2023 Missouri S&T, NextGen, OBI Symposium & Poster Session

April 28th, 2023

Havener Center

St. Pat's Ballroom

9:00 AM – 4:00 PM

Track 1: Ballroom B

Translational Medicine

Track 2: Ballroom A

Biomedical Informatics

Missouri S&T University of Science & Technology

MU | NEXTGEN PRECISION HEALTH

2023 Missouri S&T, NextGen and OBI Symposium Program

April 28th, 2023
9:00 – 9:15 Coffee and Pastries
9:15 – 9:30 Welcome and Opening
Dr. W. David Arnold and Vice Chancellor, Dr. Kamal Khayat

Track 1 – Translational Medicine - St. Pat's Ballroom B

9:30 – 9:45	Dr. Manashi Nath	Developing Multifunctional Biosensors
9:45 – 10:00	Dr. Amitai Zuckerman	TBI Preclinical Studies
10:00 – 10:15	Dr. Yue-Wern Huang	Aerosol Health: Bioaerosols and Electronic Cigarettes
10:15 – 10:30	**Break**	
10:30 – 10:45	Dr. Kris Kelly	Differential Impact on Motor Unit characteristics Across Severities of Adult Spinal Muscular Atrophy
10:45 – 11:00	Dr. Mark Towler	A Proprietary Glass-Based Hemostat for Trauma

11:00 – 12:30
Lunch and Networking

12:30 – 12:45	Dr. Julie Semon	Adult Stem Cells: Differentiating Between the Good and the Bad
12:45 – 1:00	Dr. Anthony Convertine	PolyDrug Therapeutics for the Treatment of Cancer and Infectious Disease
1:00 – 1:15	Vidit Singh (PhD student)	Lipid Based Nanoparticle Delivery System for Pulmonary Route of Administration
1:15 – 1:30	**Break**	
1:30 – 1:45	Dr. Risheng Wang	The Applications of DNA Nanostructures for Drug Delivery and Biosensing
1:45 – 2:00	Dr. Carmen Cristea	Motor Cortex MR Spectroscopy in Neurological Conditions Affecting Hand Function
2:00 – 2:15	Dr. Fateme (Sha) Fayyazbakhsh	Effect of Bioactive Glass on Water Release Profile and Functionality of 3D-Printed Hydrogel Dressings for Burn Wound Treatment

2:00 – 3:45 Poster Session

3:45 – 4:00 Closing Remarks

MISSOURI S&T

Dr. Manashi Nath received her PhD from the Indian Institute of Science in Bangalore, India. Following her graduation she joined Colorado State University, Fort Collins, CO as a postdoc in Prof. Bruce Parkinson's lab. She joined Missouri University of Science & Technology in 2008 as an Assistant professor.

Manashi Nath is currently an Associate Professor at the Missouri University of Science & Technology at Rolla, MO. Research in the Nath group focuses on innovative materials chemistry with the current emphasis being on designing efficient electrocatalysts for various electrochemical energy conversion technologies including solar water splitting, carbon dioxide reduction, biomass conversion, and biosensors. Dr. Nath has received the research excellence award from Missouri S&T in addition to several excellence in teaching awards. Some of the publications from the group, specifically from water splitting project has received high citations, naming Dr. Nath among the top 5% of the highly cited research in Royal Society of Chemistry. Dr. Nath's research has been funded through NSF, and ACS PRF.

Designing Smart Materials for Non-enzymatic Multifunctional Biosensors

Manashi Nath, Harish Singh, Justin Chern, Kazuma Taira, Sophie Keene

Department of Chemistry

Missouri University of Science and Technology

Diabetes and neurodegenerative diseases have continued to be one of the major causes of death affecting millions of people globally. One of the major treatment modules for these diseases is to keep progression of the disease under check by monitoring the respective biomarkers for each. While glucose (Glu) has been a well-recognized biomarker for diabetes, neurochemicals such as dopamine (DA) has been recognized as effective biomarker related to several neurodegenerative diseases such as post-traumatic stress disorder (PTSD), Parkinson's and chronic depression. However, the common detection method for these biomarkers involves high-end instrumentation in pathological laboratory with a long wait time. The need for continuous monitoring devices and point-of-care (POC) detection for these biomolecules has become very apparent owing to the rapid spread of these among the global population. This talk will focus on the elucidating a proper understanding of the structure-property correlation of transition metal chalcogenides and employing concepts of materials chemistry and physics to design optimal nanostructured electrocatalysts towards biomolecule detection enhancing their applicability as biosensors for detecting potentially life-threatening disorders. During the last several years, the Nath group has successfully identified several electrocatalysts for glucose and dopamine sensing. These include copper selenides and tellurides, nickel telluride, cobalt telluride and carbon nanotube encapsulated nickel selenide. Some of these sensors were observed to be multifunctional sensors active for multiple analyte detection (e.g. dopamine and glucose) in the same platform. All of these sensors showed high sensitivity (~19 – 40 $mAcm^{-2}/mM$) with low limit of detection surpassing conventional enzyme-based sensors. More importantly, the Nath group has developed dopamine sensors that can quantitatively detect dopamine with high sensitivity through tear analysis. Direct electrochemical detection has several advantages including rapid sampling rates, possibility of developing a flexible wearable sensor, high biocompatibility and provides opportunity for POC testing that has the potential to improve management of infectious diseases, especially in resource-limited settings where health care infrastructure is weak, and access to quality and timely medical care is a challenge.

Dr. Amitai Zuckerman completed his Ph.D. studies at Ben Gurion University in the lab of Prof. Hagit Cohen. In his Ph.D., he developed an animal model to study blast wave-induced mild traumatic brain injury (mTBI) and post-traumatic stress disorder (PTSD). Following his Ph.D., he joined Dr. Victoria Johnson's lab at the University of Pennsylvania, as a postdoctoral fellow, where he studied the changes in the distribution of axonal-pathology in the brain, following TBI. In 2021, he joined the lab of Prof. Zezong Gu at the University of Missouri's School of Medicine, where his postdoctoral research seeks to identify potential biomarkers and therapeutic targets for Blast-induced Chronic Traumatic Brain Injury. In his studies, he combines behavioral, histological, and molecular methods. In addition to academic research, he worked for more than ten years at two contract research organizations (CRO's) - Envigo CRS (Israel) and Pharmaseed, specializing in pre-clinical models for the biomedical and pharmaceutical industry. His extensive experience in both academic and industrial studies, gives him a thorough understanding of the field of animal-based modeling. In addition to his studies on brain pathologies, he is also interested in improving the quality and promoting the use of translational animal models.

