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CMBEC44

Virtual Conference

PROGRAM

May 11-13, 2021

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CMBES/SCGB
THE CANADIAN MEDICAL AND BIOLOGICAL ENGINEERING SOCIETY
LA SOCIÉTÉ CANADIENNE DE GÉNIE BIOMÉDICAL

Welcome/Bienvenue

On behalf of the Canadian Medial and Biological Engineering Society, I would like to welcome you to our first ever Virtual Conference.

The committee organizers have worked hard to put forth a great program with 3 streams including: the Academic, Clinical Engineering, and Medical Device Innovation & Development areas. We have 3 great keynote speakers who will enlighten us on their areas of research: Dr. David Juncker, Dr. Phil Edgcumbe, and Dr. Karen Cheung.

I would like to extend my appreciation for the support of our sponsors and virtual booth vendors participating in our first virtual environment. Please visit the virtual booths to see what new medical technology is on the market. Be sure to participate in the Passcode Game as prizes will be provided to the winners.

On the first 2 days of the conference, there will be networking and wellness sessions for you to participate with colleagues in a Zoom environment, so please participate to exchange ideas.

Please enjoy the learning and sharing with colleagues over the next few days in this virtual world. Perhaps we can meet face to face next time?

Au nom de la Société Canadienne du Génie Biomédical, je vous souhaite la bienvenue à notre toute première conférence virtuelle.

Les organisateurs du comité ont travaillé forts pour proposer un excellent programme avec 3 volets, notamment: le domaine académique, le génie clinique et l'innovation et développement de dispositifs médicaux. Nous avons 3 grands conférenciers qui nous informeront sur leurs domaines de recherche: le Dr David Juncker, le Dr Phil Edgcumbe et la Dre Karen Cheung.

Je tiens à exprimer ma gratitude pour le soutien de nos commanditaires et les vendeurs aux kiosques virtuels participant à notre premier environnement virtuel. Veuillez visiter les kiosques virtuels pour voir quelles sont les nouvelles technologies médicales sur le marché. Assurez-vous de participer au jeu de code d'accès car des prix seront remis aux gagnants.

Les 2 premiers jours de la conférence, il y aura des sessions de réseautage et de bien-être pour que vous puissiez participer avec des collègues dans un environnement Zoom, alors on vous invite à participer pour échanger des idées.

Profitez de l'apprentissage et du partage avec vos collègues au cours des prochains jours dans ce monde virtuel. Peut-être pourrons-nous nous retrouver face à face la prochaine fois?

Sincerely,

Martin Poulin, M.Eng., P.Eng.
CMBEC44 Chair

2021 CMBEC44 Virtual Conference

Organizing Committee

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Schedule at a Glance

Found at www.cmbes.ca

TUESDAY, May 11, 2021

07:30-07:45 PDT/10:30-10:45 EDT

Opening Remarks

0745-0800 PDT/1045-1100 EDT

Smiths Medical Remarks and Keynote Introduction

08:00-09:15 PDT/11:00-12:15 EST

Keynote Address: COVID and Nanotechnology

Dr. David Juncker – McGill University

09:15-09:45 PDT/12:15-12:45 EDT

Break – Opportunity to visit the Virtual Booths

09:45-11:15 PDT/12:45-14:15 EDT

A1 Academic – Clinical Engineering

A1.1 A Cybersecurity Vulnerability Management System for Medical Devices

S.D.S. Sappal[1] and P.D.H. Prowse[2]

[1]University of Manitoba, Computer Engineering, Winnipeg, MB, Canada [2]Clinical Engineering, Health Sciences Centre, Winnipeg Regional Health Authority, Winnipeg, MB, Canada

An effective cybersecurity management program relies on consistent and complete patching of cybersecurity vulnerabilities in an expedited manner. We have presented a process to establish a vulnerability tracking, scoring, and reporting system that aligns with pre-existing processes for preventive and corrective maintenance to simplify the workflow for staff. The proposed system introduces a risk-based scoring system to provide management with visibility into the cybersecurity risk

posture of the organization due to the connected medical devices in the environment. Finally, the implementation of a governance structure to make decisions on how to address unresolved vulnerabilities will make healthcare safer for patients.

A1.2 Development of a Cardiac and Respiratory Phantom (CARP) for use in Radiosurgery Dosimetry

D. Ta[1, 2] , A. Chan[1] and S. Thomas[2]

[1] University of British Columbia, School of Biomedical Engineering, Vancouver, Canada [2]BC Cancer – Vancouver Centre, Department of Medical Physics, Vancouver, Canada

Cardiac Radiosurgery is one of the newest modalities for management of ventricular tachyarrhythmia (VT). It precisely targets radiation to the heart using a high-dose single fraction treatment to scar or destroy cardiac tissue that is allowing irregular electrical signals. Patients often have ICDs with leads that have metal components close to the targets for treatment within the heart. These ICD leads are easily distinguished in kilovolt imaging avoiding any need for additional invasive surgery to implant fiducial markers within the patient. Although respiratory motion management techniques are well established in the radiotherapy setting, there are currently no commercially available systems that evaluate the effects of cardiac motion on respiratory tracking. The cardiac and respiratory phantom (CARP) is designed to mimic cardiac-coupled respiratory motion for use in determining the ability of a medical linear accelerator to track an ICD lead as a motion surrogate. The phantom displaces a platform, which can house ICD leads and dosimeters, in the cranio-caudal and medial-lateral directions. The cardiac and respiratory rates and displacements are user controlled through a computer which is coupled to the phantom by an Arduino. The CARP can achieve up to 150 breaths and 250 cardiac beats per minute to within a 1% error, for standard displacements. The total cardiac and respiratory travel ranges achieved are 3.5 and 4cm, respectively. The CARP can successfully be used as a quality assurance tool in the setting of tracked radiosurgery for cardiac targets.

A1.3 Quality Improvement Project: IV Pump Corrective Repairs

Joël Brose[1] , Andrew AM Ibey[1, 2]

[1]Department of Biomedical Engineering, The Ottawa Hospital, Ottawa, Canada [2] Department of Systems and Computer Engineering, Carleton University, Ottawa, Canada

The Ottawa Hospital is a tertiary academic teaching hospital comprised of three campuses and greater than 1,200 care beds. The hospital has more than 1,860 Baxter Sigma Spectrum large volume infusion devices in service. Data analysis of the large fleet revealed approximately 2,100 hours of corrective repair per year at a cost of approximately $200,000 per year in repairs. Corrective repair details also converged upon 3 failure types: AC Adapter, Battery, and Pumping issues. We propose a few quality improvement initiatives focused on the failure types to reduce the number of corrective repairs and provide greater pump reliability and patient safety.

A1.4 Certification Survey of Canadian Biomedical Engineering Professionals

Anthony Chan[1], [2], Kelly Kobe[3]

[1] Biomedical Engineering Technology, British Columbia Institute of Technology, Burnaby, B.C., Canada [2] School of Biomedical Engineering, University of British Columbia, Vancouver, B.C., Canada [3]Clinical Engineering, Alberta Health Services, Foothills Medical Center, Calgary, Alberta, Canada

This survey obtained statistics in professional registration and certification amongst BME professionals working in the Canadian healthcare sector. It revealed incentives and disincentives in seeking registration and certification. The information will be useful to streamline and improve processes, and hopefully increase the values of BME professional registration and certification.

A1.5 Management of Infusion Pumps in the Lower Mainland of British Columbia

Alice Casagrande Cesconetto, M.Eng., Emily Rose, P.Eng., M.H.Sc., M.P.H.

Lower Mainland Biomedical Engineering, Vancouver, BC, Canada

Infusion pumps are used by clinical staff to deliver medications and fluids intravenously to patients. Each of the 27 hospitals in the Lower Mainland of British Columbia has a fleet of Alaris™ infusion pumps, and these pumps are often shared among the units of each hospital. There are several challenges associated with the management and support of a mobile pump fleet, namely: perceived pump shortages, misplaced pumps across hospitals (i.e. mixing of pump fleets following patient transfers), and difficulties associated with identifying, locating, and tracking specific pump modules due for preventative maintenance. This project sought to discover, document, and critically assess hospital-level processes for pump redistribution across units, return of pumps following patient transfers between hospitals, and local management of preventative maintenance logistics by Biomedical Engineering Technologists. Recommendations are provided to improve each of these processes.

B1 COVID Medical Technology Innovations

Development of the Pantheon Emergency Ventilator

Presented by Corbin Lowe of Ocalink

Corbin Lowe

Corbin is an entrepreneur based in Vancouver BC – Corbin has two successful ventures in food and finance and lent the expertise of rapidly scaling a company to the medical device space.

Ocalink

Ocalink was started by a group of companies looking to help bridge what medical equipment was missing in Canadian hospitals. We determined that likely the best impact we could make was to build

ventilators specifically for the wave of infections that were coming to hospitals across the country. In the end, patient need was quite different from originally determined.

Developing a new Clinically Relevant ICU Ventilator Fast

Presented by John Walmsley of Starfish Medical and Canadian Emergency Ventilators, Inc.

An expert in Product Development innovation and team building, John has over 25 years' experience with device technology companies in UK, US and Canada. He has overseen the design of over 150 products, including up to 30 concurrently.

