encase, contract, and impede implant function. Refined approaches distinguishing the inflection point between pathological and reparative FBR are needed to inform material, drug, and device design to reduce PIMD complications. In FBR, MMPs play critical roles in inflammatory cell proliferation, re-vascularization, and remodelling through differential specificity of extracellular matrix components. Here, we characterize temporal MMP expression associated with clinically relevant polypropylene (PP) and silicone implantation. We provide insight into potential of MMPs as biomarkers of pathological inflammation underlying PIMD complications. Analysis of murine capsular tissue associated with PP and silicone implants from 1-6 weeks post-implantation, indicate significant temporal and material non-specific upregulation of Mmp9 and 12 supporting MMPs as universal biomarkers of chronic FBR inflammation. Unique temporal MMP expression in FBR informs targeted material design and drug delivery methodologies to improve PIMD complications.

IS THE STANDARD CLINICAL MRI PROTOCOL FOR CHOLESTEATOMA WRONG?

R. Weaver[1], C. Bowen[1,2] J. Rioux[1,2], D.P. Morris[1,2], S.D. Beyea[1,2,3]

[1]Dalhousie University; [2]Nova Scotia Health; [3]IWK Health

Introduction: Cholesteatoma is a locally invasive middle ear cyst that can cause hearing loss, balance issues, and chronic infection. Surgery is often curative; however, high recurrence rates have led to planned second-look procedures. Postoperative surveillance using diffusion-weighted MRI (DWI) is emerging as a non-invasive alternative. At clinical field strengths, magnetic susceptibility differences in the ear introduce image distortions, necessitating slow, spin echo-based DWI. Low-field MRI inherently reduces these artifacts, allowing exploration of a broader acquisition parameter space using multishot echo planar DWI (ms-DWI) for protocol optimization.

Methods: Four volunteers with suspected cholesteatoma were scanned under a REB-approved protocol using a 0.5T MRI system. Several ms-DWI variants were tested to evaluate the impact of shot number (artifact resistance), b-values (diffusion weighting), echo times (T2 weighting) on lesion visibility. Apparent diffusion coefficient (ADC) maps were calculated from a baseline ms-DWI scan, and a multi-echo spin echo sequence was used to measure T2 values.

Results and Discussion: Susceptibility artifacts were negligible when using more than four shots. Higher b-values and shorter echo times reduced lesion conspicuity. ADC measurements (~900×10-6 mm2/s) aligned with literature values while T2 measurements (~300ms) agree with reports of T2 shine-through. These preliminary findings undermine the clinical assumption that cholesteatoma is diffusion restricted, suggesting lesion contrast is driven primarily by T2 weighting, although further exploration is needed.

A NOVEL IN VITRO MODEL FOR PERIPHERAL NERVE REGNERATION

M. Thompson[1], J. Frampton[1]

[1]School of Biomedical Engineering, Dalhousie University

One of the greatest challenges in peripheral nerve tissue engineering is to align regenerating nerves with their target. Fibrous scaffolds, typically containing collagen, can be engineered to direct the growth of neurites in an oriented fashion. The production of collagen in its fibrous form is a challenging task that suffers from low throughput production and poor cell infiltration due to small pore size. The Frampton lab has previously demonstrated that contact drawing is an easily scalable technique for production of aligned collagen fiber substrates under ambient conditions without the need for specialized equipment or hazardous solvents. This project aims to utilize contact drawn collagen multifilaments to generate an in vitro model of peripheral nerve regeneration that does not require highly specialized equipment for fabrication. Introduction of various extracellular matrix constituents, both sensory and motor neurons, as well as electrical stimulation, demonstrates that this model can be used to easily and quickly screen possible therapeutic conditions for clinical use.

IDENTIFYING CLINICALLY RELEVANT GAIT KINEMATIC CLUSTERS IN END-STAGE KNEE OSTEOARTHRITIS PATIENTS

O.Falkenham[1], S. Civiero[1,2], M. Dunbar[1,2,3], J. Leighton[1,3], G. Richardson [1,3], D. Wilson[1,2,3], L. Roffe[2], J. Astephen Wilson[1,2]

[1]School of Biomedical Engineering, Dalhousie University; [2]Nova Scotia Health Authority; [3]Department of Surgery, Dalhousie University

Understanding patient variability in gait biomechanics and its relationship to clinical factors is important for personalized treatment options for patients with knee osteoarthritis (OA). This study examined if clusters of patients with end stage knee OA can be defined based on gait kinematic data during the perioperative arthroplasty period using in-clinic markerless motion capture and subsequently, evaluated differences in pre-operative characteristics.

Seven clinically relevant gait metrics based on past research were extracted from captured gait waveforms using principal component analysis, along with average session gait speed. Clusters were established using hierarchical clustering with n=145 patient sessions, evaluated with silhouette score and weighted sum of squares. A k-way ANOVA and Tukey's honest significant difference test were employed to examine inter-cluster differences in gait kinematics, and in anthropometrics, demographics and patient reported outcome measures for single pre-operative datapoints (closest to surgery, n=77).

Clusters (n=3) organized along severity of gait impact with significant sagittal and frontal plane knee angle differences. Post-clustering analysis identified significant differences between clinical responses that were consistent with the severity of gait impact on the kinematic clusters. Continuing to expand the dataset will provide refined clusters, enabling participant evaluation not as static datapoints, but across their perioperative period. Clinical differences in kinematic clusters have implications for use of patient kinematics to inform screening and treatment decisions.

THE OPTIMIZATION OF ULTRASOUND SONICATION FOR CREATING AN ACOUSTICALLY TRANSPARENT SKULL

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Performing preclinical craniectomies in rodents for the purpose of using ultrasound on the brain introduces challenges during recovery. To forgo these problems, a procedure that involves thinning the skull followed by 15 minutes of decalcification with ethylenediaminetetraacetic acid (EDTA) and simultaneous low power ultrasound sonication has been developed and tested in rats. The result is a skull that is acoustically transparent to ultrasound. This research aims to optimize frequency and power output of transducers for future in-vivo sonication recovery procedures. 75% volume fraction PZT5H piezoelectric material of four different frequencies (500kHz, 1MHz, 2MHz, 5MHz) were diced into a 9.5mm diameter circle, placed in custom-designed 3D-printed cases, and connected to 3ft SMA cables. Hydrophone measurements were recorded to determine acoustic pressure outputs. 500kHz, 1MHz, 2MHz and 5MHz PZT5H composite transducers driven at 10V had power outputs of 77mW, 293.5mW, 260mW and 113mW respectively. The 1MHz transducer used in previous in-vivo studies made of Pz39 material outputted only 24mW of acoustic power when driven at 10V. An ex-vivo experiment for determining ultrasound attenuation through decalcified bone was designed, involving submersion of a full-thickness rat skull in EDTA for two hours with continuous sonication, and taking periodic pulse echo recordings of quartz glass through bone. Further ex-vivo attenuation measurements with PZT5H transducers, as well as bone density analysis will be performed to determine the efficacy of each sonication transducer for use in longitudinal in-vivo studies.