A Preclinical Model of Blast-Induced Mild Traumatic Brain Injuries – Abnormalities From Behavior to Ultrastructure

Amitai Zuckerman[1,2], Shanyan Chen[1,2], Heather Siedhoff[1,2], Pei Liu[3], Hailong Song[1], Landry M. Konan[1], DeAna Grant[4], Catherine E. Johnson[5], C. Michael Greenlief[3], Graham K. Hubler[1,6], Ibolja Cernak[7], Ralph G. DePalma[8], Jiankun Cui[1,2], Zezong Gu[1,2]

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Exposure to primary low-intensity blast (LIB) commonly causes mild traumatic brain injury (mTBI) in service members and veterans. While moderate to high-intensity blast-injury results in macroscopic and microscopic neuropathology, neuroimaging often detects no abnormalities following exposure to LIB, which led to the phrase "invisible injuries." Yet previous studies showed that exposure to LIB may increase the risk for neurodegenerative pathologies and dementia. To investigate the effect of exposure to LIB, we developed the "Missouri Blast model", an open-field blast (OFB) model. Young-adult male mice were detonated with a single blast exposure from 350 g of high-energy explosive C4 in an open field environment. The mice were in prone position 3 to 7 meters from the C4, facing the blast wave. Following the blast, the mice were subjected to a battery of neurobehavioral tests, and the brains were collected 7 days / 1 month / 3 months post-expose. While these mice's appearance showed no signs of injury under light microscopy, the use of a battery of behavioral tests revealed blast-induced alteration in the mice's neurological status, anxiety-like responses, spatial learning, and memory. Silver staining revealed axonal degeneration, more damage in the frontal brain. Transmission electron microscopy imaging revealed blast-induced neuropathology at the ultrastructural level including myelin sheath defects, mitochondrial abnormalities, and alteration in the synaptic number and structure. Moreover, quantitative proteomics analyses revealed differentially expressed proteins post-exposure. In conclusion, the "invisibility" of OFB-induced mTBI, requires using sensitive examination tools to reveal those pathologies and study the mechanisms.

KEYWORDS: low-intensity blast; preclinical model of mTBI; axonal damage; mitochondria; synapse; dementia.

MISSOURI S&T

Dr. Yue-Wern Huang received his PhD degree from the University of Wisconsin-Madison and joined Missouri S&T in 2000. He is Associate Dean for Research and External Relations of the College of Arts, Sciences, and Education. He is also interim Director of the Missouri S&T Center for Biomedical Research. His current research focuses on drug delivery, tissue regeneration, evolution and behaviors of indoor pathogens, and electronic cigarette toxicity. His research has been supported by eleven funding agencies including NSF, NIH, EPA, DOD. He was a plenary speaker in two conferences. He is on the editorial boards for Current Gene Therapy and MDPI Cells. He serves as an ad hoc member of the United States Environmental Protection Agency's Toxic Substance Control Act Science Advisory Committee on Chemicals.

Dr. Yang Wang's research focuses on the gas-phase aerosol synthesis, the health effects of engineered nanoparticles, and aerosol instrumentation. He is a member of the Center of Aerosol Science and Technology (CAST) jointly created with faculty from Engineering, Rosenstiel School of Marine and Atmospheric Science (RSMAS), and the Miller School of Medicine. Yang obtained his Ph.D. degree from Washington University in St. Louis in 2017 and B.S. degree from Tsinghua University in 2012. Between 2017 and 2019, he was a postdoctoral research associate at Brookhaven National Laboratory. From 2019 to 2022, he was an Assistant Professor in the Department of Civil, Architectural and Environmental Engineering at Missouri University of Science and Technology.

Aerosol Health: Bioaerosols and Electronic Cigarettes

Yue-Wern Huang[1] and Yang Wang[2]

[1]Department of Biological Sciences, Missouri University of Science and Technology, Rolla, MO 65409;[2]Department of Chemical, Environmental, and Materials Engineering, Miami, FL33146

Aerosols and bioaerosols (i.e., microbe-containing aerosols) are of importance in inhalation toxicity. I will present two different research topics but both of them are within the realm of aerosol/bioaerosol characterization and health impact First, during the pandemic, we investigated behavior and evolution of microbe-containing aerosols in various indoor environments. Our aim is to decipher how environmental factors such as humidity and temperature influencing distribution and survivability; the knowledge gained can help device better ventilation systems. The second study pertains to electronic cigarette consumption. With the advent of Electronic Nicotine Delivery Systems (ENDS) such as e-cigarettes, e-hookahs, and vape pens and common positive perceptions regarding their use, we are at risk of reversing years of efforts regarding tobacco control and instead advancing towards a new addiction with unknown long-term health hazards. Based upon the 2021 National Youth Tobacco Survey, 320,000 of middle school students and 1.72 million high school students reported e-cigarette use. As of July 1, 2019, 32 U.S. states still allow or partially allow the usage of ENDS in smoke-free places, including many indoor environments where non-smokers may passively inhale the secondhand ENDS aerosols. I will present a device created to reproduce secondhand smokes without using human subjects. This new device allows us to study the effects of secondhand smokes.

Keywords: aerosol; microbe-containing aerosols; electronic cigarette; inhalation toxicity

Dr. Kristina M. Kelly is an Assistant Research Professor in the Department of Physical Medicine and Rehabilitation at the University of Missouri. She is clinically trained as a neurologic physical therapist with a focus on adults with rare neuromuscular disorders. Within this patient population, her research interests include understanding the relationships between disease pathophysiology and motor function, uncovering the modes and mechanisms of effective physical therapy intervention, and identifying collaborative approaches to modify the effects of disease chronicity and aging for improved patient health span.