His early career spanned Research, Development, New Product Introduction and Product Engineering in high reliability optoelectronics for Hewlett Packard, Spectra Diode Labs and JDS Uniphase. As VP of Product Development at StarFish Medical, he built a team of 80 engineering staff, delivering on the most ambitious technical challenges. As COO, he led the broadening and strengthening of the company's capabilities, including establishing eastern-time-zone operations. This culminated in recognition of StarFish as one of the Globe & Mail's Top Growing Companies in Canada. As Executive VP, he is responsible for making and growing the company's strategic relationships. Currently, he has recently been leading the ultra fast design, development, manufacture and delivery of new ICU-level ventilators for the Government of Canada.

A Fellow of the Institute of Physics, He is a frequent industry speaker and university lecturer across North America. He is Chair of the BioMedical Engineering Advisory Board at the University of Victoria, and he sits on review panels for UK Chartered Physicists and Canadian Professional Physicists.

StarFish Medical

StarFish Medical is Canada's largest medical device design, development and contract manufacturing company. We help medtech innovators throughout North America overcome challenging technology obstacles to create breakthrough products that improve health and save lives.

C1 Cross Canada Check up

This session involves a cross country view and update from each provincial region. Presenters will share what's going on in their neck of the woods, with an opportunity to learn and share best practices, efficiencies and innovative projects and ideas.

Presenters:

Province	Name	Job Title

Nova Scotia	Michael Barton	Clinical Engineer for the Nova Scotia Health Central Zone
New Brunswick	Ronald Sturge	Executive Director for Clinical Engineering at Service New Brunswick
Quebec	Philippe Laporte	Manager of Groupe Biomédical Montérégie (GBM) at Montreal, Quebec
Ontario	Andrew Ibey	Acting Corporate Manager for Biomedical Engineering at The Ottawa Hospital
Manitoba	Paul Prowse	Regional Manager for Integrated Systems at Health Sciences Centre in Winnipeg
Alberta	Eldon Berezanski	Director of Clinical Engineering for Alberta Health Services in the Edmonton Zone
British Columbia	Carol Park	Executive Director for Lower Mainland Biomedical Engineering in Vancouver

Eldon Berezanski

Eldon Berezanski, P.Eng., CCE-CA
Elson is the Director of Clinical Engineering for Alberta Health Services, Edmonton Zone. He has worked for 24 years in private healthcare technical /customer service delivery and 12 years in public healthcare. He has a B.Sc. in Electrical Engineering from University of Alberta

Carol Park

Carol is the Executive Director of Lower Mainland Biomedical Engineering, providing biomedical engineering services to the British Columbia lower mainland regional health authorities. She has over 20 years of experience in biomedical engineering, and 9 years of experience leading collaborative change initiatives in primary and community care delivery in BC. Carol has a master's degree in Clinical Engineering from the University of British Columbia and a master's degree in Leadership and Training from Royal Roads University. She is the current Vice-President on the Engineers and Geoscientists BC's Council.

Ronald Sturge

Ron is the Executive Director of Clinical Engineering for the Health Service Division of Service New Brunswick. He has been in Clinical Engineering Management since 2007. Prior to joining civil service in 2007 Ron worked for 10 years as a service engineer with Siemens Canada. Ron is a professional engineer (P. Eng.) with a Bachelor of Engineering (electrical) from Memorial University of Newfoundland and holds a Master of Business Administration (MBA) from UdeM.

Philippe Laporte

Philippe has been the manager of Groupe Biomédical Montérégie (GBM) for more than 10 years. GBM is a self-funded, non-profit service of the Integrated Health and Social Services Center of

CISSS de la Montérégie-Centre (CISSS-MC). GBM's mission consists of providing advice to organizations and establishments in the Quebec health and social services network for all aspects relating to the management and safe use of health technologies.

Philippe Laporte is a biomedical engineer, member of the Quebec Order of Engineers, a registered attorney to the bar of Quebec, and vice-president of the Association of Physicists and Biomedical Engineers of Quebec (APIBQ). He is also PMP-certified and holder of the Certification of Certified Clinical Engineer in Canada (CCE).

11:15-11:45 PDT/14:15-14:45 EDT

Break – Opportunity to visit the Virtual Booths or check in with colleagues

11:45-12:45 PDT/14:45-15:45 EDT

Networking Break Out Session

1 hour duration

Facilitator introduces everyone to the process (5 min)

Participants broken out into breakout rooms of 4-5 people.

Participants expected to:

- Introduce themselves, including where they're from and what is their work focus
- Discuss the quEDTion of the day

Timing:

- 15 min session with 1 min warning towards end.
- 10 min full group discussion with representatives from each breakout group contributing the primary responses from their session.
- 15 min session with 1 min warning towards end.
- 15 min full group discussion and closure
- Two 15 min breakout sessions with different groups.

At end of event, everyone will be encouraged to continue the conversations on the platform under Network Café. The Network Café will have these questions posted so registrants can type comments to a notice board.

Today's Question:

How do you envision Artificial Intelligence to affect your workplace or healthcare in general?

Canada Biomedical Engineering Schools Meeting

Hosted by Dr. Michael Kallos

11:45-12:15 PDT/14:45-15:15 EDT

Wellness Session – Mindfulness Meditation with Kate Mak

12:15-12:45 PDT/15:15-15:45 EDT

Wellness Session – Laughter Yoga with Petra Friedrichson, M.Ed

12:45-13:00 PDT/15:45-16:00 EDT

Break – Chat with you colleagues online

13:00-14:30 PDT/16:00-17:30 EDT

A2 Academic - Medical Devices and Related Technologies

A2.1 Development of a new generation of neurovascular device for the treatment of cerebral bifurcation aneurysms

Mehdi Jahandardoost[1] , Donald Ricci[2] and Dana Grecov[1]

[1]Biological Multiphysics Research Lab, Department of Mechanical Engineering, University of British Columbia, Vancouver, Canada [2] Evasc Medical System Inc., Vancouver Canada

Cerebral (brain) aneurysm (CA), is an abnormal dilation of the cerebral arterial wall, which accounts for more than half a million deaths each year worldwide. It is well recognized that hemodynamic factors play an important role in aneurysm development and propagation. Flow diverters (FDs) represent one method recently developed in treating CAs . Evasc Medical System Inc., whose area of expertise is developing novel CA therapies, has recently introduced a novel FD (eCLIPs) for the percutaneous treatment of bifurcation cerebral aneurysms. Unlike other devices for such treatment, eCLIPs is implanted at the daughter arteries and does not impede the flow in the main or daughter arteries. Prior studies in the literature clearly indicate the advantages of eCLIPs over conventional FDs, such as Pipeline (Medtronic product), in disrupting the flow at the aneurysm neck. In spite of its advantages over other

FDs in the market, there are some shortcomings pertaining to eCLIPs design, including blood flow leakage through the gap between the device and parent artery where there is a fusiform-like pathology. In partnership with Evasc, we have developed a new design for eCLIPs for particular aneurysms that have fusiform like properties involving the confluence of the main and daughter branches.

A2.2 Flow meter, PEEP valve development and performance testing for use in a volume controlled emergency use ventilator (EUV-SK1)

J.R. Boire[1] , B. Roberts[1] , T. Calow[1] , M. Johnston[1] and J.B. Montgomery[2]

[1] One Health Medical Technologies Inc., RMD Group of Companies, Saskatoon, Canada [2] Western College of Veterinary Medicine and Division of Biomedical Engineering, University of Saskatchewan, Saskatoon, Canada

In March 2020 Health Canada (HC) released its “Interim order respecting the importation and sale of medical devices for use in relation to COVID-19”[1]. This led to the development, testing and HC approval of an emergency use ventilator (EUV-SK1) by a Saskatoon-based engineering and manufacturing company (RMD Engineering), with support from members of the Saskatchewan Health Authority (SHA) and subject matter experts from several colleges at the University of Saskatchewan (USask). The EUV-SK1 was designed as a volume-controlled ventilator, using medical air and oxygen. The main considerations for the design were minimizing the number of moving parts, keeping the majority of manufacturing inhouse and using readily available materials. These were important risk mitigation strategies amidst disruptions to the global supply chain and business closures during lockdown. At the start of the project, it became rapidly apparent that two of the critical components, the flow meter and the PEEP (positive end expiratory pressure) valve would have to be developed and built inhouse. The current industry standard for flow measurement in ventilators are mass flow meters, however, they were not available at the time, and all PEEP devices were of a proprietary nature, and again, unobtainable. Boyles law and the Venturi effect were leaned on, and differential pressure across an inhouse design of a variable rate mechanical orifice was used to overcome precision flow challenges. The PEEP, being the most critical component, required development of a proportionally controlled solenoid on top of a balanced check valve, both developed and produced inhouse during the pandemic. Performance testing was completed using a commercial test lung (active servo lung, ASL 5000TM, Ingmar Medical). Testing was performed using the settings provided by Table 201.104 in ISO 80601-2-80 [2]. The EUV-SK 1 was further subjected to extensive inhouse and third-party testing for reliability and safety.

