# College of Engineering Biomedical Research Day
# Oral Presentation Abstracts

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| Abstract Title: | **The Effects of Extracellular Cholesterol Elevations and Membrane Fluidity Changes on the Fluid Shear Stress Control of Mac1-Dependent Neutrophil Adhesion** |
| Author(s): | M.L. Akenhead, Department of Biomedical Engineering, U of Kentucky<br>D.L. Rateri, Saha Cardiovascular Research Center, U of Kentucky<br>A. Daugherty, Saha Cardiovascular Research Center, U of Kentucky<br>H.Y. Shin, Department of Biomedical Engineering, U of Kentucky |

**Abstract:** Chronic leukocyte activation and adhesion in the microcirculation is associated with microvascular dysfunction due to pathological blood cholesterol elevations. Previously, we demonstrated that cholesterol-related changes in membrane fluidity impair neutrophil mechanosensitivity to fluid shear stresses (FSSes). But it remains to be seen how dysregulated shear sensitivity manifests as microvascular dysfunction. Recently, we showed that FSS regulates surface expression of Mac1 (CD11b/CD18) adhesion integrins, as they are cleaved by flow-induced cathepsin B (ctsB) release. Since Mac1 cleavage restricts neutrophil adhesion, we tested the hypothesis that elevated cholesterol may contribute toward dysregulated neutrophil adhesion by impairing FSS-induced cleavage of Mac1 through membrane fluidity changes. We exposed cholesterol-enriched neutrophils to 5 dyn/cm2 laminar shear stress for 10 minutes using cone-plate viscometry. Flow cytometric analyses indicated that treatment of neutrophils with >2 µg/mL cholesterol blocked Mac1 cleavage and ctsB release, but membrane fluidizers (e.g., 1 – 2 mM benzyl alcohol (BnOH) or 7 – 8 mM ethanol) recovered these responses. We also used parallel-plate flow chambers to quantify neutrophil adhesion by measuring flow-induced detachment from platelet monolayers. Cholesterol-enriched neutrophils remained adherent under flow, but detached when treated with membrane fluidizers, suggesting impaired Mac1 cleavage enhances neutrophil adhesion. Lastly, by feeding low density lipoprotein receptor-deficient (LDLR-/-) mice a high fat diet for 6 – 8 weeks, we observed sheared hypercholesterolemic neutrophils were unable to cleave Mac1 integrins, further supporting our cleavage data. Combined, these results provide evidence that elevated membrane cholesterol impairs the FSS-induced Mac1 cleavage response that may play a role in dysregulated neutrophil adhesion during hypercholesterolemia.

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# College of Engineering Biomedical Research Day
# Oral Presentation Abstracts

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| Abstract Title: | **Design and Fabrication of a Novel Microfluidic Platform For 3D Cell Culture Using Engineered Superhydrophobicity** |
| Author(s): | S. Torabi, Department of Mechanical Engineering, U of Kentucky<br>L. Li, Department of Pharmacology and Nutritional Sciences, U of Kentucky<br>R. Xu, Department of Pharmacology and Nutritional Sciences, U of Kentucky<br>C. Trinkle, Department of Mechanical Engineering, U of Kentucky |

**Abstract:** In the fields of cell biology and medicine, there is a need for biologically relevant in vitro cell culture models that not only capture the three-dimensional, dynamic microenvironment of living tissue, but also provide capability for biochemical and morphological analysis during cell culture. To address this need, a novel microfluidic device was designed that incorporates 3D cell culture with biomimetic microvasculature. This device provides cells with a mechanical and biologically relevant microenvironment, but unlike animal models, the cells are observable during the entire growth process. The device was fabricated such that an array of polydimethylsiloxane (PDMS) microchannels mimics the in vivo vasculature and also provides a superhydrophobic surface to retain cell-embedded collagen on top. In this manner, the cells were maintained in a 3D collagen microenvironment while being continuously fed by cell culture medium flow through the microchannels. In order to design such multifunctional microchannels, the surface wettability analysis was performed analytically and followed by experimental validation. MDA-231 breast cancer cells were successfully cultured in the device to illustrate cell viability and the collagen was then retrieved for further histological and biochemical analysis.