Differential Impact on Motor Unit Characteristics Across Severities of Adult Spinal Muscular Atrophy

Kristina M. Kelly, DPT, MS, EdM[1,2], Jordan Mizell, MPH[3], Ladan Bigdeli, BS[3], Samuel Paul, BS[3], Marco A. Tellez[4], Amy Bartlett, BA[5], Sarah Heintzman, MS[4], Jerold E. Reynolds, PhD[4], Gary Brent Sterling, BSN[4], Kiran F. Rajneesh, MBBS[4], Stephen J. Kolb, MD, PhD[4], Bakri Elsheikh, MBBS[4], W. David Arnold, MD[1,2]

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Spinal muscular atrophy (SMA) is an inherited motoneuronal disorder caused by reduced Survival Motor Neuron protein that results in progressive motor neuron death, loss of motor units (MUs), and muscle weakness. MU enlargement via collateral sprouting is a mechanism that can compensate for motor neuron loss to maintain strength and function. Muscle force production is also influenced by rate coding, the frequency at which MUs fire. While traditional electrical stimulation-evoked electrophysiological measures can identify MU losses and compensatory enlargement in SMA, these techniques are unable to quantify voluntary MU recruitment or firing. In this study, we used decomposition electromyography (dEMG) to examine MU compensations in adults with varying severities of SMA during voluntary MU activation. Ambulatory and non-ambulatory adults with SMA on nusinersen and healthy controls were enrolled. MUs were decomposed from multi-electrode surface recordings during a 30-second maximum contraction of the abductor digiti minimi. Strength, function, and standard electrophysiologic measures were also collected. Group differences and correlations were calculated. There were significant group differences in dEMG MU action potential amplitudes and firing rates. Decomposition EMG parameters of SMA participants showed moderate to strong positive correlation with measures of strength and function whereas standard electrophysiologic measures showed inconsistent associations. MUs of ambulatory adults with SMA display significantly more compensatory behavior compared to healthy control participants and non-ambulatory adults with SMA. Voluntary MU activation captured via dEMG may be a better and more accurate reflection of natural physiologic functioning than traditional evoked electrophysiologic methods, making it a strong biomarker candidate.

Keywords: Decomposition electromyography, spinal muscular atrophy, adults, motor units.

Dr. Mark Towler was appointed Doshi Professor in Missouri University of Science and Technology in 2023. Prior to this, he was Professor (Strategic Hire) in the Department of Mechanical and Industrial Engineering at Toronto Metropolitan University (Canada) with a cross-appointment in neighboring St. Michael's Hospital. He previously held faculty posts in Alfred University (NY) and the University of Limerick (Ireland). He has a PhD (1997) in Biomaterials from Queen Mary College (London, UK).

Towler has generated over $28M funding to sustain active research programs on devices for hard tissue applications, *in-vitro* diagnostics, bioglasses and biofilm inhibition, leading to the publication of 177 papers in the peer reviewed literature. He holds ten patents and is the co-founder of Crescent Operations a private equity funded company which launched a diagnostic for fracture risk, Osentia (www.osentia.co.uk), based on the exclusive licensing of four of those patents.

A Proprietary Glass-Based Hemostat for Trauma

Tantalum-Based Bioglasses for Hemostasis

Hemorrhage is the most common cause of mortality during both surgery and combat. In the conflicts in Iraq and Afghanistan it accounted for almost 50% of fatalities before evacuation. Organic and inorganic hemostats are the current options for hemostasis but have inherent drawbacks. Organic dressings (*eg* cellulose) retard bleeding by providing a matrix for blood cell adhesion, but their acidic nature causes inflammation. Inorganic hemostats (*eg* kaolinite clays) are somewhat effective in arresting hemorrhage; their net negative surface charge activates the contact pathway of coagulation, and their structure facilitates the rapid absorption of water from the blood, but the exothermic setting reaction that they exhibit when interacting with blood causes endothelial injury. Their efficacy also depends on the coagulation function of the host.

Mesoporous bioactive glasses (MBGs) possess ordered channel structures and high specific surface area. They have been shown to react with blood without producing an exotherm but their potential for hemostasis has been retarded by both their pedestrian clotting ability and an absence of antimicrobial activity.

A novel, patented series of tantalum-based mesoporous bioglasses (Ta-MBGs) have been synthesized. They are hemostatic in a wide range of bleeding environments due to their ability to promote clotting by both physical and chemical means. I will discuss the processing and characterization of these novel materials alongside their evaluation in a range of laboratory and living systems. These materials are currently the subject of a pre-submission application to the Food and Drugs Administration (FDA).

MISSOURI S&T

Dr. Julie Semon graduated with a B.S. from Purdue University. She then worked as a relief and development aide in Liberia, for a biotech startup in Minnesota, and as a lab technician in a virology / parasitology lab at Mayo Clinic. She returned to academics and earned an MSPH in infectious disease from Tulane University. She then studied under the tutelage of Dr. Darwin Prockop and earned a PhD in Molecular and Cell Biology, also from Tulane University.

She worked with Dr. Bruce Bunnell as a postdoctoral fellow which furthered her work with adult stem cells. Dr. Semon came to Missouri S&T in 2014 and teaches classes in anatomy, stem cell biology, tissue engineering, and biodesign & innovation. Her lab at S&T still investigates adult stem cells, as well as 3D bioprints human tissues for drug testing and *in vitro* studies. Her husband and three young kids are super fans of S&T students and can be seen often at home games.

Adult Stem Cells: Differentiating Between the Good and the Bad

Mesenchymal stem cells (MSCs) have broad anti-inflammatory and immune-modulatory properties. Despite their promise and use in over 950 clinical trials, pivotal questions remain unanswered. Currently, there are discrepancies in the field if MSCs from patients with autoimmune disease, obesity, or advanced age are as therapeutically effective as MSCs from younger, healthy donors. Our results indicate that MSCs from autoimmune patients display reduced characteristics of stemness and regenerative properties, including decreased proliferation, differentiation, and trafficking abilities. In order to further test our results, we have developed a novel bioink to 3D bioprint human organoids. Our results will: 1) increase understanding of MSC biology, 2) help to identify quality MSCs through patient selection, and 3) shed new light onto the pathology of autoimmune disease.