A2.3 Conceptual Design and Simulation of a Smart Posture Corrective Orthosis for Kyphotic Patients

F.S. AlGadhib , R.M. AlQahtani , R.M. AlBej , W.M. AlOtaibi , E.A. AlFakih, and I.S. Ateeq

Biomedical Engineering Department, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

This project aims to design an innovative smart posture corrective orthosis that monitors, mitigates, and corrects the kyphotic spine. Kyphosis is a spine deformity of an abnormal excessive outward curve of the thoracic and sacral regions due to congenital disabilities, Scheuermann's disease, poor posture, or spine malformation overtime. Some moderate kyphosis cases continue to get more severe without being monitored continuously, causing back pain, spine stiffness, and muscle atrophy. The proposed system uses inertial measurement units for posture monitoring along with a designed electrical stimulation unit that is all embedded in a semirigid spinal orthosis. The results of the system simulation on LabVIEW software and NI Multisim software are presented in this paper. This system attains the need for accurate continuous telemonitoring and prevents deformity progression via a threepoint pressure design that embeds electrical stimulators (ES) for muscle weakness and pain management.

A2.4 Fabricating a Dielectric Coating for an Improved Electrokinetic Micropump

S. Cenaiko[1], [2], T. Lijnse3 and C. Dalton[3],[4]

[1] Chemical and Petroleum Engineering Department, University of Calgary, Calgary, Canada [2] Centre for Bioengineering Research and Education, University of Calgary, Calgary, Canada [3] Biomedical Engineering Graduate Program, University of Calgary, Calgary, Canada [4] Electrical and Computer Engineering Department, University of Calgary, Calgary, Canada

This research proposes a method of fabricating a dielectric coating over the microelectrodes of an alternating current electrothermal (ACET) device to create a barrier between the biofluid and microelectrodes, eliminating the risk of electrolysis and creating a more effective device. Strontium titanate (STO) is proposed as a potential dielectric material for ACET devices, as it has a high dielectric constant compared to other materials, allowing for a higher device flow rate. This work examines various parameters used for the radio-frequency sputtering (rf-sputtering) of STO, and how these parameters affect the deposited film properties and the microelectrodes being coated. It was found during initial experimentation that the rf-sputtering technique used to deposit STO thin-films tends to etch away at the electrodes due to high energy oxygen ions. Literature is scarce on the topic but provides some guidance on modifications to the initial sputtering parameters. Through additional experiments, the following observations were made: a high oxygen injection (~30%) is required to ensure the STO film is nonconductive, sputtering the slides at 90° significantly reduces etching, a lower RF power reduces etching (but has not been found to eliminate it) and decreasing the bias power appears to reduce both etching and deposition rates. This work shows that a dielectric coating could be deposited over ACET electrodes with further work to optimize the parameters.

A2.5 The VascuLens - A Handsfree Projector-Based Augmented Reality System for Surgical Guidance During DIEP Flap Harvest

Sebastian Gonzalez[1] , Michael J. Stein[2] , Robert Rohling[1], [3] , Philip Edgcumbe[4]

[1] Electrical and Computer Engineering, University of British Columbia, Vancouver, Canada [2]Department of Plastic Surgery, Lenox Hill Hospital, New York, United States of America [3] Department of Mechanical

Engineering, University of British Columbia, Vancouver, Canada [4]Department of Radiology, University of British Columbia, Vancouver, Canada

Augmented reality technologies are increasingly being used to provide enhanced surgical navigation for surgeons. The goal of such augmented reality technology is to improve both the safety and efficiency of operations. The VascuLens, a novel handsfree and focus free projector-based augmented reality system, is presented in this paper. The proposed application for the VascuLens is for improving visualization of the vascular anatomy during deep inferior epigastric perforator (DIEP) flap breast reconstruction. The DIEP flap is a fasciocutaneous flap that is harvested based on perforating vessels 1-2mm in size and then connected under the microscope to the internal mammary vessels in the chest to create a new breast mound after mastectomy. The ultimate goal of this work is that the VascuLens system will take preoperative CT scan data, register the preoperative data to the patient on the operating room table, and project the segmented DIEP arteries directly onto the patient. The novel aspects of the system include: 1) a handsfree projector, 2) a simple preoperative to intraoperative image registration technique that does not require a fiducial marker or camera, 3) and intraoperative surgeon-in-the-loop surgical guidance. This paper describes the proof-of-concept Vasculens workflow and reports the Vasculens accuracy. The accuracy is reported as a function of registration technique, patient body type, projector height and projector angle. Using the ideal registration technique, projector height and projector angle, the mean absolute point reprojection error is 1.7mm, making it a good candidate for DIEP flap breast reconstruction surgery.

B2 Local Biomedical Device Company Showcase

SteriTrak - Medical Device Concept to Commercial Launch

Presented by Michael Cancilla from Arbutus Medical

Arbutus Medical

In 2014, co-founders of Arbutus Medical and surgeons from the Uganda Sustainable Trauma Orthopaedic Program came together to solve a crisis. In many countries, frequent car accident injuries drive high demand for orthopedic surgery, but specialized drills are expensive and unavailable, forcing doctors to use slow, imprecise, manual drills that often result in lasting disabilities. Arbutus Medical designed a simple, yet long-lasting solution: a waterproof, sterilizable cover that allows a non-sterile, powered drill to safely perform surgical bone drilling. After partnering with known brands such as DeWalt, the company designed a line of surgical devices that are FDA-registered, and Health Canada licensed. By providing simple products with fewer and rugged features at the lowest cost of ownership, Arbutus Medical aims to reduce the cost of healthcare around the world and enable its vision of safe surgery for all.

Guidestar Medical

Presented by Dr. Michael Dolphin - GuideStar Medical

Mike Dolphin earned a Masters degree and PhD from Stanford University in Aeronautical and Astronautical Engineering. He completed his Honours Bachelor of Science degree at the University of Western Ontario in Astronomy and Geophysics. Dr. Dolphin has a diverse background including work in precision engineering and manufacturing, rocket design, satellite component engineering, geophysics and computer software production. He has managed engineering teams on spaceflight projects and teams for software development. For the past six years, he has led the design and manufacture of medical devices. GuideStar Medical Devices is his first startup as CEO.

C2 Bedside Medical Device Interoperability Implementation - Lessons Learned

Presented by Rob Hollis and Dr. Charles Lo

Rob will provide a general introduction and background of device interoperability (also known as bedside medical device interface, or BMDI) efforts at multiple health authorities in BC. His discussion will provide general architecture options, typical resource requirements, and some lessons learned from his experiences at several hospitals, including planning and site/device readiness and sustainment and ongoing operations support planning. Dr. Lo will reflect on the clinical impact that BMDI has enabled for patient care and the value of involving clinical stakeholders in the process of planning and evaluating solutions.

Rob Hollis

Rob has been a project manager for several bedside medical device interface projects in British Columbia. He initially worked at Vancouver Island Health Authority's implementation of the Cerner iBus and integration of vital signs and patient monitors at the Royal Jubilee Hospital. That was followed by a broader implementation at Nanaimo Regional General Hospital of vital signs monitors, patient monitors, anesthesia machines and an endoscopy imaging project. Currently Rob is working as a project manager for BMDI implementations at the CST initiative for the BC Provincial Health Services Authority, Vancouver Coastal Health Authority, and Providence Healthcare. Rob has an MBA (Fin) from Dalhousie University and a BA (Econ) from Acadia University and lives in Victoria BC with his wife and two children.

Dr Charles Lo

Dr. Charles Lo is a Consultant Anesthesiologist and the Associate Chief Medical Information Officer at Providence Health Care in Vancouver, BC. He serves as co-Physician Lead for Clinical and Health Informatics. He also holds an appointment of Clinical Associate Professor at the University of British Columbia.

14:30+ PDT/17:30+ EDT

Time to visit those Virtual Booths and learn about the latest medical technology advances.

WEDNESDAY, May 12, 2021

07:30-07:45 PDT/10:30-10:45 EDT

Announcements – CCE Overview by Dr. Marie-Ange Janvier

0745-0800 PDT/1045-1100 EDT

Masimo Remarks and Keynote Introduction

08:00-09:15 PDT/11:00-12:15 EDT

Keynote Address: Exponential Technology and Crowdsourcing Meets COVID 19

Dr. Philip Edgcumbe – University of BC

09:15-09:45 PDT/12:15-12:45 EDT

Break – Opportunity to visit the Virtual Booths or chat with colleagues on the platform

09:45-11:15 PDT/12:45-14:15 EDT

A3 Academic - Computational and Numerical Modeling

A3.1 A New Venting Valve for Anti-colic Nursing Bottles

Meitham Amereh[1] , Sina Kheiri[2] , Keekyoung Kim[2] , Ri Li[2] and Mohsen Akbari[1]

[1] Laboratory for Innovations in Micro Engineering (LiME), Department of Mechanical Engineering, University of Victoria, Victoria, Canada [2]School of Engineering, University of British Columbia, Kelowna, BC, V1V1V7, Canada

Conventional nursing bottles are completely sealed except for the small hole on the teat. Without appropriate venting, the interior partial vacuum can increase the incidence of otitis and gastrointestinal

disorders in infants. This study presents the design, modeling and fabrication process of new venting system for the nursing bottle. Finite element (FE) and fluidstructural interaction (FSI) analyses were carried out to show the transient response of both fluid flow and flexible structure of the valve to the pressure difference. In addition, experimental system was established for testing and analyzing the performance of different valves.