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# College of Engineering Biomedical Research Day
# Oral Presentation Abstracts

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| Abstract Title: | **MEBook: Multimedia Social Greetings Intervention for Children with Autism Spectrum Disorders** |
| Author(s): | N. Uzuegbunam, Department of Electrical and Computer Engineering, U of Kentucky<br>W.H Wong, Educational, School, and Counseling Psychology Department, U of Kentucky<br>S.C. Cheung, Department of Electrical and Computer Engineering, U of Kentucky<br>L. Ruble, Educational, School, and Counseling Psychology Department, U of Kentucky |

**Abstract:** Autism spectrum disorder (ASD) is a chronic developmental disorder that impairs the development of social and communication skills. Video self-modeling (VSM), an evidence-based ASD intervention in which one learns by watching oneself on video performing a target behavior, has been shown effective in mitigating some of the effects due to ASD. VSM content is difficult to create as target behaviors are sporadic. In this paper, we propose the MEBook system which uses a Kinect sensor to inject self-images into a social narrative game to teach children with ASD proper greeting behaviors. MEBook consists of two components. The first component is a social narrative, an animated story about the main character meeting and greeting different cartoon characters in a particular setting. Self-modeling is achieved by first replacing the main character's face with an image of the learner, and animating the learner's body and voice to match the narration. The second component is a positive reinforcement game in which the subject is prompted to greet different cartoon characters. Through depth-based body posture tracking, proper greeting behaviors are recognized and immediately reinforced with praise and visual confetti. Novel computational multimedia tools are proposed to turn video recordings of successful attempts into VSM content, thereby alleviating the tedious production process. A multiple-baseline single-subject study has been conducted and the preliminary results show that MEBook is effective in teaching greeting behaviors to children with ASD.

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# College of Engineering Biomedical Research Day
# Oral Presentation Abstracts

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| Abstract Title: | **Closed-Loop Afferent Nerve Stimulation for Rehabilitation of Hand Grip in Motor Incomplete Spinal Cord Injured Subjects** |
| Author(s): | C.J. Schildt, Department of Biomedical Engineering, U of Kentucky<br>S.H. Thomas, Department of Biomedical Engineering, U of Kentucky<br>E.S. Powell, Department of Physical Medicine and Rehabilitation, U of Kentucky<br>L. Sawaki, Department of Physical Medicine and Rehabilitation, U of Kentucky<br>S. Sunderam, Department of Biomedical Engineering, U of Kentucky |

**Abstract:** Efficacy of motor rehabilitation depends heavily on frequency and intensity of practice. Afferent electrical stimulation is commonly used to augment rehabilitation through use-dependent plasticity. Generally, peripheral nerve stimulation (PNS) is applied in open-loop for a couple hours prior to motor exercise; afferent nerves are electrically stimulated, regardless of subjects' intent to move, to prime corticospinal tracts for motor training. Transcranial magnetic stimulation (TMS) paired with PNS has been experimentally shown to have a timing-dependent effect on motor evoked potential (MEP) amplitude, suggesting that PNS applied only in response to attempted movement will further augment motor rehabilitation. We present early results from a clinical trial in which an EEG brain-machine interface (BMI) was used to apply closed-loop (CL) PNS to subjects in response to motor intent detected from sensorimotor cortex in a cue-driven hand grip task. Subject recruitment and data collection are ongoing. However, initial results from the first two subjects to complete intervention consisting of 12 consecutive sessions of CL-PNS suggested improved hand grip strength, increased task-related modulation of the EEG in one hand of both subjects, and increased TMS-measured motor map volume in one subject.

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# College of Engineering Biomedical Research Day
# Oral Presentation Abstracts

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| Abstract Title: | **Timing Aspect of the Lumbopelvic Rhythm in Forward Bending and Backward Return** |
| Author(s): | M. Vazirian, Department of Biomedical Engineering, U of Kentucky<br>I. Shojaei, Department of Biomedical Engineering, U of Kentucky<br>B. Bazrgari, Department of Biomedical Engineering, U of Kentucky |

**Abstract:** The lumbopelvic rhythm in forward bending and backward return is studied to identify differences in the trunk kinematics of patients and healthy individuals, as well as to study the effects of various task conditions on such kinematics, using a measure related either to the timing or magnitude of lumbar and pelvic motions. In this study, the timing aspect of lumbopelvic rhythm, represented by the mean absolute relative phase (MARP), is compared among different age groups. Sixty participants in five equal-sized and gender-balanced age groups between 20 and 70 years old were asked to complete six repetitions of forward bending and backward return once with a self-selected pace, and another time “as fast as possible”. Two magnetic-inertial motion trackers placed on the pelvis and thorax recorded the rotation data of these segments, which were later used to create continuous relative phase curves using the method suggested by Lamb and Stöckl, 2014. After that, the suggested method by Stergiou et al., 2001 was used to obtain the MARP of each participant under each task condition (i.e., fast or slow, and bending or return). A mixed ANOVA revealed that the older versus younger age groups had a significantly smaller mean MARP, while there was no significant difference between genders. It is concluded that the older versus younger individuals demonstrated a more in-phase lumbopelvic rhythm which could be due to either their stiffer lumbar spine, or a neuromuscular strategy adopted to protect the lumbar spine.

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