Dr. Anthony J. Convertine, a scientist and academic, has contributed to polymer science, drug delivery, tissue engineering, and 3D printing. He earned his Ph.D. in Polymer Science and Engineering at the University of Southern Mississippi under Professor Charles L. McCormick and further developed his expertise in polymer science through postdoctoral research at the University of Washington, working with Professors Patrick Stayton and Allan Hoffman. He later joined the university faculty as a research assistant professor, eventually being promoted to research associate professor. At the University of Washington, Dr. Convertine's research focused on innovative drug delivery and tissue engineering technologies, targeting therapies for cancer, infectious diseases, and traumatic brain injuries using advanced polymer systems. In addition to drug delivery, he contributed to the field of 3D printing by developing advanced materials and processes for fabricating complex structures in applications such as tissue engineering, medical devices, and industrial components. After his time at the University of Washington, Dr. Convertine joined Missouri University of Science and Technology's Department of Materials Science and Engineering, as an assistant professor where he has continued his research while engaging in teaching and mentorship. In 2022, he was named a Senior Member of the National Academy of Inventors. Throughout his career, Dr. Convertine has authored 57 peer-reviewed publications and holds numerous patents, reflecting his commitment to advancing knowledge in his fields of expertise.

PolyDrug Platform for Integrated Drug Delivery and Imaging

The PolyDrug platform offers a novel approach to drug delivery, enabling integration of therapeutic agents, solubilizing components, cell-targeting molecules, BBB transporters, and imaging agents into a single polymeric structure through a single polymerization step. PolyDrugs are synthesized via controlled RAFT polymerization technology using polymerizable prodrug monomers (Drugamers), polymerizable peptide macromonomers (Targamers), polymerizable gadolinium chelates (Probamers), and polymerizable solubilizing monomers (Solvamers). The platform can also incorporate polymerizable DOTA residues to bind radioisotopes (Radamers) for nuclear imaging. This talk focuses on the application of the PolyDrug approach in developing therapeutic systems for cancer and infectious disease. The Drugamer technology can be applied to nearly all established chemotherapeutic agents, providing broad applicability. We demonstrate the use of peptide-based Targamers to increase tumor specificity and BBB transport, and the development of gadolinium-based Probamers to equip polyDrugs with a clinically relevant MRI contrast agent, simplifying carrier biodistribution profiling. Our work has already led to the development of chemotherapeutic polyDrugs containing phage-selected peptide sequences that effectively bind to surface receptors overexpressed by ovarian, breast cancers, and glioblastomas. These findings demonstrate the potential of the PolyDrug platform to treat triple-negative breast cancer effectively and establish a foundation for building BBB transport capability and additional cancer targeting functionality.

MISSOURI S&T

Vidit Singh is a 3rd year PhD student in Linda and Bipin Doshi Department of Chemical and Biochemical Engineering. He was born in India. He graduated with an undergraduate degree in Chemical Engineering from National Institute of Technology – Raipur, India (2015) and a Master's degree in Chemical Engineering from the Missouri University of Science and Technology- Rolla, (2019)

Lipid-based Nanoparticle Delivery System for Pulmonary Route of Administration

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Conventional routes of genes and drugs via the bloodstream for lung diseases offer a broad distribution across the body with reduced bioavailability in the alveolar region of the lung itself. A lipid-based nanoparticle delivery system was developed to be delivered via a jet nebulizer for direct pulmonary route of administrator which can be used for drug or gene delivery. The advantages of the pulmonary route of administration are to preserve the pharmacological activity of genes and drugs, ensure delivery to the target site and maintain genes and drugs at therapeutic concentrations long enough to have a desired pharmacological effect. Cationic liposomes made with DOTAP, Egg PC, Cholesterol and DSPE-PEG 2000 (2.9:7:10:0.1) and ionized lipid nanoparticles made with ALC-0315, DSPC, Cholesterol and ALC-0159 (2.9: 12: 5: 0.1) were mixed using Y-shaped microfluidics to make the liposomes. The size, zeta potential and PDI by DLS measurement gave a result of approximately 180 nm, 40 mV and 0.22 PDI for positively charged liposomes, and 190 nm, 4mV and 0.25 for ionizable lipid nanoparticles. The SMPS studies show a reduction in the size of nanoparticles when nebulized with a mean size of 145 nm for positively charged liposomes and 150 nm for ionizable lipid nanoparticles. TEM analysis indicated the spherical morphology of these particles and hence the particles remained intact. The process also helps with higher bioavailability in lungs and lower availability in non-targeted organs. Nebulized liposomes will be compared with IV administration method for comparison in animals. Distributor developed in the lab will be utilized in biodistribution and therapeutic studies in animal models.

Key Words: Cationic and Ionized Lipid Nanoparticles; Nebulization; Gene Delivery; Pulmonary delivery

Dr. Risheng Wang joins Missouri University of Science and Technology as an assistant professor in the Department of Chemistry in the fall of 2014, then promoted to associate professor in 2020. She received her Ph.D. in Chemistry under the supervision of Professor Nadrian C. Seeman from New York University in 2010. She then joined the Department of Chemistry at Columbia University as a postdoctoral research associate, after which she became an associate research scientist at Columbia. Her research focuses on the development of novel techniques to organize functional nanomaterials for optoelectronic and biomedical applications.

The Applications of DNA Nanostructures for Drug Delivery and Biosensing

Exploration the Applications of DNA Nanostructures in Biomedical Fields

Risheng Wang[1], Liang Xu[2], Anuttara Udomprasert[3],
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[2]Department of Molecular Biosciences, The University of Kansas, Lawrence, KS 66045,[3]Department of Biochemistry, Burapha University, Chonburi, Thailand, 20131

DNA (deoxyribonucleic acid), the natural hereditary material in humans and almost all other organisms, can be fabricated into functional nanostructures through Watson-Crick base paring in biochemistry and engineering fields. Over the past four decades, researchers in the emerging field of DNA nanotechnology have synthesized a diversity of DNA nanostructures with excellent programmability, and biocompatibility. These self-assembled nanostructures have been used to precisely organize functional components into deliberately designed patterns, which exhibit a wide range of applications in material science, biomedical, electric, and environmental fields. In this talk, I will present our efforts in the design and construction of several DNA nanostructures for biomedical applications including drug delivery and the enhancement of the earlier disease diagnosis by using electrochemical biosensing system in which DNA nanostructures were employed as templates to well control the orientation of probes and incorporate with nanoparticles for signal enhancement.

Key Words: drug delivery, biosensing, DNA nanostructures, cytotoxicity, nanomaterials.