A3.2 Cellular Simulation of Startle-induced Early Afterdepolarizations in Long QT Syndrome 2

J.A. Reimer[1] , K.R. Green[2] and R.J. Spiteri[2]

[1] University of Saskatchewan, Division of Biomedical Engineering, Saskatoon, Canada [2] University of Saskatchewan, Department of Computer Science, Saskatoon, Canada

Computational cardiac models are an emerging technology that can offer unique insight into the field of medicine. However, much progress remains to be made before they can be used in standard clinical practice. One significant challenge is in representing an individual's particular disease presentation with standardized models. It is necessary to overcome this challenge in order for cardiac models to be practically beneficial to patients in a healthcare setting. In this study, we modify a computational cardiac model to observe the electrophysiological characteristics of a specific cardiac condition: long QT syndrome 2 (LQT2). We simulate the baseline cellular effects of LQT2 as well as the startle response that often triggers life-threatening arrhythmias in patients displaying this condition. Finally, a potential line of therapy for LQT2 is simulated, and significant changes in the cardiac cell action potentials are observed. The approach used demonstrates not only the feasibility of parametrizing cardiac models for disease states but also the benefit that cardiac models can offer to the current healthcare paradigm

A3.3 Stochastic Finite Element Modelling of Human Middle Ear

Arash Ebrahimian, Nima Maftoon

Department of Systems Design Engineering, University of Waterloo, Waterloo, Canada

Modelling the mechanics of the middle ear is important as it can extend our knowledge about the hearing process and enable us to develop new devices for the treatment and diagnosis of hearing disabilities. Most of the works in the literature of the modelling of middle-ear mechanics are focused on deterministic models. These models cannot consider the variability of input parameters that can happen due to the stochastic nature of the mechanical properties of tissues and variability between individuals. Stochastic models can consider the variability in the parameters and make us able to have more realistic representations of the physiology. In this work, we present a stochastic Finite Element Method (FEM) model of the human middle ear. We considered uncertainty in all mechanical properties and some geometrical properties of the middle-ear model and studied the effects of these uncertainties on the uncertainties of the outputs of the model.

A3.4 A Validated Cohesive Finite Element Analysis of Needle Insertion into Human Skin

H. Mohammadi and N. Maftoon

Department of Systems Design Engineering, University of Waterloo, Waterloo, Canada

Medical needles play important roles in many diagnostic and therapeutic applications and the development of novel surgical technologies depends on obtaining a better quantitative description of needle-tissue interactions. To develop such technologies involving needles, the investigation of the needle insertion process and the related parameters are key. This paper provides a two-dimensional finite element model of needle insertion into the human skin, validated against available experimental results in the literature. The crack propagation in the tissue was modelled via the cohesive zone method. To this end, a curve-fitting approach based on the reaction force applied to the needle during the insertion was exploited to optimize cohesive parameters. The simulations showed that failure traction of 2 MPa, initial stiffness of 4000 MPa/mm, and separation length of 1.6 mm can lead to a reliable model that can reproduce the experimental results. Also, the effect of needle diameter on the insertion force was investigated.

A3.5 Flash cupping and its effect on soft tissue elasticity

N. Jacobson, M. Driscoll

McGill University, Mechanical Engineering, Montreal, Canada

Cupping therapy is a growing treatment option for myofascial pain for its suggested ability to elongate and increase elasticity of biological tissue. However, the effect of suction on deeper tissues' elasticity has not been well documented. As such, elasticity was derived using a novel device that employs a flash cupping technique to move deeper fascia. Fourteen participants were recruited and tested with the device 5 cm subxiphoid on the abdomen and posterior calf muscle, given the relatively flat and wide geometries of each. Of results at the abdomen, 88% indicated immediate (within 30 seconds) increase in elasticity. At the calf, 64% of results indicated immediate increase in elasticity. In the short-term (1-3 minutes), stiffening occurred in 64% of results at the abdomen. Given results, it is of interest to consider the long-term effects of dry cupping on soft tissue elasticity to determine potential mechanical benefits of localized suction. The presented evidence of dynamic changes in elasticity may lend insight into the causes and treatment effects of myofascial pain.

B3 Case Study: How to launch a New Medical Device Company

Commercializing bioinks for 3D printing humanized tissues

Presented by Dr. Stephanie Willerth

Dr. Stephanie Willerth, Axolotl

Dr. Willerth, a Full Professor in Biomedical Engineering, holds a Canada Research Chair in Biomedical Engineering at the University of Victoria where she has dual appointments in the Department of Mechanical Engineering and the Division of Medical Sciences. She also holds an appointment with the School of Biomedical Engineering at the University of British Columbia. She serves as the Acting Director

of the Centre for Biomedical Research and the Biomedical Engineering undergraduate program at the University of Victoria. She is an active member of the steering committee of the B.C. Regenerative Medicine Initiative and the Stem Cell Network. She also serves as a staff scientist at Creative Destruction Lab. She also was the President of the Canadian Biomaterials Society– serving a three-year term as President-Elect then President and Past President from 2017-2019. She recently founded the start-up company - Axolotl Biosciences.

C3 Health Canada - Mandatory Reporting Updates

Presented by Peggy Seely , Ann McAlduff, and Rebecca Bose of Health Canada

Regulatory Nuances of Custom-Made Devices: The presentation will focus on the regulations surrounding the Special Access program and the requirements for custom made device applications as well as the emerging trend to align with the International Medical Device Regulators Forum (IMDRF). We will explore devices that are custom made, customized, patient matched and the trigger for the need to apply for authorization.

Mandatory Reporting Update: You can help prevent future problems from occurring by reporting your concerns about the safety, effectiveness or performance of a medical device to Health Canada through your hospital mandatory reporting process. In this presentation, you will learn more about the impact that hospital mandatory reporting requirement have had since coming into force in December 2019.

Interim Order Update: In response to the urgent need for health products during the COVID-19 pandemic, the Minister of Health signed an Interim Order to expedite the review and authorization of COVID-19 medical devices in March of 2020. Interim Order No. 2 was introduced on March 1, 2021 in order to allow for the continued authorization and sale of these medical devices. Health Canada plans to maintain the flexibilities and regulatory oversight provided by Interim Order No. 2 until at least fall 2021. Following that, Health Canada will introduce measures to support the transition of COVID-19 medical devices to regulation under the Medical Devices Regulations.

Peggy Seely - Regulatory Nuances of Custom-Made Devices:

Graduated with a BSc in Biotechnology and began working in Immuno flow cytometry with the National Centre for HIV/AIDS, Health Canada. Our laboratory worked with Manufacturers and Product Engineers, testing various robotic systems for sample processing as well as software algorithms for automated diagnostics. We were the centre for National and International Quality Assurance programs, working to ensure consistent, accurate HIV testing and reporting. I moved to the National Reference HIV Laboratory in molecular diagnostics with the Public Health Agency of Canada before arriving in the Medical Devices Directorate (MDD), Health Canada. I have worked in many capacities in MDD from the Licensing division to the Special Access Program of which I am currently the Supervisor. I have provided many lectures to University Biomedical Engineering students, as well as hospitals and manufacturer interest groups. I am very pleased to be able to share information on our Special Access Program and hope you will benefit from this presentation.

Ann McAlduff - Mandatory Reporting Update

Ann McAlduff works with Health Canada's Regulatory Operations and Enforcement Branch as a Senior Regulatory Advisor in Halifax, Nova Scotia. Ann provides policy direction and support to the Medical Device Compliance Program on medical device reporting requirements. In this capacity, she promotes voluntary and mandatory medical device incident reporting through compliance promotion, policy and program development. Ann earned her Bachelor of Science at St. Francis Xavier University and her Masters in Engineering at Carleton University.

Rebecca Bose - IO Update

Rebecca has worked for Health Canada for over 15 years, 13 of those as part of the Health Products and Food Branch. She has worked in the areas of pharmaceutical drugs, medical devices and post-market surveillance. She holds degrees in political science from both the University of Ottawa and the University of Toronto.

11:10-12:50 PDT/14:10-15:50 EDT

Canada Biomedical Engineering Technology Schools Meeting

Hosted by Dr. Anthony Chan

11:15-11:45 PDT/14:15-14:45 EDT

Break – Opportunity to visit the Virtual Booths or check in with colleagues

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11:45-12:45 PDT/14:45-15:45 EDT

Networking Break Out Session

1 hour duration

Facilitator introduces everyone to the process (5 min)

Participants broken out into breakout rooms of 4-5 people.

Participants expected to:

- Introduce themselves, including where they're from and what is their work focus
- Discuss the question of the day

Timing:

- 15 min session with 1 min warning towards end.

- 10 min full group discussion with representatives from each breakout group contributing the primary responses from their session.
- 15 min session with 1 min warning towards end.
- 15 min full group discussion and closure
- Two 15 min breakout sessions with different groups.

At end of event, everyone will be encouraged to continue the conversations on the platform under Network Café. The Network Café will have these questions posted so registrants can type comments to a notice board.

Today's Question:

What does digital health mean to you and how do you think it will impact healthcare?