Dr. Carmen M. Cirstea, MD, PhD, FAHA, is a Research Assistant Professor in the Department of Physical Medicine and Rehabilitation, Director of the Brain Plasticity & Recovery Laboratory, and Chair of the School of Medicine Research Council at the University of Missouri-Columbia. Dr. Cirstea has more than 17 years of expertise in the neurorehabilitation of several conditions, i.e., stroke, myelopathy, and limb amputation, and more than 12 years in using state-of-the-art imaging approaches to study brain plasticity in humans. Her research was continuously funded by Canadian, US, and international agencies. She has more than 40 peer-reviewed articles on neural mechanisms of brain remodeling, motor control of the arm, and motor learning, mainly in stroke. Dr. Cirstea is a reviewer for numerous prestigious journals, including the #1 journal in the field of stroke - Stroke, where she is an Assistant Editor, and grant reviewer for US, Canadian, Swiss, and UK agencies.

Motor Cortex MR Spectroscopy in Neurological Conditions Affecting Hand Function

Carmen M. Cirstea
Department of Physical Medicine & Rehabilitation, University of Missouri

Stroke and cervical myelopathy (CM), two neurological conditions prevalent in adults over 50, frequently impact hand function. Despite the latest advancements in these conditions management, a high patient number is still unable to incorporate impaired hand(s) effectively into daily activities months after treatment. The past 20+ years of neuroscience research have resulted in the consensus that functional remapping of the primary motor cortex (M1) is the driving force of hand recovery. Similar M1 functional changes have been reported in these conditions; this is an expected finding considering that both conditions induce dysfunction/damage to the M1 tract controlling the hand. Whether cellular/molecular determinants of such functional M1 remodeling are similar in these conditions remains unknown. MR Spectroscopy (MRS) may unravel these determinants noninvasively. We investigated the M1 MRS-detected cellular/molecular profiles and their functional relevance in patients with subcortical stroke or CM suffering from hand impairment within 12 months of diagnosis. We found a distinct M1 profile for each condition: MRS-detected biomarkers related to neuronal-glial interactions and intracortical excitability were altered in stroke, while in CM, an altered neuro-inflammatory biomarker was identified. The degree of these alterations, measured before treatment (motor learning in stroke; surgery in CM), predicted treatment-related hand recovery in each condition. Such relationships between relevant biological processes and clinical endpoints suggest a potential role of MRS-detected profile as a biomarker of the underlying disease processes. Identifying sensitive and specific biomarkers might open a new phase of biomarker-driven therapeutic discovery, making precision medicine a reality in these conditions.

Keywords: stroke, cervical myelopathy, MR Spectroscopy, primary motor cortex, hand impairment

MISSOURI S&T

Dr. Fateme Fayyazbakhsh is currently an Assistant Research Faculty at the Department of Mechanical and Aerospace Engineering in Missouri University of Science and Technology. She received her PhD in Biomedical Engineering from Amirkabir University of Technology (Tehran, 2017). Dr. Fayyazbakhsh has over 12 years of experience in biomaterials design, fabrication, and characterization for bone and skin tissue engineering. She has extensive knowledge and experience in *in vitro* biological be=valuation, animal surgery, clinical wound healing, and wound care product development. Dr. Fayyazbakhsh's research has been published in several peer-reviewed journals. She is a member of Biomedical Engineering Society and Tissue Engineering and Regenerative Medicine since 2019.

Effect of Bioactive Glass on Water Release Profile and Functionality of 3D-Printed Hydrogel Dressings for Burn Wound Treatment

Fateme Fayyazbakhsh [1,2,3*], Delbert Day [4], Yue-Wern Huang [3,5], Ming C. Leu [1,2,3]

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[5]Department of Biological Sciences, Missouri University of Science and Technology, Rolla, Missouri, USA

Burn wound treatment remains a clinical challenge due to the severity of tissue damage and dehydration. Advanced hydrogel dressings have gained significant attention for burn wound treatment in clinical practice due to their soothing and moisturizing activity. However, prolonged healing, pain, and traumatic removal is still a challenge in treating second-degree burn wounds due to the lack of long-term wound hydration. In this study, 3D-printed dressings were fabricated using natural hydrogels and bioactive borate glass (BBG) using an extrusion-based bioprinter. The 3D-printed dressings were characterized for mechanical properties, degradation rate, hydration activity, and *in vitro* cell viability using primary human fibroblasts and keratinocytes. BBG increased Young's modulus by 105% and decreased the 10-day degradation rate by 62 % due to the formation of covenant bonds between BBG and hydrogel chains. BBG also prevented the burst release of water from hydrogel dressings and enabled the 10-day continuous water release, which has a key role in burn wound care. The sustained release of therapeutic ions from BBG in 3D-printed dressings improved the 7-day cell viability compared to the 3D-printed hydrogel and commercial dressings. Our animal study showed that the 3D-printed dressings with BBG exhibited non-adhesive contact and atraumatic removal, as well as early re-epithelialization, faster wound closure, and significant regeneration of hair follicles compared to the commercial dressings. The superior outcome of our dressings can be attributed to synergistic effect of bioactive formulation and the porous texture of 3D-printed dressings on continuous water release and, consequently, on second-degree burn wound healing.

Keywords: Hydrogel wound dressing; Burn wound healing, 3D printing; Bioactive borate glass; Continuous water release

2023 Missouri S&T, NextGen and OBI Symposium Program

April 28th, 2023
9:00 – 9:15 Coffee and Pastries
9:15 – 9:30 Welcome and Opening
Dr. W. David Arnold and Vice Chancellor, Dr. Kamal Khayat

Track 2 – Biomedical Informatics - St. Pat's Ballroom A

9:30 – 9:45	Dr. Steve Corns	Integrated Deep Learning and Supervised Machine Learning Model for Predictive Fetal Monitoring
9:45 – 10:00	Dr. Abu Mosa	The Power of Real-World Observational Data in Translational Sciences: Usability, Pragmatic Research and Artificial Intelligence
10:00 – 10:15	**Break**	
10:15 – 10:30	Dr. K. Krishnamurthy and Dr. Venkata Sriram Siddhardh Nadendla	Machine Learning for Studying Brain Function, Structure and Connectivity

11:00 – 12:30
Lunch and Networking

12:30 – 12:45	Dr. Xing Song	Enhancing PCORnet Clinical Research Network Data Completeness by Integrating Multistate Insurance Claims with EHRs
12:45 – 1:00	Dr. Jinling Liu	A Novel Framework for Estimating Personalized Genomic Variants of Complex Traits for Precision Medicine
1:00 – 1:15	**Break**	
1:15 – 1:30	Dr. Mina Esmaeelpour	Fiber Optic Sensors, Ultrafast and Time-Stretch Detections and Applications