11:45-12:15 PDT/14:45-15:15 EDT

Wellness Session – Mindfulness Meditation with Kate Mak

12:15-12:45 PDT/15:15-15:45 EDT

Wellness Session – Virtual Fitness Workout with Philip Ndugga (Personal Trainer)

12:45-13:00 PDT/15:45-16:00 EDT

Break – Chat with you colleagues online

13:00-14:30 PDT/16:00-17:30 EDT

A4 Academic - Machine Learning and Statistical Methods

A4.1 Developing a Machine Learning Model for Automated Scoring on the Cube in Cognitive Assessments: A Pilot Study

L. Shpeller[1] , C. Cadonic[2] , S. Phrakonkham[2] , P. Nasiopoulos[3] and Z. Moussavi[2]

[1] University of British Columbia, School of Biomedical Engineering, Vancouver, Canada [2] University of Manitoba, Department of Electrical and Computer Engineering, Winnipeg, Canada [3] University of British Columbia, Department of Electrical and Computer Engineering, Vancouver, Canada

Psychological assessments are often used to help assess cognitive impairments. Inconsistencies in marking these assessments in general, and in cube drawing tests in particular, can lead to misdiagnoses and irregularity in accurate monitoring of the cognitive status; that can be crucial especially in multi-site studies. As a pilot study, a machine learning model using a convolutional neural network was developed to classify drawn cube shapes as ”correct” or ”incorrect” automatically. Techniques such as K-fold cross validation, image augmentation, and early stopping were used to optimize the model using training data. A model with a final validation accuracy of 85.7% was developed as a proof of concept; suggestions for further improvement are presented in this paper. This model will eventually help to ensure similar scoring across different sites when patients are assessed by different assessors.

A4.2 Human Mental State Monitoring in the Wild: Are We Better Off with Deeper Neural Networks or Improved Input Features?

Arthur Pimentel [1] , Abhishek Tiwari[1] , Shrikanth Narayanan[2] and Tiago H. Falk[1]

[1] INRS-EMT, Université du Québec, Montréal, Québec, Canada [2] University of Southern California, Los Angeles, USA

Advances in wearable devices have allowed for the collection of multimodal biomedical data from hundreds of subjects in everyday environments (i.e., in the wild). This has enabled the development of real-time monitoring of various human mental states, such as stress and anxiety, in highly ecological settings. Within a hospital setting, for example, this allows for prediction of burnout within medical staff, as well as anxiety within the patient population, thus improving their quality-of-life. Long-term monitoring via wearables has allowed for large amounts of data to be collected – so-called big data – and thus has opened doors for new applications relying on data-heavy deep learning algorithms. One question that remains unanswered, however, concerns the benefits of blindly applying deep learning algorithms with the collected data versus spending some time and resources on feature engineering prior to machine learning. Feature engineering relies on domain knowledge to extract relevant parameters from the collected signals. In this paper, we aim to answer this question. In particular, we use a dataset collected from 200 hospital workers over a period of 10 weeks during their work shifts. We compare the advantages of using data directly from the wearable devices and applying them to deep learning algorithms versus carefully-crafted features applied to conventional machine learning algorithms. Experimental results are reported for stress and anxiety measurement from heart and breathing rate signals.

A4.3 Enhancing the performance of machine learning models developed for neurodiagnostic testing of children with Auditory Processing Disorder

Hasitha Wimalarathna[1, 2] , Sangamnatha Ankmal-Veranna[2] , Chris Allan[2, 5] , Sumit K. Agrawal[1, 2, 3,4,6] , Prudence Allen[2, 5] , Jagath Samarabandu[1] and Hanif M. Ladak[1, 2, 3,4,6]

[1] Department of Electrical and Computer Engineering; [2]National Centre for Audiology; [3]Department of Medical Biophysics; [4]Department of Otolaryngology-Head and Neck Surgery; [5]School of Communication Sciences & Disorders, [6]School of Biomedical Engineering, Western University, London, ON, Canada

APD is a disorder with limited availability of clinical data needed to train ML models. Here, the use of active learning (AL) was found to be a suitable approach to improve the accuracy of a supervised learning model while requiring a smaller number of clinical datasets.

A4.4 Age-related differences in foot structure and mobility

N. Marcial[1, 2], U. Kuruganti[2] and V. Chester[2]

[1] University of New Brunswick/ Mechanical Engineering, Fredericton, Canada [2]Andrew and Marjorie McCain Human Performance Laboratory/ University of New Brunswick, Fredericton, Canada

Previous research has suggested that changes in foot anthropometrics occur with age, however, further research is warranted. The use of portable technology, such as of threedimensional (3D) body scanners, to collect foot anthropometrics facilitates the exploration of potential differences between and within individuals. Therefore, the purpose of this study was to examine age-related differences in foot anthropometrics using a 3D foot scanner. Sixteen young (8 males, 8 females, mean age 23.6$\pm$3.7 years) and sixteen older (8 males, 8 females, mean age 71.6$\pm$5.9 years) adults without foot deformities or lower-extremity injuries were recruited. Eight anthropometric measures of each foot were obtained during weight bearing (WB) and nonweight bearing (NWB) conditions using a portable, white light, 3D scanner (TechMed 3D Inc., QC). Measures included dorsal arch height (DAH), foot length (FL), truncated foot length (TFL), forefoot width (FFW), midfoot width (MFW), rearfoot width (RFW), arch height ratio (AHR) and foot mobility magnitude (FMM). Significant differences in foot measures between age groups were analyzed using an independent samples t-test. A secondary comparison between age groups was also evaluated using an analysis of covariance (ANCOVA) with TFL as a covariate. The older group had greater arch height ratio (AHR) during weight bearing (WB) and non-weight bearing (NWB), as well as greater dorsal arch height (DAH) in the NWB condition, suggesting that the older group had a higher arch. Further, the older group had significantly greater rearfoot width (RFW) during WB than the younger group, indicating a greater splay of the metatarsus in the older group. After controlling for the TFL, the older group also showed a greater DAH in the NWB condition. In addition, the forefoot width (FFW), RFW and midfoot width (MFW) in the NWB condition were also significantly greater for the older adults. Furthermore, for the WB condition, the older group had significantly greater DAH and RFW. Additionally, the older group showed less mobility of the foot. Preliminary results based on the sample size of the study provide evidence of anthropometric foot variations between younger and older adults. Examining differences in foot structure and mobility between younger and older adults is fundamental for comprehending foot mechanics and function during movements, such as gait.

A4.5 Sensor-based 9-week Serial Balance Data Show Need for Individualized Baseline Profiles: Implications on Concussion Diagnosis

D. Al-Mfarej[1] , D. Gonzalez[2] and J. Tung[1]

[1] Department of Mechanical and Mechatronics Engineering, University of Waterloo, Waterloo, Canada
[2]School of Health and Human Performance, Dalhousie University, Halifax, Canada

Objective: The ability to accurately identify concussions and assess recovery is essential to protect individuals from experiencing negative consequences regarding premature return-to-play. To date, there is no “gold” standard of concussion diagnosis nor method to track recovery. Instead, clinicians rely on symptom checklists and neuropsychiatric tests to inform clinical decisions. Balance is one of several commonly assessed motor capabilities to screen for concussion, including sensor based assessments of balance using normative data as baseline to track changes. However, the timing and frequency of balance measurements to screen for impairment and monitor recovery remains underexamined. This study examines the utility of a rapid (5-min) sensor-based balance measurement on a habitual (i.e., pre/post-practice) schedule to screen for concussions. The primary objective of the study is to determine the factors that affect baseline sway measures. Factors considered include individual differences, assessment timing (pre/post activity), balance condition, and longitudinal changes. Additionally, this study examines whether normative data gathered from a large sample of healthy controls are reflective of individual balance profiles. Design: A pilot study using a repeated observation design. Methods: Five varsity hockey players (3 males, 2 females) were recruited for a 9-week study. Each athlete was tested prior to and after practice using an IMU, performing a modified Balance Error Scoring System (BESS) test. Results: Sampled data used to estimate individual beta distributions indicates significant individual differences in balance behaviour across a range of metrics. Additionally, preliminary results show that normative values drawn from a large cross-sectional sample are not reflective of individual balance profiles drawn from our longitudinal sample. Conclusions: This study supports the need for individualized baseline profiles for balance in order to achieve higher accuracy and sensitivity in concussion detection. Serial, habitual testing is recommended to enable concussion detection from objective measures with higher accuracy and sensitivity during sideline assessments.

B4 How Can You Succeed in Commercialization? Lessons in Medical Device Development

Medical Devices - Hard Lessons from the Market

Presented by Geof Auchinleck, Co-founder and CEO of Claris Healthcare Inc.

Geof Auchinleck

Geof has 35 years of experience with medical device start-ups. He has worked on surgical robotics, joint implants, minimally invasive surgery, lab automation and blood transfusion management. Most recently he co-founded Claris Healthcare to develop a platform for the delivery of care into the home – including social isolation prevention, remote patient monitoring and coaching for recovery from surgery. Geof is active in the Vancouver community through Creative Destruction Labs, the Medical Device Development Centre and the boards of several medical device companies.

Avoiding the Traps in Medical Device Development

Presented by John Walmsley of Starfish Medical and Canadian Emergency Ventilators, Inc.

John Walmsley

An expert in Product Development innovation and team building, John has over 25 years' experience with device technology companies in UK, US and Canada. He has overseen the design of over 150 products, including up to 30 concurrently.