2:00 – 3:45 Poster Session

3:45 – 4:00 Closing Remarks

MISSOURI S&T

Dr. Steven M. Corns an Associate Professor of Engineering Management and Systems Engineering at Missouri University of Science and Technology. He received his PhD degree in mechanical engineering from Iowa State University in 2008. Dr. Corns research interests include computational intelligence applications, the mechanics of information transfer in evolutionary algorithms, and model-based approaches for complex systems design and analysis. Applications include computational biology/bioinformatics, transportation, and defense. He was the academic lead for the virtual forward operating base camp project and is leading research efforts in localization and controls for autonomous systems

Integrated Deep Learning and Supervised Machine Learning Model for Predictive Fetal Monitoring

Comparison of Support Vector Machines and Random Forest Classifiers for Real-time Fetal monitoring system based on cardiotocography data.

Antepartum Fetal Monitoring provides information that can be used to predict the state of the fetus during labor. In this paper we compare methods for evaluating this time series data to better classify potential risks to the fetus. For this work, we use Cardiotocography (CTG), which is a common monitoring technique to record the heart rate of the fetus and uterine activity of the mother. The CTG data is separated into important features among the ones provided in the dataset data using machine learning algorithms. All the three fetal states (normal, suspect and pathological) were considered for this research. The paper discusses the importance of machine learning in providing assistance for the obstetricians in 'suspect' cases. The paper also evaluates the effectiveness of these predictions in a real-time clinical decision support system and extracting other features which can provide further valuable information regarding the fetal state. It was found that support vector machines and Random Forests both had over 96% accuracy when predicting fetal outcomes.

Dr. Abu Mosa is a visionary informatician who believes in the power of data to predict the future and transform healthcare. With expertise in biomedical informatics, his focus is on healthcare innovation, patient-centered outcomes, and the application of precision medicine. During his 9-year tenure as the Director of Research Informatics at the University of Missouri (MU) School of Medicine, Dr. Mosa dedicated his efforts to enhancing institutional research capacity, improving access to real-world observational data, and applying advanced informatics and data science approaches for data management and analysis. Currently, Dr. Mosa serves as the Sr. Director of Informatics Technology and Associate Professor of Biomedical Informatics at the MU School of Medicine, with adjunct and core faculty appointments in the Department of Electrical Engineering and Computer Science, and the Institute for Data Science and Informatics, respectively. He holds a BS and MS in Computer Science, and a PhD in Biomedical Informatics. Dr. Mosa received the NIH Data Science Rotations for Advancing Discovery (RoAD-Trip) Fellowship in 2018 and was inducted as a Fellow of the American Medical Informatics Association (FAMIA) in 2020. Dr. Mosa has served as a principal investigator (PI) and co-investigator on numerous extramural research grants funded by organizations such as PCORI, NIH, AHRQ, State of Missouri, and industry partners. He is also the site-PI for MU's participation in the Greater Plains Collaborative (GPC) PCORNet Clinical Research Network, a national healthcare data infrastructure project funded by PCORI. Outside of his professional life, Dr. Mosa enjoys gardening, traveling, and engaging in outdoor activities, as well as playing and following sports like cricket, soccer and football.

The Power of Real-World Observational Data in Translational Sciences: Usability, Pragmatic Research and Artificial Intelligence

Real-world observational datasets are gold mines for translational research but present challenges in the process of discovering pragmatic evidence. Improving the usability aspects of data can significantly improve its utility in cohort discovery, pragmatic trials, comparative effectiveness research, population health outcomes research, predictive analytics, and artificial intelligence model discovery. In this presentation, Dr. Mosa will share practical stories about real-world data that are linked to a person for use in healthcare, driving forces behind improved access, his journey through informatics and data science capacity building for precision health research, and contribution to science.

MISSOURI S&T

Dr. K. Krishnamurthy received his B.E. degree in Mechanical Engineering from Bangalore University, India, and his M.S. and Ph.D. degrees also in Mechanical Engineering from Washington State University, Pullman, Washington. He is Currently a Professor of Mechanical Engineering in the Department of Mechanical and Aerospace Engineering at Missouri University of Science and Technology (Missouri S&T) and has been a faculty at Missouri S&T for the past 36 years. Starting as an assistant professor, Dr. Krishnamurthy has risen through the ranks and held various positions of Increasing responsibilities and served in several different administrative capacities, including Associate Chair for Graduate Affairs in the Department of Mechanical and Aerospace Engineering, Associate Dean for Research and Graduate Affairs in the School of Engineering and Vice Provost for Research

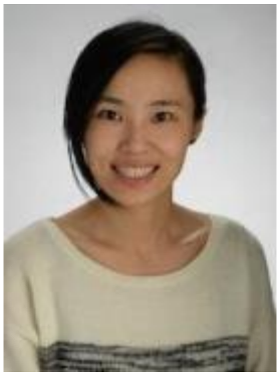
Dr. Venkata Sriram Siddhardh Nadendla is currently an Assistant Professor in the Department of Computer Science at Missouri University of Science and Technology (Missouri S&T). Prior to joining Missouri S&T in Fall 2018, Dr. Nadendla worked as a postdoctoral research associate in Coordinated Science Laboratory at University of Illinois at Urbana Champaign since Oct 2016. He received his PhD degree in Electrical and Computer Engineering from Syracuse University in 2016, his MS degree in Electrical Engineering from Louisiana State University in 2009, and his BE degree in Electronics and Computer Engineering in 2007 from SCSVMV University (India). Recently, he served as a Publications co-chair for WoWMoM 2022, and as a Session Chair in CISS 2018. His current research interests broadly span the field of cyber-physical human systems, statistical inference/learning, networks, security, trust and influence.