His early career spanned Research, Development, New Product Introduction and Product Engineering in high reliability optoelectronics for Hewlett Packard, Spectra Diode Labs and JDS Uniphase. As VP of Product Development at StarFish Medical, he built a team of 80 engineering staff, delivering on the most ambitious technical challenges. As COO, he led the broadening and strengthening of the company's capabilities, including establishing eastern-time-zone operations. This culminated in recognition of StarFish as one of the Globe & Mail's Top Growing Companies in Canada. As Executive VP, he is responsible for making and growing the company's strategic relationships. Currently, he has recently been leading the ultra fast design, development, manufacture and delivery of new ICU-level ventilators for the Government of Canada.

A Fellow of the Institute of Physics, He is a frequent industry speaker and university lecturer across North America. He is Chair of the BioMedical Engineering Advisory Board at the University of Victoria, and he sits on review panels for UK Chartered Physicists and Canadian Professional Physicists.

StarFish Medical

StarFish Medical is Canada's largest medical device design, development and contract manufacturing company. We help medtech innovators throughout North America overcome challenging technology obstacles to create breakthrough products that improve health and save lives

C4 Principles and Practices for Medical Device Cybersecurity

Presented by Emil-Peter Sosnowski, Juuso Leinonen, and Marc Lamoureux

Healthcare providers across Canada are increasing the connectivity of medical devices to networks resulting in increased exposure to cyber-attacks. This session will focus on the opportunity for cybersecurity stakeholders to enhance their principles and practices for medical device cybersecurity. ECRI will review hazards associated with vulnerable systems and why they matter, as well as cybersecurity industry trends. Lower Mainland Biomedical Engineering will share their learnings from a recent cybersecurity audit with a focus on clinical engineering's role for cybersecurity management and opportunities for healthcare providers to strengthen their cyber defenses. Lastly, Health Canada will review their initiatives to strengthen the regulatory environment surrounding medical device cybersecurity. You will leave this session with increased confidence that your organization can capitalize on today's opportunity to improve medical device cyber-defenses.

Emil-Peter Sosnowski

Emil-Peter Sosnowski is a biomedical engineer with Lower Mainland Biomedical Engineering in Vancouver BC, where he leads medical device incident investigations, quality improvement initiatives, and risk management-related activities. Emil completed his undergraduate and master's degrees at the University of Manitoba, in Winnipeg MB, where he focused his research on additive manufacturing of medical devices. More recently, Emil has been involved in several CMMS improvement projects, and has been leading the lower mainland's response to a recent cybersecurity audit performed by the BC Auditor General.

Juuso Leinonen

Juuso Leinonen is a senior project engineer at the Device Evaluation group at ECRI, where he performs comparative medical device evaluations and investigates medical device related accidents. Juuso is a part of the ECRI medical device security team and has been involved with various ECRI medical device security research and publication efforts. Juuso has presented ECRI's perspectives on medical device cybersecurity at international, national, and local conferences including HIMSS, AAMI. Juuso was the principal investigator for the ECRI top 10 Health Technology Hazard - Ransomware and Other Cybersecurity Threats to Healthcare Delivery Can Endanger Patients. Juuso has over 7 years of experience in biomedical engineering and he holds a bachelor's degree in biomedical engineering from City University London, United Kingdom.

Marc Lamoureux

Marc obtained his B.Sc. in Biophysics from the University of Guelph and his M.Sc. in Medical Physics from Carleton University. Before joining Health Canada, Marc spent two years as a Medical Health Physicist with The Ottawa Hospital where he worked closely with federal and provincial regulatory bodies to improve the quality and safety of diagnostic and therapeutic radiation programs.

Since 2011, Marc has worked in medical devices at Health Canada specializing in the technical assessment of medical software, diagnostic imaging devices, and radiotherapy equipment. He is vice-chair of Canada's IEC Subcommittees for Diagnostic Imaging and Radiotherapy and he co-chairs the International Medical Device Regulators Forum (IMDRF) Cybersecurity Working Group with the US FDA. He is currently the lead for Health Canada's Building Better Access to Digital Health Technologies initiative and is the manager of the Digital Health Division at Health Canada.

14:30+ PDT /17:30+ EDT

Time to visit those Virtual Booths and learn about the latEDT medical technology advances.

THURSDAY, May 13, 2021

07:30-07:45 PDT/10:30-10:45 EDT

Announcements

0745-0800 PDT/1045-1100 EDT

Bomimed Remarks and Keynote Introduction

08:00-09:15 PDT/11:00-12:15 EDT

Keynote Address: Inkjet-based high throughput single cell dispensing

Dr. Karen Cheung – University of BC

09:15-09:45 PDT/12:15-12:45 EDT

Break – Opportunity to visit the Virtual Booths or chat with colleagues on the platform

09:45-11:15 PDT/12:45-14:15 EDT

A5 Academic - Images, Signals and Sensors

A5.1 Wearable technologies for assessing the effects of nature on physiological states

Dannie Fu[1] , Hubert Mansion[2] , Emilie Tamko Mansion[2] and Stefanie Blain-Moraes[1]

[1] Biosignal Interaction and Personhood Technology Lab, McGill University, Montreal, Quebec, Canada
[2]L'Universite Dans la Nature, Quebec, Canada

Forest bathing (FB) has been shown to have quantifiable positive effects on human physical and mental health, but few studies have employed non-invasive wearable technologies to monitor autonomic nervous system signals. This study investigated the impacts of a 90-minute Nature Break activity on the physiological response of 10 individuals and the psychological response of 38 (age=43.55± 11.61 years) individuals. Autonomic nervous system response was assessed through continuous measurement of electrodermal activity (EDA), fingertip temperature, and blood volume pulse (BVP) using a wearable fingertip sensor. Psychological distress was assessed using the Profile of Mood States (POMS). Our

results showed a decrease in the negative dimensions of POMS and an increase in the positive (vigor) dimension following Nature Break. Moderate evidence for a difference pre-forest and post-forest was found for the mean of the standard deviation of EDA slopes (BF10 = 4.462). Significant differences across segments was found for the mean of the standard deviation of EDA slopes ($p<0.05$) mean of the median skin temperatures ($p<0.001$), and average HR ($p<0.001$), but not for the average HRV features or the slopes of the HR. Mean HR was found to decrease throughout Nature Break. Future research should further investigate the use of EDA and skin temperature as measures of autonomic nervous system (ANS) activity in order to develop a better understanding of the changes in these signals in the FB context.

A5.2 An Investigation of HDEMG Spatial Parameters in Individuals with Transtibial Amputation

J. Gaudet, A. Pradhan, J. Toner and U. Kuruganti

Andrew and Marjorie McCain Human Performance Laboratory, Faculty of Kinesiology, University of New Brunswick, Fredericton, Canada

Mutlichannel surface electromyography (EMG) or high density surface EMG (HDsEMG) can be used to examine spatial activity of muscle in those with amputation. HDsEMG has not been used extensively to study muscle adapations of those with transtibial amputation and this tool can be particularly valuable to study residual muscle activity after amputation. Torque and HDsEMG were recorded from the rectus femoris muscle during isokinetic knee extensions of varying speed in able-bodied participants (n=2) and those with transtibial amputation (n=2). Spatial distribution was estimated using the RMS value for each of the 64 electrode grid locations and 2- Dimensional (2D) maps were developed for each participant. Peak torque, and HDsEMG spatial features were compared across speed and the clinical participants were compared with an age-matched control participant. The results from this exploratory study showed that HDsEMG spatial parameters can be used to provide insight regarding muscle function, particularly those representative of muscle heterogeneity. This study also showed that HDsEMG can be successfully used with those with lower limb amputation. The information obtained can be used to help improve the design of powered limbs and training protocols.

A5.3 A Pilot Study for Investigating Differences between Alzheimer's Patients with and without Significant Vascular Pathology

Chandan Saha[1] , Chase R. Figley[1, 2], Zeinab Dastgheib[1] , Brian Lithgow[1] and Zahra Moussavi[1]

[1] Biomedical Engineering Program, University of Manitoba, Winnipeg, Canada [2]Department of Radiology, University of Manitoba, Winnipeg, Canada

Distinguishing Alzheimer's disease (AD) from mixed Alzheimer's and vascular dementia (VD) is a challenging task. In this study, we explored the differences between AD patients and a group with a mixed pathology of AD with cerebrovascular disease (CVD) by analyzing the volumes of several brain regions vulnerable to AD and evidenced by white matter hyper-intensities (WMHs). Moreover, we investigated the correlation between brain volumes and the Alzheimer's Disease Assessment Scale-

Cognitive Subscale (ADAS-Cog) scores of the AD and AD-CVD groups. We collected T1-weighted Magnetization Prepared Acquisition with Gradient Echo (MPRAGE) MRI scans from 9 AD participants and 8 AD-CVD participants. Then, we performed the region of interest (ROI) analysis over the MRI data to measure the gray matter (GM) volume of the hippocampus, frontal gyrus, and precuneus as well as the cerebrospinal fluid (CSF) volume of ventricles. Also, we calculated the volume of white matter hyper-intensities (WMHs) of the whole brain and of the frontal-temporal (FT) area. The results did not show any correlation between the baseline ADAS-Cog scores of AD participants and their volumes of above-affected areas and WMHs, while in the AD-CVD group, the CSF volume in ventricles showed a high correlation with ADAS-Cog scores (Spearman's $\rho = 0.714$). We did not observe any statistically significant difference in these volumes between AD patients and AD-CVD group.

A5.4 SonoAssist: Open source acquisition software for ultrasound imaging studies

David Olivier and Catherine Laporte

Department of electrical engineering, École de technologie supérieure, Montreal, Canada

We present "SonoAssist", an open-source acquisition software designed to facilitate the development of point-of-care ultrasound (POCUS) assistance systems by simplifying the data collection process. This software caters to research utilizing ultrasound images along with gaze data or probe movement measurements to tackle tasks like standard scan plane detection, anatomical landmark detection, and ultrasound probe guidance. Through SonoAssist's simple interface, users can easily collect data from the following sensors: an ultrasound probe, an RGBD camera, an eye tracker, a screen recorder, and IMUs (Inertial Measurement Unit). Furthermore, SonoAssist timestamps data as they are acquired with a single time reference, removing the need for additional synchronization steps. To document the software's performance, we characterized the synchronization between the ultrasound image and IMU data streams, the eye tracker accuracy, and the acquisition frequencies (ultrasound probe: 22 Hz, eye tracker: 87 Hz, external IMU: 100 Hz, screen recorder: 13Hz).

A5.5 Stochastic Finite Element Modelling of Human Middle Ear

Arash Ebrahimian, Nima Maftoon

Department of Systems Design Engineering, University of Waterloo, Waterloo, Canada

Modelling the mechanics of the middle ear is important as it can extend our knowledge about the hearing process and enable us to develop new devices for the treatment and diagnosis of hearing disabilities. Most of the works in the literature of the modelling of middle-ear mechanics are focused on deterministic models. These models cannot consider the variability of input parameters that can happen due to the stochastic nature of the mechanical properties of tissues and variability between individuals. Stochastic models can consider the variability in the parameters and make us able to have more realistic representations of the physiology. In this work, we present a stochastic Finite Element Method (FEM) model of the human middle ear. We considered uncertainty in all mechanical properties and some

geometrical properties of the middle-ear model and studied the effects of these uncertainties on the uncertainties of the outputs of the model.

B5 Biomedical Device Innovations

Development and examination of a novel multimodal biosensor for screening and monitoring COVID-19 patients

Presented by Dr. Babak Shadgan of the University of British Columbia

Dr. Babak Shadan

Dr. Babak Shadgan is a MSFHR Scholar, an Assistant Professor in the Department of Orthopaedics at the University of British Columbia (UBC), an Associate faculty member at the UBC School of Biomedical Engineering and a Principal Investigator at the International Collaboration on Repair Discoveries (ICORD), where he is directing the Clinical Biophotonics Laboratory. He is a medical doctor specialized in Sports and Exercise Medicine, graduated from the Queen Mary College of the University of London, with a PhD in Experimental Medicine from UBC. He completed a fellowship on NIRS-Diffused Optical Tomography at Martinos Center for Biomedical Imaging of Harvard University. His post-doctoral fellowship at UBC was focused on remote optical monitoring of muscle dysfunction in people with spinal cord injury. With more than two decades of medical practice and research, Dr. Shadgan has developed a specific knowledge in clinical applications of biosensing technologies with a unique integrated transitional bedside-to-bench and bench-to-bedside approach. Dr. Shadgan is actively working on design and development of novel wearable and implantable biosensors and their applications in health and diseases. Dr. Shadgan is a Fellow member, an instructor, and a conference chair at the International Society for Optics and Photonics (SPIE). He is an advocator of multidisciplinary networking and collaborations between biomedical engineering and clinical scientists for innovative and applied technology development in medicine. As an international level sports physician, leading Medical & Anti-Doping Commission of the International Olympic Styles Wrestling, Dr. Shadgan has been serving elite athletes at world championships and Olympic Games since 2002. He is currently involved in special preparation of 2021 Tokyo Olympic Games under the COVID-19 situation.

The Role of Advanced 3D Printing for Biomedical Devices

Presented by Dr. Woo Soo Kim of Simon Fraser University

Dr. Woo Soo Kim

Dr. Woo Soo Kim began his career at Xerox Corporation after postdoctoral work at MIT. Since he came to the School of Mechatronic Systems Engineering at Simon Fraser University BC Canada in 2010, he had been developing advanced materials for 3D printing, contributing to biomedical wearables and sensing robot systems. His research finds solutions to engineering challenges for health, energy, and technology

sectors. Recently, his research is dedicated to the advanced 3D printing technologies for architectured solids and 3D printed sensing robot applications.

C5 Showcase of Innovative Responses to COVID-19

UHN's Innovative Response to COVID-19

Presented by David Gretzinger, Tabitha Chiu and Gary Bassi

The pandemic brought many new challenges to the management of hospital technology, both real and projected. Being a resourceful group, Clinical Engineers and Biomedical Engineering Professionals used resources, connections and creativity to meet these challenges. Dave will discuss some of these approaches, including the development of a utilization hierarchy for critical care ventilators, which was projected to be in short supply early in the pandemic.

Decontaminating N95 Respirators for Reuse in a Hospital Setting (Sinai Health)

With the COVID-19 global pandemic outbreak, hospitals in Canada and around the world have been forced to consider conservation strategies to ensure continued availability of personal protective equipment (PPE) for healthcare providers. To mitigate against critical PPE shortages, Sinai Health System (Sinai Health), a large academic healthcare institution in Canada has developed and operationalized a Standard Operating Procedure for the collection, decontamination and reuse of N95 respirators and other single-use PPE by means of vaporized hydrogen peroxide decontamination method. We incorporated stringent quality assurance steps to ensure that the N95 respirators are successfully decontaminated without deformation and are safe to use. These included: the use of biological indicators, a device designed onsite to measure elasticity tension of the elastic straps after decontamination and reforming the nose bridge of respirators to original equipment manufacturer specifications. During the development of this process, we followed an interdisciplinary approach, involving various expertise, including Medical Device Reprocessing, Infection Prevention and Control, Support Staff, Human Factors, and lean experts from Toyota Motor Manufacturing Canada Inc.

David Gretzinger

Dave Gretzinger is a Clinical Engineer, who enjoys the challenges of developing an environment of safe and powerful technology to facilitate positive patient outcomes in the hospital. He is Director of Medical Engineering at the University Health Network (Toronto General Hospital, Princess Margaret Cancer Centre, Toronto Western Hospital, Toronto Rehab, Michener Institute), and Sinai Health (Mount Sinai Hospital, Bridgepoint Health), and previously worked at the Health Sciences Centre and the Winnipeg Regional Health Authority.

David is a Professional Engineer and a Certified Clinical Engineer, and holds a Bachelor's Degree in Mechanical Engineering from McMaster University and Master of Health Sciences in Clinical Engineering from the University of Toronto.

Tabitha Chiu

Tabitha is a human factors specialist with a background in biological and clinical engineering. She has been working in hospitals and the healthcare industry for over 7 years. In her current role at Sinai Health System, Toronto, ON, she is involved in the mitigation of clinical and enterprise risks, process design and improvement, device procurement and implementation, and physical space redesign. Tabitha has previously worked with a variety of multi-national medical device companies as a human factors consultant at University Health Network, Toronto, ON.

Garry Bassi

Garry Bassi is the Director of Medical Device Reprocessing and Support Services at Mount Sinai Hospital in Toronto, ON, where he supports daily operations and the planning and redevelopment of the future expansion of the department. In addition to his day-to-day responsibilities, he sits on the CSA Z314-18 Medical Device Reprocessing Standards Technical Committee and is currently the President Elect for the Canadian Association of Medical Device Reprocessing (CAMDR). Garry is the course coordinator and instructor for Seneca college for the Medical Device Reprocessing certification and has held the director of Education Position at the provincial level for the Medical Device Reprocessing Association of Ontario (MDRAO). He has been working in the field of Medical Device Reprocessing since 2013.

BC Ventilator Deployment and Utilization Tracking

Presented by Jane Boal Laura Yong and Jeffin Vekkal

BC is made up of seven (7) Health Organizations, operating independently from one another. In March 2020, the BC Ministry of Health was working towards fully understanding the state of ventilators in the province. Information was being collected and reports were being provided from multiple groups in various formats. As hospitals were learning to cope and treat patients with COVID-19, staff were tasked with reporting the daily numbers to enable local, regional, and provincial planning and monitoring.

That is when a light was shined on the BC Biomed CMMS system. The BC BME CMMS system had already been tracking ventilator inventories across BC as a standardized system for 9 years; but it's primary focus was on maintenance, repair, and capital planning within the Biomed Community.

To meet the clinical need for ventilator tracking, the BC BME CMMS was readapted to track whether a device was part of a Pandemic fleet, where it was deployed, and to eliminate the device in a "usage count" if was out-of-service for repairs. Reports could then be exported to the Provincial Clinical Database being built.

This information was combined with patient data to demonstrate ventilators in use and those available for use. Using PowerBI, the information was turned into an interactive dashboard accessible by over 300 Ministry and Health Authority staff to understand the daily state and needs of all BC hospitals.