Machine Learning for Studying Brain Function, Structure and Connectivity

K. Krishnamurthy† and V. S. Siddhardh Nadendla‡† Department of Mechanical and Aerospace Engineering ‡Department of Computer Science Missouri University of Science and Technology Rolla, Missouri

Machine learning is now increasingly being applied to neuroimaging data to study a variety of different brain functions. We have successfully implemented deep learning techniques to study two challenging neuroimaging applications. First, we studied the problem of diagnosing disruptive behavior disorders (DBDs) in children. Diagnosing DBDs is challenging as they are often comorbid with other disorders, such as attention deficit/hyperactivity disorder. A multimodal ensemble three-dimensional convolutional neural network (3D CNN) deep learning model was used to classify children with DBDs and typically developing children using data from the Adolescent Brain Cognitive Development Study. Assessments were based on the scores from the Child Behavior Checklist and on the Schedule for Affective Disorders and Schizophrenia for School-age Children-Present and Lifetime version for DSM-5. The diffusion, structural, and resting state functional magnetic resonance imaging data were used as input data to the 3D CNN. The model achieved 72% accuracy in classifying children with DBDs with 70% sensitivity and 72% specificity. Second, we studied the feasibility of using a convolutional spiking neural network (CSNN) as a classifier to detect anticipatory slow cortical potentials relating to braking intent in human drivers using an electroencephalogram. These potentials correlate to movement intent and can be used to infer the braking intention of a driver before the actual braking action is performed. Our results showed that the CSNN significantly outperformed other standard neural networks and had an average predictive accuracy of 99.06% with an average true positive rate (TPR) of 98.50% and an average true negative rate (TNR) of 99.20%.

Key Words: Deep learning; neuroimaging; brain diseases and disorders; brain-computer interface



Dr. Xing Song's research interests are in biomedical informatics, machine learning and statistical learning algorithms, data mining and knowledge discovery. Her long-term research goal is to develop computational algorithms to discover clinically meaningful knowledge from integrated healthcare database with "data" at the center. She has led the PCORnet Greater Plains Collaborative (a PCORnet network) Reusable Observable Unified Study Environment (GROUSE) project since 2020, including establishing a new cloud-based host environment for GROUSE, with scalable infrastructure that is compliant with HIPAA and NIST-800-53. Dr. Song has been co-investigator or key personnel on multiple projects sponsored by regional and national grants such as BioNexus, CTSA, PCORI, NIH, which involving developing algorithms and analytical packages for cohort identification and knowledge discovery for a variety of acute or chronic health conditions. She is currently PI of CDC-funded project to better understand amyotrophic lateral sclerosis (ALS) using multi-marker discovery algorithms and multi-modal data sources, as well as Co-Investigator on multiple NIH-, DOD-funded projects leveraging the GPC and GROUSE infrastructure.

Enhancing PCORnet Clinical Research Network Data Completeness by Integrating Multistate Insurance Claims with EHRs

Lemuel R. Waitman, PhD and Xing Song, PhD.
University of Missouri School of Medicine Columbia, Missouri

The Greater Plains Collaborative (GPC) and PCORnet Clinical Data Research Networks capture healthcare use within their health systems but may lack information on care received elsewhere in the community. The GPC Reusable Observable Unified Study Environment (GROUSE) integrates hospital and electronic health records data in the PCORnet common data model with state-wide Medicare and Medicaid claims. This project was one of the early projects approved by the federal Centers for Medicare and Medicaid Services to use cloud computing to store EHR data linked to federal insurance claims at the individual level and to social determinant estimates based upon geocoding.

EHR, billing, and tumor registry data from all GPC partner healthcare systems were integrated with multi-year, multi-state Medicare (2011 – 2020) and Medicaid (2011 – 2012) insurance claims to create deidentified databases in PCORnet Common Data Model formats, which contains over 200 billion observations from 45M unique individuals (over 20M Medicare beneficiaries; 14M Medicaid beneficiaries; over 30M GPC patients with 5M patients cross-walked, 1.8M patients with body mass index (BMI) linked to claims. We assess how claims and clinical data complement each other to identify obesity and related diseases.

Diagnosis codes from EHR and claims sources underreport obesity by 2.56 times compared with body mass index measures. However, common comorbidities such as diabetes and sleep apnea diagnoses were more often available from claims diagnoses codes (1.6 and 1.4 times, respectively). GROUSE provides a unified EHR-claims environment to address health system and federal privacy concerns, which enables investigators to generalize analyses over more representative populations.

Keywords: EHR, claims data, linked data, obesity, data completeness.

MISSOURI S&T

Dr. Jinling Liu is an assistant professor in the Department of Engineering Management and Systems Engineering at Missouri University of Science and Technology, with a joint appointment in Biological Sciences. She received her PhD degree in biology from the Pennsylvania State University in 2014 and completed a National Library of Medicine postdoctoral fellowship and a MS degree in the Department of Biomedical Informatics at the University of Pittsburgh in 2019. In 2020, Dr. Liu was selected as a NHLBI BioData Catalyst Fellow to advance the development of the cloud-computing ecosystem of BioData Catalyst that hosts multi-omics data and tools. In 2022, Dr. Liu received a NIH career development (K01) award from NHLBI to investigate hypertension genomic causes and racial disparity through developing both individualized causal inference tools and advanced machine learning models. Dr. Liu's research focuses on genetic epidemiology, with a particular emphasis on developing and applying new and generalizable methods to understand the genomic causes of diseases such as cancer, cardiovascular diseases, and Parkinson's disease. She is committed to advancing precision medicine and improving health equity through her work.

A Novel Framework for Estimating Personalized Genomic Variants of Complex Traits for Precision Medicine

An individualized Bayesian method for estimating genomic variants of hypertension

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[1]Department of Engineering Management and Systems Engineering, Missouri University of Science and Technology, Rolla, MO, USA, [2]Department of Biomedical Informatics, University of Pittsburgh, Pittsburgh, PA, USA, [3]Department of Biostatistics, University of Pittsburgh, Pittsburgh, PA, USA,[4]Department of Medicine, University of Pittsburgh, Pittsburgh, PA, USA,[5]Department of Biological Sciences, Missouri University of Science and Technology, Rolla, MO, USA,

Genomic variants of the disease are often discovered nowadays through population-based genome-wide association studies (GWAS). However, GWAS may not capture all the important, individualized factors well. In addition, GWAS typically requires a large sample size to detect the association of low-frequency genomic variants with sufficient power. Here, we report an individualized Bayesian inference (IBI) algorithm for estimating the genomic variants that influence complex traits, such as hypertension, at the level of an individual. By modeling at the level of the individual, IBI seeks to find genomic variants observed in the individual's genome that provide a strong explanation of the phenotype observed in this individual. We applied the IBI algorithm to the data from the Framingham Heart Study to explore the genomic influences of hypertension. Among the top-ranking variants identified by IBI and GWAS, there is a significant number of shared variants (intersection); the unique variants identified only by IBI tend to have relatively lower minor allele frequency than those identified by GWAS. In addition, IBI discovered more individualized and diverse variants that explain hypertension patients better than GWAS. Furthermore, IBI found several well-known low-frequency variants as well as genes related to blood pressure that GWAS missed in the same cohort. Finally, IBI identified top-ranked variants that predicted hypertension better than GWAS, according to the area under the ROC curve. The results support IBI as a promising approach for complementing GWAS, especially in detecting low-frequency genomic variants as well as learning personalized genomic variants of clinical traits and disease, such as the complex trait of hypertension, to help advance precision medicine.