During our session, we will take everyone through the process of the Design, Stakeholders, Reporting and the Dashboard experience from beginning to end.

Jane Boal

Jane Boal is the Quality Improvement Leader with the Lower Mainland Biomedical Engineering Department in Vancouver. She supports Engineers and Technologists by bringing a quality improvement lens and group organization strategies to all projects, initiatives and innovations. In her 9 years with the lower mainland Health Authorities, Jane has collaborated on many initiatives in the lower mainland and across the province. Jane has her BBA - Bachelors in Business Admin with a focus in Integrated IT Management Systems.

Laura Yong

Laura Yong is a Database Administrator with Lower Mainland Biomedical Engineering (LMBME) situated in Vancouver, British Columbia. She currently sits as the Provincial Database Administration Chair for B.C.'s Biomedical Engineering Database group, supports Risk Management for the Province, and she's advancing a database improvement project for LMBME. She's been a Biomedical Engineering Technologist since 2003, and has worked in neonatal, pediatric and adult hospital facilities before becoming a Database Administrator in 2018.

Jeffin Vekkal

Jeffin is a business analyst with the Provincial Health Services Authority, out of Vancouver, BC. He's been part of the Data Analytics, Reporting and Evaluation department for 2 years and currently supports Covid-19 Analytics and the BC Mental Health & Substance Use Informatics teams. In the past, Jeffin used analytics to detect and prevent drug diversion with the Fraser Health Authority Pharmacy team. He holds a B. Sc. In Health Science from Simon Fraser University, and graduated with honors. He was the 2016 class convocation speaker.

11:15-11:45 PDT/14:15-14:45 EDT

Break – Opportunity to visit the Virtual Booths or check in with colleagues

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11:45-12:45 PDT/14:45-15:45 EDT

A6 Academic - COVID19 and Related Technologies

A6.1 Integration of Spirometry into a Vital Sign Monitor (VSM) for COVID-19 Inspired Device Innovation and Production

S. Williams, B. Khalafalla , M. Abboud , C. Vanderkwaak, B. Morency, and F. Mussie

St. Clair College/Biomedical Engineering Technology Student, Windsor, Ontario, Canada

Monitoring vital signs are the foundation of beginning to understand what is occurring within the human body, while testing lung function is the basis of understanding pulmonary function and diagnosing

respiratory illnesses or diseases. The research conducted within this study made it possible to integrate spirometry (the testing of lung function) into a Vital Sign Monitor (VSM). The innovation and advancement of the vital sign monitor by incorporating spirometry, aids in having a better overall understanding of the disruption of homeostasis and overall human condition.

A6.2 Antimicrobial Studies of Cannabidiol as Biomaterials against superbug MRSA

K.N. Tahsin[1], D. Watson[2] , A.S.Rizkalla[1, 3], D. Heinrichs [2] and P.A.Charpentier[1, 3]

[1] Biomedical Engineering, Western University, London Ontario, Canada [2] Microbiology & Immunology, Western University, London Ontario, Canada [3] Chemical & Biochemical Engineering, Western University, London Ontario, Canada

Due to its limited treatment options, multi-drug resistant bacteria such as Gram-positive methicillin-resistant Staphylococcus aureus (MRSA) still remains a serious public health threat. The creation of new compelling antimicrobial materials, antibiotics and optional methodologies, which are successful against resistant microbes, is earnestly required. The legalization of cannabis in Canada has provided a new opportunity to investigate the antimicrobial studies of both extracts and individual cannabinoids. This study investigates pure cannabidiol (CBD) isolated from Cannabis sativa by using a methodology of extraction, purification, characterization, and quantification of CBD. The shredded plant material was dissolved in ethanol, with the extract further purified using supercritical fluid chromatography (SFC) to obtain purified CBD. Product purity was confirmed by HPLC and NMR spectroscopy. CBD's antibacterial activity on MRSA strain USA300 bacteria was studied using dilution series in liquid culture and disk diffusion assays to provide the minimum inhibitory concentration (MIC) and minimal bactericidal concentrations (MBC). We have also performed statical analysis between CBD concentration groups with no CBD (control) and found a significant difference in cell counts of these groups. Past papers had not shown any MBC values – we have obtained a novel MBC value for CBD industrially extracted from Canadian grown C. Sativa plants. The results showed that CBD exhibited a significant bactericidal effect on MRSA with the MIC value of 2.5 μg/mL and MBC of 10 μg/mL. CBD powder form gave a higher antimicrobial activity than its oil form in terms of the inhibition zone. This study shows that CBD exhibits good antimicrobial impact against the MRSA strain showing its utility for enabling a new antibiotic-free method for treating MRSA infections.

A6.3 A Made-in-Saskatchewan ventilator designed and built to support Canada's COVID 19 pandemic response

J.R. Boire[1] and J.B. Montgomery[2]

[1] One Health Medical Technologies Inc., RMD Group of Companies, Saskatoon, Canada [2] Western College of Veterinary Medicine and Division of Biomedical Engineering, University of Saskatchewan, Saskatoon, Canada I.

In March 2020 Health Canada (HC) released its "Interim order respecting the importation and sale of medical devices for use in relation to COVID-19"[1]. This led to the development, testing and HC

approval of an emergency use ventilator (EUV-SK1) by a Saskatoon-based engineering and manufacturing company (RMD Engineering), with support from members of the Saskatchewan Health Authority (SHA) and subject matter experts from the University of Saskatchewan.

A6.4 COVID-19 rapid diagnostic test for instrumentation-free virus detection in saliva

A. Parandakh[1, 2], W, Jogia[1, 2], J. Renaultand[1, 2], A. Sohrabi[1, 2], Z. Jin[1, 2], A. Ng[1, 2] and D. Juncker[1, 2, 3]*

[1] Biomedical Engineering Department, McGill University, Montreal, Canada [2]McGill Genome Centre, Montreal, QC, Canada [3] Integrated Program in Neuroscience, McGill University, Montreal, QC, Canada
*Corresponding to: D. Juncker (david.juncker@mcgill.ca) I.

Widespread home point of care (POC) testing for detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) is pivotal to control the coronavirus disease 2019 (COVID-19) [1]. Modeling suggests that accessibility to the test, frequency of testing and sample-to-answer time are of priority over test sensitivity for COVID-19 surveillance [2]. Hence the reverse transcription polymerase chain reaction, as the current gold-standard tool for diagnosis of COVID-19, even with excellent sensitivity and specificity is not well-suited for home POC diagnostics as it is expensive, hard to administer and limited to a peripheral instrument. Here, we aim to develop a user-friendly, instrument-free microfluidic kit for rapid and quantitative diagnosis of COVID-19.

B6 How to fund your new Medical Technology Innovation

This workshop provides biomedical engineering entrepreneurs some insight on how to obtain funding to convert their dream product/prototype into a commercial product.

Presented by:

Trevor Moat - National Research Council (Industrial Research Assistance Program)

Nathan Ayoubi - Rostrum Medical

David Christie - Christie Consulting Services

C6 Approaches to PM Programs (Canada, US, International Perspectives)

Presented by Martin Poulin, Dr. Matt Baretich, and Dr. Bill Gentles

Whatever we call it—preventive maintenance, planned maintenance, scheduled maintenance—we do a lot of it. Interestingly, PM practices vary from country to country. This presentation compares and contrasts PM practices in Canada, the US, and a sampling of other countries.

Martin Poulin

Martin is the Director of Biomedical Engineering for Island Health, Victoria, BC, on the west coast of Canada. He has been working in the Biomedical/Clinical Engineering environment in leadership roles for the past 23+ years. He also worked for 5 years in the medical device development industry in Vancouver in regulatory and quality systems roles. He has a B.A.Sc. and an M.Eng. in Clinical Engineering from the University of BC and is the past president of CMBES/SCGB.

Dr. Matt Baretich

Matthew F. Baretich, P.E., Ph.D., has more than 40 years of experience in clinical engineering. For the past 20 years he has been president of Baretich Engineering (Fort Collins, Colorado), providing consulting services in clinical engineering and forensic engineering. He recently accepted a Director position shared between Vancouver Coastal Health Quality and Patient Safety and Lower Mainland Biomedical Engineering. He's received his Canadian P.Eng designation and is learning to think in the metric system. He is the founder, past-president, and Fellow of ACCE.

Dr. Bill Gentles

Bill Gentles is vice president of BT Medical Technology Consulting. He is the former Director of Biomedical Engineering at Sunnybrook Health Sciences Centre in Toronto Canada. He served in that position from 1972 - 2001. He is the current President of the Clinical Engineering Society of Ontario, a past president of the Canadian Medical and Biological Engineering Society (CMBES) and is a member of the American College of Clinical Engineering. He has lectured in Taiwan, China, Malaysia, Cuba, Chile, Ecuador, Nicaragua, Kosovo, Ghana and Mongolia. He received his PhD in Biomedical Engineering from the University of Toronto in 1974. He is a Registered Professional Engineer, and a Certified Clinical Engineer.

12:45-13:00 PDT/15:45-16:00 EDT

Time to visit those Virtual Booths and learn about the latest medical technology advances.

13:00-14:30 PDT/16:00-17:30 EDT

Closing Remarks and Awards Ceremony