Keywords: individualized Bayesian inference, genome-wide association studies, genomic variants, single nucleotide polymorphism, hypertension, blood pressure, precision medicine

MISSOURI S&T

Dr. Mina Esmaeelpour received her Ph.D. in physics from Lehigh University in 2016. She performed most of her Ph.D. work at Bell Labs in Holmdel, NJ, where she was an intern from 2011-2015. She then became a postdoctoral research scholar at the Edward L. Ginzton Laboratory at Stanford University before joining the Molecular Imaging Instrumentation Laboratory (MIIL) at Stanford School of Medicine's molecular imaging program (MIPS). She joined Missouri S&T as an assistant professor in the Electrical and Computer Engineering department in September 2019. Her laboratory mainly focuses on fiber optic sensor design for various applications including biomedical imaging and sensing, acoustic and gas sensing, LIDAR, quantum lasers, and active and passive devices for future telecommunication systems applications.

Fiber Optic Sensors, Ultrafast and Time-Stretch Detections and Applications

Optical fibers have applications in various fields, including subsea and data center communication systems, fiber lasers and sensors, remote sensing, and biomedical applications, among others. In this talk, I will first talk about the different projects undergoing in my laboratory including acoustic sensors, few-mode fiber devices, and high- resolution motion detection sensors. I will then talk about a fiber-based ultrafast LIDAR system designed to achieve nanometer resolution.

Biomedical application: Since a slight head motion can result in inaccurate imaging and radiation dose delivery to tumors that may harm surrounding healthy tissues in the intracranial region, it increases the demand for high spatiotemporal motion detection during stereotactic radiotherapy even when the patient's head is under a thermoplastic mask. The motion detection under a thermoplastic mask and during the surgery necessitates developing a sensor that (1) is miniaturized and fits under the mask, (2) is small enough not to cause attenuation in radiation beams, (3) has a spatial resolution of a tenth of an mm, (4) is real-time, and (5) is immune to electromagnetic radiation. We report a fiber-optic-based ultrafast spectral laser detection and ranging (LIDAR) sensor that satisfies all the above requirements.

POSTER PRESENTATIONS

MISSOURI S&T

Presenter	Poster Title	Department
Dr. Katie Shannon & Rich Watters	Confocal and Vivarium	Center for Biomedical Research
Dr. Richard Brow, Dr. Anthony Convertine & Dr. Mark Towler	Releasing Glasses and Tissue Regeneration	Materials Science & Eng
Kendra Mehl & Jessica Frame (Dr. Amy Belfi)	Emotional Effects of Memory-Evoking Music in Younger and Older Adults	Psychological Science
Chase Sigler	Concepts of the MALDI Imager	Chemistry
Vidit Singh	Poly I:C Lipid Nanoparticle for Anti-Tumor Efficacy in Head and Neck Cancer	Chemical & Biochem Eng
Huari Kou	Dendrimer-Based Nanoparticles for Atherosclerosis Diagnosis and Therapy	Chemical & Biochem Eng
Lin Qi	Synthesis and Characterization of Dendrimer-Based Nanogels with ROS-Scavenging Activity	Chemical & Biochem Eng
Hsin-Yin Chuang (Grace)	uPA- or ACPP-Mediated Polyamidoamine Dendrimer-Based Targeted Drug Delivery System for Triple Negative Breast Cancer	Biological Sciences
Vimalin Mani	Ocular Diseases: Challenges and Translational Opportunities in Drug Delivery	Chemical & Biochem Eng
Lei Xu	Development of Maprotiline Nanoparticle for Glaucoma Therapy	Chemical & Biochem Eng
Hailey Swain	Mesenchymal Stem Cells in Autoimmune Disease	Biological Sciences
Bradley Bromet	A Novel Bioink for the Fabrication of Human Microphysiological Systems	Biological Sciences
Lev Suliandziga	3D-Printed Hydrogel Scaffolds Reinforced with Sr-Doped Borate Glass for Bone Regeneration	Mechanical and Aerospace Eng
Dr. Chang-Soo Kim	Biodegradable Sensors Toward Temporary Implantable Systems: Electronic Devices Based on Water-Soluble Glass Materials	Electrical & Computer Eng
Dr. Chang-Soo Kim, Dr. Paul Nam, Dr. William Van Stoecker	Smart Bandage for Tissue Oxygen Monitoring: Optical Sensor Ink Development and Printing on Flexible Substrate	Electrical & Computer Eng
Skirmantas Janusonis, Thomas Vojta, Ralf Metzler, Justin H. Haiman, Angela Rayle, Wei Wang	The Self-Organization of the Brain Serotonergic Matrix: From Stochastic Axon Paths to Regional Densities	Physics

POSTER PRESENTATIONS

Presenter	Poster Title	Department
Dr. Xing Song	Neurologist Care for Amyotrophic Lateral Sclerosis – A Utilization and Outcome Study	Health Management and Informatics
Andrew Apostol	Autonomic Cardiac Function in Subacute Spinal Cord Injury: A Quantitative Study in Real-World Settings	Physical Medicine & Rehabilitation
Arsh Ketabforoush	Aging Mice and H-Reflex: A Comparative Study of Middle-Age	Physical Medicine & Rehabilitation, NextGen Precision Health
Fereshteh Babaei Darvishi	Neuromuscular Decline or Resiliency	Physical Medicine & Rehabilitation, NextGen Precision Health
Azam Roshani Dashtmian	A Link Between Motoneuronal Dysfunction and Cognitive Impairment in Alzheimer's Disease	Physical Medicine & Rehabilitation, NextGen Precision Health

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